

Developing Deontological Competence in Medical Students Through a Master Adaptive Learner–Based Program: A Quasi-Experimental Controlled Study

M. Ganiyev*

Fergana Medical Institute of Public Health, Fergana, Uzbekistan
*Corresponding Email: bganiyev864@gmail.com

Abstract. Medical deontology—the ethical duties that govern a physician's conduct toward patients, families, colleagues, and society—is often taught through lectures that are weakly linked to clinical behavior. The Master Adaptive Learner (MAL) model frames learning as a self-regulated cycle of planning, learning, assessing, and adjusting. This quasi-experimental, nonequivalent pretest–posttest control-group study allocated intact academic groups of medical students to a MAL-structured program combining simulation, problem-based and team-based learning, OSCE, ethical debate, role-play, and reflective diaries ($n = 170$) or to the standard curriculum ($n = 170$). Deontological competence (motivational-value, cognitive, adaptive-activity, and reflective components) was classified as high, intermediate, or low, and the intervention effect was estimated with a proportional-odds model including a group $\times$ time interaction. The groups were equivalent at baseline ($\chi^2(2) = 0.32$, $p = 0.854$). The proportion of high-level students rose from 12.9% to 44.1% in the experimental group and from 11.2% to 12.4% in the control group (difference-in-differences 30.0 percentage points, 95% CI 18.7–41.3). The group $\times$ time interaction was significant (OR = 4.29, 95% CI 2.34–7.86, $p < 0.001$), and the posttest difference was of medium-to-large magnitude (Cliff's $\delta = 0.38$; Cramér's $V = 0.37$). A MAL-structured program was associated with a substantial improvement in overall deontological competence; because the program was multicomponent, the effect is attributable to the program as a whole rather than to MAL or any single method.

Keywords: Deontological Competence, Master Adaptive Learner, Medical Ethics Education, Professionalism, Self-Regulated Learning.

1 Introduction

Rapid change in healthcare systems, continuous advances in medical technology, and rising public expectations of care quality require new approaches to the professional preparation of future physicians. Medical education is now expected not only to build knowledge and clinical skills but also to cultivate professional values, effective communication with patients, a sense of professional responsibility, and the capacity to make sound decisions in ethically complex situations [1], [2]. International standards

for basic medical education explicitly require that programs teach and assess professionalism and medical ethics [3], and national reforms—including Uzbekistan's Concept for the Development of the Higher Education System until 2030—call for competency-oriented, practice-linked training [4].

Medical deontology, understood as the system of ethical norms, principles, and rules that regulates a physician's professional conduct, is therefore a core element of medical training. A physician's attitude toward patients, their relatives, colleagues, and society directly shapes the quality and safety of care [5], [6]. Evidence nonetheless shows that formal ethics teaching is often fragmented, lecture-based, and weakly connected to clinical practice [7], [8], that the hidden curriculum can undermine explicit ethics instruction [9], and that student empathy tends to decline during clinical training [10], [11]. These findings suggest that knowledge of ethical rules is not sufficient: students must also be motivated to act on them, practice applying them, and reflect on their own conduct.

The Master Adaptive Learner (MAL) model offers a framework for this kind of learning. Developed by Cutrer and colleagues, it describes the expert physician as a self-regulated learner who moves through a recurring cycle of **planning** (identifying a gap and setting a goal), **learning** (engaging with resources), **assessing** (trying out the new knowledge or skill and obtaining feedback), and **adjusting** (incorporating what was learned into practice) [12], [13]. The model draws on theories of self-regulated learning [14], [15], adaptive expertise [16], and reflective practice [17]. Although MAL is increasingly used as a curricular lens, few controlled studies have tested whether organizing ethics and professionalism teaching around the MAL cycle improves students' deontological competence.

This study addresses that gap. Its aim was to evaluate whether a MAL-structured, multicomponent instructional program improves the deontological competence of medical students compared with the standard curriculum. The study was guided by two research questions: (RQ1) Were the experimental and control groups comparable in deontological competence before the intervention? (RQ2) Did the distribution of deontological competence levels change more in the experimental group than in the control group from pretest to posttest? We hypothesized that the odds of being classified at a higher competence level would increase more in the experimental group than in the control group (a positive group $\times$ time interaction).

2 Literature Review

2.1 Deontology, Medical Ethics, and Professional Competence

Medical ethics and bioethics have been developed systematically in the principlist tradition of Beauchamp and Childress, which grounds clinical ethics in respect for autonomy, nonmaleficence, beneficence, and justice [5], and in professional codes such as the World Medical Association's International Code of Medical Ethics [6]. In post-Soviet scholarship, deontology has traditionally been treated as the applied, duty-centered part of medical ethics that governs everyday professional conduct. Within

the competency-based paradigm, professional competence is defined as the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice [1]. Competency-based medical education (CBME) translates such definitions into observable outcomes and developmental milestones [2], [18], and entrustable professional activities link these competencies to concrete clinical tasks that require ethical judgment [19], [20]. More recent work frames professionalism as part of professional identity formation, in which values are internalized rather than merely displayed [21].

On this basis, the present study treats deontological competence as an integrated quality with four components: a **motivational-value** component (commitment to patient-centered values and professional duty), a **cognitive** component (knowledge of ethical principles, codes, and legal norms), an **adaptive-activity** component (the ability to apply that knowledge in real or simulated clinical encounters), and a **reflective** component (the ability to analyze one's own conduct and plan improvement). Empathy, a key element of the motivational and communicative side of deontology, has been studied extensively and can be measured with validated instruments [22], [23].

2.2 The Master Adaptive Learner Model and Self-Regulated Learning

Cutrer et al. proposed the MAL model as a conceptual guide for developing physicians who continuously improve through a planning–learning–assessing–adjusting cycle supported by curiosity, motivation, a growth mindset, and resilience [12], [13]. The model operationalizes Zimmerman's theory of self-regulated learning, in which effective learners set goals, monitor their performance, and evaluate their outcomes [14]; its application to medical education is reviewed in AMEE Guide No. 58 [15]. The adjusting phase also reflects Schön's account of reflective practice, in which professional growth depends on examining one's own experience [17], and research on reflection in the health professions shows that reflective capacity can be developed through structured activities and feedback [24], [25]. Finally, the MAL emphasis on adaptive expertise—the ability to deal with novel problems rather than to repeat routines—aligns with the unpredictable, value-laden nature of ethical situations [16].

2.3 Active Learning Methods for Ethics and Professionalism

Several active learning methods have documented value in health professions education. High-fidelity and technology-enhanced simulation, especially when combined with feedback and debriefing, improves knowledge, skills, and behaviors [26], [27]. Problem-based learning (PBL) uses authentic cases to activate prior knowledge and promote self-directed learning [28], and team-based learning (TBL) combines individual preparation, readiness assurance tests, and team application exercises [29]. The objective structured clinical examination (OSCE) provides standardized performance-based assessment, including assessment of communication and ethical conduct [30]. Reflective writing, evaluated with structured rubrics such as REFLECT, can develop and document reflective capacity [31]. The Romanell Report recommends that ethics

teaching use such case-based and experiential methods and be integrated longitudinally with professionalism education [8].

2.4 Research Gap

Most studies evaluate these methods individually and rarely link them to an explicit learning-cycle framework. The MAL model has been widely described conceptually but less often tested empirically with a control group, and very few such studies concern ethics or deontology, particularly in Central Asian medical schools. This study therefore uses the MAL cycle as an organizing framework for sequencing established active learning methods and evaluates the resulting program against the standard curriculum.

3 Methods

3.1 Study Design

A quasi-experimental, nonequivalent pretest–posttest control-group design was used [32]. Because the curriculum is delivered to fixed academic groups, individual randomization was not feasible; instead, intact groups were allocated to the experimental or control condition. The study was reported following the TREND statement for nonrandomized evaluations [33], and the intervention is described according to the TIDieR and GREET guidelines [34], [35]. The study was conducted in three stages: a diagnostic stage (pretest), a formative stage (intervention), and a final stage (posttest).

3.2 Setting, Participants, and Allocation

The study was conducted at the Fergana Medical Institute of Public Health. The study population comprised students enrolled. participation was voluntary and did not affect course grades.

A total of 340 students in intact academic groups took part. Groups were assigned to conditions byyielding an experimental group (n = 170 of groups) and a control group (n = 170, of groups). To reduce selection bias and contamination, (a) groups rather than individuals were allocated, (b) both conditions followed the same course syllabus, timetable, and final examination, (c) experimental and control groups were taught by different instructors, and (d) baseline equivalence on the outcome and on demographic and educational characteristics was tested formally (Table 3).

3.3 Construct and Operational Definitions

Deontological competence was operationalized through four components, each linked to specific indicators, measurement instruments, and scoring rules (Table 1). The instruments correspond to the empirical methods used in the study: a questionnaire, a knowledge test, analysis of clinical-ethical cases, simulation assessment, an OSCE, a

reflective diary, and student self-assessment. Pedagogical observation was used to monitor implementation fidelity and was not included in the outcome score.

Table 1. Operational definition and measurement of the components of deontological competence

Component	Operational definition (indicators)	Instrument (items)	Scoring rule
Motivational-value	Commitment to patient welfare, professional duty, confidentiality, and respect for patient autonomy; empathic orientation	Deontological values questionnaire, 5-point Likert (n items); self-assessment scale (n items)	Mean item score converted to 0–100; Cronbach's α
Cognitive	Knowledge of ethical principles, the medical code of ethics, patients' rights, and relevant legal norms; ability to identify the ethical issue in a case	Knowledge test (n multiple-choice items); written analysis of n clinical-ethical cases	Percentage correct (test) and analytic rubric (0–n points per case); KR-20; inter-rater ICC
Adaptive-activity	Applying ethical norms in communication with patients, relatives, and colleagues; breaking bad news; obtaining informed consent; managing conflict	Simulation assessment (n scenarios) and OSCE (n ethics/communication stations, min each) [30]	Station checklist plus global rating scale, converted to 0–100; inter-rater ICC
Reflective	Analyzing one's own conduct, recognizing errors, and formulating improvement goals	Reflective diary (n entries) scored with the REFLECT rubric [31]; self-assessment	REFLECT level (1–4) converted to 0–100; inter-rater agreement κ

Composite score and level classification. Each component score was rescaled to 0–100, and a composite deontological competence index was calculated. Students were classified as **high**, **intermediate**, or **low**. The cut-offs were set and the same instruments, cut-offs, and assessors were used at pretest and posttest.

Measurement quality. Content validity of the questionnaire, test, cases, and OSCE stations was established by *n* experts in medical ethics and medical education. Validity evidence was interpreted within Kane's argument-based framework [36], [37]. OSCE stations used and were scored by *n* assessors per station who completed a calibration session using exemplar performances. Assessors of the OSCE, simulation, cases, and diaries were blinded to group allocation.

3.4 Intervention: MAL-Structured Program

The experimental program lasted in sessions of academic hours; and was delivered within the regular course by trained faculty members, who completed a preparatory workshop on the MAL model and the teaching methods. Clinical-ethical topics included. Each topic was taught as one complete MAL cycle (Fig. 1, Table 2), so that every learning activity was tied to a specific phase rather than being used in isolation.

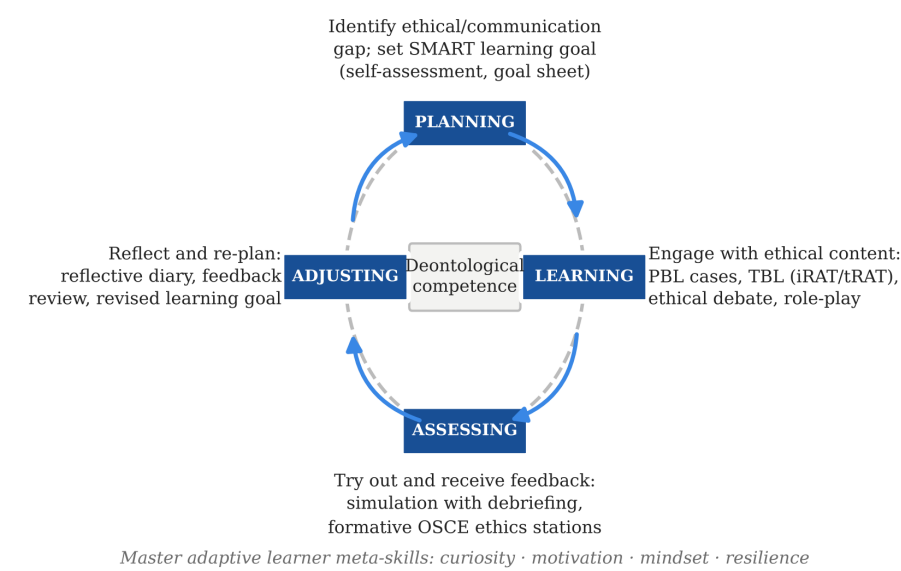


Fig. 1. The Master Adaptive Learner cycle used to sequence learning activities in the experimental program (adapted from Cutrer et al. [12])

Table 2. Intervention protocol: MAL phases, learning activities, and dose per topic (TIDieR-based)

MAL phase	Learning and assessment activities	Faculty role	Time per topic
Planning	Students complete a short self-assessment on the topic, identify a personal gap, and write a SMART learning goal on a goal sheet	Reviews goals and gives brief written feedback	n min
Learning	PBL case analysis in small groups; TBL session (individual and team readiness assurance tests, application exercise); structured ethical debate; role-play of physician–patient, physician–family, and physician–colleague interactions [28], [29]	Tutor/facilitator; moderates debate	n h
Assessing	Simulation scenario with standardized patient followed by structured debriefing; formative OSCE ethics station with checklist feedback [26], [30]	Assessor and debriefer	n h
Adjusting	Reflective diary entry (what happened, what I did, what I would change); review of feedback; revision of the learning goal for the next cycle [25], [31]	Reads diaries and gives written feedback	n min

Control condition. The control group studied the same topics, for the same number of hours, under the standard curriculum, which consisted without goal-setting, simula-

tion, structured reflection, or the MAL sequence. Implementation fidelity in the experimental group was monitored by pedagogical observation using a planned activities were delivered as intended.

3.5 Statistical Analysis

The outcome was the ordinal competence level (low = 1, intermediate = 2, high = 3) measured at pretest and posttest. Categorical data are summarized as counts and percentages. Baseline equivalence (RQ1) was tested with Pearson's chi-square test for the 2×3 table and with the Mann–Whitney U test, which respects the ordering of the categories; demographic characteristics were compared with chi-square tests or t-tests as appropriate. For RQ2, posttest distributions were compared in the same way, and within-group changes were described.

Because a comparison of percentages alone cannot separate the intervention effect from general change over time, the primary analysis was a proportional-odds (cumulative logit) model [38], [39] with group, time, and a group $\times$ time interaction as predictors. The exponentiated interaction coefficient is an ordinal difference-in-differences estimate: the ratio by which the odds of a higher competence level changed in the experimental group relative to the control group. The interaction was tested with a likelihood-ratio test. The proportional-odds assumption was checked by fitting separate binary logistic models with the same interaction at each cut-point (high vs. intermediate/low; intermediate or high vs. low). Difference-in-differences in the percentage of high-level and low-level students was also computed with 95% confidence intervals.

Effect sizes were Cramér's V for chi-square tests (for $df = 2$: 0.07 small, 0.21 medium, 0.35 large [40]), Cliff's delta (δ) for ordinal comparisons, with bootstrap 95% CIs (5,000 resamples) [41] ($|\delta| \geq 0.147$ small, ≥ 0.33 medium, ≥ 0.474 large [42]), and Cohen's h for differences in proportions. The analysis used the level counts reported for each group and time point; pretest and posttest observations were therefore treated as independent. Because the pretest and posttest scores of the same student are positively correlated, ignoring this pairing generally inflates the standard error of the group $\times$ time interaction, which makes the test conservative; a model for repeated measures, such as generalized estimating equations [43], would require individually linked records. With 170 students per group, the study had 80% power (two-sided $\alpha = 0.05$) to detect a difference in proportions corresponding to Cohen's $h = 0.30$. Analyses were performed in Python 3 with SciPy 1.18 and statsmodels 0.15, with significance set at $p < 0.05$.

3.6 Ethical Considerations

The study protocol was approved by Fergana Medical Institute of Public Health. All participants gave written informed consent after being told that participation was voluntary, that they could withdraw at any time without academic consequences, and that their data would be analyzed anonymously. Control-group students were offered access to the MAL-based materials after the study ended.

4 RESULTS

4.1 Participants and Baseline Equivalence

All 340 students were included in the analysis. Table 3 shows that the groups were comparable at baseline. The distribution of deontological competence levels did not differ between the experimental group (high 22, intermediate 103, low 45) and the control group (high 19, intermediate 103, low 48): $\chi^2(2) = 0.32$, $p = 0.854$, Cramér's $V = 0.03$; Mann–Whitney $U = 14,859.5$, $z = 0.52$, $p = 0.604$; Cliff's $\delta = 0.03$ (95% CI -0.08 to 0.14). In the ordinal model, the baseline group difference was likewise negligible (OR = 1.12, 95% CI 0.73–1.70).

Table 3. Baseline characteristics and pretest deontological competence of the study groups

Characteristic	Experimental (n = 170)	Control (n = 170)	Test, p
Age, years, mean (SD)	[...]	[...]	[t = , p =]
Female, n (%)	[...]	[...]	[χ^2 = , p =]
Year of study, n (%)	[...]	[...]	[χ^2 = , p =]
Prior clinical exposure, n (%)	[...]	[...]	[χ^2 = , p =]
Previous course grade/GPA, mean (SD)	[...]	[...]	[t = , p =]
Competence level: high, n (%)	22 (12.9)	19 (11.2)	$\chi^2(2) = 0.32$, $p = 0.854$
Competence level: intermediate, n (%)	103 (60.6)	103 (60.6)	
Competence level: low, n (%)	45 (26.5)	48 (28.2)	
Mean level score (1–3), mean (SD)	1.86 (0.61)	1.83 (0.61)	$U = 14,859.5$, $p = 0.604$

4.2 Changes in Deontological Competence

Table 4 and Fig. 2 show the distribution of competence levels before and after the intervention. In the experimental group, the number of high-level students rose from 22 (12.9%) to 75 (44.1%), an increase of 31.2 percentage points, while the number of low-level students fell from 45 (26.5%) to 15 (8.8%), a decrease of 17.6 percentage points. In the control group, the corresponding changes were small: high level from 19 (11.2%) to 21 (12.4%) and low level from 48 (28.2%) to 42 (24.7%).

Table 4. Distribution of deontological competence levels before and after the intervention, n (%)

Level	Experimental, pretest	Experimental, posttest	Control, pretest	Control, posttest
High	22 (12.9)	75 (44.1)	19 (11.2)	21 (12.4)
Intermediate	103 (60.6)	80 (47.1)	103 (60.6)	107 (62.9)

Level	Experimental, pretest	Experimental, posttest	Control, pretest	Control, posttest
Low	45 (26.5)	15 (8.8)	48 (28.2)	42 (24.7)
Total	170 (100)	170 (100)	170 (100)	170 (100)
Mean level score (SD)	1.86 (0.61)	2.35 (0.64)	1.83 (0.61)	1.88 (0.60)

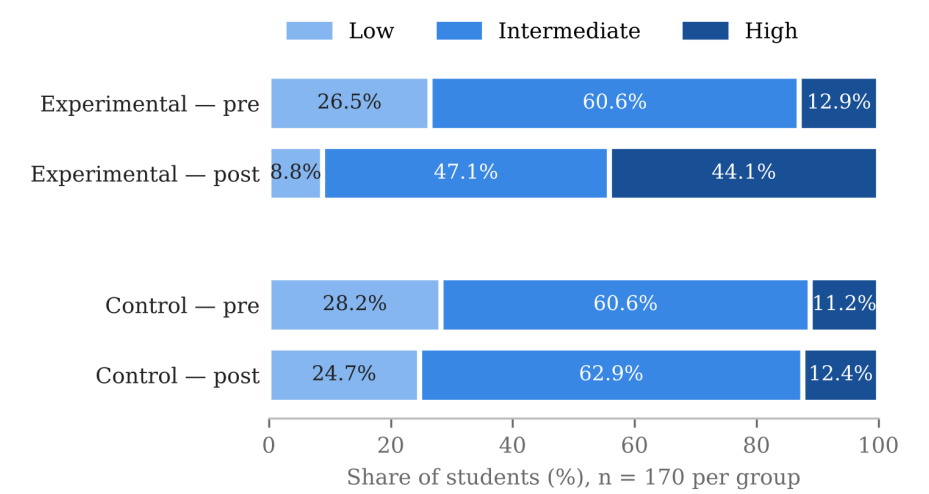


Fig. 2. Distribution of deontological competence levels by group and time point (n = 170 per group)

Table 5 summarizes the bivariate tests. At posttest, the experimental group had a significantly more favorable distribution than the control group ($\chi^2(2) = 47.06$, $p < 0.001$, Cramér's $V = 0.37$; Mann–Whitney $U = 19,917.5$, $z = 6.72$, $p < 0.001$), with a medium-to-large ordinal effect size (Cliff's $\delta = 0.38$, 95% CI 0.28–0.47). The proportion of high-level students differed by 31.8 percentage points (Cohen's $h = 0.73$). Within the experimental group, the pretest–posttest shift was of similar magnitude ($\delta = 0.38$), whereas the control group showed no meaningful change ($\chi^2(2) = 0.58$, $p = 0.750$; $\delta = 0.04$, 95% CI -0.06 to 0.15).

Table 5. Bivariate comparisons of competence-level distributions

Comparison	$\chi^2(2)$, p	Cramér's V	Mann–Whitney z, p	Cliff's δ [95% CI]
Experimental vs. control, pretest	0.32, 0.854	0.03	0.52, 0.604	0.03 [−0.08, 0.14]
Experimental vs. control, posttest	47.06, < 0.001	0.37	6.72, < 0.001	0.38 [0.28, 0.47]
Experimental, posttest vs. pretest†	46.85, < 0.001	0.37	6.76, < 0.001	0.38 [0.28, 0.48]

Comparison	$\chi^2(2), p$	Cramér's V	Mann-Whitney z, p	Cliff's δ [95% CI]
Control, posttest vs. pretest†	0.58, 0.750	0.04	0.74, 0.462	0.04 [-0.06, 0.15]

† Within-group comparisons treat the pretest and posttest as independent samples and are descriptive; the group $\times$ time interaction in Table 6 is the primary test of the intervention effect.

4.3 Intervention Effect: Ordinal Difference-in-Differences

Table 6 presents the proportional-odds model. The time effect in the control group was small and not significant (OR = 1.17, 95% CI 0.77–1.78, $p = 0.473$), indicating little change attributable to maturation or the standard curriculum. The group $\times$ time interaction was large and significant (OR = 4.29, 95% CI 2.34–7.86, $p < 0.001$; likelihood-ratio $\chi^2(1) = 22.58$, $p < 0.001$): relative to the control group, the odds of an experimental-group student being classified at a higher competence level increased about fourfold from pretest to posttest.

Table 6. Proportional-odds (cumulative logit) model of competence level (680 observations)

Predictor	B	SE	OR [95% CI]	p
Group (experimental vs. control)	0.111	0.215	1.12 [0.73, 1.70]	0.606
Time (posttest vs. pretest)	0.154	0.214	1.17 [0.77, 1.78]	0.473
Group $\times$ time (difference-in-differences)	1.455	0.310	4.29 [2.34, 7.86]	< 0.001

Likelihood-ratio test for the interaction: $\chi^2(1) = 22.58$, $p < 0.001$. Thresholds are not shown.

The sensitivity analyses supported the primary result (Fig. 3). The interaction ORs from separate binary models were 4.74 (95% CI 2.02–11.13, $p < 0.001$) for reaching the high level and 3.10 (95% CI 1.40–6.86, $p = 0.005$) for reaching at least the intermediate level. These estimates are similar in direction and magnitude, and their confidence intervals overlap that of the pooled estimate, so the proportional-odds assumption is reasonable. Expressed as a difference-in-differences in percentages, the intervention was associated with a 30.0 percentage-point greater increase in high-level students (95% CI 18.7–41.3; $p < 0.001$) and a 14.1 percentage-point greater decrease in low-level students (95% CI –26.4 to –1.9; $p = 0.024$) than the control condition.

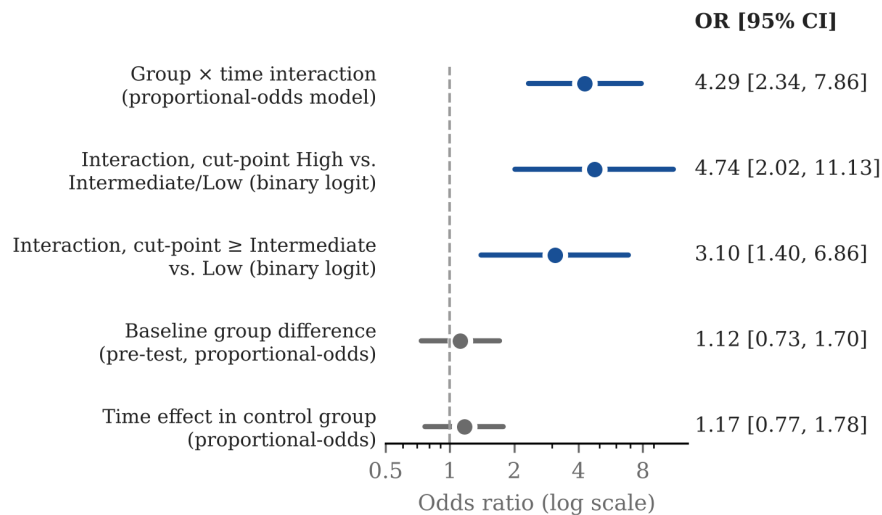


Fig. 3. Odds ratios (log scale) for the intervention effect and sensitivity analyses; the dashed line marks no effect

5 DISCUSSION

5.1 Principal Findings

This controlled study found that a MAL-structured, multicomponent program was associated with a substantial improvement in the overall deontological competence of medical students. The groups were equivalent at baseline, the control group changed little, and the group × time interaction showed an approximately fourfold relative increase in the odds of a higher competence level in the experimental group. The post-test effect size was medium to large, and the share of high-level students rose by 30 percentage points more than in the control group. These results are consistent with evidence that active, feedback-rich, and reflective methods are more effective than passive instruction for developing professional behaviors [24], [26], [27] and with recommendations that ethics teaching be experiential and longitudinal [8].

5.2 Interpretation and Proposed Mechanisms

The study measured the composite competence level; component-specific outcomes such as empathy, communication, professional responsibility, clinical reasoning, and ethical decision-making were not analyzed separately. The explanations offered in this section are therefore proposed mechanisms, informed by theory and prior research, and not effects demonstrated by the present data.

First, the planning and adjusting phases of the MAL cycle required students to set goals, monitor their performance, and revise their plans. This is the core of self-

regulated learning [14], [15], and it may explain why gains extended to the reflective and motivational aspects of competence. Second, simulation and formative OSCE stations gave students repeated practice in ethically demanding encounters, with immediate feedback and debriefing, which are the features most strongly associated with effective simulation-based learning [26], [27]; this plausibly strengthened the adaptive-activity component. Third, PBL, TBL, and ethical debate required students to analyze dilemmas, justify positions, and negotiate disagreement in groups [28], [29], which may have supported the cognitive component and ethical reasoning. Fourth, role-play and reflective diaries, scored with explicit criteria, may have encouraged students to examine their own conduct, as Schön's model of reflective practice predicts [17], [25], [31]. Finally, organizing all activities around a personal learning goal may have helped counteract the erosion of empathy and the influence of the hidden curriculum reported in clinical training [9]–[11] by making ethical growth an explicit and personal objective consistent with professional identity formation [21].

5.3 Attribution: MAL Framework Versus Its Components

The intervention combined the MAL framework with several established methods, and the design does not allow their effects to be separated. The observed effect should therefore be attributed to the MAL-structured program as a whole, not to the MAL model alone or to any single method. In this study, MAL served as the organizing principle that determined when and why each method was used—as one phase of a goal-directed cycle—rather than as a separate intervention. Whether this sequencing adds value beyond offering the same methods without the cycle remains an open question. Future studies could address it with dismantling or factorial designs, for example by comparing the same activities with and without the planning and adjusting phases, or by adding the components step by step.

5.4 Evidence Matrix

Table 7 links each component of deontological competence to its instrument, scoring criterion, intervention activity, result, statistical test, and type of evidence. It shows which conclusions rest on data from this study and which rest on prior literature.

Table 7. Evidence matrix linking competence components, measurement, intervention, and results

Component	Instrument	Scoring criterion	Intervention activity (MAL phase)	Pre→post result	Test / effect size	Evidence status
Motivational-value	Values questionnaire; self-assessment	0–100 scale	Goal-setting (planning); role-play (learning)	[component scores, E and C]	[test, effect]	mechanism from literature [22]
Cognitive	Knowledge test; case analysis	% correct; rubric	PBL, TBL, ethical debate (learning)	[component scores]	[test, effect]	mechanism from literature [28], [29]

Component	Instrument	Scoring criterion	Intervention activity (MAL phase)	Pre→post result	Test / effect size	Evidence status
Adaptive-activity	Simulation; OSCE	Checklist + global rating	Simulation with debriefing; formative OSCE (assessing)	[component scores]	[test, effect]	mechanism from literature [26], [27]
Reflective	Reflective diary; self-assessment	REFLECT levels 1–4	Reflective diary; goal revision (adjusting)	[component scores]	[test, effect]	mechanism from literature [24], [31]
Composite deontological competence	Composite index of all instruments	High / intermediate / low cut-offs	Complete MAL cycle per topic	High: E 12.9%→44.1%, C 11.2%→12.4%; low: E 26.5%→8.8%, C 28.2%→24.7%	Group × time OR = 4.29 [2.34, 7.86]; posttest δ = 0.38; V = 0.37	Demonstrated in this study

5.5 Limitations

Several limitations should be considered. First, allocation was by intact groups rather than by individual randomization, so unmeasured differences between groups cannot be excluded, even though the groups were equivalent on the baseline outcome. Clustering of students within academic groups was not modeled, which may make the confidence intervals somewhat narrower than they should be. Second, the analysis used group-level counts per category; pretest and posttest observations were treated as independent, and a repeated-measures model (such as GEE or a mixed-effects ordinal model) using individually linked data would give more precise estimates. Third, the three-level classification reduces the information in the underlying continuous scores, and component-level outcomes were not reported separately. Fourth, which could introduce assessment bias in the performance-based measures. Fifth, the study was conducted at a single institution with a posttest administered immediately after the intervention, so generalizability and the durability of the effect remain to be established. Finally, as discussed above, the contribution of the MAL framework cannot be separated from that of the individual teaching methods.

5.6 Implications

For medical schools, the findings suggest that ethics and deontology teaching can be strengthened by organizing existing active learning methods into explicit learning cycles in which students set personal goals, practice with feedback, and reflect. This approach fits CBME and WFME expectations for teaching and assessing professionalism [2], [3] and can be introduced within existing course hours. Future research should use cluster-randomized or stepped-wedge designs, report component-level and continuous outcomes with individually linked data, follow students into clinical clerkships, and use dismantling designs to identify the active ingredients of the program.

6 Conclusions

In this quasi-experimental controlled study, a Master Adaptive Learner–structured program that combined simulation, PBL, TBL, OSCE, ethical debate, role-play, and reflective diaries was associated with a substantial improvement in the overall deontological competence of medical students. The groups were equivalent at baseline, and the relative odds of reaching a higher competence level increased about fourfold in the experimental group compared with the control group. Deontological competence can therefore be developed deliberately when ethics teaching is organized as a cycle of goal-setting, practice, feedback, and reflection. Because the program was multi-component and the components were not measured separately, the effect should be attributed to the program as a whole; confirming the specific contribution of the MAL framework and the durability of the gains requires randomized, multisite, and longitudinal studies.

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Declarations

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Disclosure of Interests. The author has no competing interests to declare that are relevant to the content of this article.

Ethics Approval and Consent to Participate. The study was approved by Fergana Medical Institute of Public Health and was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent; participation was voluntary, and withdrawal had no academic consequences.

Data and Code Availability. The aggregated data supporting the findings are reported in Tables 3–6. Anonymized individual-level data and the Python analysis script are available from the corresponding author on reasonable request.

Author Contributions. M. Ganiyev: conceptualization, methodology, investigation, formal analysis, data curation, writing—original draft, writing—review and editing.

Use of Generative AI. During the revision of this manuscript, the author used an AI-based assistant to improve language and readability and to help re-run the statistical analysis of the reported aggregate data. The author reviewed and verified all content and takes full responsibility for the published article.

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