ASSESSING THE INTERDEPENDENCE OF REPRODUCTIVE AND CREATIVE COMPONENTS OF STUDENTS' INDEPENDENT WORK: AN EPISTEMIC-INTEGRATIVE DIAGNOSTIC MODEL AND EXPERIMENTAL EVIDENCE FROM PEDAGOGY COURSES IN UZBEKISTAN

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DOI: ***https://doi.org/10.5281/zenodo.24128283***

Abstract: *Independent work occupies a growing share of credit-module curricula in Uzbek higher education, yet it is still assessed mostly by final grades that cannot show how reproduced knowledge becomes a justified creative product. This article proposes an epistemic-integrative diagnostic model that evaluates four components of independent work: reproductive-cognitive (R), creative-transformative (C), epistemic-verificational (E) and metacognitive-reflective (M). Each component is measured by four indicators on a 0–3 analytic scale; their interdependence is expressed by a harmonic coherence coefficient, a weighted epistemic integration index and a reproductive–creative imbalance indicator. The model was embedded in a five-stage instructional procedure and tested in the course "General Pedagogy" at three higher education institutions (experimental group n = 267, control group n = 268). The groups were equivalent at the start (mean 3.36 and 3.35). After the intervention the experimental group scored 3.79 and the control group 3.36 (Welch t = 6.65, p < 0.001; Mann–Whitney p < 0.001; Cohen's d = 0.58); grades 4–5 were obtained by 68.5% and 36.6% of students respectively. Because the experiment used course grades, the component-level indicators remain to be validated in future work.*

Keywords: *independent work, reproductive and creative components, epistemic verification, analytic rubric, harmonic coherence coefficient, diagnostic matrix, pedagogical experiment.*

INTRODUCTION

The reform of higher education in Uzbekistan, framed by the concept of developing the higher education system until 2030, has expanded the share of students' independent work in credit-module curricula. Uzbek studies of independent learning stress its role in developing students' cognitive competence, its methodological place across subjects and the organizational lessons of foreign experience. However, a larger volume of independent work does not guarantee its quality: in practice it often reduces to copying or retelling ready-made information, while assessment concentrates on the final product rather than on the process of arriving at justified knowledge.

Two opposite simplifications make the problem harder. The first treats reproductive activity as a "low-level" activity to be replaced by creative tasks. Yet retrieval from memory strengthens long-term retention , and creativity theory names domain-relevant knowledge as a core component of creative performance. The second equates creativity with unusual output, whereas the standard

definition requires a product to be both novel and appropriate. Creative output that is unsupported by evidence or based on unreliable sources is not an acceptable result of university study, especially in the era of generative information environments.

This article therefore asks how the interdependence of reproductive and creative components of independent work can be diagnosed and developed. We (1) propose a four-component diagnostic model with an explicit epistemic component, (2) introduce indices that express the connection, rather than the sum, of the components, (3) embed the model in a five-stage instructional procedure and (4) report an experiment with future teachers in pedagogy courses.

THEORETICAL BACKGROUND

Reproductive and creative activity as a continuum. We follow the view that reproductive knowledge is not the opposite of creativity but its content-related, operational and comparative basis: it supplies concepts and algorithms, methods and strategies, and the standard against which novelty can be judged. Between recall and creation lies transformative-productive activity, in which students restructure knowledge by explaining, comparing, finding analogies, analyzing flawed solutions and varying conditions. This view is consistent with research on generative learning and with Uzbek work on developing creative thinking and creative competence of students [6–8].

Epistemic justification. Assessment of creativity must include the question "how well is this knowledge justified?" Epistemic education research proposes that learners should perform apt epistemic actions: evaluating sources, linking evidence to claims and weighing alternatives [10]. In our model these actions form a separate verificational component; they also include distinguishing the student's own contribution from the contribution of sources and of digital or generative tools.

Self-regulation, scaffolding and feedback. Independent work does not mean working without help. Models of self-regulated learning treat planning, monitoring and reflection as integral parts of successful study; scaffolding is gradually withdrawn as competence grows; and feedback is most useful when it answers where the learner is going, how they are doing and what comes next. Metacognition, the monitoring and regulation of one's own thinking, therefore constitutes the fourth component of the model. Finally, rubrics support reliable and valid assessment when descriptors are explicit and raters are calibrated, and formative assessment improves learning. Uzbek manuals on assessment emphasize rubrics, portfolios, case studies and project-based assessment as practical tools.

METHOD

The model distinguishes four components, each measured by four indicators (Table 1). Reproduction is not equated with memorization: the R component covers accurate, systematic and functional reconstruction of subject knowledge. Creativity is not reduced to originality: the C component includes transfer and pedagogical appropriateness. The E component is the distinctive element of the model.

Table 1. Components, indicators and diagnostic evidence

Component	Indicators	Diagnostic evidence
Reproductive-cognitive (R)	R1 accurate reproduction of concepts and categories; R2 completeness and systematicity of knowledge; R3 correct application of rules and algorithms in typical situations; R4 faithful paraphrasing of source content	test, terminological map, structured outline, theory question, algorithmic task
Creative-transformative (C)	C1 variety of ideas; C2 original combination; C3 transfer of knowledge to a new situation; C4 elaboration, usefulness and pedagogical appropriateness of the solution	case, project, problem situation, micro-method, essay, conceptual model
Epistemic-verificational (E)	E1 awareness of the epistemic aim; E2 justification of the evidence–conclusion link; E3 verification and comparison of sources; E4 distinguishing own, source and digital/AI contribution	source expertise, argument map, annotation, evidence matrix, epistemic protocol
Metacognitive-reflective (M)	M1 planning; M2 monitoring and correction; M3 self-assessment; M4 explaining errors and choosing a next strategy	reflective diary, self-assessment sheet, drafts, portfolio, post-task reflection

Scoring, indices and interpretation

Every indicator is scored from 0 to 3 (Table 2). With four indicators per component, the maximum raw score is 12, and each component is normalized to a 100-point scale: $R = (\Sigma R_i / 12) \times 100$, and analogously for C, E and M.

Table 2. The 0–3 analytic scale for each indicator

Score	General descriptor
0	The indicator is not observed, or the result is incorrect in content
1	The indicator appears partly; the student depends considerably on instructions, a model or external help
2	The indicator appears independently and stably, with some shortcomings or a narrow context
3	The indicator appears independently, consciously, with justification, transferably and reflectively

A simple arithmetic mean of R and C can hide imbalance: a student with R = 95 and C = 25 has a mean of 60, although the components are clearly not connected. We therefore propose a harmonic coherence coefficient, which falls sharply when one component is low:

$$H = 2 \cdot R \cdot C / (R + C)$$

For the example above H = 39.6. Because a connected performance also requires verified and self-regulated work, the epistemic integration index combines H with E and M:

$$I = 0.50 \cdot H + 0.30 \cdot E + 0.20 \cdot M$$

The weights express the central place of the reproductive–creative connection (0.50), the epistemic quality (0.30) and the supporting role of self-regulation (0.20). They are treated as an initial expert model, not as final values; a simpler alternative with equal weights, $I_{eq} = (R + C + E + M)/4$, should be compared with it in a pilot study by correlation with external expert judgments. The imbalance indicator $D = |R - C|$ complements H: for R = 82 and C = 80, D = 2, whereas for R = 95 and C = 45, D = 50. D is not a quality indicator by itself (R = C = 20 gives D = 0), so it is interpreted only together with H and I. The preliminary interpretation of I is given in Table 3.

Table 3. Provisional interpretation of the epistemic integration index (I)

Index (I)	Level	Meaning
0–39	Reproductive-fragmentary	Integration of components is not formed; knowledge is mostly copied or memorized
40–59	Reproductive-adaptive	Basic integration exists; creative and epistemic transfer is unstable
60–79	Productive-creative	Components are stably linked; creative transfer and justification are present
80–100	Epistemic-integrative	Reproduction, transformation, verification and reflection are systematically united

The cut-off values are provisional and should be refined after a pilot study using expert ratings, score distributions and criterion validity.

Instructional procedure

The model was implemented through five interconnected stages (Table 4). The stages are not a one-way line: depending on diagnostic results, a student may return to an earlier stage or move faster. Tasks form a chain in which the output of one task becomes the resource of the next. For example, a student restores the main claims of a pedagogical concept, compares it with another concept, applies it to a real situation, designs an own methodological solution and finally verifies it against sources and criteria. A reproductive task asks for recall and explanation rather than copying: instead of "copy the definition from the article", students write the essential features of the concept with the source closed, compare with the original, mark the errors and explain them.

Table 4. Five-stage procedure of organizing independent work

Stage	Leading activity	Epistemic support	Expected product
1. Diagnostic-epistemic orientation	identifying prior knowledge, setting aims	epistemic aim and criteria	work plan, knowledge map

Stage	Leading activity	Epistemic support	Expected product
2. Stabilizing the reproductive foundation	recall, models, algorithms, key concepts	source and accuracy control	structured support model
3. Transformative bridge	comparison, self-explanation, analogy, error analysis, varied tasks	"why?", "which evidence?", "under which condition?"	restructured knowledge product
4. Creative construction	problem, project, hypothesis, alternative solutions	novelty + appropriateness + justification	project, model, method, concept
5. Epistemic verification and reflection	self- and peer assessment, evidence check, correction	aim–criterion–evidence–process audit	improved final product and reflective report

Each creative product is accompanied by an "epistemic passport" in which the student states the problem, the basic knowledge used, the sources and their verification, the transformation made, the alternatives, the evidence for the chosen solution, the personal contribution, the role of any digital or generative tool and a final reflection. Assessment follows a cycle of diagnostics, differentiated tasks, self-assessment, expert assessment, feedback, correction and resubmission, so that it becomes part of instruction rather than only terminal control. The teacher's role changes from supplying answers to designing epistemic conditions and giving quality feedback, while support is reduced adaptively.

Table 5. Structure of the epistemic passport attached to each creative product

Section	Question the student answers
Problem	Which question did I address?
Basic knowledge	Which theory, concept or model did I rely on?
Sources and verification	Which sources did I use, which of them are reliable, and why?
Transformation	What exactly did I change in the ready-made knowledge?
Alternative and evidence	Which other solution existed, and why did I choose this one?
Personal contribution	Which part of the product is my own independent decision?
AI / digital contribution	If a digital or generative tool was used, in which operation?
Reflection	What would I change if I did the work again?

To observe development rather than a single before-and-after difference, the diagnostic matrix in Table 6 is proposed. It records R, C, E and M at entry, during formative monitoring, at the end and after a delay of four to eight weeks, which helps to distinguish a stable change from a short-term test effect. Experts should evaluate the indicators for correspondence to the construct, clarity, non-duplication, observability and relevance to epistemic support; creative products should be rated by at least two independent experts after calibration on three to five sample works.

Table 6. Diagnostic matrix for the experiment

Stage	R	C	E	M	Integral output
Entry diagnostics	+	+	+	+	H, I, D (baseline profile)
Formative monitoring	+	+	+	+	dynamic profile
Final diagnostics	+	+	+	+	H, I, D (final profile)
Delayed control (4–8 weeks)	+	+	+	+	stability index

Research design and participants

The experiment was carried out in the course "General Pedagogy" at Kokand State University, Andijan State Pedagogical Institute and Namangan State Pedagogical Institute. In total 535 future teachers took part: 267 in the experimental group, which studied independent work organized by the described methodology, and 268 in the control group, which followed the traditional organization. Outcomes were recorded on the 5-point scale (5 = excellent, 4 = good, 3 = satisfactory, 2 = unsatisfactory). We report the distributions given in the experimental protocols and, in addition to the Student–Fisher analysis performed earlier, recomputed descriptive statistics, Welch's t-test, the Mann–Whitney test (appropriate for ordinal grades), a χ^2 test of the grade distributions and Cohen's d from these distributions.

RESULTS

At the start of the experiment the groups were practically identical (Table 7): mean grades were 3.36 and 3.35, and neither Welch's t-test ($p = 0.98$), the Mann–Whitney test ($p = 0.96$) nor the χ^2 test ($p = 0.96$) detected a difference. After the intervention the experimental group's mean rose by 0.43 points to 3.79, whereas the control group's mean remained 3.36 (a change of 0.01). The share of grades 4 and 5 increased from 35.6% to 68.5% in the experimental group and stayed at about 36–37% in the control group; the share of unsatisfactory grades fell from 9.0% to 2.6% in the experimental group, but remained near 10% in the control group.

Table 7. Distribution of grades before and after the experiment (pooled)

Group, stage	5	4	3	2	N	Mean	SD	Grades 4–5, %
Experimental, before	24	71	148	24	267	3.36	0.77	35.6
Experimental, after	34	149	77	7	267	3.79	0.69	68.5

Group, stage	5	4	3	2	N	Mean	SD	Grades 4–5, %
Control, before	26	70	145	27	268	3.35	0.79	35.8
Control, after	25	73	144	26	268	3.36	0.78	36.6

The post-test difference is statistically significant and moderate in size (Table 8). The 95% confidence interval for the post-test mean is 3.70–3.87 in the experimental group and 3.27–3.46 in the control group; the intervals do not overlap. By the Mann–Whitney statistic, a randomly chosen experimental student outperformed a randomly chosen control student with a probability of about 0.66.

Table 8. Comparison of experimental and control groups

Statistic	Before	After	
Mean difference (EG − CG)	0.00	0.43	
Welch's t (p)	0.02 (0.98)	6.65 (< 0.001)	
Mann–Whitney (p)	p = 0.96	p < 0.001	
χ^2 (df = 3), p	0.29, p = 0.96	58.64, p < 0.001	
Cohen's d	0.00	0.58	

The effect appears at each institution (Table 9). Means in the experimental groups rose to 3.77–3.81 at Kokand and Andijan and to 3.78 at Namangan, whereas control means stayed within 0.03 of their starting values. All three post-test differences are significant (Mann–Whitney $p < 0.001$ at Kokand and Andijan, $p = 0.007$ at Namangan, where the samples are smaller).

Table 9. Mean grades by institution (EG = experimental, CG = control)

Institution	EG before	CG before	EG after	CG after	Post-test difference (p)
Kokand State University (100 / 98)	3.32	3.30	3.77	3.31	0.46 (p < 0.001)
Andijan State Pedagogical Institute (100 / 102)	3.36	3.36	3.81	3.37	0.44 (p < 0.001)
Namangan State Pedagogical Institute (67 / 68)	3.40	3.43	3.78	3.43	0.35 (p = 0.007)

DISCUSSION

The results support the hypothesis that organizing independent work as a chain of transformative tasks with epistemic verification, adaptive support reduction and criterion-based feedback improves students' learning outcomes in pedagogy. The intervention effect ($d \approx 0.6$) is consistent across

institutions, and the equivalence of groups at pre-test strengthens the causal interpretation, although the study was not randomized at the student level.

Several limitations should be stated. First, the outcome measure was the course grade, which reflects overall knowledge and cannot show whether the components R, C, E and M developed in the expected pattern; the component-level indicators, the harmonic coherence coefficient and the integration index have not yet been validated empirically. Second, the weights and cut-off values are provisional. Third, no delayed post-test was included, so the stability of the effect over several weeks is unknown. Fourth, reporting teacher assignment, rater calibration (at least two independent experts and inter-rater agreement), reliability coefficients and factor analysis would strengthen the instrument. The recommended next steps are an expert content-validation of the indicators, a pilot with exploratory factor analysis, comparison of the weighted and equal-weight indices with external criteria (course performance, project and defense scores, portfolio) and a repeated-measures design with entry, intermediate, final and delayed measurements.

The model also has practical implications. Rubrics should be given to students in advance, but the format of creative products should not be over-standardized; the minimum epistemic requirements (verifying several sources, showing alternative solutions, justifying the decision) can be obligatory without fixing the product itself. Where students use generative tools, the epistemic passport makes their contribution transparent and keeps the verification stage assessable.

CONCLUSION

The study proposes treating reproductive and creative components of independent work as a single didactic continuum linked by epistemic verification, and assessing not only their separate levels but the strength of their connection. The four-component model (R, C, E, M), the 0–3 indicator scale, the harmonic coherence coefficient, the epistemic integration index and the imbalance indicator offer a transparent way to detect cases in which high reproduction or high creativity alone hides weak justification. The five-stage procedure and the epistemic passport translate this idea into classroom practice.

In the experiment with 535 future teachers at three institutions, the experimental group improved its mean grade from 3.36 to 3.79 while the control group did not change (3.35 to 3.36); the share of grades 4–5 reached 68.5% against 36.6%, and the difference was significant ($p < 0.001$, $d = 0.58$). The next stage of research should validate the component-level instrument, refine weights and cut-offs and test the durability of the effect.

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