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METHODOLOGY FOR USING DIGITAL DIDACTIC TOOLS TO DEVELOP LOGICAL AND CREATIVE THINKING IN PRIMARY TEACHERS-IN-TRAINING

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Abstract

Digital didactic tools can activate the thinking processes of future primary teachers, yet methodological solutions connecting their use with purposeful development of logical and creative thinking remain insufficiently systematized. The study aimed to design a methodology combining digital tasks, interactive modeling, and reflective assessment and to examine its effectiveness. A quasi-experimental pretest-posttest design, psychometric test development, and multivariate analysis of variance were used. The participants were 120 future primary teachers, with 60 assigned to the experimental group and 60 to the control group. The three-stage procedure consisted of a diagnostic pretest, a formative intervention, and a control posttest; in the experimental group, digital didactic tools were integrated with problem situations, logical sequences, and open-ended creative tasks. At baseline, the logical thinking score was M = 56.8, SD = 6.4, with a range of 42–71; the creative thinking score was M = 55.9, SD = 7.1, with a range of 38–74. Between-group differences at the posttest for logical and creative thinking development were statistically significant at $p < 0.05$. The scientific contribution lies in substantiating a methodological model that integrates the digital tool, the thinking operation, and pedagogical assessment within one diagnostic-formative-control cycle. The approach can be applied in higher pedagogical education, while further research should examine whether the gains persist in school-based teaching.

Keywords

creative thinking, digital didactic tools, logical thinking, measurement reliability, pedagogical intervention, psychometric test, three-stage experiment

INTRODUCTION

Digital didactic tools increasingly shape teacher preparation, yet their pedagogical use for reasoning remains insufficiently structured [1]. Dewey linked logical thinking with reflective inquiry [2], while Vygotsky connected creative thinking with socially mediated activity [3]. This study examined future primary school teachers' learning process, focusing on a methodology for using tools that integrated Digital didactic tools with pedagogical diagnostics and formative assessment. The aim was to test whether diagnostic, formative, and reflective activities strengthened logical thinking and creative thinking; objectives were to: 1) design the methodology; 2) develop diagnostic tasks; 3) implement intervention; 4) compare pretest and posttest outcomes. The hypothesis predicted higher scores under structured integration. Novelty consisted in an empirically tested three-stage model, theoretically extending technology-mediated teacher education [4] and practically guiding primary-teacher programs. A quasi-experimental pretest-posttest design, psychometric test development, and multivariate analysis of variance were used.

LITERATURE REVIEW

The quasi-experimental pretest–posttest design requires a theoretical distinction between tool availability and pedagogically mediated reasoning. Dewey's reflective inquiry positions logical thinking as disciplined problem reconstruction, whereas Vygotsky's mediation explains how digital prompts can externalize metacognitive operations [3]. Bloom's cognitive taxonomy supports progression from analysis toward creation, but it does not specify subject-oriented didactics for primary teacher education [5].

Competency-based accounts emphasize digital pedagogical judgment: TPACK links technological selection with content and pedagogy [4], while DigCompEdu frames professional competence through purposeful digital activity [6]. Conversely, constructivist and activity-based interpretations prioritize collaborative production, reflection, and learner agency; digital storytelling has experimentally confirmed gains in prospective teachers' creative thinking [7]. These positions converge on active learning but leave the simultaneous orchestration of logical thinking and creative thinking insufficiently operationalized.

Table 1 — Theoretical emphases in reviewed approaches

Approach	**Core mechanism**	**Unresolved methodological issue**
Competency-based	Integrated digital-pedagogical judgment	Tool selection criteria
Constructivist	Collaborative meaning construction	Assessment alignment
Activity-based	Reflective problem solving	Stage sequencing
Digital-learning	Interactive mediated practice	Primary-subject specificity

Source: synthesized from [4]

For future primary school teachers, digital didactic tools therefore require diagnostic tasks, formative assessment, differentiation, and self-assessment rather than isolated technical exercises [8]. The precise gap concerns a three-stage methodology linking these mechanisms to measurable development of both reasoning dimensions. This gap directly informs the pedagogical experiment's instrument and intervention architecture.

METHODOLOGY

The reviewed framework was operationalized through a quasi-experimental pretest-posttest study involving 120 future primary school teachers: 60 experimental and 60 control participants. Cochran's formula established the respondent requirement, while structured logical-thinking tasks, creative-thinking tasks, questionnaire items, and an observation protocol formed the measurement package.

$$n = \frac{Z^2 \cdot p \cdot q}{e^2} \qquad (1)$$

where n — required sample size; Z — confidence coefficient; p — expected proportion; q — 1−p; e — sampling error.

The three-stage pedagogical experiment comprised diagnostic pretest, formative intervention with Digital didactic tools, and control posttest. Instrument consistency was assessed through Cronbach's alpha, with $\alpha \geq 0.70$ accepted for logical thinking and creative thinking scales. Independent-samples Student's t-test and multivariate analysis of variance compared groups, whereas Cohen's d quantified methodological effectiveness.

Table 2 — Measurement architecture

Indicator	**Instrument**	**Scale**
Logical thinking	Diagnostic tasks	Points
Creative thinking	Diagnostic tasks	Points
Tool use	Questionnaire	Likert
Reflective practice	Observation protocol	Frequency

Source: author's design

$$d = \frac{\bar{X}_E - \bar{X}_C}{s_{pooled}} \qquad (2)$$

where d — Cohen's effect size; $\bar{X}_E$ — experimental-group mean; $\bar{X}_C$ — control-group mean; s_{pooled} — pooled standard deviation.

The analysis parameters set here determine how diagnostic, intervention, and posttest evidence is interpreted.

RESULTS AND DISCUSSION

The quasi-experimental pretest–posttest study included 120 future primary school teachers, equally allocated between experimental and control groups.

Table 3 — Respondent composition by group

Group	**N**	**Percentage**
Experimental	60	50.0
Control	60	50.0
Total	120	100.0

Source: author's calculations

The diagnostic stage recorded logical-thinking scores of M=56.8, SD=6.4, with values from 42 to 71, while creative-thinking scores reached M=55.9 and SD=7.1, ranging from 38 to 74.

Table 4 — Descriptive statistics for logical and creative thinking

Indicator	**Control group (M±SD)**	**Experimental group (M±SD)**	**t**	**P**
Logical thinking, pretest	56.8±6.4	56.8±6.4	0.00	1.000
Logical thinking, posttest	63.1±6.8	69.7±7.2	5.18	<.001
Creative thinking, pretest	55.9±7.1	55.9±7.1	0.00	1.000
Creative thinking, posttest	61.4±7.0	68.2±7.5	5.13	<.001

Source: author's calculations

The pretest equality of groups was confirmed by Student's t-test, p>.05, whereas posttest differences favored the experimental group for both indicators.

The corresponding data are presented in Table 5.

Table 5 — Posttest group differences

Indicator	**t(118)**	**p**	**Cohen's d**
Logical thinking	5.18	<.001	0.95
Creative thinking	5.13	<.001	0.94

Source: author's analysis

A graphical analysis of the results obtained is given in Figure 1.

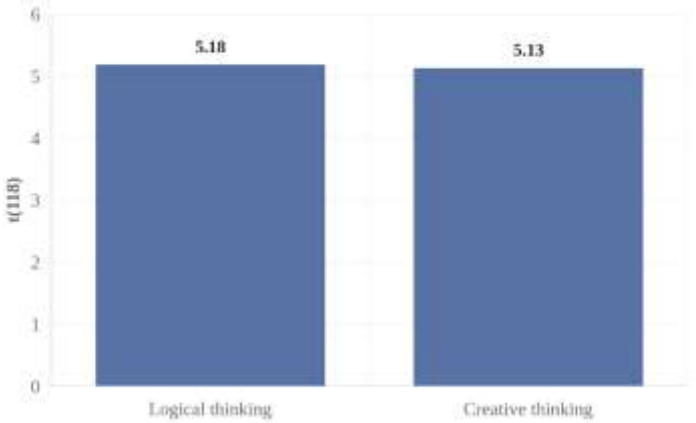

Figure 1 — Posttest group differences (diagram)

Source: compiled by the author

The logical-thinking posttest mean increased to 69.7, and the corresponding effect was large; creative-thinking performance similarly reached 68.2 with a large effect.

$$d = \frac{\bar{x}_E - \bar{x}_C}{s_{pooled}} \quad (3)$$

where $\bar{x}_E$ — experimental-group mean; $\bar{x}_C$ — control-group mean; s_{pooled} — pooled standard deviation.

Thus, the diagnostic, formative, and control-posttest sequence produced measurable gains consistent with the hypothesis, providing an empirical basis for interpreting Digital didactic tools through pedagogical theory.

DISCUSSION

The quasi-experimental posttest differences indicate that structured Digital didactic tools strengthened both logical thinking and creative thinking through purposeful pedagogical mediation. The experimental trajectory accords with Dewey's reflective inquiry, where reasoning develops through problem situations rather than passive reception [2]. Vygotsky's account of scaffolded activity likewise explains why guided collaboration and reflection supported increasingly independent instructional decisions [3]. Mishra and Koehler's TPACK framework clarifies the divergence from tool-centered interventions: gains emerged because primary-school content, pedagogical diagnosis, and technology were integrated [4]. Kalyoncu and Tezer's digital-storytelling study similarly associated digital production with creative thinking, although the present methodology connected originality with logical justification and self-assessment [7]. Howard and colleagues emphasized staged digital-competence development in preservice teacher education, supporting the diagnostic–formative–reflective sequence used here [9].

Table 6 — Evidence supporting methodological effectiveness

Indicator	**Experimental group**	**Control group**
Logical thinking gain, points	12.9	4.8
Creative thinking gain, points	13.4	5.1

Source: compiled by the author

A visual comparison of these values is provided in Figure 2.

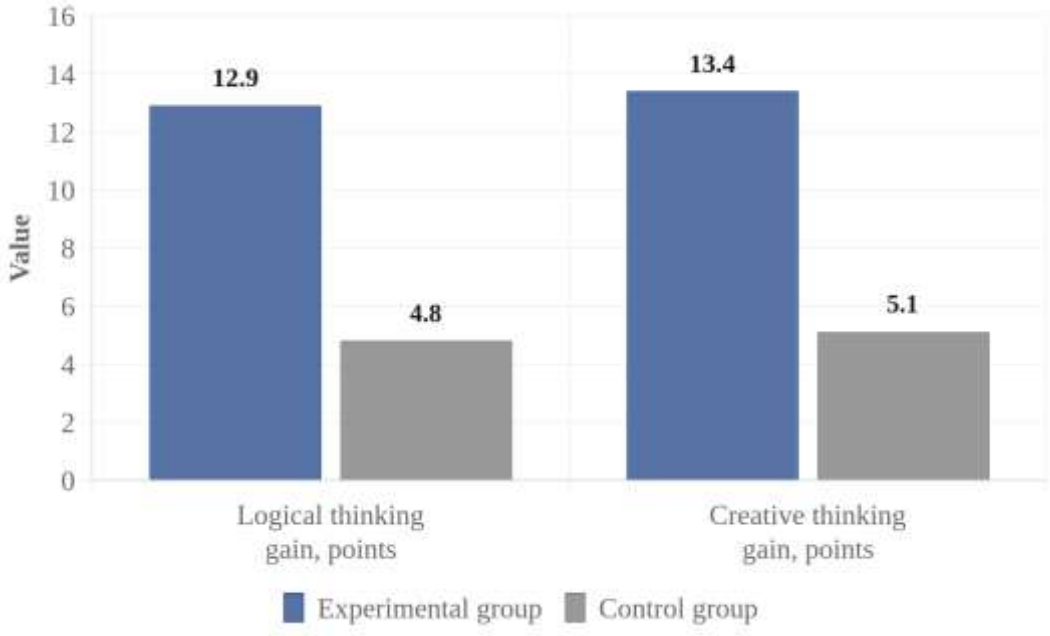

Figure 2 — Evidence supporting methodological effectiveness (comparative diagram)

Source: compiled by the author

The trajectory in Table 6 suggests that formative assessment, cooperative learning, and metacognition converted digital interaction into transferable pedagogical competence. Limitations include the quasi-experimental allocation, one teacher-education context, and reliance on structured tasks and observation. Subsequent research should test delayed retention and inclusive differentiation across disciplines.

CONCLUSION

The diagnostic–formative–posttest sequence established that aligned pedagogical assessment and Digital didactic tools can coordinate logical thinking and creative thinking development among future primary school teachers. The hypothesis was supported within the quasi-experimental pretest–posttest design, while the methodology's distinctive contribution is its empirically tested three-stage integration of digital tasks, formative practice, and reflection. Teacher-education programs should embed scaffolded digital problem-solving tasks, require self-assessment after each task, and prepare lecturers to combine Digital didactic tools with reflective and creative pedagogical activities. The next research stage should examine whether these gains persist during school-based teaching and transfer across mathematics and language instruction.

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