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Development and Quasi-Experimental Evaluation of a Visual Textbook for Learning Theories in Teacher Education

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Abstract

This study developed and evaluated a visually structured textbook for the Learning Theories course in teacher education, addressing the limited empirical evidence on visually oriented core textbooks for concept-heavy theory courses. A Research and Development approach using the ADDIE framework guided the analysis, design, development, expert validation, implementation, and evaluation stages. Participants were 56 first-semester Information Technology Education students at Universitas Pendidikan Mandalika, assigned by intact class to an experimental group using the visual textbook (n = 28) and a control group using a conventional printed textbook (n = 28). Data were collected through expert-validation questionnaires, a student-response questionnaire, and a pretest–posttest Course Achievement Test. Content, media, and practitioner evaluations ranged from 85% to 90%, placing the textbook in the highly valid category. Students also reported favorable perceptions of readability, visual presentation, relevance, and support for independent study. After controlling for pretest achievement, ANCOVA showed a significant group effect on posttest scores, $F(1,53) = 1380.908$, $p < .001$, partial $\eta^2 = .963$. The experimental group also achieved a higher normalized gain ($M = 0.640$, $SD = 0.031$) than the control group ($M = 0.303$, $SD = 0.050$), with Welch's $t(45.077) = 30.283$, $p < .001$. These findings indicate that, within the present quasi-experimental context, use of the visually structured textbook was associated with substantially greater learning achievement and positive perceived instructional support. Further multi-institutional and longitudinal studies are needed to assess generalizability, retention, and underlying learning mechanisms.

Keywords: Visual Textbook; Learning Theories; Teacher Education; ADDIE; Quasi-Experimental Study; Learning Achievement

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INTRODUCTION

Textbooks remain an important instructional resource in higher education because they provide structured access to disciplinary knowledge and can support learning independently of continuous internet access. However, conventional text-heavy textbooks may be less effective when students are required to understand abstract, relational, and conceptually dense material. This issue is particularly relevant in settings where students cannot consistently rely on digital resources because of cost, availability, or infrastructural constraints. Limited access to up-to-date printed materials can restrict opportunities for sustained engagement with course content (Fredriksen & Brar, 2015), while unreliable internet infrastructure may constrain the

adoption of fully digital learning environments (Uhawenimana et al., 2023). Even where digital technologies are available, differences in digital literacy and familiarity with electronic learning resources can affect their effective use (Uhawenimana et al., 2024). These conditions suggest that improving the instructional design of a core textbook may remain relevant even as higher education increasingly adopts digital and multimedia resources.

The challenge is not simply whether instructional material is printed or digital, but how information is represented and organized for learning. Conventional text-dominant materials may provide insufficient representational support when learners must differentiate abstract concepts, identify theoretical relationships, and apply them to unfamiliar situations. Research in higher education has shown that visual and multimedia representations can support comprehension when they are meaningfully integrated with verbal explanations. Visual aids have supported learning in disciplines involving complex conceptual content (Nabirye et al., 2023), while multimedia resources incorporating diagrams, demonstrations, and narrated explanations have been associated with improved understanding compared with predominantly verbal presentation (Bjurström et al., 2024). More recent evidence likewise indicates that digital and multimedia textbooks can improve academic performance, learning interest, and learning skills in university settings (Lee et al., 2023), while mobile electronic textbooks have produced measurable learning gains in language education (Xodabande & Hashemi, 2022).

Evidence from teacher education further supports the instructional potential of multimodal learning resources. Smagulova et al. (2024) reported improvements in preservice teachers' readiness to design and use multimedia-based textbooks, while Zhekibayeva et al. (2024) demonstrated the use of electronic textbooks to support preservice teachers' readiness for integrated learning. Alciso et al. (2022), drawing on a comparatively large sample of preservice teachers and faculty members, documented extensive use of digital instructional materials while also identifying the need for materials that are more systematically aligned with intended learning outcomes. These studies indicate growing interest in multimedia and electronic materials within teacher education, although their purposes, formats, and implementation contexts differ substantially.

The theoretical rationale for visually structured learning materials can be explained through cognitive-load, dual-coding, and multimedia-learning perspectives. Cognitive load theory emphasizes the limited capacity of working memory and the importance of reducing unnecessary processing demands during learning (Kalyuga, 2011). When learners must repeatedly move among disconnected textbooks, presentation slides, and online readings, they may need to integrate fragmented information themselves, potentially increasing unnecessary processing demands (Christiansen et al., 2024). Multimedia-learning principles similarly emphasize coherence, signaling, and purposeful coordination between verbal and visual representations, while dual-coding accounts propose that information represented through coordinated verbal and pictorial forms can provide complementary pathways for encoding and retrieval. Jibililu (2024) highlights the relevance of these principles for the practical design of multimedia instructional materials, and empirical research has shown that text–picture combinations can improve recall relative to text-only presentation.

For concept-heavy courses, these principles imply that visual design should extend beyond the decorative addition of images. Diagrams, concept maps, signaling devices, structured layouts, and contextual illustrations should clarify conceptual relationships and direct attention to important information. Kalyuga (2011) further emphasizes that instructional guidance should be calibrated to learners' existing knowledge, supporting the use of scaffolding and carefully sequenced information. Similarly, multimedia materials developed according to cognitive-design principles have been associated with improved engagement and examination performance (Zhu et al., 2024). Eye-tracking research also demonstrates that the positioning and organization of multimedia information can influence how learners allocate visual attention, providing additional evidence that the structure of instructional representations matters for cognitive processing (Dagienė et al., 2021).

These considerations are especially relevant to the Learning Theories course in teacher education. Students are expected not merely to memorize definitions but to distinguish among behaviorism, cognitivism, constructivism, and humanism; recognize their underlying assumptions; connect theoretical principles with major scholars; and apply those principles to instructional situations. Such tasks require students to organize multiple abstract relationships simultaneously. A textbook that combines concise explanations with concept maps, diagrams, contextual examples, and structured visual signaling may therefore offer a more coherent representation of this conceptual system than extended prose alone. Importantly, this rationale concerns the availability of multiple coordinated representations rather than assumptions about fixed student "learning styles."

Visual organization may also reduce the fragmentation that arises when instructional support is distributed across separate resources. Christiansen et al. (2024) demonstrated the potential value of integrating existing instructional media into a coherent learning resource, while Marcus-Quinn et al. (2024) emphasize the importance of accessibility in the design of electronic learning materials. Flexible and well-organized resources can also support learning in blended environments, where autonomy, collaboration, and digital competence are increasingly important (Liu et al., 2022). Thus, an integrated visual textbook can potentially retain the accessibility and continuity of a core textbook while incorporating representational strategies more commonly associated with multimedia learning.

The instructional value of such a resource may be strengthened further when visual presentation is combined with opportunities for active engagement. Active-learning strategies that require learners to reflect, discuss, solve problems, or apply concepts can improve critical thinking and academic outcomes (Styers et al., 2018). Embedded prompts, guided choices, and reflective activities may also provide learners with greater agency in interacting with instructional content (Wallington, 2025). Accordingly, a visually structured textbook can be designed not only to present information differently but also to incorporate concept application, reflection, and competency-oriented tasks within the same resource.

Nevertheless, existing evidence does not yet provide a direct answer to how such an approach performs in a university-level Learning Theories course. Previous studies in teacher education have predominantly examined electronic textbooks, digital resources, multimedia-design readiness, or collections of digital instructional materials (Alciso et al., 2022; Smagulova et al., 2024; Zhekibayeva et al., 2024). Studies in other higher-education contexts similarly demonstrate benefits of digital or

multimedia textbooks but often focus on specific disciplinary applications or technology-mediated formats rather than a visually structured core textbook (Lee et al., 2023; Xodabande & Hashemi, 2022). Research using multimedia approaches in medicine, science, and other disciplinary settings provides useful design evidence (Bjurström et al., 2024; Ren et al., 2022), but these contexts differ from teacher-education courses centered on abstract educational theories.

Moreover, the existing literature identifies practical limitations that complicate a simple transition from conventional textbooks to fully digital resources. Digital adoption may be restricted by infrastructure, institutional capacity, and insufficient preparation for integrating technology into instruction (Alciso et al., 2022; Jibililu, 2024). Electronic resources can also introduce usability, distraction, or health-related concerns depending on the format and learning context (Xodabande & Hashemi, 2022; Zhekibayeva et al., 2024). Technology-intensive approaches such as virtual-reality-based instructional design may provide valuable learning experiences but can require substantial development time, professional preparation, and institutional resources (Lee & Hwang, 2022). These constraints strengthen the rationale for examining whether established multimedia-design principles can be incorporated into a comparatively accessible core textbook rather than assuming that more technologically complex formats are always necessary.

Taken together, the literature indicates substantial evidence for multimedia, electronic, and visually supported instructional materials, but direct empirical evidence remains limited regarding a visually structured core textbook developed specifically for Learning Theories in teacher education. Existing studies demonstrate the potential of multimedia resources but do not establish whether a textbook integrating concept maps, structured visual scaffolding, contextual applications, and embedded practice activities can function effectively as the primary instructional resource for this conceptually dense course. In addition, many instructional-material development studies emphasize development and validation, whereas fewer combine systematic product development with a controlled comparison of student learning outcomes. This constitutes the specific gap addressed in the present study.

Objective, Novelty, Research Questions, and Scope of the Current Study

The objective of this study was to develop and evaluate a visually structured textbook for the Learning Theories course in teacher education. The textbook was designed using cognitive-load, dual-coding, multimedia-learning, active-learning, and inclusive-design considerations and incorporated structured textual explanations, concept maps, diagrams, contextual examples, application-oriented content, and competency-test components.

The novelty of the study lies in three complementary dimensions. First, in terms of domain specificity, the study focuses on Learning Theories, a conceptually dense teacher-education course for which direct empirical evidence concerning visually structured core textbooks remains limited. Second, in terms of design–theory alignment, the textbook systematically integrates coordinated verbal and visual representations, signaling, conceptual organization, contextual examples, and application-oriented activities rather than using visuals as supplementary decoration. Third, in terms of evaluation, the study combines the complete ADDIE development cycle and expert-guided product refinement with a quasi-experimental pretest–posttest non-equivalent control-group evaluation of student achievement.

The study addressed the following research questions:

1. RQ1. To what extent does the developed visual textbook meet expert criteria for content quality, media design, and practical instructional suitability, and how do students perceive its readability, visual presentation, relevance, and support for independent study?
2. RQ2. After accounting for pretest achievement, do students who use the visual textbook demonstrate higher posttest achievement than students who use a conventional printed textbook?
3. RQ3. Do students who use the visual textbook demonstrate greater normalized learning gains than students who use a conventional printed textbook?

For the effectiveness component, the following directional hypothesis was tested:

1. H1. Students who use the visual textbook will demonstrate significantly higher learning outcomes than students who use the conventional printed textbook after baseline achievement is taken into account.

The scope of the study encompassed the complete ADDIE process—Analysis, Design, Development, Implementation, and Evaluation—including needs analysis, textbook design, expert validation, product revision, classroom implementation, student-response evaluation, and quasi-experimental assessment of learning outcomes. Expert judgments were used to evaluate product quality, student responses were treated as perception-based evidence, and achievement data were used to evaluate learning outcomes.

METHOD

Research Design

This study employed a Research and Development (R&D) approach using the ADDIE framework, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE framework provided a systematic and iterative structure for identifying instructional needs, designing and developing the visual textbook, implementing the product, and evaluating its feasibility and instructional effectiveness. The use of a formal analysis phase before product development is consistent with instructional-material studies that use learner needs, curriculum requirements, and stakeholder input to guide the development of multimodal learning resources (Handayani et al., 2023; Permatasari et al., 2023; Hryvko & Sytnyk, 2022).

Figure 1 summarizes the development process used in this study. During the Analysis stage, the curriculum, course requirements, existing instructional materials, and learner needs were examined. The Design stage translated these findings into learning objectives, chapter structures, content sequencing, visual representations, and evaluation instruments. During the Development stage, the initial textbook prototype was produced and subjected to expert validation. The Implementation stage involved classroom use of the validated textbook, while the Evaluation stage incorporated expert feedback, student responses, achievement outcomes, and product revision.

To evaluate learning outcomes, the development study incorporated a quasi-experimental pretest–posttest non-equivalent control-group design. Two intact classes were assigned as the experimental and control groups because individual

random assignment was not feasible within the existing academic-class structure. The experimental group used the developed visual textbook, whereas the control group used the conventional printed textbook. Both groups completed the same pretest and posttest.

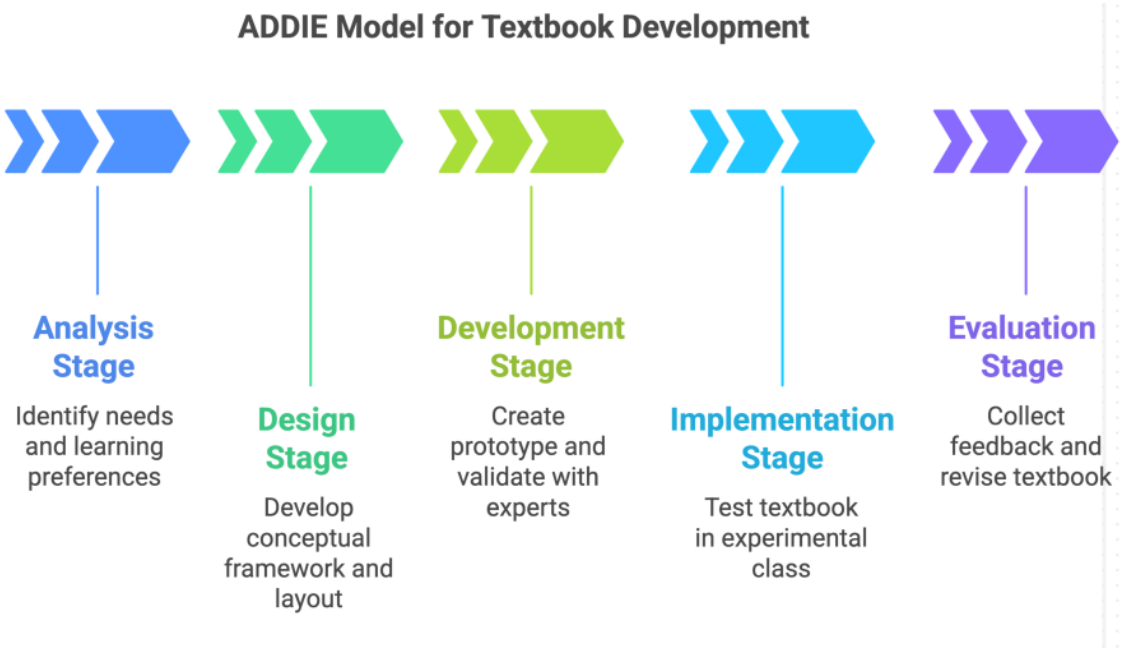

Figure 1. ADDIE model for visual-textbook development

Because intact, non-randomized classes were used, potential baseline differences were explicitly considered rather than assuming initial group equivalence. Pretest achievement was examined before the intervention comparison and subsequently entered as a covariate in the primary ANCOVA. This approach is consistent with quasi-experimental research using non-equivalent groups, in which baseline assessment, adjustment for pre-intervention scores, and verification of ANCOVA assumptions are recommended (Tang et al., 2021; Culclasure et al., 2024; Nozhovnik et al., 2023; Satayev et al., 2022; Li, 2021; Llorca et al., 2022; Luan et al., 2026).

Table 1. Quasi-experimental design used to evaluate learning outcomes

Group	Pretest	Instructional Condition	Posttest
Experimental	O_1	X: Visual textbook	O_2
Control	O_1	Conventional printed textbook	O_2

Note. O_1 *= pretest; X = visual-textbook intervention;* O_2 *= posttest.*

Participants

The participants were 56 first-semester students enrolled in the Information Technology Education (PTI) Program at Universitas Pendidikan Mandalika (UNDIKMA), all of whom were taking the Learning Theories course. Two intact classes of equal size participated: 28 students constituted the experimental group and 28 students constituted the control group. Class selection followed purposive sampling based on enrollment in the same course, comparable class size, and exposure to the same curriculum (Rahma & Suwandi, 2021).

Participants were 20 years old. The overall gender distribution was approximately 60% female and 40% male. All participants were active first-semester PTI students enrolled in the Learning Theories course and participated in the pretest, instructional activities, and posttest.

Table 2. Participant characteristics by study group

Characteristic	Experimental Group	Control Group	Overall Sample
Number of participants	28	28	56
Age	20 years	20 years	20 years
Gender distribution	—	—	≈60% female; 40% male
Pretest score, M ± SD	61.643 ± 1.870	60.679 ± 1.827	—

Both groups were taught by the same instructor to minimize variation in instructional delivery attributable to lecturer differences. The experimental group used the developed visual textbook integrating structured textual explanations, concept maps, diagrams, contextual illustrations, and application-oriented content. The control group used the conventional text-oriented printed textbook adopted for the course. Both groups followed the same course learning outcomes, instructional schedule, and achievement assessments.

The sample size reflected the total number of students available in the two intact classes participating in the study. Because the research was embedded within the existing course structure, class membership was retained rather than reorganizing students through individual random assignment.

Research Procedure

The research procedure followed the five ADDIE stages: Analysis, Design, Development, Implementation, and Evaluation.

Analysis

The Analysis stage examined the instructional context, curriculum requirements, existing course resources, and learner needs. Course documents and expected learning outcomes were reviewed to determine the conceptual scope of the visual textbook and ensure alignment with the PTI curriculum. Existing instructional materials were also reviewed to determine how major Learning Theories concepts and relationships were presented.

The needs analysis was developmental and qualitative rather than survey-based. No quantitative needs-analysis data were collected. The review indicated that the available materials relied predominantly on extended textual explanations with limited integrated visual representations of theoretical relationships. Curriculum review and student-related instructional observations also indicated a need for materials that could present abstract concepts in a more structured and contextually accessible form. Similar instructional-material development studies have used curriculum analysis, stakeholder input, learner difficulties, and review of existing materials to establish the rationale for multimodal redesign (Handayani et al., 2023; Permatasari et al., 2023; Hryvko & Sytnyk, 2022).

Design

The Design stage translated the needs-analysis findings into a blueprint for the visual textbook. The design specified learning objectives, content sequencing, chapter organization, concept maps, diagrams, contextual examples, application-oriented components, summaries, and competency-test activities.

Visual elements were designed to function as integral representations of the content rather than as decorative additions. Text and visual information were

coordinated to provide structured representations of theoretical concepts and their applications. This approach is consistent with multimodal instructional-design recommendations emphasizing integrated visual–verbal presentation, readability, systematic organization, contextual examples, and embedded practice or self-assessment activities (Barlow et al., 2021; Petrova, 2021; Golubeva et al., 2021; Permatasari et al., 2023; Handayani et al., 2023). During this stage, the expert-validation questionnaires, student-response questionnaire, and achievement assessment procedures were also prepared.

Development

During the Development stage, the design blueprint was transformed into a complete visual-textbook prototype. Chapters were developed systematically and supplemented with concept maps, diagrams, illustrations, contextual examples, and applications relevant to Information Technology Education. Consistency was maintained in typography, headings, numbering, spacing, and page organization.

The initial prototype was subsequently evaluated by six experts. Two content experts evaluated conceptual accuracy and curriculum alignment, two media experts evaluated visual and technical design, and two practitioner lecturers evaluated instructional relevance and practical applicability. The use of two validators within each expert category provided independent judgments from multiple perspectives before the textbook was implemented.

Table 3. Expert-validation framework for content, media, and practitioner evaluation

Validator Type	Evaluation Aspect	Indicator
Content expert	Curriculum alignment	Content aligns with the PTI curriculum and course learning outcomes
	Accuracy and relevance	Learning theories are presented accurately and supported by appropriate references
	Visual support	Illustrations and diagrams support conceptual understanding
	Contextualization	Content reflects practical contexts in Information Technology Education
	Usefulness	The textbook provides opportunities for independent and active learning
Media expert	Layout and design	Text, images, spacing, and page organization are consistent
	Readability	Typography and visual contrast support readability
	Illustration quality	Visual elements support understanding rather than functioning only as decoration
	Overall appearance	The visual design is appropriate for instructional use
Practitioner	Alignment with teaching practice	Content corresponds with instructional practice in the PTI program
	Clarity of explanation	Theoretical content is presented systematically and clearly
	Visual integration	Images and diagrams are meaningfully integrated with explanatory content
	Independent-learning support	The textbook provides structures intended to support autonomous study

Expert comments and numerical evaluations were used formatively to revise the prototype. Revisions addressed concept-map organization, formatting consistency, visual quality, cover presentation, independent-learning guidance, and contextual applications in digital and online learning environments.

Implementation

After expert-guided revision, the visual textbook was implemented as the primary instructional resource in the experimental group for four weeks. The intervention comprised eight instructional meetings, with approximately 100 minutes allocated to each meeting. The control group followed the same instructional schedule but used the conventional printed textbook. Both groups were taught by the same instructor and followed the same intended course learning outcomes.

No additional supplementary-material condition was introduced as part of the treatment comparison. The principal instructional difference between the groups was therefore the primary textbook used during the intervention. Both groups completed the same pretest before implementation and the same posttest after the four-week instructional period.

Evaluation

Evaluation occurred formatively and summatively. Formative evaluation used feedback from content experts, media experts, and practitioner lecturers to refine the textbook before implementation. Student responses were subsequently collected to describe perceptions of readability, organization, visual presentation, attractiveness, perceived support for independent study, and relevance to Information Technology Education. Summative evaluation focused on pretest–posttest achievement and between-group differences in learning outcomes.

Open-ended student responses were analyzed descriptively using an inductive thematic procedure. Two members of the research team independently reviewed the responses, identified meaningful units, assigned initial codes, and grouped related codes into broader themes. The coders subsequently compared their coding decisions and resolved differences through discussion and consensus. The resulting themes were reviewed against the original responses before representative statements were selected. This procedure is consistent with qualitative approaches that involve familiarization, coding, theme development, refinement, and presentation of illustrative quotations (Parmar et al., 2025; Ren & Zhou, 2024; Li & Huang, 2023; Zhang, 2024).

Data Collection Instruments

Expert-Validation Questionnaires

Three structured expert-validation questionnaires were used to evaluate the textbook from content, media, and practitioner perspectives. Each questionnaire employed a five-point Likert response format. Six validators participated in total: two content experts, two media experts, and two practitioners. Table 3 summarizes the evaluation dimensions across the three validator groups.

The expert-validation process emphasized content relevance, conceptual accuracy, visual quality, instructional suitability, and alignment with the intended learning context. The two experts within each category evaluated the product independently, after which their numerical ratings and qualitative recommendations were synthesized to guide revision. Because these instruments functioned as expert-

appraisal rubrics administered to only two validators within each specialist category, internal-consistency coefficients were not treated as the primary reliability indicator. Instead, validity evidence was established through specialist judgment and convergence of independent ratings and comments. This treatment is consistent with measurement guidance emphasizing the importance of expert-based content validity and appropriate interpretation of reliability evidence according to instrument purpose and sample characteristics (Montagut-Martínez et al., 2021; Wondim et al., 2023; Bengochea & Sembiante, 2024; Mustain & Ahmadi, 2023).

Student-Response Questionnaire

The student-response questionnaire assessed perceptions of the developed textbook rather than product validity. It used a five-point Likert scale and addressed language readability, content organization, visual presentation, aesthetic appeal, perceived support for self-study, and relevance to the PTI context.

Table 4. Student-response questionnaire framework

No.	Evaluation Aspect	Indicator
1	Language Readability	The language is clear and easy to understand
2	Content Organization	The material is logically arranged and coherent
3	Visual Presentation	Illustrations and diagrams support understanding
4	Aesthetic Appeal	The visual appearance is attractive for instructional use
5	Support for Self-Study	The textbook is perceived as supporting independent study
6	Relevance to PTI Context	The content reflects contexts relevant to Information Technology Education

The questionnaire demonstrated good internal consistency, with Cronbach's α = .86. This reliability level supported its use for describing students' perceptions of the textbook. Reporting internal consistency for student-response instruments is consistent with contemporary measurement guidance emphasizing reliability alongside content validity (Montagut-Martínez et al., 2021; Wondim et al., 2023).

Course Achievement Test

The Course Achievement Test served as the primary objective measure of learning outcomes. The instrument had been previously used for assessing Learning Theories achievement and had demonstrated appropriate reliability, with a reliability coefficient of r = .87. The instrument covered the principal theoretical domains addressed in the course, including behaviorism, cognitivism, constructivism, and humanism.

Table 5. Content blueprint of the Course Achievement Test

Content Domain	Assessment Focus
Behaviorism	Identification and application of major behaviorist concepts and principles
Cognitivism	Understanding and application of cognitive learning processes and principles
Constructivism	Interpretation and application of constructivist principles in instructional situations
Humanism	Understanding and application of humanistic principles in learning and teaching

The suitability of the instrument for the present instructional context was also considered during the expert-validation process. The content experts reviewed alignment between the assessment content, course learning outcomes, theoretical material, and the developed textbook. Thus, the assessment was supported both by previously established reliability evidence and by expert review of its relevance to the present course content.

The achievement scores were used consistently for the pretest and posttest comparisons, allowing changes in students' conceptual understanding across the intervention period to be quantified.

Psychometric Evidence for the Study Instruments

Achievement assessments in educational interventions should provide evidence for both validity and score reliability. Expert review is commonly used to establish content relevance, while internal consistency or previously established reliability coefficients provide evidence regarding score consistency (Ajai et al., 2022; Wondim et al., 2023; Montagut-Martínez et al., 2021).

Table 6. Validity and reliability evidence for the study instruments

Instrument	Validity Evidence	Reliability/Agreement Evidence
Content-validation questionnaire	Expert-based content appraisal by two content specialists	Independent expert ratings and convergent qualitative judgments
Media-validation questionnaire	Expert appraisal by two media specialists	Independent expert ratings and convergent qualitative judgments
Practitioner-validation questionnaire	Expert appraisal by two practitioner lecturers	Independent expert ratings and convergent qualitative judgments
Student-response questionnaire	Content aligned with readability, organization, visual presentation, attractiveness, self-study support, and contextual relevance	Cronbach's α = .86
Course Achievement Test	Previously established instrument; content suitability reviewed by content experts for the present course	Reliability coefficient r = .87

Interpretation of Expert-Validation Scores

Expert-validation scores were converted to percentages and interpreted as follows: 0–20% = not valid, 21–40% = poor, 41–60% = fair, 61–80% = valid, and 81–100% = highly valid. Student-response scores were reported separately as perception scores rather than being interpreted as measures of product validity.

Data Analysis

The analysis combined descriptive statistics, product-evaluation summaries, qualitative student feedback, and inferential analyses of learning outcomes. Expert-validation ratings and student-response scores were summarized using percentages and descriptive statistics. Open-ended responses were coded thematically as described above and used to provide contextual information regarding student perceptions.

Normalized Gain

Normalized gain (N-Gain) was calculated for each student to describe improvement relative to the maximum possible improvement from the pretest score:

$$g = (S\_post - S\_pre) / (S\_max - S\_pre)$$

where S_post represents the posttest score, S_pre the pretest score, and S_max the maximum possible score. Individual N-Gain values were then summarized at the group level. Scores below 0.30 were classified as low, values from 0.30 to 0.70 as moderate, and values above 0.70 as high, consistent with commonly used normalized-gain criteria in educational-intervention research (Sole, 2021; Ambarwati et al., 2022; Ardiansya et al., 2024; Gök & Gök, 2023; Garg, 2026).

Baseline and Assumption Testing

Baseline pretest scores were compared between the experimental and control groups before intervention effects were interpreted. Distributional assumptions were examined using the Shapiro–Wilk test, while homogeneity of variance was evaluated using Levene's test. Variance-homogeneity assessment was used to determine whether conventional equal-variance procedures or more robust alternatives were appropriate (Ambarwati et al., 2022; Ardiansya et al., 2024; Gök & Gök, 2023; Satayev et al., 2022; Muttaqin et al., 2021).

Primary Effectiveness Analysis

Because the study used intact non-randomized classes, analysis of covariance (ANCOVA) was specified as the primary inferential analysis of effectiveness. Posttest achievement was entered as the dependent variable, instructional group as the fixed factor, and pretest achievement as the covariate. Before the final ANCOVA was interpreted, the homogeneity-of-regression-slopes assumption was examined through the Group × Pretest interaction. Equality of error variance and residual distribution were also examined.

When the interaction term was non-significant, indicating that the regression-slope assumption was satisfied, the final ANCOVA model was estimated without the interaction term. This strategy is consistent with quasi-experimental studies that use pretest scores as covariates to account for potential baseline differences between non-equivalent groups (Tang et al., 2021; Culclasure et al., 2024; Nozhovnik et al., 2023; Satayev et al., 2022; Li, 2021; Llorca et al., 2022; Luan et al., 2026).

ANCOVA results were reported using the F statistic, degrees of freedom, p value, adjusted group means with 95% confidence intervals, adjusted mean differences, and partial eta squared (partial η^2) as the effect-size measure.

Complementary N-Gain Analysis

The N-Gain comparison was conducted as a complementary analysis of relative improvement. Normality and variance homogeneity were assessed before group comparison. Because Levene's test indicated unequal N-Gain variances, Welch's independent-samples t-test was used instead of the equal-variance Student's t-test. This robust procedure avoids imposing the equal-variance assumption when group variances differ. The analysis was reported using Welch's t statistic, adjusted degrees of freedom, p value, mean difference, 95% confidence interval, and Cohen's d with its corresponding confidence interval.

All inferential tests were two-sided with a significance level of $\alpha = .05$. Probability values below .001 were reported as $p < .001$ rather than $p = .000$. Statistical analyses were conducted using SPSS version 25.

RESULTS AND DISCUSSION

Needs Analysis and Visual Textbook Design

The preliminary needs analysis identified a mismatch between the characteristics of the Learning Theories course and the instructional materials available to students. Existing course materials relied predominantly on textual explanations with limited visual representation of relationships among theoretical concepts. Curriculum analysis further confirmed that Learning Theories constitutes a core component of the Information Technology Education (PTI) program and requires students to understand and apply abstract concepts, including behaviorism, cognitivism, constructivism, and humanism. These findings provided the basis for developing a visually structured textbook that combined theoretical explanations with visual representations and contextual applications relevant to Information Technology Education.

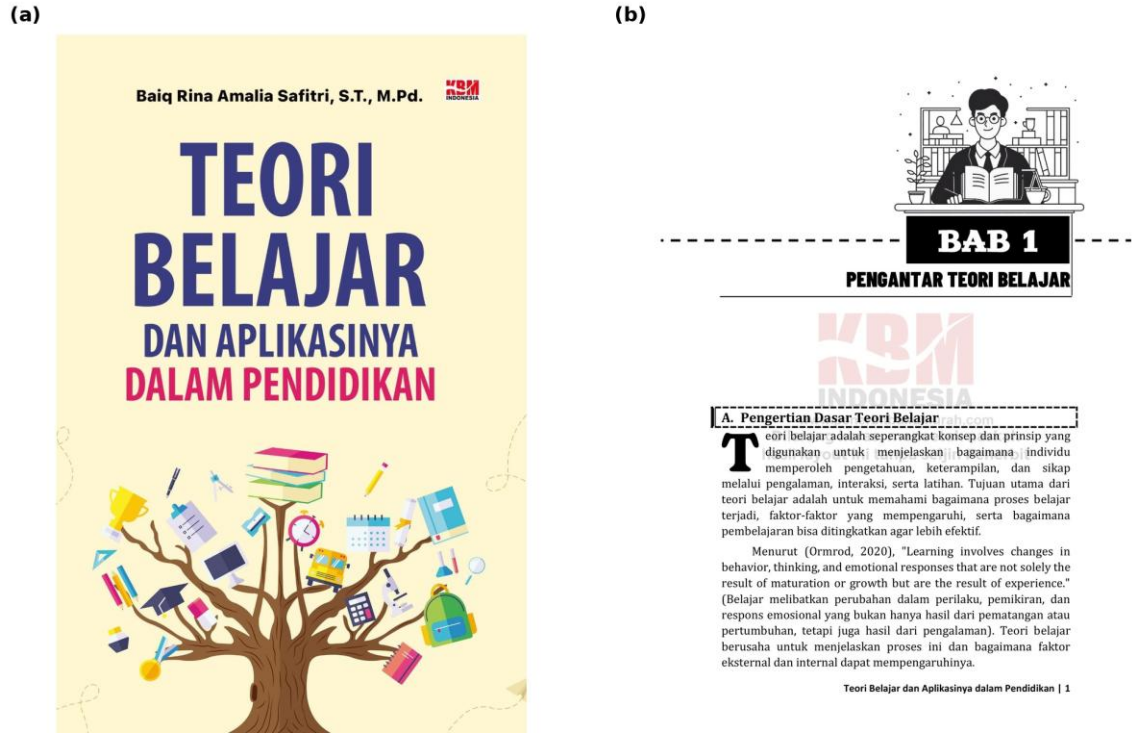

Figure 2. Representative design features of the developed visual textbook: (a) textbook cover and (b) chapter-opening structure

Based on the needs analysis, the textbook was designed with a consistent instructional structure that integrated textual explanations, visual representations, concept maps, contextual examples, chapter summaries, application-oriented content, and competency-test items. The developed textbook, entitled Teori Belajar dan Aplikasinya dalam Pendidikan, also incorporated examples connecting learning theories with online learning, programming, network simulation, educational technology, and gamification contexts.

Gambar Peta Konsep Teori Belajar dan Aplikasi dalam Pendidikan

Figure 3. Concept map organizing the major Learning Theories topics in the developed textbook

Figures 2–4 make the principal design characteristics directly inspectable. The concept map organizes major theoretical domains within the textbook structure and the contextual examples connect theoretical explanations with technology-mediated instructional situations.

menyelesaikan proyek pemrograman dalam bentuk game. Setiap tantangan yang diselesaikan memberikan poin atau penghargaan, yang meningkatkan motivasi dan keterlibatan mahasiswa.

Teori Pembelajaran Sosial (Albert Bandura): Gamifikasi juga melibatkan pembelajaran sosial, di mana mahasiswa saling berkompetisi atau bekerja sama dalam game, berbagi strategi, dan mempelajari keterampilan baru dari satu sama lain.

Ilustrasi visual: Platform game pembelajaran yang menunjukkan mahasiswa yang berkompetisi atau berkolaborasi dalam menyelesaikan tantangan pemrograman, dengan status poin dan leaderboard yang terlihat di layar.

Gambar 6.4 Mahasiswa yang berkompetisi atau berkolaborasi dalam menyelesaikan tantangan pemrograman

E. Kesimpulan

Dalam pendidikan teknologi informasi, penerapan teori-teori belajar seperti konstruktivisme, pembelajaran sosial, dan teori kognitif sangat penting untuk merancang pengalaman pembelajaran yang efektif dan menarik. Ilustrasi di atas menggambarkan bagaimana teori-teori ini dapat diterapkan dalam berbagai aspek pendidikan TI, dari pembelajaran daring hingga penggunaan teknologi dan gamifikasi. Dengan pendekatan yang berbasis teori ini, teknologi tidak hanya menjadi alat bantu, tetapi juga menjadi pendorong utama dalam menciptakan pengalaman belajar yang lebih interaktif, mendalam, dan menyenangkan bagi mahasiswa.

Figure 4. Visual and contextual scaffolding linking theoretical concepts with Information Technology Education applications

Expert Validation and Product Revision

Following completion of the initial prototype, the visual textbook underwent expert validation to assess its content quality, media design, and practical suitability for instructional use. The validation involved content, media, and practitioner perspectives. Table 7 integrates the quantitative scores, principal feedback, and corresponding revisions, while Figure 6 illustrates the validation scores.

Table 7. Expert-validation results, principal feedback, and revisions implemented

Validator Type	Score (%)	Category	Principal Feedback	Revision Implemented
Content experts	88	Highly Valid	Align the concept-map sequence with the textbook content.	The concept map was reorganized to follow the sequence and hierarchy of the textbook content.
Media experts	85	Highly Valid	Improve formatting consistency, image quality, and cover design.	Formatting and page organization were standardized, lower-resolution images were improved or replaced, and the cover was redesigned.
Practitioners	90	Highly Valid	Strengthen independent-study guidance and applications in digital and online learning.	Additional instructional guidance and contextual examples for technology-based and online learning were incorporated.

All three validation perspectives placed the textbook within the "Highly Valid" category. Practitioner validation produced the highest score (90%), followed by content validation (88%) and media validation (85%).

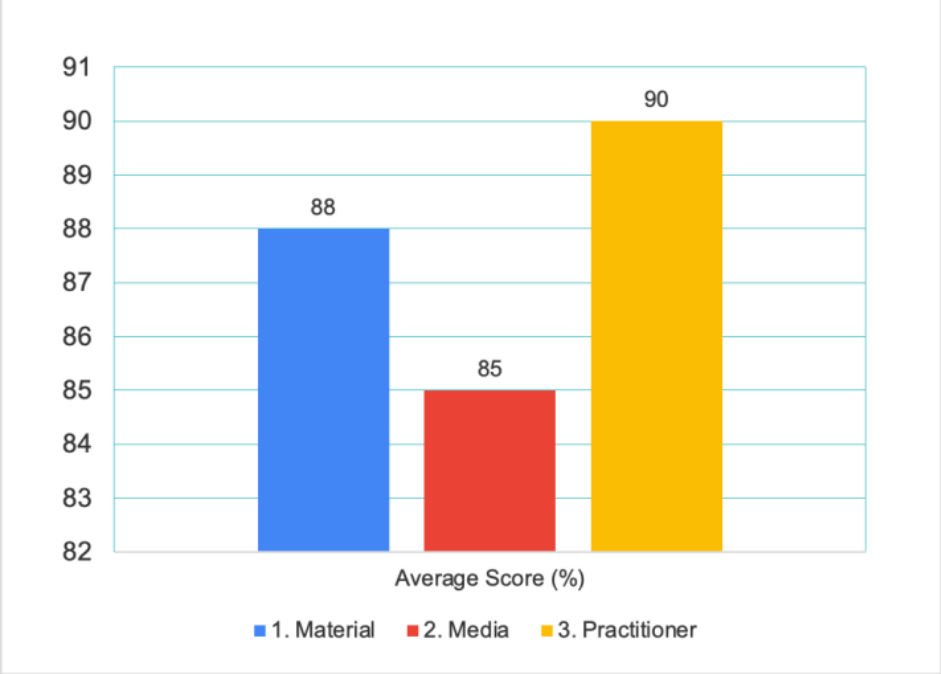

Figure 6. Validation scores of the visual textbook provided by content, media, and practitioner validators

The integrated evidence in Table 7 shows how quantitative expert appraisal was linked directly to qualitative feedback and subsequent product revision. The implementation of the validator recommendations produced observable changes in the organization and visual presentation of the textbook. Figure 7 provides a direct before-and-after example of the revision.

BEFORE – Naskah sebelum terbit (p.92)

92

Integrasi Berpikir Komputasi yakni dalam pembelajaran daring, mahasiswa dapat mengembangkan algoritma atau solusi berbasis TI melalui eksperimen langsung dan refleksi terhadap pekerjaan mereka. Misalnya, mereka dapat mengerjakan tugas pemrograman yang mengharuskan mereka untuk mendesain dan menguji algoritma mereka sendiri.

Indikator Berpikir Komputasi yaitu mahasiswa membangun algoritma atau aplikasi melalui eksperimen dan refleksi terhadap hasil pekerjaan mereka, berfokus pada penerapan prinsip-prinsip komputasi untuk menyelesaikan masalah yang diberikan. Kolaborasi dalam forum diskusi daring memungkinkan mahasiswa untuk berbagi ide dan solusi dalam menghadapi tantangan pemrograman atau desain sistem.

Menurut Brusilovsky (2021), "Online learning environments need to be designed to support active, student-centered learning, where students build their knowledge through exploration and reflection". Oleh karena itu, platform pembelajaran daring yang memfasilitasi interaksi aktif, seperti forum diskusi, kuis interaktif, dan proyek berbasis web, sangat mendukung pembelajaran berbasis konstruktivisme.

Gambar 6.1 Mahasiswa terhubung dengan diskusi online

6.3 Desain Instruksional Berbasis Teknologi

AFTER – Buku final terbit (p.80)

B. Pembelajaran Daring (Online Learning) dan Teori Belajar

Pembelajaran daring telah menjadi komponen utama dalam pendidikan teknologi informasi. Dalam konteks ini, teori konstruktivisme yang dikembangkan oleh Piaget dan Vygotsky dapat diterapkan dengan sangat baik. Menurut teori ini, mahasiswa membangun pengetahuan mereka sendiri melalui pengalaman langsung dan interaksi dengan materi.

(Brusilovsky, 2021) mengungkapkan bahwa "Online learning environments need to be designed to support active, student-centered learning, where students build their knowledge through exploration and reflection". Ini mengarah pada pentingnya interaksi mahasiswa dengan materi pembelajaran, seperti penggunaan forum diskusi, kuis interaktif, atau proyek berbasis web yang memungkinkan pembelajaran aktif.

Selain itu, Teori Pembelajaran Sosial (Albert Bandura) menekankan bahwa pembelajaran dapat terjadi melalui observasi dan interaksi sosial. Dalam konteks pembelajaran daring, mahasiswa dapat belajar dari teman-teman sekelas mereka melalui kolaborasi dalam platform pembelajaran berbasis grup, media sosial, atau bahkan dalam video tutorial yang dibuat oleh instruktur atau sesama mahasiswa.

Ilustrasi visual: Seorang mahasiswa yang bekerja dengan modul pemrograman interaktif di laptop, sementara di layar terhubung dengan forum diskusi online tempat mereka berbicara dengan teman-teman sekelas.

Gambar 6.1 Mahasiswa terhubung dengan diskusi online

80 | Teori Belajar dan Aplikasinya dalam Pendidikan

Figure 7. Example of the visual textbook before and after expert-guided revision, showing changes in section organization, visual hierarchy, formatting consistency, and integration of contextual visual material

Student Responses and Qualitative Feedback

Following expert validation and revision, the textbook was implemented in a limited student trial. Student responses were collected to examine perceptions of language readability, content presentation, visual design, textbook attractiveness, support for independent learning, and relevance to Information Technology Education.

Table 8. Student response results for the revised visual textbook

Evaluated Aspect	Average Score (%)
Language Readability	90.91
Content Presentation	87.27
Visual Design	87.27
Book Attractiveness	90.91
Perceived Support for Independent Learning	89.09
Relevance to the IT Education Field	89.09

Student-response scores ranged from 87.27% to 90.91%. Language readability and textbook attractiveness received the highest ratings (90.91%), followed by perceived support for independent learning and relevance to Information Technology Education (89.09%). Content presentation and visual design each received a score of 87.27%.

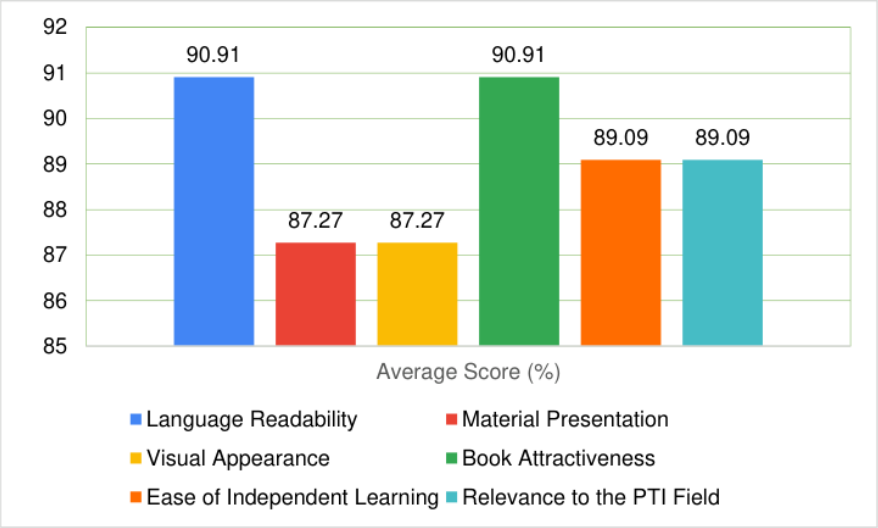

Figure 8. Student ratings of language readability, content presentation, visual design, textbook attractiveness, perceived support for independent learning, and relevance to Information Technology Education

Open-ended responses were also examined to identify recurring aspects of students' experiences with the textbook. The responses were organized descriptively into themes related to ease of understanding, completeness and relevance, suggestions for improvement, and general appreciation.

Table 9. Descriptive themes identified from open-ended student feedback

Main Theme	Representative Student Statements	Descriptive Summary
Ease of Understanding	"This book is easy to understand and very comprehensive…"; "The book is great and easy to follow."	Students commented on the clarity and ease of following the textbook content
Completeness and Relevance	"This book is very good because we can apply learning theories like behaviorism, cognitive, constructivist, humanist, and cybernetic."	Students referred to the breadth and applicability of the theoretical content
Suggestions for Improvement	"Add more sub-chapters for better understanding…"; "Keep improving it, ma'am."	Students suggested further expansion and refinement of the textbook content
General Appreciation	"Okay"; "Wishing you continued success."	Students expressed general positive reactions to the developed textbook

The student-response data therefore showed consistently positive perceptions across the evaluated dimensions. These findings represent students' self-reported evaluations of the textbook and are reported separately from the objective achievement outcomes presented in the following subsection.

Effectiveness on Learning Outcomes

Descriptive Learning Outcomes and Baseline Comparison

The effectiveness evaluation involved 56 students, comprising 28 students in the experimental group and 28 students in the control group. Learning outcomes were examined using pretest, posttest, and normalized gain (N-Gain) scores.

Table 10. Descriptive statistics for pretest, posttest, and normalized gain scores

Group	N	Pretest M ± SD	Posttest M ± SD	N-Gain M ± SD	N-Gain Category
Experimental	28	61.643 ± 1.870	86.143 ± 1.145	0.640 ± 0.031	Moderate
Control	28	60.679 ± 1.827	72.607 ± 1.449	0.303 ± 0.050	Moderate

At baseline, the experimental group obtained a mean pretest score of 61.643 (SD = 1.870), compared with 60.679 (SD = 1.827) in the control group. The pretest difference did not reach statistical significance, $t(54) = 1.95$, $p = .056$, with a mean difference of 0.964 points (95% CI [−0.027, 1.955]). Because participants belonged to intact, non-randomized classes, pretest achievement was retained as a covariate in the primary effectiveness analysis.

Following the intervention, the experimental group obtained a mean posttest score of 86.143 (SD = 1.145), whereas the control group obtained a mean of 72.607 (SD = 1.449). The distribution of posttest scores is presented in Figure 9.

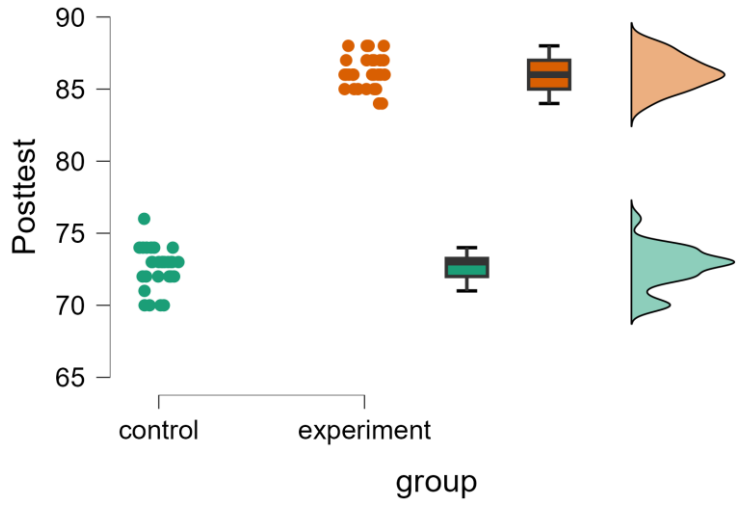

Figure 9. Raincloud plot showing the distribution of posttest achievement scores in the experimental and control groups

Figure 9 shows the individual observations and score distributions for both groups. The experimental-group posttest scores were concentrated at a higher range than those of the control group, with limited overlap between the two distributions.

Assumption Testing and ANCOVA

Because the study used a quasi-experimental non-equivalent control-group design, analysis of covariance (ANCOVA) was used as the primary inferential analysis, with posttest achievement as the dependent variable, instructional group as the fixed factor, and pretest achievement as the covariate. Assumptions relevant to the effectiveness analyses were examined before interpreting the inferential results.

Table 11. Assumption checks for the effectiveness analyses

Analysis	Assumption/Test	Statistic	p	Result
Posttest	Shapiro–Wilk test of residuals	W = 0.966	.111	No significant deviation from normality
Posttest	Levene's test	F(1,54) = 1.082	.303	Homogeneity of variance supported
ANCOVA	Levene's test of error variance	F(1,54) = 1.297	.260	Homogeneity of error variance supported

Analysis	Assumption/Test	Statistic	p	Result
ANCOVA	Group × Pretest interaction	F(1,52) = 0.767	.385	Homogeneity of regression slopes supported
N-Gain	Shapiro–Wilk test of residuals	W = 0.967	.125	No significant deviation from normality
N-Gain	Levene's test	F(1,54) = 4.870	.032	Equal-variance assumption not supported

The Group × Pretest interaction was not statistically significant, F(1,52) = 0.767, p = .385, partial η^2 = .014, indicating that the homogeneity-of-regression-slopes assumption was supported. Levene's test of equality of error variances for the ANCOVA was also non-significant, F(1,54) = 1.297, p = .260. The final ANCOVA model was therefore estimated without the interaction term.

Table 12. Summary of inferential analyses of learning outcomes

Analysis	Effect/Comparison	Statistic	p	Estimate (95% CI)	Effect Size (95% CI)
ANCOVA	Group effect on posttest, adjusted for pretest	F(1, 53) = 1380.908	< .001	Adjusted mean difference = 13.458 [12.732, 14.184]	Partial η^2 = .963
ANCOVA	Pretest covariate	F(1, 53) = 0.701	.406	—	Partial η^2 = .013
Welch's t-test	Experimental − control N-Gain	t(45.077) = 30.283	< .001	Mean difference = 0.336 [0.314, 0.359]	Cohen's d = 8.093 [6.343, 9.833]

After adjustment for pretest achievement, the group effect was statistically significant, F(1,53) = 1380.908, p < .001, partial η^2 = .963. The adjusted posttest mean was 86.104 (95% CI [85.599, 86.609]) for the experimental group and 72.646 (95% CI [72.141, 73.151]) for the control group. The adjusted between-group difference was 13.458 points (SE = 0.362, 95% CI [12.732, 14.184], p < .001). Pretest achievement was not a statistically significant covariate, F(1,53) = 0.701, p = .406, partial η^2 = .013.

Normalized Gain Analysis

Normalized gain scores were calculated to describe the magnitude of improvement from pretest to posttest. The experimental group obtained a mean N-Gain of 0.640 (SD = 0.031; 95% CI [0.628, 0.652]), whereas the control group obtained a mean N-Gain of 0.303 (SD = 0.050; 95% CI [0.284, 0.323]). Although both group means were classified within the broad moderate category, the experimental-group mean was more than twice the control-group mean. The distribution of individual N-Gain scores is shown in Figure 10.

The Shapiro–Wilk test indicated no significant departure from normality for the N-Gain residuals (W = 0.967, p = .125). However, Levene's test indicated unequal variances between groups, F(1,54) = 4.870, p = .032. Accordingly, Welch's independent-samples t-test was used for the between-group comparison rather than the equal-variance Student's t-test.

As summarized in Table 12, Welch's test showed a statistically significant between-group difference in N-Gain, t(45.077) = 30.283, p < .001. The experimental

group exceeded the control group by 0.336 N-Gain units (95% CI [0.314, 0.359]). The standardized mean difference was Cohen's d = 8.093 (95% CI [6.343, 9.833]).

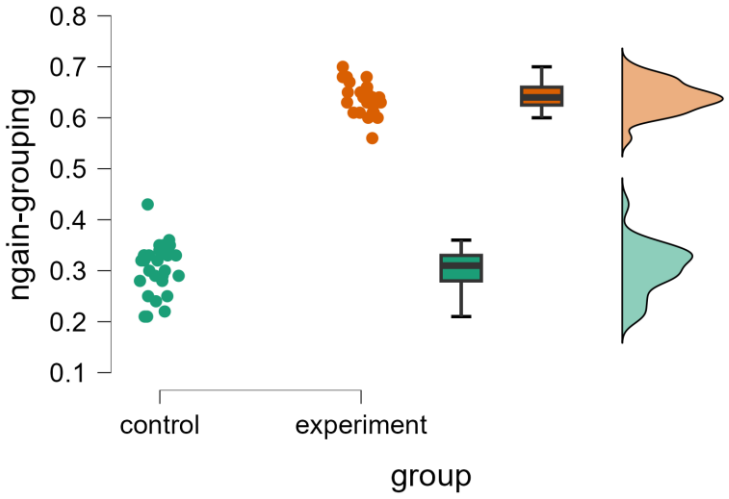

Figure 10. Raincloud plot showing the distribution of normalized gain (N-Gain) scores in the experimental and control groups

Overall, the descriptive results, adjusted posttest analysis, and normalized-gain comparison consistently showed higher post-intervention achievement and greater learning gains in the experimental group than in the control group. The theoretical interpretation of these findings, their relationship with previous research, their practical significance, and the limitations of the quasi-experimental design are addressed separately in the Discussion section.

Discussion

Needs Analysis, Visual Design, and Product Refinement

The development findings indicate that the need for a visual textbook arose from a mismatch between the abstract and conceptually dense nature of the Learning Theories course and the predominantly text-oriented materials available to students. The design response was therefore not limited to adding illustrations to conventional text but involved reorganizing content through concept maps, contextual visual examples, structured chapter layouts, and assessment-oriented components. The representative features shown in Figures 2–5 demonstrate how these elements were integrated into the textbook, while Figure 6 provides direct evidence of how the product was refined following expert feedback.

This design process is consistent with instructional-material development studies in which needs analysis functions as the basis for identifying weaknesses in existing resources and specifying design requirements. Handayani et al. (2023), for example, demonstrated the value of embedding needs analysis within a systematic instructional-development process, while Permatasari et al. (2023) reported a clear learner demand for integrated multimodal materials when conventional resources were perceived as difficult to understand. Hryvko and Sytnyk (2022) similarly emphasized the importance of structured multimodal resources for supporting reading and literacy in specialized learning contexts. Together, these studies support the use of readability, conceptual accessibility, and integration of multiple representations as relevant criteria when deciding whether conventional text-heavy materials require redesign.

The textbook features illustrated in Figures 2–5 also correspond to principles increasingly reported in multimodal instructional-material research. Integrated text–image formats, concept maps, infographics, and contextual representations have been associated with improved readability, information processing, and conceptual access in higher education (Barlow et al., 2021; Bauling, 2023; Espinar & Hernández, 2023; Golubeva et al., 2021). Permatasari et al. (2023) further advocate systematically integrated multimodal textbooks rather than the ad hoc addition of visual elements. In the present study, the visuals were therefore designed to represent relationships among theoretical concepts and to connect those concepts with applications in Information Technology Education rather than to function solely as decorative elements.

Expert validation further supported the feasibility of this design approach. As reported in Table 7, content, media, and practitioner validators placed the textbook within the highly valid category. The same table links the principal expert recommendations to the revisions implemented in concept-map organization, image quality, formatting consistency, visual presentation, independent-learning guidance, and digital-learning contextualization; Figure 6 illustrates an example of the resulting product refinement. These findings are consistent with previous instructional-material development studies in which expert validation contributed to iterative improvements in content accuracy, visual presentation, and instructional usability (Rismala et al., 2023; Nasution et al., 2022; Herawati & Muhtadi, 2018; Khosi'in & Ni'am, 2022; Liunokas & Billik, 2021; Makur & Fedi, 2018; Nissa et al., 2022; Fathoni et al., 2022). The present study extends that approach by linking expert-guided revision with a subsequent quasi-experimental evaluation of learning outcomes.

Learning Outcomes and Practical Significance

The effectiveness analysis provides the strongest empirical evidence for the instructional value of the developed textbook. As shown in Table 10, students in the experimental group achieved a posttest mean of 86.143 compared with 72.607 in the control group. More importantly, the primary ANCOVA reported in Table 12 showed that the between-group difference remained statistically significant after pretest achievement was controlled, $F(1,53) = 1380.908$, $p < .001$, partial $\eta^2 = .963$. The adjusted posttest means were 86.104 for the experimental group and 72.646 for the control group, with an adjusted difference of 13.458 points. The score distributions shown in Figure 9 further demonstrate that the experimental-group posttest scores were concentrated substantially above those of the control group.

The N-Gain analysis provides convergent evidence. The experimental group obtained a mean N-Gain of 0.640, whereas the control group obtained 0.303 (Table 10). Although both values fall within the broad "moderate" classification, this categorical label masks a substantial quantitative difference: the experimental-group mean gain was more than twice that of the control group. Because the equal-variance assumption for N-Gain was not satisfied, the revised analysis appropriately used Welch's test. As reported in Table 12, the groups differed significantly, Welch's $t(45.077) = 30.283$, $p < .001$, with a mean difference of 0.336 and a 95% confidence interval of [0.314, 0.359]. Figure 10 also shows clear separation between the distributions of the two groups. Thus, the practical interpretation should not rely only on the shared "moderate" classification but also consider the magnitude and precision of the between-group difference.

These findings are consistent with previous studies reporting improved learning outcomes following the use of developed or visually enriched instructional materials (Reksamunandar, 2020; Liunokas & Billik, 2021; Setyowati & Murwaningsih, 2022). They also align with multimodal-learning research showing that integrated representations can improve comprehension, motivation, literacy, and academic performance across higher-education contexts (Chen & Jamiat, 2023; Espinar & Hernández, 2023; Shalaby, 2024; Zhou & Peng, 2026). Multimodal engagement has likewise been advocated in online and technology-supported higher education (Turk et al., 2024).

The present statistical evidence is stronger than the initial analysis because it does not rely solely on significance testing. Previous instructional-material studies have frequently used N-Gain and inferential comparisons to evaluate effectiveness (Andriani et al., 2023; Wahab et al., 2021; Rachmawati & Setiyawati, 2023; Fatihah et al., 2021). The revised analysis additionally reports confidence intervals, adjusted means, and standardized effect-size information. Nevertheless, the very large effect estimates observed in this study require cautious interpretation. The ANCOVA partial η^2 of .963 and the Welch-test Cohen's d of 8.093 are unusually large for educational interventions. As emphasized in broader multimedia-learning research, observed effects may depend on task characteristics, learner characteristics, instructional context, and measurement properties (Prinz et al., 2021; Petrova, 2021; Thao et al., 2022; Sun, 2026). Studies such as Barlow et al. (2021), Hryvko and Sytnyk (2022), and Milad (2026) also illustrate that favorable multimedia outcomes should not be interpreted solely from statistical significance or headline effect magnitudes. Therefore, the present effect sizes should be interpreted as context-specific estimates requiring replication rather than as universal estimates of the impact of visual textbooks.

Visual and Multimodal Support for Conceptual Understanding

One plausible explanation for the higher achievement observed in the experimental group is the coordinated presentation of verbal and visual representations. The textbook used concept maps, diagrams, images, contextual examples, and structured textual explanations to represent relationships among abstract concepts. These features are visible in Figures 2–5 and differ from conventional text-heavy presentation because they provide multiple routes for organizing and interpreting theoretical information.

This interpretation is consistent with dual-coding and multimedia-learning perspectives. Nancekivell et al. (2021) found that presenting information through coordinated text and pictures can improve recall relative to text-only presentation. Chen and Jamiat (2023) likewise reported that interactive multimodal representations can improve comprehension and motivation when learners engage with complex material. From a cognitive-load perspective, their CATLM-based account suggests that appropriately integrated multimodal information can guide attention toward relevant content and reduce unnecessary processing demands. Similar findings have been reported in studies of multimodal representations in English-medium instruction and related settings, where visual–verbal integration supported literacy, motivation, and performance (Espinar & Hernández, 2023), as well as in language-learning contexts where multimodal instruction produced measurable learning gains (Shalaby, 2024).

The visual textbook used in the present study applied these principles to a different instructional domain: theories of learning in teacher education. Behaviorism, cognitivism, constructivism, and humanism require learners to distinguish overlapping concepts, theoretical assumptions, major scholars, and applications. Concept maps and contextual illustrations can externalize these relationships and reduce the need for students to construct all conceptual links from uninterrupted prose. Research on infographics and multimodal instructional representations similarly indicates that well-designed visual-textual integration can facilitate readability, knowledge construction, and conceptual processing (Barlow et al., 2021; Bauling, 2023; Golubeva et al., 2021; Petrova, 2021; Sun, 2026; Thao et al., 2022).

The present findings also support the earlier result reported by Setyowati and Murwaningsih (2022), who found benefits from integrating visual material into textbook design. Although their disciplinary context differed from the present Learning Theories course, the convergence of findings suggests that purposeful visual organization may support learning across different content domains. The key qualification is that the current study did not directly measure cognitive load. Accordingly, the higher achievement cannot be interpreted as direct empirical evidence that the textbook reduced cognitive load; rather, cognitive-load theory provides a plausible explanatory framework for the observed outcome.

Application-Oriented and Active-Learning Features

The textbook also incorporated application-oriented examples and competency-test components that required students to connect theoretical concepts with instructional situations. The examples displayed in Figures 4 and 5 include technology-related contexts such as online learning, programming, network simulation, and gamification. These features extend the textbook beyond passive presentation by requiring students to recognize how theoretical principles may operate in authentic educational-technology contexts.

This approach is consistent with instructional-material research emphasizing the incorporation of practice and application within learning resources. Handayani et al. (2023) showed that interactive e-modules combining multimedia resources with practice questions can support active-learning processes and applied tasks. Rossi et al. (2020) likewise reported benefits of active-learning strategies for academic performance and scientific reasoning, although their study occurred in a different instructional setting. The present textbook did not implement a full active-learning intervention in the same sense; instead, it embedded opportunities for application and self-assessment within the learning material itself.

Broader evidence from experiential and technology-supported learning also suggests that visual and interactive representations can strengthen achievement and motivation. Chiu et al. (2022) and Özeren and Top (2023), for example, reported positive outcomes from virtual- and augmented-reality learning environments. These technologies are considerably more immersive than the printed visual textbook examined here, so they should not be treated as direct equivalents. Nevertheless, their findings reinforce the broader principle that instructional representations that make abstract information more observable and actionable can support learning.

Student Perceptions, Readability, and Independent-Learning Support

Student responses complement, but should not be conflated with, the objective achievement findings. As shown in Table 8 and Figure 8, students rated language

readability and textbook attractiveness most highly, while content presentation, visual design, perceived support for independent learning, and relevance to Information Technology Education also received consistently positive scores. These data indicate that students perceived the textbook favorably; they do not independently demonstrate behavioral engagement or objectively measured self-regulated learning.

The positive readability ratings are consistent with research suggesting that multimodal and visual-textual materials can improve the accessibility and navigability of instructional information. Barlow et al. (2021), Petrova (2021), Golubeva et al. (2021), Hryvko and Sytnyk (2022), Sun (2026), and Milad (2026) describe ways in which integrated visual and textual representations can facilitate information processing, knowledge construction, and independent navigation of learning materials. Bauling (2023) similarly links multimodal representation with readability and learner engagement in professional education contexts. These findings provide a theoretical and empirical basis for the favorable student responses reported in the present study.

The perceived support for independent learning may also be related to the textbook's structured organization. Clear chapter divisions, concept maps, contextual examples, summaries, and competency-test items provide learners with visible pathways through the content and opportunities to monitor their understanding. Zhang et al. (2022) similarly reported that visually structured digital textbooks could support performance and adaptability, although their cloud-based format differs from the printed resource examined here. The present findings should therefore be described specifically as evidence of perceived support for independent learning, rather than evidence that students' self-regulated-learning behavior objectively improved.

The original manuscript also interpreted the textbook in relation to diverse learning styles. That interpretation requires moderation. Khotimah et al. (2024) reported differences in educational outcomes in relation to learners' stated preferences, but the present study neither classified students into fixed learning-style categories nor tested a learning-styles hypothesis. The more defensible interpretation is that the textbook provided multiple forms of representation and multiple ways of accessing conceptual information, rather than that it was effective because it matched stable learning styles.

Qualitative Feedback and Convergence of Evidence

The descriptive themes summarized in Table 9 provide additional context for the quantitative student-response data. Students commented on ease of understanding, completeness and relevance, opportunities for further improvement, and general appreciation. These themes broadly converge with the questionnaire findings in Table 8, particularly the high ratings for readability, relevance, and independent-learning support.

The qualitative findings should nevertheless be interpreted as descriptive supporting evidence rather than as a separate demonstration of effectiveness. Contemporary studies analyzing open-ended student feedback commonly use explicit thematic- or content-analysis procedures involving data familiarization, coding, theme development, refinement, and representative quotations (Li & Huang, 2023; Parmar et al., 2025; Ren & Zhou, 2024; Zhang, 2024). Mixed-method studies may additionally triangulate qualitative themes with quantitative findings (Kim et al.,

2026; Şimşek, 2022). The present revision therefore treats the open-ended responses primarily as contextual information that helps explain the quantitative perceptions rather than assigning strong inferential meaning to theme prevalence.

Implications and Limitations

The combined evidence suggests that a visually structured core textbook can be a useful instructional resource for concept-heavy Learning Theories coursework. The main practical contribution is not simply the use of more images but the coordinated integration of conceptual organization, visual representations, contextual applications, and assessment-oriented components within a single instructional resource. This integration may be particularly relevant where students would otherwise need to alternate among textbooks, lecture slides, and disconnected online resources.

For teacher education, the findings also indicate value in contextualizing theoretical content within the disciplinary environment of the learners. The examples shown in Figures 4 and 5 connect learning theories with online learning, programming, network simulations, educational technology, and gamification. Such contextualization may help students move from identifying theoretical definitions toward recognizing possible applications in their own professional field. This interpretation is consistent with the broader literature advocating multimodal, context-sensitive, and systematically integrated instructional materials (Permatasari et al., 2023; Turk et al., 2024; Handayani et al., 2023).

Several limitations, however, constrain the strength and generalizability of the findings. First, the study used two intact classes rather than random assignment, so selection effects cannot be completely excluded despite the absence of a statistically significant baseline difference and the use of ANCOVA to adjust for pretest achievement. Second, the study involved only 56 students from one academic program at a single institution, which limits external validity. Third, both classes were taught by the same lecturer; this improved instructional consistency but does not allow separation of textbook effects from instructor-specific implementation characteristics. Fourth, the evaluation focused on short-term post-intervention achievement and did not include a delayed posttest, so the durability of the observed gains remains unknown. Fifth, student responses concerning readability, attractiveness, and independent-learning support were self-reported and should not be interpreted as direct behavioral measures of engagement or self-regulation. Finally, the unusually large effect sizes observed in the achievement analyses reinforce the need for replication with larger samples, multiple institutions, independent instructors, and rigorous psychometric documentation of the achievement instrument.

Future research should therefore examine whether the findings replicate across teacher-education programs and institutions, assess retention through delayed posttests, and compare printed and interactive digital versions of the visual textbook. Future studies may also directly measure cognitive load, engagement, and self-regulated learning rather than inferring these processes from achievement and perception data. Such extensions would clarify which design features account for learning gains and under what instructional conditions visually structured textbooks provide the greatest benefit.

CONCLUSIONS

This study developed and evaluated a visually structured textbook for the Learning Theories course in teacher education using the ADDIE development framework and a quasi-experimental pretest–posttest non-equivalent control-group design. The textbook was rated as highly valid across content, media, and practitioner evaluations, and students reported favorable perceptions of its readability, visual presentation, attractiveness, relevance to Information Technology Education, and support for independent study. These perception-based findings should be distinguished from the objectively measured learning outcomes.

The effectiveness analysis showed that students who used the visual textbook achieved higher posttest scores and greater normalized learning gains than those who used a conventional textbook. After controlling for pretest achievement, ANCOVA indicated a significant group effect, $F(1,53) = 1380.908$, $p < .001$, partial $\eta^2 = .963$, with adjusted posttest means of 86.104 for the experimental group and 72.646 for the control group. Consistent with this result, the experimental group achieved a higher mean N-Gain (0.640 ± 0.031) than the control group (0.303 ± 0.050), and Welch's t-test confirmed a significant between-group difference, $t(45.077) = 30.283$, $p < .001$. These convergent results indicate that, within the context of this study, use of the visual textbook was associated with substantially greater improvement in learning achievement.

The contribution of the study lies in the development of a core instructional textbook that integrates structured textual explanations, concept maps, visual scaffolding, contextual examples, application-oriented content, and competency-test components within a single learning resource. Rather than demonstrating direct changes in engagement, self-regulated learning, or cognitive load, the present findings provide evidence of improved academic achievement together with positive student perceptions of the textbook's instructional support.

Because the study involved intact non-randomized classes, a single institution, one lecturer, a modest sample, and short-term post-intervention assessment, the findings should be interpreted within these methodological boundaries. Nevertheless, the combination of expert validation, student feedback, and adjusted achievement analysis provides a basis for further investigation of visually structured textbooks in concept-heavy teacher-education courses.

RECOMMENDATIONS

Future research should prioritize replication across multiple institutions, academic programs, cohorts, and instructors to determine whether the observed learning gains are consistent beyond the present setting. Larger samples and, where feasible, randomized or more rigorously matched comparison designs would strengthen causal inference and improve the generalizability of the findings.

Longer-term evaluation is also recommended. Delayed posttests should be used to determine whether the observed achievement gains are retained over time, while additional validated instruments could directly measure cognitive load, engagement, motivation, and self-regulated learning. Such measures would allow future studies to test the mechanisms proposed by cognitive-load, dual-coding, and multimedia-learning perspectives rather than inferring these processes from achievement and perception data alone.

Further development of the textbook may include interactive digital features, adaptive navigation, embedded multimedia, self-assessment activities, and online learning components while retaining the structured visual and contextual design demonstrated in the printed version. Comparative studies between printed, digital, and blended versions could determine which delivery format provides the most effective and accessible support for students in Learning Theories and other conceptually demanding courses.

Future studies should also provide detailed psychometric documentation for achievement tests and perception questionnaires, including content-validity procedures, item characteristics, and reliability coefficients. Given the unusually large effect sizes observed in the present study, replication with independently validated outcome measures will be particularly important for establishing the stability and practical magnitude of the instructional effect.

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Conflict of Interest Statement
The authors declare no conflict of interest.

Informed Consent
Participants were informed about the objectives and procedures of the study, the voluntary nature of participation, confidentiality protections, and their right to withdraw from the study without penalty. Written informed consent was obtained before participation. Personal identifiers were not included in the analytical dataset, and research data were stored securely and used exclusively for academic purposes.

Ethical Approval
The study adhered to institutional and professional ethical standards for research involving human participants. Ethical approval was obtained from the Research Ethics Committee of Universitas Pendidikan Mandalika (UNDIKMA) before data collection.

Data Availability
The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
BR Amalia Safitri	✓	✓			✓	✓		✓	✓		✓			
NN Sri Putu Verawati		✓		✓						✓			✓	
Irham Azmi			✓	✓	✓	✓				✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

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