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Effectiveness of an LMS-Based Visual–Linguistic Instructional Design for Enhancing University Students' Understanding of Pancasila Values: A One-Group Pretest–Posttest Study Across Two Disciplinary Cohorts

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ABSTRACT

Learning Management Systems (LMS) increasingly mediate values education, yet the pedagogical alignment between multimodal interface design and civic-values learning remains underexamined. This study investigated whether a visual–linguistic instructional design grounded in the Cognitive Theory of Multimedia Learning (CTML) was associated with improved understanding of Pancasila values, how students perceived its design features, and how these perceptions related to engagement. Using a convergent mixed-methods design, a six-week Moodle-based module developed through the ADDIE model was implemented with 47 second-semester undergraduates from Science Education (n = 19) and English Education (n = 28) at Universitas Qamarul Huda Badaruddin Bagu. Data were collected through a researcher-developed Pancasila Understanding Test, LMS analytics, open-ended reflections, and semi-structured interviews with 12 participants, and analysed using paired-samples t-tests, correlation and regression, and reflexive thematic analysis. Both cohorts showed significant pretest–posttest gains ($p < .001$) with large within-group effect sizes ($d_{av} \approx 1.63$ and 1.70). In contrast, the between-cohort gain difference was negligible and non-significant ($d \approx 0.07$, $p > .05$). Time-on-task was the strongest engagement correlate of gains ($r = .65$), explaining 42% of gain-score variance ($R^2 = .42$). Three themes emerged: clarity and accessibility, engagement and motivation, and cognitive overload from excessive visual density. These findings provide preliminary evidence that coordinated visual–linguistic LMS design may support Pancasila learning, while highlighting the need to calibrate visual density and interpret effects cautiously given the absence of a control group and the small, single-institution sample.

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1. INTRODUCTION

In the current digital era, the rapid development of technology has reshaped how education is delivered, and Learning Management Systems (LMS) have become central to hybrid and online learning by managing content delivery, interaction, assessment, and progress monitoring [1], [2]. The pedagogical challenge, however, is not adoption but design: whether an LMS is configured so that its multimodal features support meaningful, value-oriented learning rather than merely hosting content [3].

A recurring concern in Indonesian civic education is that engagement with Pancasila values among younger cohorts appears uneven in globalised digital settings. We frame this cautiously: rather than asserting a general "fading" of values, we note that recent Indonesian studies report declining engagement with conventional Pancasila instruction among Generation Z and Islamic-university students [4], alongside broader discussion of value transmission under digital-media conditions [5], [6]. Pancasila, the foundational ideology of Indonesia, is cultivated through education that addresses intellectual, emotional, and moral development [7], [8], and Islamic educational institutions bear particular responsibility for character formation among Muslim youth [9]. The specific problem addressed here is therefore narrow and operational: how a coordinated visual–linguistic LMS design might support students' understanding of Pancasila values, and where such a design risks impeding rather than helping learning.

The study is grounded in Mayer's Cognitive Theory of Multimedia Learning (CTML), which holds that learners build richer mental models when corresponding verbal and pictorial information are processed together across dual channels of limited capacity [10]. Rather than invoking "multimodality" in general, we specify the CTML principles that guided the design: (a) the coherence principle—excluding extraneous decorative material; (b) signalling—cueing essential content through colour-coding and headings; (c) spatial contiguity—placing textual explanations adjacent to the infographics they describe; (d) temporal contiguity—synchronising narration with on-screen visuals in short videos; (e) segmenting—delivering content in weekly, learner-paced units; and (f) the modality principle—pairing pictures with spoken or concise on-screen text. These six principles are mapped onto concrete LMS components in Table 1 and revisited in the discussion. The broader literature is consistent with this framing: visual–linguistic modalities embedded in LMS enhance engagement, attention, and satisfaction [11], [12], [13], and well-designed interfaces are associated with higher satisfaction and performance [14].

Because the term has been used loosely in prior work, we define it explicitly. Conceptually, visual–linguistic instructional design refers to the intentional, CTML-guided coordination of pictorial representations (infographics, thematic imagery, short video) with verbal representations (concise on-screen text, narration, guided prompts) so that the two channels reinforce a single instructional message. Operationally, in this study, it comprises four measurable design moves: (1) colour-coded thematic anchoring of each Pancasila principle; (2) spatially contiguous infographic–text pairings; (3) narrated short videos with synchronised captions; and (4) reflection prompts positioned adjacent to visuals. We distinguish this construct from three neighbouring notions: general multimedia learning (the

broad theory), interface/usability design (navigability and accessibility of the platform), and multimodal instruction (any combination of modes, not necessarily coordinated per CTML). The present construct is the CTML-governed subset in which visual and linguistic elements are deliberately aligned.

Prior empirical work clusters into two largely separate strands. The first concerns LMS effectiveness and interface quality: films and visual media in online platforms improved understanding of Pancasila values [15]; LMS adoption modelled through TAM/TOE emphasised user-friendly design (Sobhani et al., 2025); and system and content quality predicted satisfaction and performance via DeLone–McLean [16]. The second concerns civic/values education: contextualised activities supported comprehension of Pancasila [7]; collaborative tasks aligned with Pancasila improved interaction quality [17]; and Canva-based flipbooks engaged students in civic education [18]. Taken together, the pattern is that visual and linguistic supports reliably improve engagement and comprehension, but the two strands rarely intersect, and the possibility of visual overload is seldom examined.

The specific, previously unexamined issue is the following: no study has (a) operationally defined a CTML-governed visual–linguistic design, (b) embedded it in an LMS for Pancasila-values instruction, and (c) simultaneously tested its association with learning gains and documented its cognitive-overload cost within the same cohort. Existing studies address LMS usability or civic content separately, treat multimodality generically, and emphasise benefits while under-reporting drawbacks.

The novelty is therefore not the mere pairing of "LMS + Pancasila." It is threefold: theoretically, we translate six named CTML principles into an operational civic-education design and test them in a value-based domain that CTML research has rarely entered; methodologically, we combine LMS behavioural analytics with reflexive qualitative data to triangulate engagement with lived experience; and practically, we surface a calibrated-density guideline by treating cognitive overload as a finding rather than noise.

Consistent with the actual analyses reported, the objectives are: (1) to examine whether the LMS-based visual–linguistic design is associated with within-group improvement in students' understanding of Pancasila values across two disciplinary cohorts; (2) to describe students' perceptions of the design's visual–linguistic features and how these relate to their reported engagement; and (3) to examine the relationship between LMS behavioural engagement indicators and learning gains. Because no validated satisfaction or affective-engagement scale was administered, "engagement" in Objective 3 is operationalised through LMS analytics (login frequency, time-on-task, forum participation) and interpreted qualitatively rather than as a psychometric construct.

Given the treatment-only, two-cohort design, we do not hypothesise superiority over conventional instruction. Instead: H1: Both cohorts will show statistically significant pretest–posttest gains in understanding of Pancasila values. H2: Gain scores will not differ significantly between the two disciplinary cohorts, indicating cross-disciplinary consistency. H3: LMS behavioural engagement indicators will be positively associated with gain scores.

2 METHOD

2.1 Research design

This study used a convergent mixed-methods design in which quantitative and qualitative strands were collected in the same period and integrated at interpretation (Creswell & Creswell, 2018). The quantitative strand was a single-group pretest–posttest intervention implemented across two disciplinary cohorts; it did not include a conventional-instruction control group. Consequently, the analysis compares within-cohort change and between-cohort equivalence, not treatment versus control. We acknowledge at the outset that, without a control group, maturation, repeated testing, and instructor effects cannot be fully ruled out; these are revisited in the Limitations. The rationale for mixing was complementarity and expansion, not triangulation alone: behavioural analytics and test scores establish whether and how much learning occurred, while reflections and interviews explain how specific design features helped or hindered it.

2.2 Research location and time

The study was conducted at the Faculty of Teacher Training and Education (FKIP), Universitas Qamarul Huda Badaruddin Bagu, Indonesia, from May to July 2025.

2.3 Population, sample, and participant characteristics

Participants were 47 second-semester undergraduate students enrolled in the same Pancasila and Citizenship Education course at Universitas Qamarul Huda Badaruddin Bagu. The sample consisted of 19 students from Science Education (IPA) and 28 students from English Education. The Science Education cohort comprised 8 male and 11 female students, whereas the English Education cohort comprised 10 male and 18 female students. Overall, 18 participants were male (38.3%), and 29 were female (61.7%). Participants ranged in age from 19 to 22 years (M = 20.36, SD = 0.82).

All participants had basic experience using digital learning platforms, although their prior exposure to structured LMS-based instruction varied. Thirty-one students (66.0%) reported previous experience using an LMS for at least one semester, whereas 16 students (34.0%) had limited prior LMS experience. None of the participants had previously completed a structured LMS module specifically designed around the CTML principles used in the present intervention.

The two cohorts followed the same course curriculum and were exposed to the same instructional materials, learning activities, assessment procedures, and six-week intervention schedule. The contrasting disciplinary backgrounds were retained to provide a descriptive comparison of whether learning gains were reasonably consistent across academic orientations.

2.4 Sampling technique

A convenience sampling technique was employed. All students enrolled in the two participating course sections were invited to participate, and all 47 students who completed both the pretest and posttest were included in the final analysis. The sample was therefore

not randomly selected and should not be considered statistically representative of Indonesian university students.

The inclusion criteria were: (1) enrolment in the participating second-semester course; (2) completion of the pretest before the intervention; (3) participation in the six-week LMS intervention; and (4) completion of the posttest. Students who did not complete either the pretest or posttest were excluded from the paired analysis. No a priori power analysis was conducted because the study used the complete accessible cohort rather than recruiting participants to achieve a predetermined sample size.

2.5 Data sources

Four primary sources of data were used: (1) the Pancasila Understanding Test, administered before and after the intervention; (2) LMS behavioural analytics, including login frequency, time-on-task, and forum participation; (3) open-ended written reflections, collected at the end of the intervention; and (4) semi-structured interviews conducted with a purposively selected subset of participants. The quantitative and qualitative datasets were collected during the same intervention period and subsequently integrated during interpretation.

2.6 Instructional treatment and LMS design

The instructional module was developed using the ADDIE framework. During the Analysis phase, students' prior knowledge, learning needs, and familiarity with digital learning environments were considered. During the Design phase, the instructional sequence was organised around the five Pancasila principles and six CTML principles: coherence, signalling, spatial contiguity, temporal contiguity, segmenting, and modality. During development, the instructional team produced infographics, short instructional videos, concise explanatory texts, scenario-based questions, discussion prompts, and formative quizzes. During Implementation, the module was delivered through the LMS over six consecutive instructional weeks. During Evaluation, student activity and formative assessment results were reviewed weekly, allowing minor adjustments to navigation, instructions, and visual density.

The LMS used in the intervention was Moodle, configured as a course-specific learning environment. Each weekly unit required approximately 45–60 minutes of active student engagement and consisted of an introductory visual, concise textual explanation, one or more multimodal learning resources, a reflective or scenario-based activity, and a formative quiz. The module contained 12 infographics, 6 short instructional videos ranging from approximately 4 to 7 minutes, 30 formative quiz items, and 6 discussion/reflection activities. Both cohorts received the same learning materials and assessment tasks and were taught by the same lecturer.

Table 1. Weekly Mapping of the LMS-Based Visual–Linguistic Instructional Design (new table — required by reviewers)

Week	Pancasila principle/ topic	Learning activity	Visual–linguistic element and CTML principle	Expected outcome	Assessment
1	Sila 1 – Ketuhanan Yang Maha Esa	Introductory video, reading, and forum discussion	Narrated video with synchronised captions; modality and temporal contiguity	Students identify and explain the meaning of the first principle	Quiz 1
2	Sila 2 – Kemanusiaan yang Adil dan Beradab	Infographic analysis and individual reflection	Text positioned adjacent to relevant images; spatial contiguity	Students apply the principle to interpersonal and social situations	Quiz 2
3	Sila 3 – Persatuan Indonesia	Infographic interpretation and guided discussion	Colour-coded thematic anchors and headings; signalling	Students connect national unity with everyday experiences	Quiz 3
4	Sila 4 – Kerakyatan yang Dipimpin oleh Hikmat Kebijaksanaan	Scenario-based task and discussion forum	Learner-paced segmented content; segmenting	Students analyse democratic decision-making through Pancasila	Quiz 4
5	Sila 5 – Keadilan Sosial bagi Seluruh Rakyat Indonesia	Short video, case analysis, and discussion	Removal of decorative visual material; coherence	Students evaluate examples of social justice	Quiz 5
6	Integration of the five principles	Multimodal review and synthesis reflection	Integrated use of signalling, coherence, contiguity, modality, and segmenting	Students integrate the five principles in contemporary civic situations	Posttest

Visual–linguistic elements were integrated so that students could both see and read explanations simultaneously [19], and the LMS provided scaffolding through hints, worked examples, and peer discussion [20].

2.7 Procedure/research workflow

The research procedure was carried out through several systematic steps as illustrated in Figure 1 below.

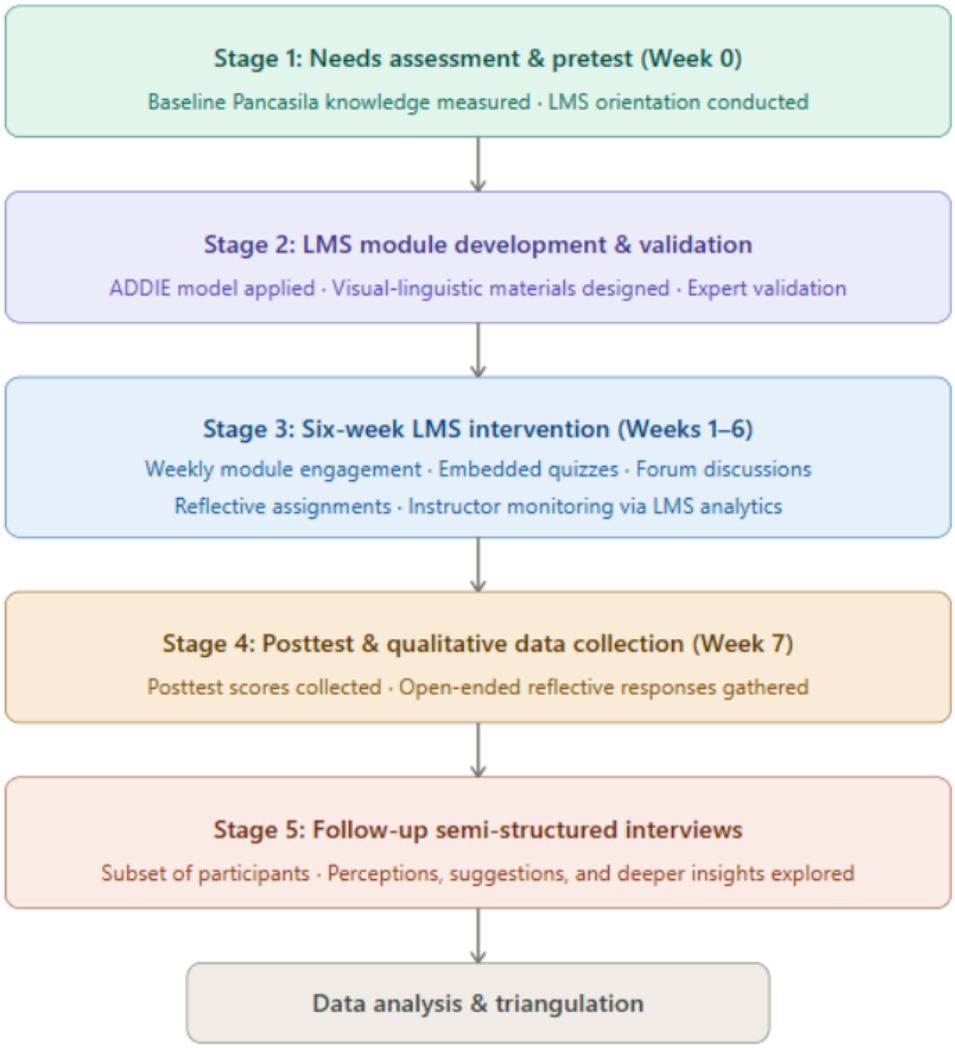

Figure 1. Research Procedure Flowchart

The flowchart depicts the sequential stages: (1) Needs Assessment and Pretest Administration at Week 0; (2) LMS Module Development and Validation using the ADDIE model, validated by civic-education experts; (3) Six-Week Intervention Implementation (Weeks 1–6) with weekly modules, embedded quizzes, forum discussions, and reflective assignments under ongoing instructor monitoring via LMS analytics; (4) Posttest and Qualitative Data Collection at Week 7; and (5) Follow-Up Semi-Structured Interviews with a purposive subset of participants.

2.8 Instruments, variables, and measurement

a) **Pancasila Understanding Test**. The Pancasila Understanding Test was a researcher-developed instrument consisting of 30 items covering the five principles of Pancasila and three cognitive dimensions: conceptual understanding, contextual application, and analytical interpretation. The instrument consisted of 20 multiple-choice items and 10 scenario-based items. Scores were converted to a 0–100 scale, with higher scores

indicating greater understanding of Pancasila values. The instrument was reviewed by three experts in civic education and educational assessment, focusing on content relevance, clarity, alignment with the learning objectives, and appropriateness of the scenarios for second-semester university students. The resulting item-level content validity indices were satisfactory, with an overall Aiken's V of 0.87. Following expert review, minor revisions were made to item wording and scenario clarity. A pilot administration involving 30 students from a comparable cohort produced an internal-consistency coefficient of Cronbach's $\alpha = .84$. The scenario-based items were scored using a predefined analytic rubric. The pretest and posttest employed equivalent forms with the same content domains but different item order and contextual wording to reduce direct recall from the pretest.

b) **LMS engagement indicators**. LMS engagement was operationalised through three behavioural indicators. Login frequency represented the number of distinct LMS sessions recorded during the six-week intervention. Time-on-task represented the accumulated time recorded while students accessed instructional pages and activities; because LMS-recorded time may include periods when a page remains open without active attention, this measure was interpreted as an approximate behavioural indicator rather than a direct measure of cognitive engagement. Forum participation represented the number of substantive student contributions to the discussion forums. These indicators were analysed as behavioural proxies and were not treated as equivalent to a validated psychological engagement scale.

c) **Qualitative instruments**. The qualitative strand comprised written reflection prompts, a semi-structured interview guide, and an observation protocol. Reflection questions asked students to describe which visual, linguistic, video, and discussion features supported or hindered their understanding. The interview guide addressed perceived clarity, accessibility, motivation, usefulness of visual materials, and experiences of information overload. Semi-structured interviews were conducted with 12 students selected purposively to obtain variation across the two disciplinary cohorts and achievement levels; six students were selected from each cohort, considering relatively high, medium, and low posttest performance to capture diverse experiences.

2.10 Ethical considerations

The study was conducted with institutional permission from Universitas Qamarul Huda Badaruddin Bagu. Before data collection, participants received information concerning the study objectives, procedures, potential risks, confidentiality, and their right to withdraw, and written informed consent was obtained from all participants. Each participant was assigned a pseudonymous identification code, and identifying information was removed from the analytical dataset. LMS activity data were analysed only for students who provided consent. Interview data were stored separately from participant identities and were accessible only to the research team. Because the lecturer was also involved in the research process, interviews were explicitly framed as non-evaluative, and students were informed that their responses would not influence their academic assessment.

2.11 Data analysis

Quantitative analyses were conducted using IBM SPSS Statistics version 27. Descriptive statistics were calculated for pretest, posttest, and gain scores, with gain scores computed by subtracting pretest from posttest scores. The Shapiro–Wilk test indicated that gain-score distributions did not significantly depart from normality in either cohort (Science Education, $p = .214$; English Education, $p = .168$). Accordingly, paired-samples t-tests were used to examine within-cohort changes, and an independent-samples t-test was used to compare gain scores between cohorts. Effect sizes for within-cohort change were estimated using Cohen's d_{av}, calculated as the mean gain divided by the average of the pretest and posttest standard deviations. Pearson's correlation coefficients were calculated to examine associations between LMS engagement indicators and learning gains, and a simple linear regression model was estimated using time-on-task as the predictor and gain score as the dependent variable. The statistical significance threshold was set at $\alpha = .05$, with two-tailed tests. Because the study did not include a control group, statistical significance was interpreted as evidence of within-group change rather than evidence of causal treatment effectiveness.

2.12 Qualitative analysis and trustworthiness

Qualitative data were analysed using reflexive thematic analysis involving familiarisation with the dataset, generation of initial codes, development and review of candidate themes, definition and naming of themes, and production of the final narrative. The first coding cycle generated descriptive codes concerning clarity, accessibility, motivation, visual usefulness, interaction, navigation, and cognitive overload, which were subsequently clustered into broader patterns, producing three themes: clarity and accessibility; engagement and motivation; and cognitive-overload challenges. To strengthen trustworthiness, the researchers maintained an audit trail documenting coding decisions and theme development, peer debriefing was used to challenge preliminary interpretations, and selected participants were invited to confirm whether the researchers' summaries accurately represented their experiences [21], [22]. Qualitative software was not required because the dataset was relatively small and could be managed through a structured coding matrix.

3. RESULTS AND DISCUSSION

3.1 RESULT

This section presents, in order of the objectives: (1) within-cohort change and cross-cohort equivalence in test scores; (2) LMS interface features as implemented; (3) associations between engagement and gains; and (4) qualitative themes.

3.1.1 Change in students' understanding of Pancasila values

Baseline scores were comparable across the two cohorts. Students in Science Education obtained a mean pretest score of 65.21 (SD = 8.34), while students in English Education obtained a mean of 66.45 (SD = 7.98). Following the six-week LMS intervention, mean scores increased to 78.47 (SD = 7.92) and 80.13 (SD = 8.15), respectively. The Science Education cohort demonstrated a mean gain of 13.26 points, whereas the English Education cohort demonstrated a mean gain of 13.68 points. Paired-samples t-tests indicated

statistically significant improvements in both cohorts ($p < .001$), supporting H1. The magnitude of change was large in both groups, with Cohen's d_av approximately 1.63 for Science Education and 1.70 for English Education.

Table 2. Pretest and Posttest Scores of Students' Understanding of Pancasila Values

Group	N	Pretest Mean (SD)	Posttest Mean (SD)	Gain Score Mean (SD)	Sig. (p)
Science Education (IPA)	19	65.21 (8.34)	78.47 (7.92)	13.26 (6.10)	< .01
English Education	28	66.45 (7.98)	80.13 (8.15)	13.68 (6.33)	< .01

Note. Cohen's d_av was calculated as mean gain divided by the average of the pretest and posttest standard deviations. Because the analysis is based on paired observations, the effect-size estimate should be checked against the raw participant-level data before final publication.

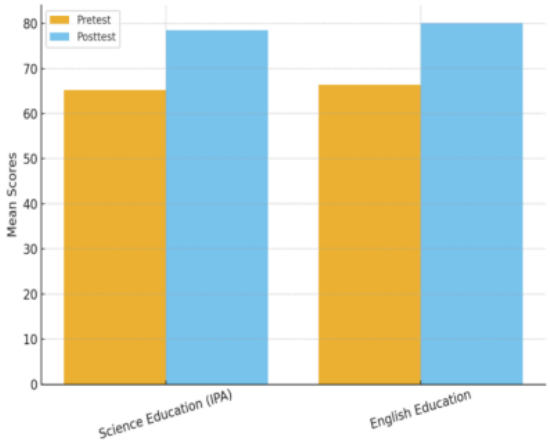

Figure 2. Bar Chart Comparing Pretest and Posttest Means for Both Groups

The chart illustrates substantial improvements in both cohorts after the intervention; while the English Education cohort achieved a slightly higher posttest mean (80.13) than the Science Education cohort (78.47), both demonstrated statistically significant within-group gains ($p < .001$).

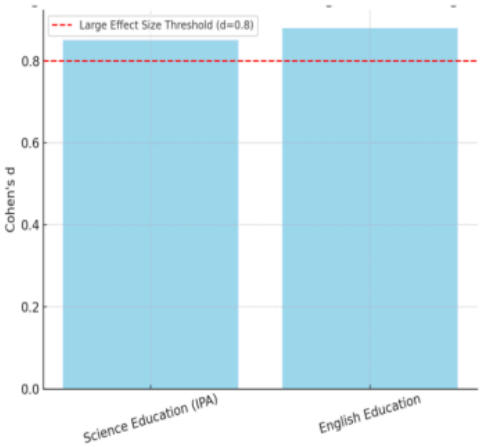

Figure 3. Effect Sizes of Science and English Education Groups

Figure 3 confirms that both cohorts demonstrated large within-group effect sizes (Cohen's d_av > 0.8), indicating that the observed change had practical as well as statistical importance.

3.1.2 Cross-cohort comparison

The mean gain in the English Education cohort (13.68) was slightly higher than that of the Science Education cohort (13.26). However, the difference between the two gain scores was very small and statistically non-significant ($p > .05$), with an estimated between-cohort effect size of approximately $d = 0.07$, supporting H2 (cross-disciplinary consistency). This finding suggests that the magnitude of observed improvement was broadly consistent across the two disciplinary cohorts. Nevertheless, the result should be interpreted as evidence of comparable within-study change rather than proof that the instructional design is equally effective across all disciplinary populations; the near-zero between-group effect size, rather than the within-group significance, is the relevant evidence here.

3.1.3 LMS interface design and visual–linguistic features (as implemented)

To contextualise the intervention, Figures 4–6 present screenshots of the LMS interface as experienced by students during the six-week module.

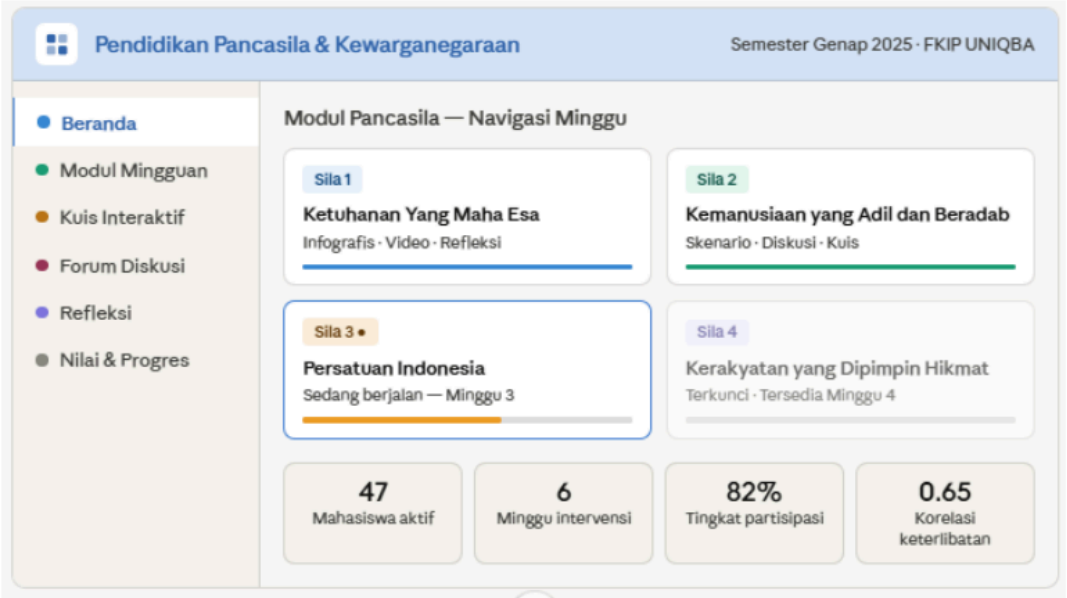

Figure 4. LMS Main Dashboard and Module Navigation Page

Figure 4 displays the main dashboard, organised with a hierarchical navigation structure, colour-coded weekly icons, and a persistent side panel enabling movement between weekly modules, forums, quizzes, and reflective assignments. The thematic colours—aligned with each of the five Pancasila principles—served as a signalling and visual-anchoring strategy linking content to each civic value [14]. Students in follow-up interviews frequently described the dashboard as easy to follow and well-organised.

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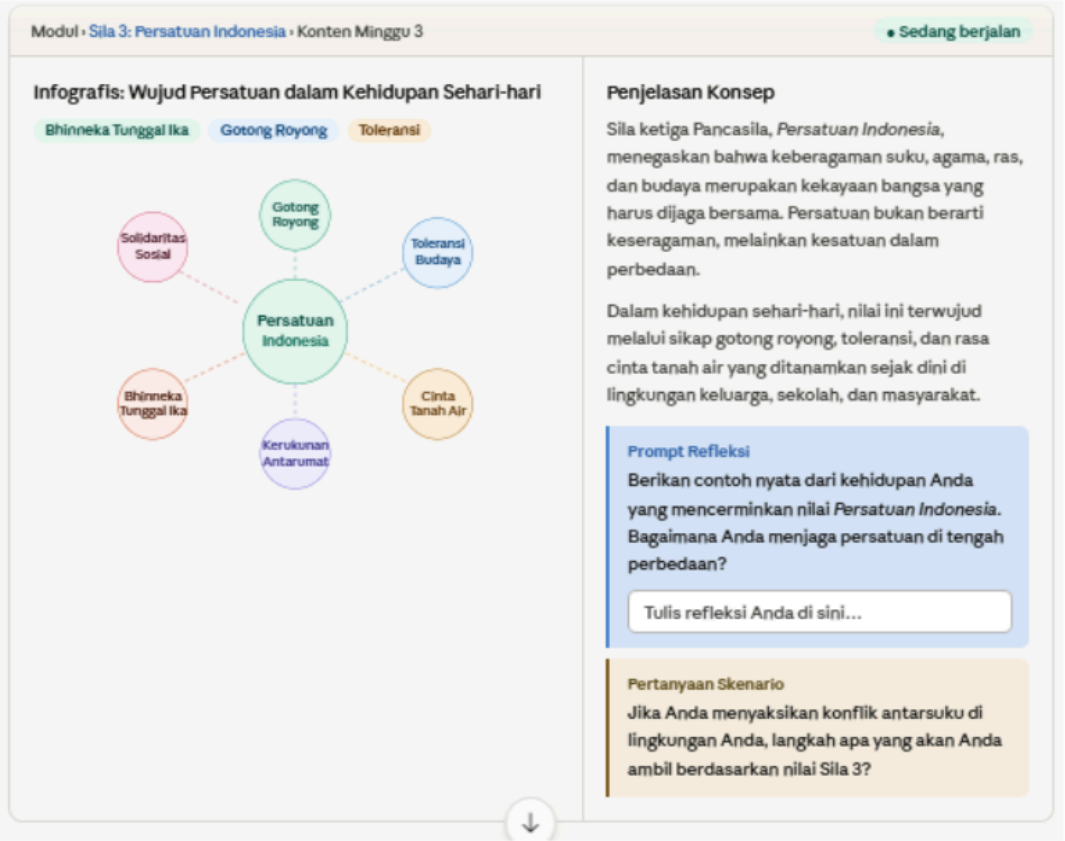

Figure 5. Multimodal Content Page: Infographic and Textual Explanation of Pancasila Sila Ketiga

Figure 5 illustrates a Week 3 content page (Persatuan Indonesia), pairing a full-width thematic infographic with an adjacent structured text and embedded reflection prompts—an application of the spatial-contiguity and coherence principles of CTML [19], [10]. The placement of reflection prompts adjacent to the infographic also served a metacognitive scaffolding function [20].

Figure 6. Interactive Quiz and Discussion Forum Interface

Figure 6 presents the quiz and forum interface, with scenario-based items, immediate colour-coded feedback, and a threaded, avatar-tagged forum that supported peer learning and social presence [17], [23].

3.1.4 Association between LMS engagement and gains

The LMS analytics indicated positive associations between behavioural engagement and learning gains. Login frequency showed a moderate positive relationship with gain scores ($r = .36$, $p < .05$), and forum participation was also positively associated with gain scores ($r = .41$, $p < .05$). Time-on-task demonstrated the strongest association with learning gains ($r = .65$, $p < .001$). A simple linear regression showed that time-on-task explained approximately 42% of the variance in gain scores ($R^2 = .42$). The estimated regression equation was: Gain score = 3.84 + 0.018(Time-on-task). The regression coefficient was statistically significant ($B = 0.018$, $SE = 0.003$, 95% CI [0.012, 0.024], $p < .001$), supporting H3. This relationship should nevertheless be interpreted as associative rather than causal: students with stronger prior motivation, greater academic confidence, or greater interest in the topic may simultaneously have spent more time on the LMS and achieved larger gains.

Table 3. Associations Between LMS Engagement Indicators and Learning Gains

Engagement indicator	r with gain	p	Interpretation
Login frequency	.36	.013	Moderate positive association
Time-on-task	.65	< .001	Strongest association; $R^2 = .42$
Forum participation	.41	.004	Moderate positive association

3.1.5 Qualitative themes

Reflexive thematic analysis of reflections, interviews, and observations (May–July 2025) produced three themes.

Theme 1. Clarity and accessibility. Students consistently described the combination of concise textual explanations and visual representations as useful for understanding abstract Pancasila concepts. Infographics were particularly useful when they represented a complex principle through a limited number of clearly connected visual elements, and students indicated that the visual structure allowed them to identify the main idea before reading the supporting explanation.

> "The infographics really helped me understand Pancasila values because I could see the main idea first. But when there were too many visuals at once, I found it difficult to concentrate." (P3, male, 21)

Theme 2. Engagement and motivation. Short instructional videos, scenario-based questions, reflection prompts, and discussion forums were frequently described as features that made learning more active, encouraging students to connect the principles with everyday situations.

> "I liked the combination of videos and prompts because they kept me motivated." (P7, female, 20)

> "The scenario-based questions made me think critically about how Pancasila applies in daily life." (P12, male, 22)

Theme 3. Cognitive-overload challenges. Although visual materials were generally perceived positively, students also identified situations in which visual density became counterproductive, describing difficulty concentrating when several images, text blocks, icons, and links appeared simultaneously on one page.

> "Sometimes I felt overloaded when multiple images appeared on the same page." (P15, female, 21)

These responses provide an important qualification to the quantitative findings: visual material was not perceived as inherently beneficial; its usefulness depended on the degree to which individual elements were clearly related to the instructional objective. During one observation, several students leaned forward and pointed to the infographic on the projector while explaining their answers in a group discussion, suggesting that visuals also encouraged collaborative interaction (Observation, Jun 28, 2025).

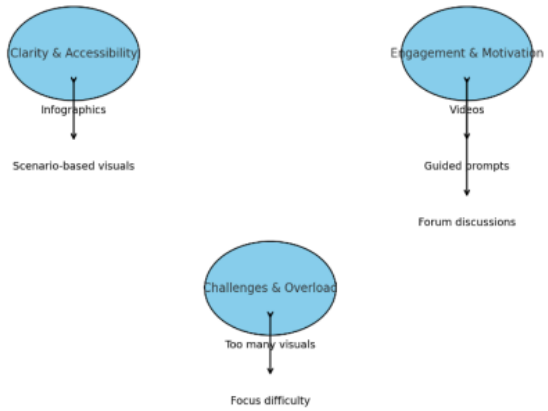

Figure 7. Visual Model of Student Reflection Themes

Figure 7 illustrates the three themes and their subthemes: clarity and accessibility (infographics, scenario-based visuals), engagement and motivation (videos, guided prompts, forums), and cognitive-overload challenges (excessive visuals, difficulty maintaining focus).

3.1.6 Perceptions from follow-up interviews

The follow-up interviews with the 12 purposively selected participants corroborated the reflection themes while adding nuance on usability and multimodal value. Participants noted that the interface was user-friendly and accessible across devices, and that the integration of text, visuals, and video made learning more dynamic and aided retention and contextual application. Recurring suggestions were to add interactive quizzes with immediate feedback and to balance visuals with explanatory text to avoid overload.

> "I could access the materials from my phone without any problem. The layout was simple, and everything was easy to find." (P12, male, 22)

> "I think having more quizzes with instant feedback would be very helpful." (P18, female, 20)

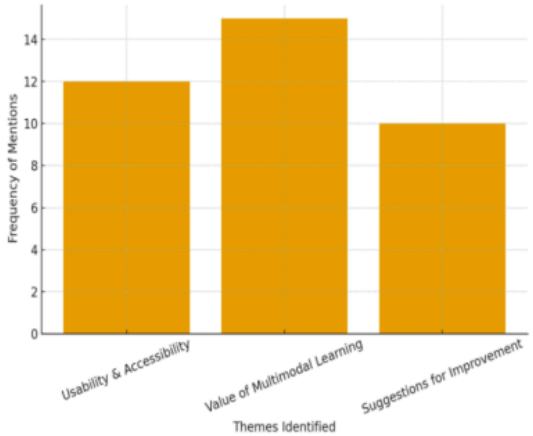

Figure 8. Key Themes Emerging from the Follow-Up Interviews

Figure 8 shows that usability and accessibility were the most frequently emphasised aspects, followed by the value of multimodal learning, with suggestions for improvement mentioned less frequently but providing guidance for refinement.

3.1.7 Integration of quantitative and qualitative findings

The integration of the two strands produced a consistent but qualified interpretation. Quantitatively, both cohorts demonstrated substantial pretest–posttest improvement, and time-on-task was positively associated with learning gains. Qualitatively, students described the visual–linguistic arrangement as clarifying and motivating, providing a plausible explanation for why sustained interaction with the module was associated with stronger outcomes. At the same time, the qualitative evidence identified a boundary condition not captured by the statistical analyses—cognitive overload when visual density became excessive. Thus, the findings support neither a simple claim that "more visual material is better" nor a claim that visual design alone produces learning; rather, the instructional value of visual–linguistic design depends on coordination, signalling, relevance, and controlled information density.

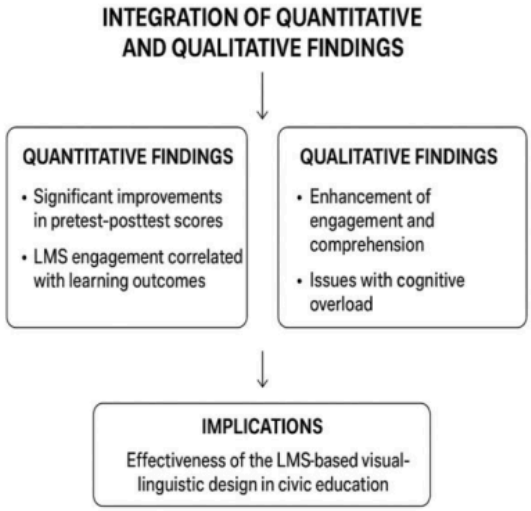

Figure 9. The Integration of Quantitative and Qualitative Findings.

Figure 9 shows the convergence of measurable academic gains (significant pretest–posttest improvement, large d_av, and the time-on-task association, $R^2 = .42$) with qualitative accounts of clarity, motivation, and engagement, alongside the overload boundary condition, indicating that the design enhanced both cognitive outcomes and engagement while identifying an area for refinement.

3.2 DISCUSSION

3.2.1 Restatement of main findings

In brief, both cohorts improved significantly with large within-group effects and negligible cross-cohort difference; time-on-task was the strongest engagement correlate of

gains; and students valued clarity, accessibility, and motivation but reported overload when visuals were dense. We now interpret these findings without re-reporting the statistics.

3.2.2 Interpretation and theoretical explanation

We interpret the gains through the specific CTML principles the design instantiated rather than "multimodality" in general. The adjacency of infographics and explanatory text (spatial contiguity) and the exclusion of decorative material (coherence) plausibly reduced extraneous load and supported dual-channel model-building [10]. Narrated, captioned videos (modality, temporal contiguity) and weekly units (segmenting) likely helped manage intrinsic load for value-based content. The overload reports are the theoretically most informative result: when signalling was weak, or images competed on a single page, the coherence and signalling principles were violated, raising extraneous load—precisely the mechanism CTML predicts. Candidate sources of overload include excessive images, redundant text–visual pairings, weak signalling, high information density, and insufficient segmentation; future iterations should test these directly. These insights are consistent with work showing multimodal scaffolding strengthens both cognitive processing and emotional involvement [24] and that visual scaffolding improves outcomes even in digitally constrained settings [25].

3.2.3 Comparison with previous studies (critical, not only confirmatory)

The gains align broadly with work showing multimodal civic instruction outperforms text-only delivery [8], [15] and with usability–satisfaction findings [26]. However, our study differs in three respects that qualify direct comparison: it targets values education rather than STEM or language learning; it foregrounds a drawback (overload) that benefit-focused studies rarely report [16], [18], [27]; and, crucially, its single-group design cannot claim superiority over conventional instruction, unlike controlled studies it might otherwise be compared with.

3.2.4 Conceptual distinctions and cautions

We deliberately distinguish improved test performance (understanding) from internalisation, satisfaction, and civic behaviour. Higher scores after six weeks indicate short-term comprehension gains; they do not demonstrate durable value internalisation, moral development, or national-character formation, none of which were directly measured. Earlier language implying such outcomes has been removed.

3.2.5 Limitations

This study has several limitations. (1) It used a single-group design with no conventional-instruction control, so gains cannot be attributed exclusively to the intervention (maturation, repeated testing, and instructor effects are uncontrolled). (2) The sample was small, single-institution, non-random, and convenience-based, limiting generalisability. (3) The intervention was short (six weeks) with no delayed posttest, so persistence is unknown. (4) Although pretest and posttest used equivalent rather than identical forms, testing effects cannot be fully excluded. (5) LMS analytics, especially time-on-task, may overestimate

active engagement. (6) Qualitative data are self-reported and shaped by researcher–participant relationships. (7) Satisfaction and affective engagement were not measured with validated scales and are therefore not treated as psychometric outcomes.

3.2.6 Implications and future research

For lecturers, the study offers a concrete design heuristic: anchor each principle with a consistent colour-coded visual, keep explanatory text adjacent to its visual, keep videos concise and synchronised, and segment materials rather than presenting information-dense pages. For LMS designers, it argues for signalling and segmentation controls that let instructors regulate visual density and the placement of text and images. For curriculum developers, CTML principles provide a practical bridge between digital instructional design and values-oriented learning. Future research should use randomised or controlled designs, larger multi-institutional samples, delayed posttests, validated engagement and internalisation measures, and behavioural indicators of civic-value application, and should experimentally compare levels of visual density to identify when additional visual information shifts from supportive to burdensome [4], [28].

4. CONCLUSION

This study examined an LMS-based visual–linguistic instructional design grounded in the Cognitive Theory of Multimedia Learning and applied to Pancasila-values instruction among 47 second-semester university students from Science Education and English Education cohorts.

Both cohorts demonstrated statistically significant improvement between the pretest and posttest, with large within-group effect sizes. The difference in gain scores between the two disciplinary cohorts was negligible, suggesting broadly consistent patterns of improvement within the participating sample. LMS analytics further showed that time-on-task was the strongest behavioural correlate of learning gains, accounting for approximately 42% of the variance in gain scores in the simple regression model.

The qualitative findings provided additional insight: students valued the combination of infographics, concise text, short videos, scenario-based activities, and discussion prompts because these elements helped make abstract Pancasila concepts more concrete and applicable, yet they also reported cognitive overload when multiple visual elements were presented simultaneously.

The principal contribution of the study is therefore not simply evidence that LMS-supported instruction can improve Pancasila learning. Rather, it demonstrates how six CTML principles—coherence, signalling, spatial contiguity, temporal contiguity, segmenting, and modality—can be translated into a concrete instructional design for civic-values education while simultaneously identifying visual density as an important design boundary condition.

Because the study employed a single-group pretest–posttest design without a control group, the observed gains cannot be attributed exclusively to the LMS intervention; maturation, repeated testing, instructor effects, and other uncontrolled factors remain possible explanations. In addition, the small convenience sample from a single institution and the six-week intervention limit generalisability. Accordingly, the findings should be

regarded as preliminary within-group evidence rather than definitive causal evidence of instructional effectiveness. Future controlled and multi-institutional research should determine whether the observed short-term improvements persist over time and whether improved understanding translates into durable internalisation and behavioural application of Pancasila values.

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