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Designing a Project-Based Learning Model with Digital Technology Integration to Enhance Students' Creativity in Craft Subject

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Abstract: Project-Based Learning (PjBL) is increasingly recognized as a transformative approach in education, particularly for developing student creativity. Rather than focusing solely on conventional classroom routines, PjBL immerses learners in authentic, inquiry-driven, and collaborative projects that reflect real-world challenges. As digital technologies become increasingly central to daily life, educational models must innovate to meet the complex demands of the 21st century. This study set out to design and implement a technology-enhanced PjBL model for Grade VIII Craft (Prakarya) students at SMP Tahta Syajar, Bekasi, Indonesia. A quasi-experimental design was used, with 43 students divided into experimental and control groups. The intervention included digital brainstorming, visualization software, and collaborative platforms, all intended to scaffold the phases of project work. Student creativity was assessed using a validated, Torrance-based rubric measuring fluency, flexibility, originality, and elaboration. Results showed a significant improvement in all creativity domains for the experimental group (*p* < 0.05), with moderate to large effect sizes observed. Moreover, students reported greater enthusiasm, engagement, and creative confidence when digital technology was a core part of their learning.Overall, this study confirms that digital PjBL not only has a measurable positive impact on student creativity but also supports educational goals outlined by international frameworks such as OECD Education 2030 and UNESCO's Futures of Education. The findings provide a foundation for future research in technology-supported creative learning.

Keywords: Project-Based Learning, Creativity, Digital Learning, Craft Education, 21st-Century Skills

Abstrak: *Pembelajaran Berbasis Proyek (PjBL) semakin diakui sebagai pendekatan transformatif dalam pendidikan, khususnya untuk mengembangkan kreativitas siswa. Alih-alih hanya berfokus pada rutinitas kelas konvensional, PjBL melibatkan peserta didik dalam proyek-proyek otentik, berbasis penyelidikan, dan kolaboratif yang mencerminkan tantangan dunia nyata. Seiring dengan semakin sentralnya teknologi digital dalam kehidupan sehari-hari, model pendidikan harus berinovasi untuk memenuhi tuntutan kompleks abad ke-21. Studi ini bertujuan untuk merancang dan mengimplementasikan model PjBL yang ditingkatkan teknologi untuk siswa kelas VIII Kerajinan (Prakarya) di SMP Tahta Syajar, Bekasi, Indonesia. Desain kuasi-eksperimental digunakan, dengan 43 siswa dibagi menjadi kelompok eksperimen dan kontrol. Intervensi meliputi brainstorming digital, perangkat lunak visualisasi, dan platform kolaboratif, yang semuanya dimaksudkan untuk mendukung tahapan kerja proyek. Kreativitas siswa dinilai menggunakan rubrik berbasis Torrance yang telah*

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*divalidasi, yang mengukur kelancaran, fleksibilitas, orisinalitas, dan elaborasi. Hasil penelitian menunjukkan peningkatan signifikan di semua domain kreativitas untuk kelompok eksperimen (*p* < 0,05), dengan ukuran efek sedang hingga besar yang diamati. Selain itu, siswa melaporkan antusiasme, keterlibatan, dan kepercayaan diri kreatif yang lebih besar ketika teknologi digital menjadi bagian inti dari pembelajaran mereka. Secara keseluruhan, studi ini menegaskan bahwa PjBL digital tidak hanya memiliki dampak positif yang terukur pada kreativitas siswa, tetapi juga mendukung tujuan pendidikan yang digariskan oleh kerangka kerja internasional seperti OECD Education 2030 dan Futures of Education UNESCO. Temuan ini memberikan dasar untuk penelitian masa depan dalam pembelajaran kreatif yang didukung teknologi.*

Kata Kunci: *Pembelajaran Berbasis Proyek, Kreativitas, Pembelajaran Digital, Pendidikan Kerajinan Tangan, Keterampilan Abad ke-21*

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INTRODUCTION

Today's education extends well beyond the mere transmission of knowledge; learners must also cultivate critical competencies such as critical thinking, creativity, communication, collaboration, and digital literacy (OECD, 2023; UNESCO, 2023). Creativity is widely recognised as a fundamental driver of innovation, adaptability, and sustainable development (Plucker, 2022; Kaufman & Beghetto, 2023). In Indonesia, the Merdeka Belajar curriculum emphasises learner autonomy, entrepreneurship, and sustainability, positioning the Craft (Prakarya) subject as a promising domain for fostering creativity through project-based and entrepreneurial activities (Artayasa et al., 2024). However, the successful implementation of this curriculum is heavily contingent upon teacher readiness. There is an urgent need for structured mentoring policies particularly for Islamic Religious Education (PAI) teachers to support the development of independent teaching modules that align with the flexible architecture of the Merdeka Curriculum (Kemendikbudristek, 2024).

Within this educational ecosystem, the implementation of the Pancasila Student Profile Strengthening Project (P5) presents specific pedagogical challenges, particularly in religious education subjects. Teachers frequently struggle to integrate P5 themes with doctrinal content, encountering difficulties in assessing character outcomes alongside cognitive achievements (Kemendikbudristek, 2024). Despite these challenges, pioneering schools (Sekolah Penggerak) have demonstrated exemplary practices in which collaborative mentoring and modular learning have successfully bridged the gap between religious values and project-based inquiry. These contextual realities underscore the importance of adaptable pedagogical models across all subjects, including Craft. Comparative analyses of Islamic Religious Education curricula across Muslim-majority countries emphasise character internalisation over doctrinal memorisation, a stance that aligns with Indonesia's approach under the 2024 Independent Curriculum policy update (Kemendikbudristek, 2024).

The imperatives of the digital era accentuate the urgency of a responsive curriculum. The Academic Study of the Merdeka Curriculum (2024) affirms that the principle of flexibility is central to responding to this dynamic landscape, supplanting the previous "one-size-fits-all" paradigm that had long constrained pedagogical innovation (Kemendikbudristek, 2024). The flexible structure of the Merdeka Curriculum is designed specifically to accommodate the integration of cutting-edge technologies, including artificial intelligence (AI), cloud computing, and augmented reality without being constrained by rigid syllabi. This flexibility enables schools to adjust the pace and content of learning in accordance with

their local resource readiness while simultaneously pursuing global competency standards. Implementation evaluations, however, reveal that whilst the new curriculum offers considerable flexibility, many teachers remain uncertain about translating these principles into classroom practice. Key obstacles include difficulties in conducting diagnostic assessments and implementing differentiated instruction, compounded by limited digital infrastructure and disparate levels of pedagogical readiness across schools (Kemendikbudristek, 2024).

Project-Based Learning (PjBL), grounded in constructivist perspectives (Vygotsky, 1930; Piaget, 1969; Eshankulova & Nuritdinova, 2024; Wibowo et al., 2025), has been demonstrated to enhance student engagement by situating learning within authentic inquiry, collaboration, and reflection (Thomas, 2000; Bell, 2010). Empirical studies consistently report that PjBL strengthens motivation, problem-solving, and creative thinking (Guo et al., 2020; Yu, 2024). In the context of Society 5.0, the benefits of PjBL are further amplified by digital technologies that afford new possibilities for visualisation, iterative design, and collaborative production (Aslan, 2021; Kim, 2021; Chang et al., 2022; Han, 2025). The selection of Grade VIII students for this study is deliberate: adolescents aged 13–14 are in transition from concrete to formal operational thinking (Piaget, 1969), rendering them particularly receptive to inquiry-based and technology-enhanced learning. This developmental stage is further corroborated by adolescent learning psychology in secondary education, which underscores the critical role of autonomy and self-regulation in independent learning contexts (Tapia, 2014; Cleary, 2015; Panadero & Alonso-Santrock, 2018; Bardach et al., 2023; Wu et al., 2024).

Despite this potential, Craft education in Indonesian schools remains predominantly teacher-centred and lecture-based, thereby limiting opportunities for creative and collaborative exploration (Ngurah & Laksana, 2024). Although the international literature on technology-enhanced PjBL continues to expand, comparable studies situated within the Indonesian lower-secondary Craft context remain scarce (Jamil et al., 2025). This disconnect between global pedagogical innovation and local practice signals a clear imperative for a contextually relevant digital PjBL model specifically tailored to enhance creativity in Prakarya classrooms.

Creativity in educational research is commonly operationalised across four dimensions: fluency, flexibility, originality, and elaboration all of which are amenable to purposeful pedagogical intervention (Almeida et al., 2008; Torrance, 2018). Learning environments that foster exploration, constructive feedback, and peer interaction support development across these dimensions (Runco, 2014; Botella et al., 2022). Comparative evidence demonstrates that pedagogical approaches such as PjBL, Design Thinking, and STEAM can effectively strengthen creative thinking, whilst digital tools extend opportunities for visualisation, experimentation, and reflective practice (Wong et al., 2021; Utami et al., 2025; Tang et al., 2022).

Recent empirical work further indicates that integrating digital tools into PjBL enhances motivation, collaboration, and innovation across disciplines (Carvalho et al., 2022; Mardizal et al., 2023; Ratih & Arsih, 2024; Anggarani et al., 2025). Such integration aligns with major international frameworks, notably the OECD Education 2030 agenda and UNESCO's Futures of Education initiative both of which foreground creativity, digital literacy, and collaboration as essential competencies for the twenty-first century (OECD, 2023; UNESCO, 2023).

In response to the identified gap, this study aims to design and evaluate a technology-enhanced PjBL model for the Craft subject at SMP Tahta Syajar, Bekasi. This model is conceived not only to enhance creativity, but also to be consonant with the school's readiness level during the curriculum transition, aligned with Islamic ethical values, and responsive to the demands of flexibility in the Society 5.0 era. Specifically, the research objectives are to: (1) develop a digital PjBL model that integrates brainstorming, visualisation, and online collaboration tools whilst aligning them with Islamic ethical values;

(2) implement the model with Grade VIII students, with due consideration of the school's infrastructural and pedagogical readiness; and (3) evaluate its effectiveness in enhancing creativity across Torrance's four dimensions which were fluency, flexibility, originality, and elaboration within the broader context of twenty-first-century competency demands.

METHOD

Research Design

This study adopted a quasi-experimental design with pre-test and post-test control groups — a design widely employed in educational research when randomisation is not feasible yet control of variables remains essential (Shadish et al., 2002; Cook, 2015). This approach enables valid comparisons between treatment and control groups whilst accounting for the ecological realities of classroom settings, and has been frequently applied in recent PjBL research (Mardizal et al., 2023; Adawiah et al., 2024). The design further aligns with the 2024 Independent Curriculum policy update, which advocates for flexible, evidence-based pedagogical interventions that prioritise student agency and contextual relevance (Kemendikbudristek, 2024). This methodology permitted precise measurement of changes in creativity, digital literacy, and engagement prior to and following the intervention, thereby ensuring that observed differences could be attributed to the digital PjBL model rather than extraneous factors. Furthermore, whilst the primary focus of this study is Craft education, the ethical framework underpinning the model is consonant with recent comparative analyses of Islamic Religious Education curricula across Muslim-majority countries, which emphasise character internalisation over doctrinal memorisation (Munastiwi & Marfuah, 2019).

Research Participants

Participants comprised 43 Grade VIII students from SMP Tahta Syajar, Bekasi, Indonesia, during the 2024/2025 academic year. They were assigned to either an experimental group (n = 22), which engaged with the digital PjBL model integrating Padlet, Canva, Google Classroom, and digital presentation tools, or a control group (n = 21), which received conventional instruction through lectures, worksheets, and paper-based assignments. The selection of Grade VIII was deliberate: adolescents aged 13–14 occupy a transitional stage from concrete to formal operational thinking (Piaget, 1969), rendering them particularly receptive to inquiry-based and technology-enhanced learning. This developmental stage is further corroborated by adolescent learning psychology in secondary education, which underscores the critical role of autonomy and self-regulation in independent learning contexts (Santrock, 2018). Demographic information including gender distribution and prior digital literacy levels was collected via a pre-study survey to ensure equivalence between groups prior to the intervention.

Systematic Literature Search and Selection Strategy

To ground the development of the digital PjBL model in robust empirical evidence, a systematic literature search was conducted prior to the experiment. Keywords were formulated in both English and Indonesian to broaden the scope and capture local contextual studies. The English search strings included combinations of: "Project-Based Learning" OR "PjBL" AND "digital tools" OR "technology integration" AND "creativity" AND "secondary education". To ensure inclusivity of Indonesian scholarship, parallel searches were conducted using Indonesian keywords: "Pembelajaran Berbasis Proyek" OR "PjBL" AND "teknologi digital" AND "kreativitas" AND "Sekolah Menengah Pertama" OR "SMP". Databases searched included Scopus, Web of Science, ERIC, Google Scholar, and Garuda (for Indonesian journals).

From an initial pool of over 1,500 search results, the final selection of 28 articles was based on three specific inclusion criteria: (1) Contextual Relevance: Studies must focus on lower-secondary education (grades 7–9) within STEM or Craft subjects to ensure alignment with the target demographic; (2) Intervention Specificity: Articles must explicitly detail the integration of digital collaboration or

visualization tools (e.g., cloud platforms, AR, AI) within a PjBL framework; and (3) Recency and Rigor: Only peer-reviewed empirical studies published between 2019 and 2025 with clear quantitative or mixed-method outcomes on creativity were included. This rigorous filtering ensured that the synthesized model reflects current technological affordances and pedagogical best practices relevant to the Indonesian curriculum context.

Data Coding and Reliability

To ensure the reliability of the data coding process during the literature synthesis, a structured coding protocol was developed based on key variables: instructional tools used, creativity dimensions measured, and effect sizes reported. Two independent researchers coded the selected 28 articles. Inter-rater reliability was assessed using Cohen's Kappa coefficient, yielding a value of 0.85, indicating substantial agreement. Discrepancies in coding were resolved through consensus discussions involving a third senior researcher. This triangulated coding process minimized bias and ensured the consistency and accuracy of the thematic analysis used to construct the digital PjBL framework.

Instruments and Intervention

To ensure methodological rigour in the experimental phase, several instruments were employed. A creativity rubric adapted from the Torrance Tests of Creative Thinking (Torrance, 2018) measured four dimensions — fluency, flexibility, originality, and elaboration — and has been validated in recent PjBL studies (Yiling et al., 2025). Observation sheets were developed to record collaborative behaviour, participation, and engagement, drawing upon established frameworks (Reli Handayani et al., 2024; Ukobizaba et al., 2025). Student questionnaires addressed motivation, self-efficacy, and digital literacy, adapted from validated scales (Özeren, 2023). Prior to data collection, reliability (Cronbach's α) and validity (confirmatory factor analysis; CFA) analyses were conducted to confirm instrument consistency and construct accuracy (Suwono et al., 2022).

The intervention spanned six weeks (12 sessions) and encompassed a complete Craft project cycle. The control group received teacher-centred instruction with minimal technological integration, whilst the experimental group participated in structured PjBL stages aligned with recognised pedagogical frameworks (Kusumaningrum et al., 2025; Novalia et al., 2025). Project themes were purposefully designed to align with the Pancasila Student Profile Strengthening Project (P5), optimising instructional time for social project activities through which students could apply ethical principles in real-world contexts (Kemendikbudristek, 2024). The intervention incorporated four sequentially structured digital activities: digital brainstorming via Padlet (Novallyan & Nehru, 2025), design visualisation through Canva (Fitri et al., 2024), online collaboration facilitated through Google Classroom (Novalia et al., 2025), and reflective digital presentations that cultivated creativity, communication, and critical evaluation (Zhang et al., 2024). Throughout the process, formative feedback was systematically provided to guide student learning and promote iterative refinement of project outcomes (Hidayah et al., 2025; Thomas, 2000).

Data Analysis

Data analysis combined descriptive and inferential statistics using SPSS version 27 to examine the effect of the digital PjBL model on creativity outcomes. Descriptive statistics (means and standard deviations) were calculated for pre-test and post-test scores across all creativity dimensions (Field, 2024; Ndiung & Menggo, 2024). Independent-samples t-tests determined significant differences between groups (Mardizal et al., 2023; Rahayu & Afnita, 2023), while effect sizes (Cohen's d) assessed the magnitude of differences, following standard benchmarks of 0.2 (small), 0.5 (medium), and 0.8 (large) (Cohen et al., 2018; Wai & Brown, 2021; Plucker, 2022). To further validate results, an ANCOVA was performed to control for potential covariates such as prior digital literacy or baseline creativity (Chang et al., 2022; Zha et al., 2025). The integration of descriptive analysis, t-tests, effect size estimation, and ANCOVA ensured methodological robustness and comprehensive interpretation consistent with

international standards for PjBL and technology-enhanced learning research (Hasumi & Chiu, 2024; Warman et al., 2025).

RESULT AND DISCUSSION

The results of this study revealed that implementing a technology-enhanced Project-Based Learning (PjBL) model significantly improved students' creativity in the Craft (Prakarya) subject. Descriptive statistics indicated higher mean scores across all four creativity dimensions - fluency, flexibility, originality, and elaboration - for the experimental group compared to the control group. The quantitative results were further supported by qualitative classroom observations, providing a comprehensive view of the learning process and its outcomes.

Tabel 1. Mean Creativity Scores by Group

Aspect	Experimental (n = 22)	Control (n = 21)	Difference (Exp–Ctrl)
Fluency	78 (SD = 5.2)	65 (SD = 6.1)	+13
Flexibility	75 (SD = 4.8)	63 (SD = 5.4)	+12
Originality	80 (SD = 6.0)	68 (SD = 5.7)	+12
Elaboration	82 (SD = 5.5)	70 (SD = 6.2)	+12
Overall Mean	78.8	66.5	+12.3

Descriptive results revealed that the experimental group consistently outperformed the control group across all creativity dimensions, with the most pronounced gains in fluency and elaboration — indicating that the digital PjBL model effectively stimulated students' capacity to generate and elaborate upon ideas with greater depth and originality. These findings are consonant with Torrance's (1974) framework, which identifies fluency, elaboration, and originality as pivotal components of creativity cultivated through iterative, digitally supported learning experiences.

Inferential analyses confirmed statistical significance across all four dimensions: fluency, $t(41) = 6.42$, $p < .001$, $d = 0.78$; flexibility, $t(41) = 5.91$, $p < .001$, $d = 0.74$; originality, $t(41) = 6.15$, $p < .001$, $d = 0.76$; and elaboration, $t(41) = 6.82$, $p < .001$, $d = 0.81$. Effect sizes (0.74–0.81) reflect medium-to-large practical significance per Cohen's (1988) conventions. A subsequent ANCOVA controlling for prior digital literacy confirmed that group differences remained significant ($p < .01$), attributing observed creativity gains to the intervention rather than pre-existing characteristics — consistent with prior digital PjBL research (Chang et al., 2022; Mardizal et al., 2023; Paramitha et al., 2025).

Qualitative observations corroborated these outcomes. Experimental group students demonstrated markedly higher engagement, collaboration, and motivation, actively utilising Padlet for brainstorming, Canva for visualisation, and Google Classroom for peer feedback — yielding creative outputs that were both innovative and diverse. In contrast, control group students engaged more passively, producing comparatively uniform work. These behavioural contrasts illustrate how purposeful technology integration within PjBL promotes learner autonomy and inquiry, shifting pedagogy from teacher-centred to learner-centred (Hasan et al., 2023; Sausan & Masbukhin, 2024).

These findings align with a growing body of literature underscoring the synergistic relationship between digital technology and PjBL in fostering 21st-century competencies. Mardizal et al. (2023) demonstrated that blended PjBL environments simultaneously enhance creative and digital competencies, whilst Paramitha et al. (2025) confirmed that cloud-based collaboration strengthens flexibility and originality. Chang et al. (2022) further established that augmented reality supports

visualisation and engagement, and Zha et al. (2025) reported that AI integration promotes originality and elaboration. The present study extends this evidence to the Indonesian context, affirming that digital PjBL effectively enhances creativity in non-STEM subjects such as Craft.

The observed improvements across creativity dimensions can be attributed to the functional affordances of the digital tools employed. Padlet fostered fluency through open idea-sharing and clustering, facilitating rapid ideation (Nasution et al., 2024). Canva enabled detailed visualisation, thereby enhancing elaboration and originality (Azizah Lubis et al., 2023). Google Classroom provided a structured space for flexible collaboration, iterative peer feedback, and reflective refinement — collectively strengthening flexibility and communication (Karim & Na, 2024). Collectively, these findings affirm that digital learning environments offer cognitive scaffolding consonant with constructivist theory (Vygotsky, 1930; Piaget, 1969), wherein learners construct understanding through active engagement and social collaboration.

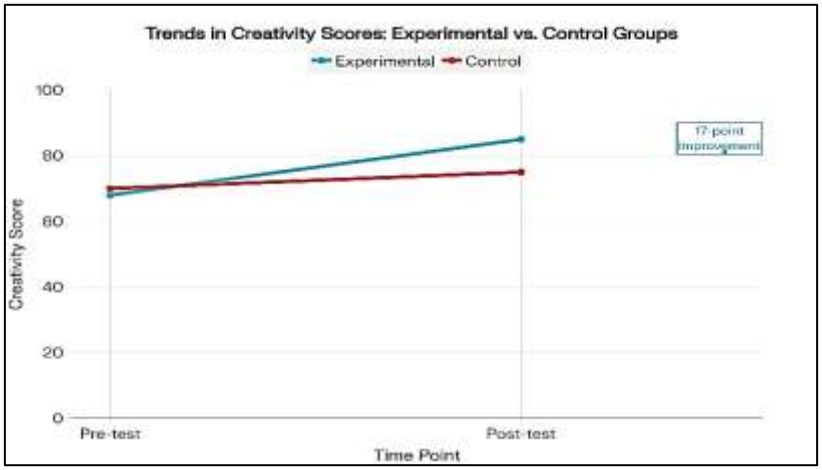

Figure 1. Trends in Creativity Scores Between Experimental and Control Groups

Figure 1 illustrates the comparative progression of mean creativity scores between the experimental and control groups. The experimental group (blue line) exhibits a markedly steeper trajectory than the control group (red line), confirming that the digital PjBL intervention produced substantially greater gains in overall creativity.

Beyond individual learning outcomes, these findings demonstrate that digital PjBL contributes meaningfully to the realisation of Merdeka Belajar principles — notably learner autonomy, creativity, and sustainability (Artayasa et al., 2024). The results further resonate with the OECD Education 2030 agenda and UNESCO's Futures of Education framework (OECD, 2023; UNESCO, 2023), both of which foreground creativity, digital literacy, and collaboration as indispensable competencies for future-ready learners. Collectively, these outcomes substantiate Runco and Jaeger's (2012) contention that creativity is not an innate fixed trait but a capacity systematically cultivable through intentional pedagogical design.

Comparative Analysis: Islamic Religious Education (PAI) in K13 vs. Merdeka Curriculum

While this study focused on the Craft subject, the success of the flexible, project-based approach resonates with the broader transformation occurring in other subjects, notably Islamic Religious Education (PAI). The shift from the 2013 Curriculum (K13) to the Merdeka Curriculum represents a fundamental change in operational boundaries and pedagogical focus for PAI. As highlighted in the Academic Study of the Merdeka Curriculum (Kemendikbudristek, 2024), the new curriculum redefines PAI not merely as doctrinal memorization but as the internalization of noble character (akhlaqul karimah) applied through real-world projects.

Table 2. Comparison of Operational Boundaries: Islamic Religious Education (PAI) in K13 vs. Merdeka Curriculum

Aspect	Curriculum 2013 (K13)	Merdeka Curriculum
Primary Focus	Mastery of cognitive content and doctrinal knowledge; emphasis on completing dense material coverage.	Internalization of values and character (*akhlaqul karimah*); focus on essential competencies and holistic development.
Pedagogical Approach	Largely teacher-centered, lecture-based, and text-book dependent; limited flexibility for contextual adaptation.	Student-centered, flexible, and context-aware; encourages project-based learning and social interaction to apply religious values.
Assessment Strategy	Summative-heavy; focuses on standardized tests measuring memory and theoretical understanding of fiqh, history, and Quranic verses.	Balanced diagnostic, formative, and summative; emphasizes authentic assessment of behavior, character projection, and ethical decision-making.
Integration with Other Subjects	Limited; PAI is often taught as an isolated silo with minimal cross-disciplinary connection.	Highly integrated; PAI serves as an ethical foundation for other subjects (e.g., guiding ethics in digital Craft projects), supporting the *Pancasila Student Profile*.
Flexibility	Rigid "*one-size-fits-all*" syllabus determined centrally; little room for local wisdom or student interest.	Flexible structure allowing teachers to adapt materials to local context, student readiness, and contemporary issues (e.g., digital ethics).
Role of Technology	Supplemental; primarily used for presenting static content or accessing digital texts.	Integral; used for collaboration, visualization of ethical scenarios, and connecting with global Islamic perspectives (Society 5.0 alignment).

Source: Adapted from Kemendikbudristek (2024).

This comparison underscores that the flexibility and project-oriented nature of the Merdeka Curriculum, which facilitated the success of our digital PjBL model in Craft, are equally critical for revitalizing PAI. Just as Craft students benefited from moving away from rigid instructions to autonomous creation, PAI students benefit from shifting from rote memorization to applying Islamic ethics in complex, modern contexts. The synergy between PAI's ethical framework and the creative freedom in subjects like Craft fosters the development of the Pancasila Student Profile, specifically the dimensions of being faithful, devout, and creative (Kemendikbudristek, 2024).

The Role of Diagnostic and Formative Evaluation in Digital PjBL

A critical factor contributing to the significant gains in creativity was the strategic implementation of diagnostic and formative evaluations, which are central tenets of the Merdeka Curriculum's learning characteristics. Unlike traditional models that rely heavily on summative testing, this study embedded continuous assessment loops to tailor instruction to student needs.

Diagnostic Evaluation: Establishing the Baseline

Prior to the intervention, diagnostic assessments were conducted to map students' initial creativity levels, digital literacy, and learning preferences. Consistent with the Merdeka Curriculum's principle of "teaching at the right level," these diagnostics allowed the researcher to differentiate instruction from day

one (Kemendikbudristek, 2024). For instance, students with lower baseline digital skills were paired with more proficient peers during the initial Padlet brainstorming sessions, ensuring that technical barriers did not hinder creative expression. This aligns with findings that diagnostic data is crucial for designing differentiated learning paths that accommodate diverse learner readiness. Without this initial diagnostic step, the "one-size-fits-all" approach of the control group would likely have persisted, limiting the potential for growth among struggling learners.

Formative Evaluation: Driving Iterative Improvement

Throughout the six-week intervention, formative evaluation functioned as the primary engine for creative refinement, operating not as a discrete event but as a continuous, technology-integrated process embedded within the digital PjBL framework. Real-time feedback was facilitated through Google Classroom and Padlet, enabling ongoing peer and teacher commentary on students' design drafts in Canva. This immediacy of response allowed for rapid iteration, a recognised driver of elaboration and originality (Karim & Na, 2024) and mirrors the Merdeka Curriculum's principle of utilising assessment for learning rather than merely of learning (Kemendikbudristek, 2024). Weekly digital reflection prompts further required students to evaluate their own creative processes and collaborative effectiveness, generating qualitative data that informed subsequent instructional adjustments. Notably, when formative data indicated a decline in group collaboration during Week 3, the instructor introduced structured team roles, which promptly restored student engagement. Concurrently, adaptive scaffolding was deployed in response to emerging patterns: students demonstrating high fluency but limited elaboration received targeted prompts to deepen their designs, whilst those exhibiting low flexibility were exposed to diverse exemplars through curated digital galleries.

The systematic integration of diagnostic and formative evaluation thus established a responsive learning ecosystem in which instruction dynamically adapted to student progress. This approach substantiates Kemendikbudristek's (2024) assertion that prioritising learning progress over content coverage yields deeper competency acquisition. The contrast with the control group, which relied predominantly on end-of-unit summative testing, underscores how the absence of iterative formative feedback constrains opportunities for correction and creative growth. By embedding evaluative practices within the digital PjBL framework, this study affirms that assessment itself can function as a transformative pedagogical instrument for enhancing student creativity.

Implications for Islamic Religious Education (PAI) Within the Merdeka Curriculum

The inquiry-based learning approach demonstrated in this study carries significant implications for Islamic Religious Education (PAI) within the Independent Curriculum. By encouraging students to question assumptions, explore diverse perspectives, and construct understanding through evidence-based reasoning, inquiry-oriented PAI instruction can serve as an effective preventive measure against religious radicalisation. When students are trained to engage with religious texts contextually rather than through rigid memorisation, they develop the critical faculties necessary to interrogate and reject extremist narratives. This is consonant with the Merdeka Curriculum's emphasis on critical reasoning, wherein PAI learning outcomes explicitly prioritise religious moderation (wasatiyah) as foundational content. Grounding creativity and technological fluency within these ethical and moderate religious principles ensures that students emerge not merely as innovative thinkers, but as spiritually balanced individuals.

Extending Zha et al.'s (2025) findings, artificial intelligence presents considerable potential in supporting PAI teachers to design personalised learning experiences. AI-driven tools can analyse student responses to religious and ethical dilemmas, enabling teachers to tailor moderation content to individual cognitive and spiritual developmental stages, thereby ensuring that the internalisation of moderate values is both contextually responsive and pedagogically effective. To broaden the curricular impact of these findings particularly for PAI three strategic implications are proposed within the Merdeka Curriculum

framework. First, the Community of Practice model, exemplified by Musyawarah Guru Mata Pelajaran (MGMP), should be systematically strengthened as a collaborative platform through which PAI teachers share digital PjBL practices and co-develop independent teaching modules, in alignment with government support for professional learning communities (Kemendikbudristek, 2024). Second, school supervisors must assume a more active role in mentoring teachers and safeguarding the quality of curriculum implementation, transitioning from administrative compliance monitoring towards substantive pedagogical support (Kemendikbudristek, 2024). Third, strategies should be developed to optimise PAI instructional time for social project activities by integrating PAI values into the Projek Penguatan Profil Pelajar Pancasila (P5) — a framework that allocates 20–30% of study time to cross-disciplinary projects — thereby affording students meaningful opportunities to apply religious moderation values within authentic real-world contexts (Kemendikbudristek, 2024).

In light of these findings, the integration of digital tools within PjBL represents not merely an enhancement but a transformation of Craft education. It fosters authentic contexts for problem-solving and reflection while equipping learners with digital fluency and creative confidence. The parallel transformation observed in the operational boundaries of PAI under the Merdeka Curriculum further suggests that these pedagogical shifts are scalable across disciplines. Nevertheless, this study acknowledges limitations, including its relatively small sample size (n = 43) and short intervention duration. Future studies should replicate this design across diverse schools and regions, employ longitudinal approaches to examine sustained impacts, and explore emerging technologies such as AI, VR, and AR for deeper creative engagement (Arqam & Asrifan, 2024; Yiling et al., 2025). Specifically, future research should investigate how AI-assisted personalized learning can be optimized for PAI teachers to monitor and nurture religious moderation indicators among students.

Overall, the results and discussion confirm that technology-enhanced Project-Based Learning significantly improves creativity in the Craft (Prakarya) subject. The findings reinforce constructivist learning theory, align with international research, and demonstrate that digital PjBL offers a scalable and contextually relevant model for integrating creativity, technology, and authentic learning experiences to nurture 21st-century.

CONCLUSION AND SUGGESTIONS

This study conclusively demonstrates that integrating digital technologies into Project-Based Learning significantly enhances student creativity within Indonesia's Merdeka Curriculum framework, yielding medium-to-large effect sizes across all four dimensions — fluency, flexibility, originality, and elaboration. Tools such as Padlet, Canva, and Google Classroom function not as supplementary additions but as critical catalysts, transforming Craft education from teacher-centred delivery into inquiry-driven knowledge construction consonant with constructivist theory and the curriculum's core objectives of autonomy and innovation. These findings empirically validate Torrance's creativity framework and reinforce the assertion that creative competencies are systematically cultivable through intentional, digitally scaffolded pedagogical design. Policymakers and school leaders must therefore prioritise sustained investment in digital infrastructure and continuous professional development to ensure the equitable and scalable adoption of technology-enhanced PjBL across diverse educational contexts.

Notwithstanding these outcomes, limitations pertaining to sample size (n = 43), intervention duration, and the use of foundational digital platforms necessitate cautious generalisation. Future research should pursue longitudinal designs to examine sustained effects on creativity, entrepreneurship, and adaptability, whilst exploring the contributions of advanced technologies — including AI, augmented reality, and virtual reality — to student engagement and learning outcomes. Investigations into the cross-disciplinary impact of digital PjBL, particularly its intersection with religious literacy, character formation, and ethical reasoning within the Merdeka Curriculum, represent especially promising avenues.

Ultimately, this study affirms that technology-enhanced PjBL constitutes a potent, contextually relevant model for nurturing learners who are not only creatively competent but also ethically grounded and adaptable to the demands of the 21st century.

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