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Innovative and Value-Based Learning Design in the Context of 21st-Century Learning

Titi Hendrawati

Sekolah Tinggi Agama Islam Haji Agus Salim Cikarang, Bekasi, Indonesia

Corresponding Author: titi.hendrawati@staihas.ac.id

Abstract. Industry 4.0 and Society 5.0 are reshaping vocational education by demanding graduates who are not only technically competent but also able to think critically and creatively, collaborate and communicate (4C), use technology responsibly, and demonstrate strong character. This study analyzes an innovative, value-based learning design at SMK Al-Amin Cikarang Utara that integrates 4C skills, higher-order thinking skills (HOTS), the TPACK framework, and Pancasila Student Profile values. Using a qualitative descriptive case study, data were collected through in-depth interviews with the vice principal and three productive teachers, classroom observations of project-based learning, and analysis of KOSP documents and teaching modules/lesson plans, then analyzed using the Miles and Huberman model. The findings show that teachers embed these pillars in initial diagnostic assessments, Project-Based Learning, the use of digital media, and authentic assessments of products, processes, and reflections. The design positions teachers as learning experience designers who bridge the transfer of knowledge and values, supporting the development of competent, independent, and characterful vocational graduates. This study was limited to one educational unit, so the findings cannot be generalized widely and suggest opportunities for comparative research across diverse vocational school contexts.

Keywords: HOTS, Pancasila Student Profile, 4C Skills, TPACK, Vocational Education.

1 Introduction

Industry 4.0 and the acceleration of digital transformation have shifted the competency landscape of the workplace from routine technical execution to adaptive problem-solving, human–technology collaboration, and continuous learning. In the Society 5.0 perspective, technology is expected not only to improve efficiency but also to remain human-centered—requiring graduates who can integrate technical competence with social responsibility and ethical judgment [1], [2], [3]. For vocational high schools (SMKs), this context creates an urgent need to redesign instruction so that students develop (a) 21st-century skills (critical thinking, creativity, communication, and collaboration/4C), (b) higher-order thinking skills (HOTS; C4–C6), (c) digital competence, and (d) character values that sustain professional conduct.

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However, evidence from vocational and school-based studies suggests that these competencies are often developed in fragmented ways: HOTS is frequently interpreted as isolated higher-level questions, 4C as generic soft-skills activities, technology integration as media substitution, and character education as an add-on outside the core learning task [4], [5], [6]. Such fragmentation is problematic for SMK learning because vocational tasks require students to simultaneously analyze real constraints, collaborate in teams, use specialized tools, and uphold integrity and safety standards.

To address this fragmentation, this study adopts a coherent theoretical rationale: 4C and HOTS represent the targeted student competencies that must be elicited through authentic vocational tasks; TPACK represents teachers' design capacity to orchestrate technology, pedagogy, and vocational content so that learning activities are feasible, safe, and industry-relevant [7], [8]; and the Pancasila Student Profile functions as the value compass that defines how competencies are practiced (e.g., integrity, mutual cooperation, independence, and professionalism) [9], [10]. Project-Based Learning (PBL) is positioned as the integrating pedagogy that operationalizes all components into one instructional flow: essential questions, collaborative production, iterative testing, and public presentation [11], [12]. Thus, the framework is not a parallel set of concepts but a single integrated instructional design in which competencies (4C–HOTS), enabling teacher knowledge (TPACK), value orientation (Pancasila Profile), and pedagogy (PBL) mutually reinforce one another.

The context of this study is an Islamic vocational school. In such settings, vocational learning is expected to produce work-ready graduates while also strengthening moral reasoning, discipline, and professional ethics. This context is particularly relevant because integrity and responsibility are critical in technical fields (e.g., network configuration and security) where mistakes or dishonesty can have real consequences. Accordingly, the integration of Pancasila values within vocational projects is not merely normative compliance but an instructional necessity to cultivate ethical practice alongside technical competence.

Previous research has examined PBL, TPACK, HOTS, or character education, yet studies that (1) integrate these constructs into a single, replicable design procedure, (2) operationalize them explicitly in lesson plans, activities, assessments, and project artefacts, and (3) justify the design within a religious-based SMK context remain limited [13], [14], [15], [16]. Therefore, this study contributes novelty by documenting an integrated value-based learning design procedure, its operationalization in real teaching tools, and the enabling–constraining factors that shape implementation in classroom practice.

The research questions are: (1) How is the procedure for designing innovative value-based learning formulated at SMK Al-Amin Cikarang Utara? (2) How is the integration of 4C, HOTS, TPACK, and Pancasila Student Profile values realized in learning design and classroom practice? (3) What internal and external factors support or hinder the implementation of the integrated learning design?

This research departs from the working hypothesis that an instructional design that systematically integrates 4C, HOTS, teachers' TPACK, and Pancasila Student Profile values through authentic PBL will better bridge the gap between vocational competency demands and daily classroom practice in the Society 5.0 era.

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2 Method

This study uses a qualitative descriptive case study to examine the design and implementation of an integrated value-based learning model at SMK Al-Amin Pasirgombong, North Cikarang, Bekasi Regency, West Java. The case study design was selected to capture the procedural detail of learning design work and the contextual conditions that shape implementation in a real vocational classroom.

Informants included the Deputy Principal for Curriculum and productive-subject teachers who implemented PBL and technology-supported vocational learning. Students were involved as supporting informants to clarify learning readiness and participation patterns observed during the project process.

Data were collected through: (1) in-depth interviews (to capture design rationale, decision rules, and perceived constraints), (2) non-participant observations of PBL sessions (to document enacted practices, interaction patterns, and technology use), and (3) document analysis of KOSP, teaching modules/lesson plans, project briefs, logbooks, peer-assessment forms, and authentic assessment rubrics (to verify the operationalization of 4C, HOTS, TPACK, and values in formal tools).

To improve construct clarity, the study used operational indicators derived from the literature: 4C indicators (collaboration, communication, creativity, critical thinking) [17]; HOTS indicators (analysis–evaluation–creation/C4–C6) [18]; TPACK components (TK, PK, CK and their intersections) [19], [20]; and Pancasila Student Profile values emphasized in projects (integrity, mutual cooperation, independence, and professionalism) [9], [21]. These indicators guided interview probes, observation sheets, and document coding.

Data analysis followed Miles and Huberman's interactive model: data reduction (coding and categorization), data display (matrices linking constructs to evidence), and conclusion drawing/verification through triangulation across sources (interviews–observations–documents) and techniques.

3 Result

3.1 Learning Design Procedure: A Replicable Integrated Framework

Document analysis and interviews indicate that teachers applied a systematic learning design procedure that can be replicated in other vocational schools. The procedure links curriculum standards to industry-like tasks, embeds 4C–HOTS outcomes in project milestones, uses TPACK to select feasible digital tools, and ensures that Pancasila values are assessed as part of performance rather than as separate moral lessons.

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Table 1. Replicable procedure for designing an integrated value-based PBL model in vocational learning

Design Stage	Key Decision/Output	Evidence in School Documents / Practice
1. Curriculum & industry-task alignment	Select a vocational task scenario (e.g., SOHO/office network) aligned with KOSP and competency targets.	Project brief; lesson plan objectives; KOSP alignment notes.
2. Integrated outcomes mapping	Map 4C + HOTS (C4–C6) + Pancasila values into measurable indicators for the project.	Learning objectives; indicator lists; assessment blueprint.
3. Initial diagnostic assessment	Assess prerequisite knowledge and non-cognitive readiness (motivation, learning preferences, digital access) for differentiation.	Diagnostic forms; grouping notes; differentiated support (print/video/LMS).
4. PBL scenario & milestones	Design essential question, roles, timeline, and milestones that force analysis–evaluation–creation and teamwork.	PBL timeline; role cards; milestone checklists; presentation plan.
5. TPACK-driven technology orchestration	Choose tools (simulator/LMS) and scaffolding strategies (demo/live-coding) matched to content and pedagogy.	Cisco Packet Tracer plan; LMS workflow; scaffolding notes.
6. Authentic assessment package	Use product–process–reflection assessment with rubrics and peer assessment; embed values indicators.	Rubrics; observation checklist; peer assessment; reflection prompts.
7. Reflection & iterative refinement	Use reflection evidence to revise project instructions and support strategies for the next cycle.	Teacher reflection notes; revised rubric/project guideline versions.

3.2 Operationalization of 4C, HOTS, TPACK, and Pancasila Values

To address construct operationalization, the lesson plans and project artefacts were coded against observable indicators. The mapping below summarizes how each construct is enacted through objectives, activities, and assessment evidence.

Table 2. Operationalization of key constructs in planning, enactment, and assessment

Construct	Lesson-Plan / Objective Indicators	Activity/Project Operationalization	Assessment & Artefacts (Evidence)
4C (Collaboration & Communication)	Team roles; presentation outcomes, and peer-feedback routines.	Role division (e.g., network engineer, security analyst, documentation); proposal and final presentation.	Peer assessment forms in LMS; presentation rubric; meeting logbooks.
4C (Critical Thinking & Creativity)	Problem diagnosis and solution alternatives; innovation target.	Troubleshooting sessions; comparing topology options; adding security/efficiency features.	Observation checklist (critical incidents); innovation score; design justification notes.
HOTS (C4–C6)	Analyze requirements (C4), evaluate alternatives (C5), create configuration/product (C6).	Needs analysis → topology selection → router/switch configuration and testing.	Network requirements document; topology diagram; configuration report/test results.
TPACK	Technology selected must support pedagogy and content (simulator/LMS/scaffolding).	Cisco Packet Tracer simulations; LMS for submission, feedback, and peer assessment; teacher demo/live coding.	LMS submission trail; simulator files/screenshots; teacher feedback logs.
Pancasila Student Profile values (contextualized)	Integrity, mutual cooperation, independence, responsibility embedded in project criteria.	Honest reporting of test failures; fair contribution; disciplined milestone completion.	Affective/process rubric; peer evaluation; reflection essay linking experience to values.

3.3 Initial Diagnostic Assessment and Learning Readiness

Based on interviews and analysis of teaching modules/lesson plans, teachers consistently conduct Initial Diagnostic Assessments (ADA) at the beginning of learning. The ADA is used to map students' learning readiness across cognitive (prerequisite mastery) and non-cognitive domains (motivation, emotional readiness, learning preferences) as well as digital access and literacy.

In practice, non-cognitive and digital readiness mapping becomes decisive for project feasibility. Teachers reported variation in device ownership and internet stability, as well as differing familiarity with LMS and vocational simulation tools. Therefore, ADA results are translated into differentiated supports: some groups can move quickly to complex simulations, while others receive step-by-step guides through printed modules, short videos, and additional mentoring.

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3.4 Project-Based Learning (PBL) Model

PBL as an Integrator of Learning Pillars

Document analysis and classroom observation show that PBL is the primary vehicle for integrating HOTS (C4–C6), 4C, TPACK, and Pancasila values in productive majors, particularly Computer and Network Engineering (TKJ). Teachers design projects that start from essential questions grounded in workplace-like scenarios, require teamwork and communication, demand iterative testing with digital tools, and culminate in presentation and reflection.

Table 3. Integration of HOTS, 4C, TPACK, and values in PBL (design rationale)

Learning Pillar	Integration in PBL Design	Theoretical Anchor
HOTS (C4–C6)	Projects begin with complex problems; students analyze constraints, evaluate alternatives, and create a tested solution.	Revised Bloom's Taxonomy
4C	Collaboration in role-based teams; communication through proposals and presentations; creativity through design choices; critical thinking through troubleshooting.	21st-century skills framework
TPACK	Teachers orchestrate a simulator/LMS + scaffolding so technology supports pedagogy and vocational content.	TPACK framework
Pancasila values	Values are embedded as performance criteria (integrity, mutual cooperation, independence, responsibility) during project work.	Pancasila Student Profile

Authentic Case Illustration in TKJ

In the TKJ department, the project centers on designing and configuring a small-scale computer network (e.g., a small office/home office network). Students are required to analyze user needs, recommend an efficient topology, configure devices, and test connectivity using a simulator before proposing improvements. Assessment records show that most students completed the stages successfully (e.g., documentation completeness, topology justification, and simulation test outcomes), suggesting that the task structure effectively elicits HOTS and teamwork.

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Table 4. PBL stages in TKJ: activities, integrated pillars, and documented evidence

PBL Stage	Student Activities	Integrated Pillars	Documented Evidence (Authentic Data)
Planning	Analyze bandwidth/security requirements based on users and layout.	HOTS (C4), Critical thinking	Needs analysis document (teacher rubric; majority adequate).
Design	Evaluate topology options (star/mesh/hybrid) and justify selection.	HOTS (C5), Creativity, Collaboration	Logical/physical diagram + justification notes (team artefact).
Implementation	Create router/switch configuration in simulator and test connectivity.	HOTS (C6), TPACK enactment, Independence	Configuration report + test results; simulator files/screenshots.

3.5 Integration of TPACK and Character Values in Classroom Practice

The integration of TPACK and values is embedded in the PBL scenario rather than treated as an add-on. Teachers select technologies (e.g., Cisco Packet Tracer and LMS workflows) because they allow repeated experimentation, safe failure, and transparent documentation—conditions that support both technical competence and responsible professional conduct.

TPACK Implementation Strategies

In TKJ classes, teachers employ: (a) simulation-based learning using Cisco Packet Tracer to reduce hardware constraints and enable iterative troubleshooting; (b) LMS for project management, submission trails, feedback, and peer assessment; and (c) teacher scaffolding through demonstration/live coding before independent exploration.

Table 5. TPACK components, implementation strategies, and value-related behaviors

TPACK Component	Strategy in TKJ PBL	Value/Character Behaviors Reinforced
TK/Simulation	Cisco Packet Tracer for designing/testing network configurations with safe iteration.	Independence in troubleshooting; integrity in reporting results.
TPK	LMS for logbooks, peer assessment, and rapid feedback cycles.	Discipline and responsibility through timely submissions; fairness in peer feedback.
PCK	Scaffolding demonstrations (e.g., basic router configuration) before team work.	Curiosity and perseverance during repeated trials.

Character Values Embedded in Projects
Values are strengthened through (1) role division and mutual accountability (mutual cooperation), (2) professional communication during presentations, and (3) explicit expectations of honest reporting of test results (integrity). Affective/process assessment records indicate generally positive ratings on contribution, professional attitude, and honesty indicators.

Table 6. Value dimensions, strengthening strategies, and assessment evidence

Value Dimension	Strengthening Strategy in PBL	Assessment Evidence (Artefacts)
Mutual cooperation	Role division with clear deliverables; collaborative problem solving.	Peer evaluation of contribution; team logbooks.
Professional attitude	Presentation routines; punctuality and respectful response to critique.	Presentation rubric; teacher observation notes.
Integrity	Transparent reporting of errors and configuration failures; ethical software use.	Project audit trail in LMS; reflection essays; absence of plagiarism flags.

3.6 Authentic Assessment Design

Assessment shifts from recall-oriented testing toward authentic assessment that evaluates products, processes, and reflections—thereby measuring HOTS, 4C, TPACK enactment, and value internalization.

Product Assessment
Product assessment evaluates the quality of the network configuration produced by students. The aspects measured include network functionality and security, as well as added value in the form of design innovation or solutions that exceed minimum standards. The instruments used are a network product assessment rubric and an innovation score from teachers/industry partners. Details of the aspects and instruments are presented in Table 7.

Table 7. Product assessment aspects and instruments

Measured Aspect	Description	Instrument / Artefact
Product quality (CK + HOTS C6)	Functionality, efficiency, and minimum security criteria.	Network product rubric; configuration report/test results.
Added value (Creativity)	Innovation beyond minimum standard (e.g., topology efficiency, security add-ons).	Innovation score + justification notes.

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Process Assessment

Process assessment evaluates 4C skills and character behaviors during the project. Teachers use daily observation checklists to record students' collaboration, communication, and critical thinking, while peer assessment evaluates team members' contributions and work ethic. The complete process assessment design is summarized in Table 8.

Table 8. Process assessment aspects and instruments

Measured Aspect	Description	Instrument / Artefact
4C skills	Collaboration, communication, critical thinking during teamwork and troubleshooting.	Teacher observation checklist; meeting logbooks.
Values (cooperation, independence, responsibility)	Contribution fairness, initiative, and role commitment.	Peer assessment (LMS form); teacher notes.

Reflective Assessment

Reflective assessment is used to measure metacognitive abilities and internalization of character values through technical reflection journals and final reflection essays. Students are asked to write down their technical experiences, troubleshooting strategies, and the values they feel while completing the project. The instruments and aspects measured are presented in Table 9.

Table 9. Reflective assessment aspects and instruments

Measured Aspect	Description	Instrument / Artefact
Metacognitive awareness (HOTS C4)	Write about encountered problems, troubleshooting steps, and lessons learned.	Technical reflection journal.
Value internalization	Reflect on integrity, patience, responsibility during project work.	Final reflection essay rubric.

3.7 Supporting and Inhibiting Factors

Implementation is shaped by both internal and external conditions. Interview and observation data suggest that leadership support for project-based planning, teachers' willingness to redesign roles, and the availability of core digital tools support the model. In contrast, uneven student digital access, varying levels of readiness, and the increased workload of authentic assessment can hinder consistent implementation.

Table 10. Supporting and inhibiting factors and implications for scaling

Factor Type	Supporting/Inhibiting Factor	How it Influences Implementation	Mitigation Strategy Observed/Recommended
Internal (School)	Curriculum leadership and culture	Enables consistent use of PBL routines	School-level templates for project

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		and value-based expectations.	briefs/rubrics; mentoring among teachers.
Internal (Teacher)	TPACK readiness and assessment literacy	Determines quality of technology orchestration and feedback.	Targeted training; peer lesson study; shared LMS workflow.
Internal (Students)	Readiness and motivation	Affects collaboration and persistence in troubleshooting.	Diagnostic-based differentiation; scaffolding and role rotation.
External (Resources)	Device/internet access variability	Constrains simulator/LMS use and pacing.	Blended supports (print/video/offline tasks); scheduled lab access.
External (Partnership)	Industry/external audience	Strengthens authenticity and professionalism through presentation.	Invite practitioners; use authentic standards and feedback loops.

4 Discussion

4.1 Urgency of an Integrated Design for Industry 4.0 and Society 5.0 Demands

The findings underscore an urgent instructional challenge in vocational education: employability in the Industry 4.0 era is no longer defined only by routine technical execution, but by students' ability to solve authentic problems, collaborate in teams, communicate solutions, and continuously learn with digital tools. In the Society 5.0 perspective, these competencies must remain human-centred, meaning that technical performance is expected to be accompanied by ethical judgement, responsibility, and social awareness [2], [22], [23]. For SMK learning, this urgency is intensified because vocational tasks require students to combine cognitive analysis, procedural accuracy, teamwork, and compliance with professional standards in the same activity. The present case shows that integrating 4C, HOTS, TPACK, and Pancasila Student Profile values is not a curricular "bundle" of separate goals, but a response to the real structure of work and learning demands in technology-intensive occupations.

The integration is critical because fragmented implementation—where HOTS is reduced to difficult questions, 4C is treated as generic soft-skills activities, technology becomes mere media substitution, and character education is delivered outside the main task—tends to produce learning that is less authentic and less transferable to the workplace. Evidence from SMK Al-Amin suggests that when competencies (4C–HOTS), pedagogy (PBL), teacher design capacity (TPACK), and value orientation (Pancasila Profile) are designed as a single system, students are more likely to practice higher-order reasoning while also being accountable for professional conduct in their teams.

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4.2 Coherent Theoretical Mechanism: From Outcomes to Enactment (Not Parallel Concepts)

The study's discussion can be read as a mechanism of how the integrated framework operates in practice. First, the design begins with integrated outcomes mapping (Table 1 and Table 2), where 4C, HOTS (C4–C6), and Pancasila values are translated into observable indicators embedded in project milestones and assessment criteria. This clarifies that 4C and HOTS are targeted student competencies, while the value component specifies the quality of participation and decision-making. Second, PBL functions as the integrating pedagogy that sequences those indicators into an authentic workflow (problem definition, design alternatives, implementation, testing, and presentation), which inherently requires collaboration, communication, and iterative reasoning [24].

Third, TPACK explains the enabling knowledge required from teachers to make the integration workable. Teachers must select and sequence digital tools (e.g., simulation software and LMS), design scaffolding (demonstration, guided practice, feedback loops), and align them with vocational content constraints such as feasibility, safety, and industry relevance [8], [25]. Finally, the Pancasila Student Profile operates as a value compass that is enacted through performance standards rather than separate moral lessons: students are expected to show integrity through transparent reporting, mutual cooperation through accountable role division, and independence through disciplined troubleshooting and task completion [26], [27]. In this way, each construct has a distinct function inside one instructional system, and their coherence is visible in how planning decisions (Table 1) become enacted routines and assessable behaviors (Table 2).

4.3 Islamic Vocational Context and Its Influence on the Instructional Approach

The Islamic vocational-school context adds instructional relevance rather than merely describing the setting. In technical domains such as network configuration and security, integrity, responsibility, and discipline are not abstract virtues; they are operational requirements because negligence, falsified documentation, or unethical behavior can create real risks. Within SMK Al-Amin, the religious-based school culture provides a strong normative language for professional ethics, which helps teachers position Pancasila values as a practical necessity within vocational projects rather than as an add-on to technical learning. This is consistent with the argument that character strengthening can be meaningfully embedded through technology-supported learning when values are built into the task structure and assessment [28].

This context influences instructional decisions in at least two ways. First, teachers emphasize transparency and accountability through LMS submission trails, logbooks, and reflection prompts, making integrity observable and assessable rather than assumed. Second, collaboration routines are framed not only as productivity strategies but also as mutual responsibility practices, reinforcing respectful communication and fairness. Consequently, the integrated learning design becomes a culturally congruent way to strengthen work ethics while developing digital competence, aligning both with the Pancasila Student Profile and with the school's religious ethos [29], [30].

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4.4 Operationalization and Empirical Evidence of Classroom Enactment

Concerns about operationalization and classroom implementation are addressed by the alignment between constructs and evidence documented in Table 2. 4C is operationalized through role-based teamwork, proposal and final presentations, peer-feedback routines, and meeting logbooks; HOTS is operationalized through sequences requiring analysis of requirements, evaluation of topology and security options, and creation of a tested configuration artefact; and TPACK is evidenced through deliberate use of Cisco Packet Tracer and a structured LMS workflow for submission, feedback, and peer assessment [31], [32]. Pancasila values are operationalized as performance criteria—such as honest reporting of test failures, fair contribution, disciplined milestone completion, and respectful professional communication—captured through process rubrics, peer evaluation, and reflection evidence [33], [34].

Importantly, the empirical trail in this case is not limited to interview narratives. Observations captured recurring enacted practices such as teacher demonstration/live coding followed by guided troubleshooting, milestone consultations, and structured reflection sessions. Document analysis adds corroborating evidence through project briefs, rubrics, peer-assessment forms, logbooks, and student artefacts (simulation files/screenshots and configuration reports). This triangulation indicates that the integrated design is implemented as routine classroom practice rather than remaining a conceptual plan.

4.5 Why the Integrated Design Works, Where It Struggles, and What Conditions Shape It

The integrated design tends to work in this SMK context because it aligns vocational authenticity with 21st-century competency demands. PBL provides a task structure that resembles workplace routines (problem definition, division of labor, iterative testing, and presentation), which naturally requires collaboration and communication while pushing students toward higher-order reasoning when troubleshooting and justifying design choices [35], [36]. The use of simulation technology supports safe failure and repeated iteration, allowing students to refine their reasoning without being limited by hardware availability; meanwhile, the LMS increases transparency of contribution and feedback cycles, strengthening responsibility and fairness in teamwork [36].

Remembered constraints are also analytically important because they explain why integration may face challenges. As summarized in Table 10, implementation is shaped by teacher TPACK readiness and assessment literacy, leadership support for project routines, and baseline digital infrastructure. Inhibiting factors include uneven student device/internet access, varied digital readiness, and the increased workload of authentic assessment and feedback. These constraints also explain the functional role of initial diagnostic assessment: by mapping readiness and digital access, teachers can differentiate supports (print guides, short videos, mentoring, lab scheduling) so that technology-rich PBL does not widen learning gaps [37], [38].

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4.6 Novelty and the Research Gap Addressed

Compared with studies that examine PBL, TPACK, HOTS, or character education as separate interventions, this study addresses a more specific gap: how these constructs can be integrated into a single instructional design that is systematic and replicable for SMK practice. The novelty is visible in (1) a staged design procedure (Table 1) that starts from curriculum and industry-task alignment and ends with reflection-based refinement, (2) explicit operationalization into lesson plans, activities, and assessment artefacts (Table 2), and (3) contextual justification showing how a religious-based SMK environment shapes the enactment of values within vocational projects. This combination strengthens the contribution beyond reporting that PBL or technology integration "works" by specifying the design logic and the conditions under which the model is feasible and scalable.

4.7 Implications for Practice and Policy (Scaling and Adaptation)

For vocational teachers, the findings imply that integration should be treated as a design task: start from integrated outcome mapping, translate it into milestone-based project briefs, and apply an authentic assessment package that makes both competence and values visible (product–process–reflection) [39]. Teacher professional development should prioritize TPACK-oriented lesson study and assessment literacy for authentic rubrics, alongside collaborative planning using shared templates to reduce workload and improve consistency [19], [40].

For school leaders and curriculum developers, scaling requires a whole-institution approach that stabilizes routines (project calendars, minimum LMS workflow, moderation of assessment), ensures baseline infrastructure (lab scheduling, device-sharing schemes, connectivity support), and builds partnerships with practitioners as external audiences for authenticity and professional standards [41]. At policy level, SMK curriculum guidance can more explicitly encourage integrated competency mapping and value-based assessment within vocational projects so that the Pancasila Student Profile becomes visible in technical performance, not only in co-curricular activities [42], [43].

Overall, the discussion supports the conclusion that an integrated value-based PBL design can bridge employability and character demands in the Society 5.0 era when it is supported by systematic design procedures, clear operational indicators, and enabling school conditions. The case simultaneously signals that implementation fidelity depends on teacher capacity, infrastructure readiness, and sustainable feedback practices, which should be addressed in future scaling efforts.

4.8 Research Limitations and Future Research Agenda

This study has several limitations. First, the research focused on only one educational unit, namely SMK Al-Amin Cikarang Utara, so the findings cannot yet be generalized to all SMK contexts with different student characteristics, school culture, and resources. Second, the data collected is predominantly qualitative, gathered through interviews, observations, and document analysis without standardized quantitative measurement of learning outcomes or character indicators. Third, the practices analyzed

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primarily come from relatively more prepared and innovative pioneer teachers, so the variation in implementation among other teachers has not been explored in depth.

Based on these limitations, further research can develop comparative studies across several vocational high schools with diverse vocational programs and social backgrounds, combining qualitative and quantitative approaches to measure the impact of the learning design on learning outcomes, 4C skills, and indicators of the Pancasila Student Profile. Additionally, future research could examine the effectiveness of teacher professional development programs in strengthening the sustainable development of TPACK-based learning design and character values, including longitudinal studies to assess the long-term impact on graduate profiles.

5 Conclusion

This study concludes that an integrated, innovative value-based learning design—linking 4C skills, higher-order thinking skills (HOTS), teachers' TPACK, and the Pancasila Student Profile values—can be implemented meaningfully in vocational education to respond to Industry 4.0 and Society 5.0 demands. In the case of an Islamic vocational school, the integration strengthens not only students' vocational competencies but also work-related character (e.g., integrity, responsibility, discipline, and collaboration) that supports employability and ethical professional practice.

The study further shows that the integration is achievable through a systematic and replicable procedure: (1) conducting non-cognitive diagnostic assessment of student readiness and learning profiles; (2) mapping vocational competencies into project outcomes that explicitly target 4C and HOTS; (3) designing Project-Based Learning (PBL) tasks with clear roles, milestones, and artifacts; (4) orchestrating digital tools (e.g., LMS and Cisco Packet Tracer) in line with TPACK principles; (5) embedding Pancasila values into classroom norms and project decision-making; (6) using authentic assessment (rubrics, peer assessment, and reflection logs) to capture both process and product; and (7) using feedback and reflection to refine subsequent cycles. Evidence for implementation was drawn from classroom observations, learning documents, and project artifacts produced by students and teachers.

Analytically, the model works because PBL provides authentic vocational problems that naturally elicit 4C performance and HOTS (analysis, evaluation, and design decisions), while TPACK enables teachers to align technology use with pedagogical strategies and vocational content so that learning activities and assessments remain coherent. The Islamic-school context reinforces the value dimension by legitimizing daily discipline, reflection, and moral reasoning as part of the learning culture, making value-based assessment less symbolic and more habitual. Implementation is supported by school leadership, a collaborative culture, and adequate facilities, but can be constrained by uneven student readiness, limited time for mentoring and authentic assessment, and variations in teachers' design competence. For wider adoption, vocational schools should prioritize staged professional development on PBL design, TPACK integration, and value-based assessment, provide shared project templates and rubrics, and strengthen LMS-based documentation and infrastructure.

This study has limitations, including its single-case scope and a focus on a limited set of informants and classrooms; therefore, the findings should be interpreted as context-sensitive rather than universally generalizable. Future studies should involve multiple vocational schools with diverse profiles, use longitudinal or mixed-method designs to examine learning outcomes and value internalization over time, and compare implementation across subject areas and teacher experience levels to further refine the integrated framework and its scaling strategy.

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