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Digital gamification and product creativity in vocational education: A systematic literature review

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Abstract

Digital gamification is increasingly used to promote engagement in vocational education, but its relationship with creative technical performance remains insufficiently understood. This systematic literature review examines how gamification, game-based learning, and related active pedagogies support creative learning and product creativity in technical and vocational education and training. A PRISMA-informed search of Web of Science, Scopus, and ScienceDirect identified 235 records. After screening and eligibility assessment, 38 publications were included. Bibliometric mapping in VOSviewer was combined with qualitative thematic synthesis. The reviewed studies associated challenges, feedback, progression, collaboration, authentic projects, and iterative improvement with motivation, persistence, experimentation, and reflection, although causal effects were not established. Most studies measured engagement, satisfaction, achievement, or creative thinking rather than the creativity of technical products. Product creativity was rarely assessed through the combined criteria of novelty, usefulness, technical feasibility, and elaboration. The review proposes a Creative Gamification Framework for TVET linking digital game design to psychological mediators, learning processes, and assessable product outcomes. Key research priorities include element-level comparisons, longitudinal and pretest-posttest designs, standardized product-creativity rubrics, and studies connecting engagement and completion with technical creative performance.

Keywords: Creative learning, Digital gamification, Game-based learning, Product creativity, Creative thinking, Design thinking, Systematic literature review, Technical and vocational education and training.

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Contents

Contribution of this paper to the literature

This study contributes to the literature by systematically integrating fragmented research on digital gamification, creative learning, and vocational education. It distinguishes engagement and creative thinking from assessable product creativity, operationalized through novelty, usefulness, technical feasibility, and elaboration, and proposes a Creative Gamification Framework for future empirical research and instructional design.

1. Introduction

Technical and vocational education and training (TVET) should develop more than procedural accuracy. Contemporary technical work requires learners to interpret ill-structured problems, combine disciplinary knowledge with practical constraints, generate and test alternatives, and improve solutions through feedback. In this context, creativity is expressed through artefacts, designs, procedures, programs, models, or services that are both original and fit for use. Unlike decontextualized measures of divergent thinking, vocational creativity is therefore inseparable from functionality, feasibility, and workmanship (Charyton, Jagacinski, & Merrill, 2008; Dorst & Cross, 2001; Howard, Culley, & Dekoninck, 2008; Shah, Smith, & Vargas-Hernandez, 2003).

Digital learning environments can support these processes through simulations, online studios, learning platforms, serious games, virtual challenges, and data-rich feedback. Such environments can make progress visible, allow repeated practice, and reduce the costs and risks associated with trial and error. However, technology-mediated participation does not automatically produce deep learning, and high activity levels do not necessarily indicate conceptual understanding or creative performance (Bond, Buntins, Bedenlier, Zawacki-Richter, & Kerres, 2020; Henrie, Halverson, & Graham, 2015; Martin, Sun, & Westine, 2020). Gamification uses game-design elements in non-game contexts, whereas game-based learning and serious games use games as the learning environment itself (Deterding, Dixon, Khaled, & Nacke, 2011; Plass, Homer, & Kinzer, 2015).

Existing reviews generally identify positive but uneven effects on motivation, participation, and learning outcomes. These differences suggest that effectiveness depends on how elements such as challenge, feedback, progression, collaboration, and recognition are incorporated into instruction (Bai, Hew, & Huang, 2020; Clark, Tanner-Smith, & Killingsworth, 2016; Dichev & Dicheva, 2017; Hamari, Koivisto, & Sarsa, 2014; Landers, 2014; Sailer & Homner, 2020; Seaborn & Fels, 2015).

The central limitation in vocational education research is that studies often end with measures of engagement, satisfaction, quiz performance, or course completion. These outcomes are important, but they do not show whether learners produce more creative technical solutions. Product creativity requires direct assessment of novelty, usefulness, technical feasibility, and elaboration. Although design research provides metrics and rubrics for these dimensions, they are rarely integrated with studies of digital gamification in TVET (Daly, Yilmaz, Christian, Seifert, & Gonzalez, 2012; Runco & Jaeger, 2012; Sarkar & Chakrabarti, 2011).

This review addresses that gap by synthesizing research at the intersection of digital gamification, creative learning, and technical or vocational education. It asks: (RQ1) Which theoretical, pedagogical, and technological themes dominate this research area? (RQ2) Which gamification elements and active pedagogies are associated with engagement, completion, creative thinking, and product creativity? (RQ3) How are creativity and product creativity operationalized and measured? (RQ4) Which methodological limitations constrain evidence about gamified creative learning in TVET? The review contributes a framework that distinguishes motivational activity from technical creative output and specifies pathways through which digital game design may support, but not substitute for, authentic vocational problem solving.

2. Conceptual Background

2.1. Gamification as an Instructional Design System

Gamification is best understood as an instructional design system rather than merely as a collection of decorative rewards. Landers (2014) argues that game attributes influence learning indirectly by changing learner behaviors and attitudes that interact with instruction. This helps explain why the same element may produce different outcomes across contexts. A leaderboard may encourage comparison and effort in one group while producing anxiety, disengagement, or superficial competition in another. Controlled studies similarly show that rewards can increase activity without necessarily increasing intrinsic motivation or performance (Hanus & Fox, 2015; Mekler, Brühlmann, Tuch, & Opwis, 2017).

In effective designs, game mechanics are linked to clearly defined learning processes. Challenges can structure increasingly complex practice; immediate feedback can shorten the cycle between action and correction; progression systems can make competence development visible; narratives can situate tasks in occupational contexts; and collaborative quests can distribute expertise. Studies of gamified and game-based learning report stronger outcomes when elements are integrated with meaningful tasks, learner choice, and feedback rather than added as external incentives (Buckley & Doyle, 2016; de Freitas & Oliver, 2006; Domínguez et al., 2013; Ibáñez, Di-Serio, & Delgado-Kloos, 2014; Kiili, 2005; Qian & Clark, 2016; Sailer, Hense, Mayr, & Mandl, 2017; Su & Cheng, 2015; Zainuddin, Shujahat, Haruna, & Chu, 2020).

2.2. Product Creativity in Vocational Learning

Creativity is commonly defined as the production of something both novel and appropriate (Runco & Jaeger, 2012). In technical and vocational domains, appropriateness depends on materials, standards, user needs, safety, cost, manufacturability, and performance. A product can be visually original but technically unusable, or technically sound but derivative. Product creativity must therefore be evaluated across several dimensions.

Engineering design research provides several ways to operationalize these dimensions. Ideation metrics distinguish novelty, variety, quality, and quantity (Shah et al., 2003) while assessment frameworks examine novelty and usefulness at the feature or solution level (Sarkar & Chakrabarti, 2011). Studies of engineering creativity also emphasize technical feasibility and disciplinary knowledge (Charyton et al., 2008).

Design heuristics, iterative framing, and problem-solution co-evolution can expand the solution space while preserving task constraints (Daly et al., 2012; Dorst & Cross, 2001). Taken together, these approaches suggest four dimensions for assessing outcomes: novelty, usefulness, technical feasibility, and elaboration or quality.

Creative learning also depends on the conditions in which teaching takes place. Reviews identify autonomy, flexible use of time and space, respectful relationships, collaboration, access to resources, constructive feedback, and tolerance of productive failure as recurring features (Bereczki & Kárpáti, 2018; Davies et al., 2013; Mullet, Willerson, Lamb, & Kettler, 2016; Richardson & Mishra, 2018). Teachers' beliefs are equally important, as creativity may be discouraged when assessment rewards only one correct procedure or when novelty is viewed as a distraction from technical accuracy (Rubenstein, McCoach, & Siegle, 2013).

2.3. Active, Authentic, and Technology-Mediated Pedagogy

Project-based learning, inquiry, design thinking, and workplace learning provide the pedagogical foundation for the use of gamification. These approaches organize learning around authentic problems, sustained investigation, collaboration, public products, and reflection (Guo, Saab, Post, & Admiraal, 2020; Kokotsaki, Menzies, & Wiggins, 2016; Razzouk & Shute, 2012).

In vocational education, authenticity also requires movement across school and workplace boundaries, where learners must translate theoretical knowledge into situated practice (de Bruijn & Leeman, 2011; Schwendimann et al., 2015; Tynjälä, 2008; Virtanen, Tynjälä, & Eteläpelto, 2014).

Digital gamification can support this foundation by sequencing authentic tasks and making formative evidence more visible. It cannot compensate for weak tasks, unclear criteria, or absent reflection. The key design question is therefore not whether points or badges are generally effective, but whether specific mechanics support the cognitive, motivational, and social processes required to produce better vocational solutions.

3. Methodology

3.1. Review Design and Questions

The study used a systematic literature review informed by PRISMA 2020. The objective was interpretive synthesis rather than meta-analysis because the evidence included heterogeneous interventions, education levels, outcomes, and research designs. Systematic searching and screening were combined with bibliometric mapping and qualitative thematic analysis, an approach suitable for fragmented interdisciplinary topics (Page et al., 2021; Snyder, 2019; Zupic & Čater, 2015).

The review focused primarily on secondary technical and vocational education. Higher-education studies were included when their pedagogical design or assessment approach was transferable to technical professional subjects. The primary publication window was 2018-2025; earlier sources were retained when citation chaining identified them as seminal conceptual or methodological contributions. Table 1 presents the search strategy and review scope, including the primary sources, publication period, core domains, synthesis approach, and software used.

Table 1. Search strategy and review scope.

Component	Specification
Primary sources	Web of Science, Scopus, and ScienceDirect
Supplementary checking	Google Scholar and backward citation tracing
Primary period	2018-2025; older seminal sources retained when justified
Core domains	Creative teaching; technical and vocational education; gamification
Main synthesis	Bibliometric mapping, structured extraction, and qualitative thematic synthesis
Software	Zotero for deduplication; VOSviewer for keyword mapping

The database searches were completed for records available through 31 December 2025.

3.2. Search Strategy

For Web of Science and Scopus, the search combined terms for creativity, vocational education, and game-informed or active pedagogy: (("creative teaching" OR "creativity in education" OR "creative learning" OR "creative thinking" OR creativity) AND ("technical vocational education" OR "vocational education and training" OR "technical education" OR TVET OR apprenticeships)) AND (gamification OR "game-based learning" OR "serious games" OR "educational games" OR "escape rooms" OR "immersive learning" OR "active learning" OR "project-based learning" OR "design thinking").

A simplified expression was used in ScienceDirect and for supplementary Google Scholar checking because of interface limitations: ("creative teaching" OR creativity) AND ("vocational education" OR "technical education") AND gamification.

3.3. Eligibility, Selection, and Extraction

Eligible publications were peer-reviewed, available in full text, and substantively connected creative learning or gamification with technical, vocational, professional, engineering, or closely transferable applied education. Empirical studies, systematic reviews, theoretical articles, and conceptual frameworks were eligible.

Studies focused exclusively on general, artistic, or humanities education without transferability to technical learning were excluded, as were technology descriptions without an explicit pedagogical framework, non-peer-reviewed commentary, inaccessible full texts, and conference abstracts without evidence of peer review. Table 2 presents the eligibility and selection criteria used to determine which publications were included or excluded from the review.

Table 2. Eligibility and selection criteria.

Decision area	Included	Excluded
Context	TVET, technical, professional, engineering, or transferable applied education	General or arts-only context without technical transfer
Intervention or concept	Gamification, serious games, creative pedagogy, active or project-based learning	Technology use without pedagogical or creativity connection
Outcomes	Engagement, completion, achievement, creative thinking, product or design creativity	No relevant learning or creative outcome
Evidence quality	Peer-reviewed full-text empirical, review, or conceptual work	Commentary, promotional material, inaccessible or methodologically unusable work

The searches identified 235 records: 143 in Web of Science, 30 in Scopus, and 62 in ScienceDirect. Deduplication and the removal of non-peer-reviewed or inaccessible records left 165 items for title and abstract screening. Seventy-three were excluded as thematically irrelevant, 92 full texts were assessed, and 54 were excluded because of weak linkage to technical vocational education, absence of a pedagogical framework, or insufficient empirical or theoretical relevance. The final synthesis comprised 38 publications, including 36 journal articles and two peer-reviewed conference papers presented in Figure 1.

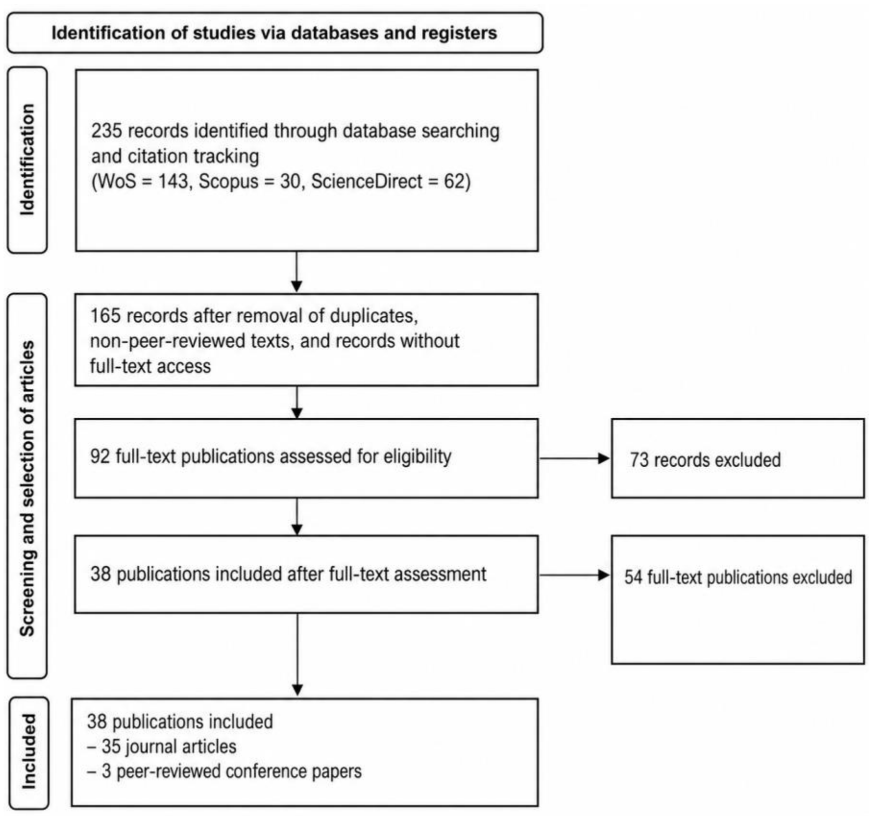

Figure 1. PRISMA-informed selection of the reviewed publications.
Source: Author-developed diagram based on the PRISMA 2020 flow structure.

3.4. Bibliometric and Thematic Synthesis

Bibliographic data, keywords, context, research objective, theoretical basis, design, sample or unit of analysis, intervention features, outcome measures, findings, and limitations were recorded in a structured matrix. VOSviewer was used to map keyword co-occurrence after harmonizing singular and plural forms and merging obvious synonyms (van Eck & Waltman, 2010). Bibliometric patterns were interpreted alongside full-text evidence because keyword frequency does not demonstrate conceptual equivalence or research quality. Thematic coding combined deductive categories derived from the research questions with inductive patterns emerging from the publications, following the principles of reflexive thematic analysis (Braun & Clarke, 2006). Screening, coding, and synthesis were conducted by one reviewer; the absence of independent duplicate coding is reported as a limitation.

4. Results

4.1. Profile and Thematic Structure of the Evidence

The evidence base was interdisciplinary and methodologically heterogeneous. It included classroom interventions, surveys, quasi-experiments, design studies, systematic reviews, platform-based studies, and conceptual frameworks. The most prominent bibliometric terms were creativity, gamification, game-based learning, creative thinking, design thinking, motivation, skills, and students. Full-text coding showed that these terms clustered around five connected areas rather than one unified research tradition.

The first area concerned theories and assessment of creativity. The second examined active pedagogies and authentic project work. The third addressed digital, online, and immersive environments. The fourth focused on gamification, serious games, and game-based learning. The fifth concerned competence frameworks, curriculum design, and transfer between education and vocational practice. Figure 2 represents their integrated relationship, while Table 3 summarizes the implications for product creativity. The VOSviewer map displayed five keyword clusters, while qualitative full-text coding identified five related thematic domains.

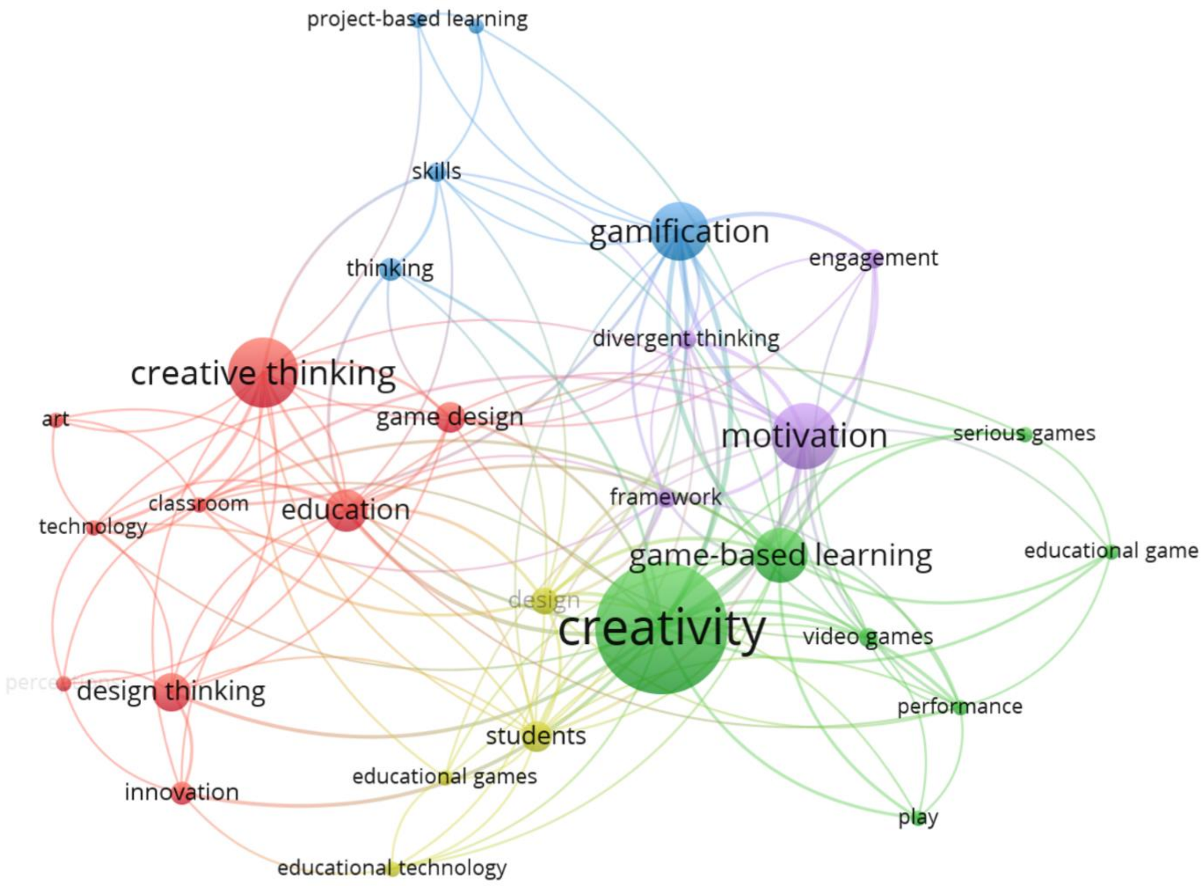

Figure 2. Integrated thematic architecture of the reviewed evidence.
Source: Author synthesis based on bibliometric mapping and qualitative thematic coding in VOSviewer.

Table 3. Main thematic domains and implications for product creativity.

Domain	Dominant concern	Implication for vocational product creativity
Creativity theory and assessment	Definitions, creative dispositions, rubrics, divergent and convergent thinking	Assess both originality and task appropriateness
Active and authentic pedagogy	Projects, inquiry, design thinking, iteration, reflection	Embed creativity in real technical problems and artefacts
Digital and immersive environments	Online platforms, simulation, learning analytics, remote participation	Support repeated practice and visible progress without confusing activity with learning
Gamification and game-based learning	Challenges, feedback, rewards, narratives, cooperation, competition	Align game mechanics with experimentation, mastery, and improvement
Competence and vocational transfer	Curriculum, workplace authenticity, professional standards, boundary crossing	Judge feasibility, functionality, and transfer to occupational practice

4.2. Gamification Mechanisms and Learning Outcomes

The reviewed literature generally identifies positive relationships between gamification and participation or motivation, although their strength and direction differ across instructional designs and educational contexts. Reviews and meta-analyses report small to moderate average effects with substantial heterogeneity (Bai et al., 2020; Dichev & Dicheva, 2017; Koivisto & Hamari, 2019; Sailer & Homner, 2020). Similar patterns have been reported for game-based learning, serious games, and educational escape rooms, although gains in knowledge and skills depend on instructional support, research design, and the comparison conditions used (Clark et al., 2016; Makri, Vlachopoulos, & Martina, 2021; Veldkamp, van de Grint, Knippels, & van Joolingen, 2020; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013).

Among the reviewed studies, challenge and feedback received the most consistent support as relevant design features. Calibrated challenges may encourage learners to explore alternatives, while timely feedback may help them compare a technical action with specified criteria and revise their work. Progression structures may represent mastery when levels correspond to increasingly complex competencies. Collaboration may expose learners to alternative strategies and distributed expertise. Narrative and role-based tasks may strengthen perceived authenticity by connecting classroom activities with occupational scenarios. By contrast, points and badges appear to have limited instructional value when they reward only frequency, speed, or compliance. These mechanisms remain plausible interpretations of the reviewed evidence rather than empirically confirmed causal effects in TVET.

Competitive mechanics should be approached with caution. Leaderboards may be associated with greater effort among learners already positioned near the top, but they may discourage learners who perceive the performance gap as unattainable. Empirical studies report mixed motivational and performance outcomes, and some studies identify increased activity without corresponding improvements in intrinsic motivation or achievement (de-Marcos, Domínguez, Saenz-de-Navarrete, & Pagés, 2014; Hanus & Fox, 2015; Mekler et al., 2017). Taken together, the evidence is more consistent with mastery-based progression and personal improvement than with persistent public ranking, especially in heterogeneous vocational cohorts. Table 4 presents the main gamification elements, their proposed mechanisms, potential associated benefits, and design risks.

Table 4. Gamification elements, mechanisms, expected benefits, and design risks.

Element	Proposed mechanism	Potential associated benefit	Main risk
Challenges and quests	Goal structure and optimal difficulty	Sustained problem solving and exploration	Overload or task completion without reflection
Immediate feedback	Error information and competence support	Faster iteration and correction	Dependence on automated cues
Levels and progression	Visible mastery trajectory	Persistence and course completion	Progress reduced to point accumulation
Badges and points	Recognition and informational reinforcement	Milestone visibility	Controlling extrinsic motivation
Collaboration	Relatedness and distributed expertise	Idea diversity and peer learning	Unequal participation
Leaderboards	Social comparison	Short-term effort for some learners	Anxiety, disengagement, superficial competition
Narrative and roles	Contextualization and identity	Occupational authenticity and meaning	Decorative story unrelated to competencies

4.3. Product Creativity as a Missing Outcome

A central finding of the review is that product creativity is rarely measured directly. Engagement, satisfaction, time on task, quiz scores, self-reported creativity, and creative-thinking tests were more common than expert evaluation of a technical product. This makes interpretation difficult because learners may enjoy a gamified course and complete more activities without producing solutions that are more original, useful, feasible, or fully developed. The design literature offers a clearer basis for assessing such outcomes than the gamification literature. Novelty concerns the extent to which a solution differs meaningfully from common or prior solutions. Usefulness concerns its ability to address the intended need.

Technical feasibility concerns whether it can be built, operated, programmed, or implemented within relevant constraints. Elaboration concerns completeness, integration, quality, and readiness for use. These dimensions should be assessed through analytic rubrics, expert judgment, authentic performance tasks, or artifact analysis rather than inferred from learner perceptions alone. Creativity assessment must also maintain a clear distinction between the creative process and the resulting product. Exploration, risk-taking, iteration, and collaboration are productive behaviors, but they are not outcomes.

A robust study should measure the process through platform traces or observations and the product through independent criteria. Combining both forms of evidence would allow researchers to examine whether gamification changes how learners work and whether these changes are reflected in the quality of what they produce. Table 5 presents the proposed dimensions of product creativity and illustrative indicators for their assessment.

Table 5. Proposed dimensions of product creativity and supplementary design reasoning.

Dimension	Core question	Illustrative indicators
Novelty	How original is the solution in its task and occupational context?	Uncommon features; diversity of approach; distance from exemplars
Usefulness	How effectively does the product address the intended need?	Functional performance; user relevance; problem fit
Technical feasibility	Can the solution be implemented safely and reliably?	Standards compliance; material or code viability; manufacturability
Elaboration and quality	How complete, integrated, and professionally executed is the product?	Detail, precision, documentation, finish, robustness
Reflective justification	Can the learner explain design choices and trade-offs?	Evidence-based rationale; evaluation of alternatives; revision decisions

4.4. Digital Learning, Engagement, and Completion

Digital platforms provide researchers with data on logins, attempts, time spent, progression, feedback use, and completion. These traces can strengthen formative evaluation and learning analytics, but their meaning depends on instructional design (Ifenthaler & Yau, 2020). Engagement is multidimensional and includes behavioral, emotional, and cognitive participation (Fredricks, Blumenfeld, & Paris, 2004). Technology-mediated studies often focus on behavioral indicators because they are relatively easy to collect, even though cognitive investment and strategic regulation may be more closely related to learning (Henrie et al., 2015). Completion in online learning is also difficult to interpret. Low completion may reflect weak design, competing work responsibilities, open enrollment, or a learner's decision to access only selected resources.

Research on online learning emphasizes self-regulation, course structure, instructor presence, and timely support (Jordan, 2015; Martin et al., 2020). Gamification can make progression visible and encourage return behavior, but evidence linking those changes to technical product quality remains sparse.

On this basis, synthesis supports a hypothesized pathway model rather than a direct-effect claim. Within this conceptual model, digital mechanics are proposed as possible antecedents of psychological conditions such as autonomy, competence, relatedness, curiosity, and mastery orientation. These conditions are then expected to be associated with engagement, persistence, experimentation, reflection, collaboration, and completion. Product creativity is conceptualized as a distal outcome that requires separate assessment. Figure 3 presents these proposed relationships, but the arrows do not represent empirically established causal pathways.

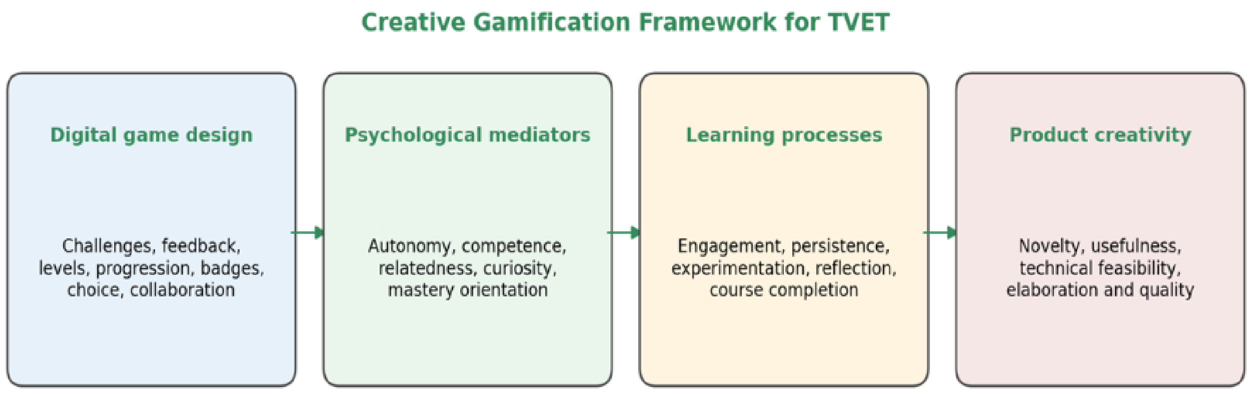

Figure 3. Creative Gamification Framework for technical and vocational education and training.

4.5. Methodological Gaps

Seven gaps recurred across the reviewed evidence. First, few studies were conducted directly in technical professional subjects. Second, studies often evaluated gamification as a package rather than isolating specific mechanics. Third, competing gamification frameworks were rarely compared using common criteria. Fourth, engagement, completion, and product creativity were seldom modeled together. Fifth, fully online and hybrid vocational contexts remained underrepresented. Sixth, longitudinal and pretest–posttest designs were uncommon. Seventh, creativity measures and product rubrics varied substantially, limiting cumulative inference. Table 6 presents the main research gaps identified in the review and the corresponding recommended study designs.

Table 6. Research gaps and recommended study designs.

Research gap	Recommended response
Limited TVET-specific evidence	Conduct field experiments in authentic technical and vocational courses
Gamification treated as a single intervention	Use factorial, component, or sequential designs to compare mechanics
Weak comparison of frameworks	Apply common criteria to MDA, design-framework, and motivational models
Engagement disconnected from product outcomes	Model platform engagement, completion, and rubric-scored products jointly
Few online and hybrid studies	Use learning-platform data combined with authentic remote or simulated tasks
Short-term and cross-sectional designs	Use pretest-posttest, delayed posttest, and longitudinal tracking
Non-equivalent creativity measures	Adopt transparent rubrics for novelty, usefulness, feasibility, and elaboration

5. Discussion

5.1. Interpretation of the Review Questions

The answer to RQ1 is that the field is organized around five interconnected themes rather than a coherent TVET-specific theory. Creativity research supplies definitions and assessment principles; active pedagogy supplies authentic tasks; digital-learning research supplies environments and trace data; gamification research supplies motivational and interaction mechanisms; and vocational-education research supplies competence and transfer constraints. Their integration remains incomplete.

For RQ2, the strongest evidence concerns engagement and motivation rather than product creativity. Challenges, feedback, progression, authentic roles, and collaboration are plausible supports because they can increase purposeful practice and iteration. Points, badges, and leaderboards are conditional tools rather than universally effective elements. They should be judged by whether they improve the target learning process, not by whether they increase clicks or competition. This interpretation is consistent with theories that treat gamification as a mediator of instruction rather than instruction itself (Landers, 2014).

For RQ3, creativity measurement is fragmented. Many studies use self-report, divergent-thinking tasks, or general creative-performance tests. These tools can capture confidence or ideational fluency, but they do not fully represent vocational product quality. Technical education requires domain-sensitive assessment that combines novelty with usefulness, feasibility, and elaboration. Including a reflective justification can further reveal whether learners understand constraints and trade-offs.

For RQ4, the principal methodological limitation is the distance between proximal digital indicators and distal vocational outcomes. Short interventions, small convenience samples, nonequivalent measures, and bundled game elements make it difficult to identify causality. Evidence is especially weak for online vocational courses in which engagement, completion, and technical products are captured together over time.

5.2. Implications for Course Design and Assessment

The Creative Gamification Framework suggests that course design should begin by identifying the vocational performance that learners are expected to demonstrate. Instructors should define the artifact, service, procedure, or technical solution; specify constraints and quality criteria; and only then select mechanics that support the required process. A progression system, for example, is useful when each level represents a qualitatively higher competence rather than a larger point total. Feedback is most useful when it directs learners' attention to evidence, standards, and revision rather than merely confirming whether an answer is correct.

Assessment should draw on both process and product evidence. Process data may include attempts, feedback cycles, collaboration, strategy changes, and persistence. Product evidence should be evaluated through a rubric with explicit criteria for novelty, usefulness, feasibility, elaboration, and reflection. Using multiple raters and reporting inter-rater reliability would strengthen validity. A comparison with a baseline or non-gamified condition is necessary before changes in creativity can be attributed to gamification.

Equity considerations also need to be addressed. Competitive systems can reproduce prior differences in digital confidence or available study time. Public rankings should therefore be optional or used sparingly, and alternative routes to recognition should be provided. Authentic tasks should not require resources that are unavailable to some learners. Responsible gamification should preserve learner agency, clearly communicate how data are used, and avoid manipulative reward loops.

5.3. Research Agenda

Future research should focus less on broad labels such as "gamified learning" and more on the specific mechanisms included in an intervention. Multisite studies could compare feedback, progression, challenge, and collaboration while holding the technical task constant. Longitudinal work should examine whether early platform engagement predicts completion and whether completion predicts independently scored product creativity. Learning analytics can contribute to this work when trace variables are linked to clearly defined pedagogical constructs rather than interpreted in isolation. Qualitative observations and learner interviews are also needed to explain why the same mechanism encourages experimentation in one group but leads to pressure or strategic gaming in another.

5.4. Limitations

This review has several limitations. Searches emphasized publications from 2018–2025 and English-language international databases, so relevant regional or non-English evidence may be underrepresented. ScienceDirect is a full-text platform rather than a citation index, and its inclusion broadened coverage but produced metadata that required additional normalization. Screening and coding were undertaken by a single reviewer. The available evidence was too heterogeneous to support a meta-analysis, and studies used inconsistent definitions of gamification, creativity, engagement, and vocational relevance. Finally, the proposed framework should be understood as a synthesis of the reviewed literature rather than a validated causal model.

6. Conclusion

Digital gamification may support creative learning in vocational education, but its potential value appears to depend on how game elements are connected to authentic technical work. Across the reviewed literature, challenge, feedback, progression, collaboration, and meaningful context emerge as plausible design features associated with engagement, persistence, experimentation, and reflection, although these relationships still require empirical validation. At the same time, the available evidence does not support the assumption that adding rewards automatically improves creativity.

The most significant gap concerns the limited measurement of product creativity. Studies frequently report motivation, satisfaction, achievement, or general creative thinking without evaluating the technical products learners create. Product creativity should be assessed through novelty, usefulness, technical feasibility, and elaboration, while reflective justification should be evaluated as supplementary evidence of design reasoning. The proposed Creative Gamification Framework offers a testable structure for this work and presents gamification as a support for, rather than a substitute for, authentic vocational pedagogy.

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