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PROOFER: INTEGRATING DIGITAL GAME-BASED ACTIVITY PACKAGES AND DELIBERATE PRACTICE FOR PROFESSIONAL PROOFREADING SKILL DEVELOPMENT

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ABSTRACT

Professional proofreading requires repeated, standards-based practice in language, document presentation, and scholarly conventions, yet technology-enhanced training models integrating game-based practice and deliberate practice remain limited. This study developed and preliminarily evaluated PROOFER, a seven-stage professional training model integrating digital game-based activity packages with deliberate practice for proofreading skill development. A three-phase research-and-development process comprised model synthesis and expert review; development and quality evaluation of the digital game-based activity package, training website, digital manual, training activity plans, and research instruments; and field implementation using a one-group posttest-only design. Five experts reviewed the model, other expert panels examined the supporting resources and instruments, and the package was piloted with 10 individuals with characteristics similar to those of the target group. Fifteen entry-level assistant editors from Sukhothai Thammathirat Open University Press voluntarily completed an 18-hour program over three weeks. The PROOFER sequence comprises Prepare and Diagnose; Review Standards and Modeling; Objective Goal Setting; Online Game-Based Focused Practice; Feedback and Error Analysis; Extended Repetition and Progressive Challenge; and Real-Task Transfer and Reflection. Expert evaluation of the model was very high (M = 4.61, SD = 0.51), and the digital game-based activity package was rated very high in quality (M = 4.74, SD = 0.48). Participants achieved an overall post-training proofreading performance score of 86.87%, with technical proofreading highest (90.56%), followed by academic proofreading (85.83%) and language proofreading (84.22%); overall satisfaction was very high (M = 4.78, SD = 0.42). The findings support the feasibility of PROOFER as a structured architecture for professional proofreading practice, although the posttest-only design limits interpretation to post-training performance rather than causal effectiveness.

Keywords: *Deliberate Practice, Digital Game-Based Activity Package, Digital Game-Based Learning, Professional Proofreading, Workplace Training*

1. INTRODUCTION

Academic and educational publications depend on accurate language, consistent presentation, and reliable scholarly apparatus. Professional proofreading is therefore important before publication because errors in spelling, grammar, punctuation, formatting, references, figures, tables, and other manuscript elements can disrupt clarity and consistency. Standards-based professional language work similarly depends on systematic quality procedures [1]. Digital tools can support syntactic error detection and correction [2], but professional proofreading also requires judgment about meaning, context, document conventions, and editorial consistency beyond automated grammar checking.

Professional proofreading is a form of constrained editorial decision-making. The proofreader must distinguish errors that can be corrected by rule from passages that require contextual judgment while avoiding unnecessary changes that alter meaning or authorial voice. This combination of visual scanning, rule application, consistency checking, and contextual judgment makes proofreading more complex than simply recognizing isolated errors and supports the need for performance-oriented training.

For novice or entry-level editorial personnel, professional proofreading skills are difficult to

develop through explanation alone. It requires repeated exposure to varied error patterns, comparison with publication standards, and feedback on both missed errors and inappropriate corrections. The practical problem addressed in this study is how to translate these requirements into a sequenced, repeatable set of activities that also prepares novices to review complete manuscripts. Reviews of online training transfer and workplace gamification emphasize alignment with job requirements, actionable feedback, and opportunities to apply practiced skills [3], [4].

Deliberate practice provides a relevant instructional foundation because it organizes improvement around explicit goals, focused practice targeting weaknesses, repeated performance, feedback, and progressively demanding tasks [5]. In workplace development, gamified and structured practice can complement this process by making repeated skill practice more visible, engaging, and manageable [6]. For proofreading, deliberate practice can be operationalized by requiring learners to diagnose error types, set targeted improvement goals, repeat correction tasks, analyze feedback, and revisit increasingly complex manuscripts.

Digital game-based learning offers one way to structure repeated rehearsal. Meta-analyses have examined cognitive and motivational outcomes in school learning [7], learning outcomes in STEM education [8], and problem-solving outcomes across educational settings [9]. These studies suggest potential benefits of digital game-based practice but do not directly address proofreading decisions in publication workflows. Serious-game frameworks emphasize progressive challenge and feedback [10], whereas other game-based reviews focus on different learners and task contexts [11]. These findings provide design principles for PROOFER rather than direct evidence of its effects on professional proofreading.

Across the literature considered here, workplace gamification studies address organizational training and engagement [4], [6], whereas game-based learning studies primarily focus on educational tasks and general performance outcomes [7]-[13]. These research strands do not, by themselves, specify a sequence for novices to identify, justify, and correct errors across an academic manuscript. The design challenge is especially relevant because proofreading spans three interdependent domains: language accuracy and clarity; technical document consistency and correction conventions; and academic proofreading involving citations, references, tables, figures, and scholarly presentation. A context-specific training workflow must connect these domains to explicit standards, targeted practice, feedback, progressive difficulty, and authentic editorial tasks.

To address this operational gap, the present study developed PROOFER as a seven-stage workflow that integrates five established design components digital game-based activities, deliberate practice, immediate feedback, progressive challenge, and authentic assessment for professional proofreading. The contribution is a domain-specific integration of these components, not a claim that any individual component is new. Digital missions serve as the focused-practice environment, with individual goal setting before practice, followed by error analysis, extended repetition, and real-task reflection. The study specifies this design, reports expert evaluations of the model and supporting package, and describes post-training proofreading performance and satisfaction in a volunteer cohort of entry-level assistant editors.

The study was guided by three research questions:

RQ1. What components and operating relationships characterize the PROOFER Training Model for professional proofreading skill development?

RQ2. How do experts evaluate the appropriateness and quality of the PROOFER model and its digital game-based activity package?

RQ3. What proofreading performance and participant satisfaction are observed after implementation of PROOFER in the study cohort?

2. LITERATURE REVIEW

2.1 Proofreading as a Professional Skill

Proofreading involves the final-stage detection and correction of errors while preserving intended meaning and maintaining consistency with publication standards. In professional academic publishing, this work requires attention to linguistic form and document-level structures such as typography, headings, tables, figures, citations, and reference lists [1], [2]. The task requires repeated shifts between local detail and global consistency, making explicit criteria and systematic review procedures especially important for novice proofreaders.

This study organized proofreading skills into three domains. Language proofreading includes spelling, word choice, grammar, punctuation, clarity, concision, and continuity. Technical proofreading includes proofreader marks,

typography, document formatting, consistency, and proposed corrections. Academic proofreading includes in-text citations, reference-list consistency, reference formatting, headings, tables, figures, captions, and compliance with academic manuscript standards. This three-domain structure provided an explicit target for training tasks and assessment.

2.2 Deliberate Practice, Feedback, and Progressive Challenge

Deliberate practice differs from undirected repetition because it targets specific performance goals and weaknesses. Learners attempt challenging tasks, receive information about performance, make corrections, and repeat practice until accuracy and fluency improve [5], [6]. In proofreading, this logic can be implemented through focused error-detection tasks, individual goal setting, repeated correction, error analysis, and progressively more complex manuscripts.

Feedback timing is especially important when learners must connect a correction with the error that produced it. Research on corrective and technology-mediated feedback indicates that useful feedback should help learners identify the discrepancy between current performance and the expected standard and should indicate an appropriate next step [14]-[16]. PROOFER therefore places feedback and error analysis immediately after focused game-based practice and before extended repetition. The sequence is intended to prevent repeated rehearsal of incorrect procedures and to guide the next practice attempt.

2.3 Digital Game-Based Learning for Repeated Skill Practice

Digital educational games can organize practice around missions, goals, progress indicators, challenges, and immediate responses. Their instructional value is strongest when game mechanics are mapped directly to the learning task rather than used only as a reward layer [7]-[11]. For proofreading, game missions can present short, bounded error-detection problems that make repeated practice less monotonous while preserving a clear relationship with professional performance.

Progressive challenge is also relevant because proofreading tasks vary substantially in complexity. Early tasks may contain obvious spelling or formatting problems, whereas later tasks require context-sensitive language decisions, cross-checking references, or addressing several error types within a complete manuscript. A staged difficulty structure can therefore support progression from focused component practice to integrated performance.

2.4 Authentic Assessment and Workplace Transfer

Authentic assessment evaluates performance through tasks that resemble the application context rather than relying only on knowledge recall. Reviews of authentic assessment emphasize realistic problems, observable performance, meaningful products, and criteria that represent the target practice [17], [18]. In PROOFER, authentic assessment is used to connect digital practice with proofreading tasks that resemble editorial work, including language correction, technical consistency, citation checking, and academic manuscript review.

Training transfer is equally important for professional development. The final stage of PROOFER requires application to work-like tasks and structured reflection to help learners connect digital-mission practice with broader editorial decisions. This design responds to the transfer problem identified in workplace training literature, where learning activities may be positively received but still fail to influence later practice unless tasks, criteria, and feedback resemble the work context [3], [4].

2.5 Research Gap and Design Principles

This focused conceptual synthesis draws on literature addressing proofreading requirements [1], [2], game-based and deliberate practice with feedback [5]-[16], and authentic assessment and workplace transfer [3], [4], [17], [18]. It emphasizes recent reviews and empirical studies that inform these design areas. Although the studies support individual features, they do not specify an integrated proofreading sequence connecting diagnosis, goals, correction practice, error analysis, progressive challenge, and authentic manuscript review. The gap concerns domain-specific integration of established approaches, rather than the absence of those approaches.

In editorial workplaces, training must connect publication standards with repeated opportunities to identify, justify, and correct errors. Existing evidence supports digital games as structured practice environments [7]-[11], deliberate practice as a mechanism for focused repetition and correction [5], [6], feedback as a guide for the next performance attempt [14]-[16], and authentic assessment as a means of observing work-like performance [17], [18]. PROOFER brings these strands together within a single operational

sequence and treats post-training proofreading performance not satisfaction alone as the principal evidence of participant performance.

PROOFER was designed around five principles: use game missions to structure repeated proofreading practice; make individual practice goals explicit; provide timely and interpretable feedback; increase difficulty as practice progresses; and end with authentic proofreading tasks and reflection. Table 1 summarizes the literature-based rationale for these principles.

Table 1: Literature-Based Design Principles for PROOFER

Foundation	Instructional contribution	PROOFER design response
Digital game-based learning [7]-[11]	Engagement, repeated practice, mission structure	Proofreading simulations and error-detection missions
Deliberate practice [5], [6]	Focused goals, targeted repetition, reflection	Individual practice goals, focused practice, repeated attempts
Feedback research [14]-[16]	Timely correction and actionable next steps	Immediate feedback followed by error analysis
Authentic assessment [17], [18]	Performance evidence in realistic tasks	Work-like proofreading tasks and product review
Training transfer [3], [4]	Application beyond the training setting	Real-task transfer and reflection

The conceptual framework uses professional proofreading requirements as its target context and integrates digital game-based activities with deliberate practice. Together, these foundations inform a professional training design that coordinates explicit goals, focused digital missions, immediate feedback, error analysis, repeated practice, progressive challenge, and authentic application. The training process targets three skill domains language proofreading, technical proofreading, and academic proofreading and culminates in a post-training proofreading assessment. The conceptual contribution is the operational integration of game-based practice and deliberate practice within a technology-supported workflow for professional proofreading. Figure 1 presents this framework.

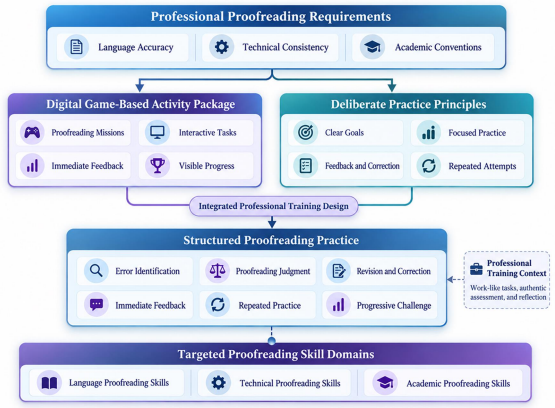


Figure 1: Conceptual Framework Linking Professional Proofreading Requirements, Digital Game-Based Activities, Deliberate Practice, Structured Practice, and Proofreading Skill Performance

3. RESEARCH OBJECTIVES

3.1 To develop the PROOFER Training Model integrating digital game-based activity packages with deliberate practice for proofreading skill development.

3.2 To develop and evaluate the digital game-based activity package and supporting training resources aligned with the PROOFER model.

3.3 To examine post-training proofreading performance and participant satisfaction following implementation of PROOFER.

4. RESEARCH METHODOLOGY

4.1 Research Design and Context

The study employed a three-phase research-and-development design. Phase 1 developed the conceptual and operational structure of the PROOFER model. Phase 2 developed the digital game-based activity package, training activity plans, website, digital manual, and research instruments then submitted these outputs for expert review and pilot refinement. Phase 3 implemented the completed model in a field study using a one-group posttest-only design.

The field implementation was conducted with assistant editors at Sukhothai Thammathirat Open University Press. The setting was relevant to the model because participants were expected to review language, document presentation, and academic manuscript conventions. The study focused on entry-level personnel who were interested in developing proofreading skills and had not previously completed the training program. Figure 2 summarizes the three-phase research design and professional field context.



Figure 2: Research Design and Context

4.2 Participants and Expert Review

Fifteen entry-level assistant editors volunteered for the field implementation. The participants formed a single organizational cohort and was not intended to be statistically representative of all editorial personnel. Participation in the training was voluntary, and the reported results are presented at the group level.

Experts reviewed the outputs at several development stages. Five experts in measurement and evaluation examined the content alignment of the evaluation instrument, using an item-objective congruence criterion with an acceptance threshold of 0.50 or higher. Five experts in learning-model development evaluated the appropriateness of the PROOFER structure. The digital game-based activity package and research instruments were reviewed by five experts in proofreading and publication production, and the quality of the digital media was evaluated by five experts in educational digital technology. The developed package was also piloted with 10 individuals whose characteristics were similar to those of the target group, and the materials were refined before field use.

The expert reviews served different purposes throughout development. Measurement-and-evaluation experts examined content alignment, model-development experts considered structural appropriateness and coherence, proofreading and publication-production experts examined domain relevance, and educational digital-technology experts considered media quality and usability. Comments from these reviews and the pilot informed revisions to wording, task sequence, interface presentation, instructions, and practice materials before field implementation. These ratings constitute development evidence rather than evidence of causal training effectiveness.

4.3 Development of the PROOFER Model

Model development began by synthesizing game-based learning, digital game-based activities, deliberate practice, immediate feedback, progressive challenge, authentic assessment, and professional proofreading skills. The synthesis produced five core design components: (1) Digital Game-Based Activities, (2) Deliberate Practice, (3) Immediate Feedback, (4) Progressive Challenge, and (5) Authentic Assessment.

These components were operationalized through seven linked stages whose initials form PROOFER. P–Prepare and Diagnose establishes readiness and identifies current needs. R–Review Standards and Modeling revisits proofreading criteria and demonstrates expected performance. O–Objective Goal Setting establishes individual practice goals. O–Online Game-Based Focused Practice engages participants in targeted digital proofreading missions. F–Feedback and Error Analysis makes errors visible and supports correction. E–Extended Repetition and Progressive Challenge requires repeated practice at increasing levels of difficulty. R–Real-Task Transfer and Reflection applies practiced standards to work-like proofreading tasks and prompts reflection on performance and next steps.

The intended training outcomes span three domains: language proofreading, technical proofreading, and academic proofreading. The resulting architecture is presented in Figure 3.

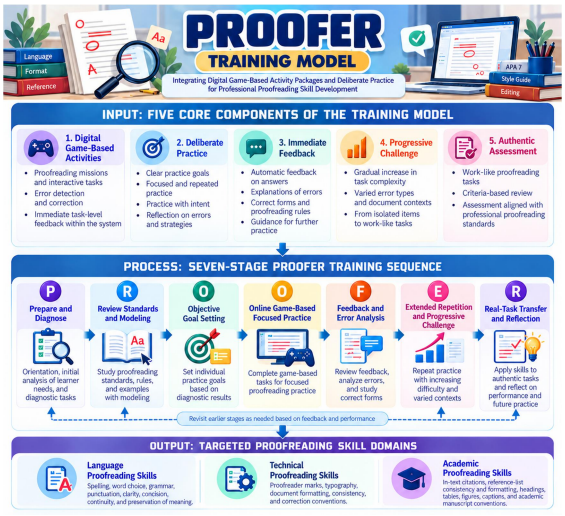


Figure 3: The PROOFER Training Model Integrating Digital Game-Based Activities and Deliberate Practice

4.4 Digital Game-Based Activity Package and Training Resources

The activity package was designed to deliver repeated proofreading practice while maintaining alignment with the seven-stage model. Digital game-based missions addressed error detection, manuscript correction, proofreading marks,

document formatting, citation and reference checking, and review of academic manuscript elements. Activities were organized from foundational to more complex tasks, and participants could repeat missions when errors persisted or further practice was needed.

Participants accessed the package through a training website that served as a central workspace for activities and resources. A digital manual explained the training sequence, task procedures, and practice recommendations so that participants could review standards and prepare for independent practice. The training environment was accessible from multiple digital devices and included immediate feedback and visible progress information to support continued practice.

The package was designed as a coordinated practice system rather than a collection of unrelated games. Each mission presented a bounded proofreading problem, required an observable response, returned task-level feedback, and allowed participants to repeat the task or progress to a more complex one. This arrangement made error identification, correction decisions, feedback, and repetition visible within the same workflow. The website and digital manual functioned as scaffolds for navigation and standards review, whereas the game missions served as the principal focused-practice mechanism. Figure 4 summarizes the digital game-based activity package and its supporting training resources. The game-based layer was defined by mission framing, bounded challenges, visible progress, immediate feedback, repeat attempts, and progression to more complex tasks rather than by digital delivery alone.



Figure 4: Digital Game-Based Activity Package and Training Resources

4.5 Training Program and PROOFER Stages

The field implementation comprised an 18-hour training program delivered over three weeks. The program was organized around the seven PROOFER stages and combined standards review, modeled examples, individual goal setting, digital game-based missions, immediate feedback, repeated practice, progressively more complex proofreading tasks, and authentic application. Activities addressed the three target domains language proofreading, technical proofreading, and academic proofreading and were sequenced to allow additional focused practice when needed.

The seven stages formed a structured but iterative professional practice cycle:

a) P – Prepare and Diagnose: Participants are oriented to the training process and complete diagnostic practice activities that help identify current proofreading needs. These activities support practice planning and are not treated as a formal pretraining outcome measure.

b) R – Review Standards and Modeling: Participants review proofreading criteria, publication conventions, and representative examples across language, technical, and academic proofreading while observing modeled correction procedures.

c) O – Objective Goal Setting: Participants establish focused practice goals based on identified error patterns and select the proofreading areas that require additional attention.

d) O – Online Game-Based Focused Practice: Participants complete targeted digital proofreading missions through the training website, applying the reviewed standards to bounded error-detection and correction tasks.

e) F – Feedback and Error Analysis: Immediate task-level feedback is used to identify missed errors, inappropriate corrections, and recurring error patterns before the next practice attempt.

f) E – Extended Repetition and Progressive Challenge: Participants repeat activities as needed and progress from focused tasks to increasingly complex proofreading situations that combine multiple error types.

g) R – Real-Task Transfer and Reflection: Participants apply the practiced standards to work-like proofreading tasks that integrate multiple error types, then review their performance and identify priorities for continued professional practice.

Progression through the stages was guided by task performance and feedback, not by a formal adaptive algorithm. Participants could revisit standards or repeat digital missions when errors persisted, while the final stage shifted practice from bounded game tasks to work-like proofreading. This structure preserved the distinction between formative in-game practice and the final post-training proofreading assessment. Figure 5

summarizes the training-program structure and the seven-stage PROOFER sequence.



Figure 5: Structure of the Training Program and Seven PROOFER Stages

4.5.1 Proofreading Skill–Assessment Alignment

Assessment alignment was based on the same three proofreading domains used to design the training activities. Language proofreading covered spelling, word choice, grammar, punctuation, clarity, concision, continuity, and preservation of meaning. Technical proofreading covered proofreader marks, typography, document formatting, consistency, and correction conventions. Academic proofreading covered in-text citations, reference-list consistency and formatting, headings, tables, figures, captions, and compliance with academic manuscript conventions. These domains were practiced across the PROOFER stages rather than confined to a single stage. Focused digital missions provided formative practice evidence, whereas the final proofreading skills assessment provided the field-phase outcome measure. Table 2 summarizes this alignment.

Table 2: Proofreading Skill Domains and Assessment Alignment

Proofreading domain	Practice and performance focus	Final assessment evidence
Language proofreading	Spelling, word choice, grammar, punctuation, clarity, concision, continuity, and preservation of meaning; practiced through focused language-error missions with immediate feedback and repetition.	Post-training language proofreading score
Technical proofreading	Proofreader marks, typography, formatting, document consistency, and correction conventions; practiced through technical proofreading and document-formatting missions.	Post-training technical proofreading score
Academic proofreading	In-text citations, reference lists, headings, tables, figures, captions, and academic manuscript conventions; practiced through citation, reference, and manuscript-review missions.	Post-training academic proofreading score

4.6 Research Instruments and Evidence Sources

The research instruments comprised the PROOFER model evaluation form, the digital game-based activity package quality evaluation form, the proofreading skills assessment, and the participant satisfaction questionnaire. The training activity plans, digital games, training website, and digital manual were development outputs evaluated as part of package quality, not separate research instruments. Observations, participant reflections, and comments were retained as supplementary implementation notes rather than formal outcome measures. Table 3 summarizes the research instruments and supplementary evidence sources used in the study.

The three-domain proofreading assessment was the outcome measure for the field phase. Practice scores generated during digital missions were used formatively to guide repetition and progression and were not treated as equivalent to the final proofreading assessment. No inter-rater reliability coefficient was available to report for the final performance scoring; this limitation is reported explicitly and should be addressed in future replication studies.

Table 3: Research Instruments and Evidence Sources Used in the Study

Instrument / source	Primary evidence	Use
PROOFER model evaluation form	Expert ratings and comments	Evaluate model appropriateness and coherence
Digital game-based activity package quality evaluation form	Expert ratings	Evaluate plans, games, website, and digital manual
Proofreading skills assessment	Post-training percentage scores	Describe performance in three skill domains
Satisfaction questionnaire	Post-training M and SD	Describe participant satisfaction
Observation and reflection	Notes	Implementation context only; not an outcome measure

4.7 Data Collection

After expert review and pilot refinement, participants completed the three-week training program. Digital missions progressed from basic to more complex proofreading tasks, and immediate feedback was provided after each mission. Participants could repeat activities when errors persisted or additional practice was needed.

After training, proofreading performance was assessed across the three skill domains and participants completed the satisfaction questionnaire. The field phase did not include a pretraining performance measure or a comparison group. Consequently, the study describes the level of post-training performance observed after implementation and does not estimate a causal training effect.

4.8 Implementation Controls and Data Management

Because the field study used a one-group posttest-only design, no baseline performance score or comparison condition was collected. Implementation controls therefore focused on consistent training exposure and the separation of formative practice from the outcome assessment. All participants followed the same 18-hour, three-week program, used the same training website and digital manual, and completed the same core sequence of digital missions and work-like proofreading activities.

Practice scores and immediate feedback generated during digital missions were used only to guide repetition and progression and were not included as outcome scores. At the end of the program, participants completed the same three-domain proofreading skills assessment and satisfaction questionnaire using the same instructions and scoring criteria. This procedure reduced the risk of conflating in-game progress with post-training professional performance.

Participant results were reported at the group level. Observations, reflections, and comments were retained only as supplementary implementation notes and were not analyzed as formal outcome evidence. No inter-rater reliability coefficient was available to report for the final performance scoring; no reliability value was inferred or imputed.

All 15 participants who completed the field implementation were included in the reported post-training summaries. The analysis was limited to descriptive statistics appropriate to the study design, comprising means and standard deviations for expert and satisfaction ratings and percentage scores for the three proofreading domains and overall performance. Table 4 summarizes the principal implementation and data-quality controls.

Table 4: Implementation and Data-Quality Controls

Control area	Procedure	Purpose
Training exposure	All participants completed the same three-week training program and used the same core training resources.	Ensure consistent training across the cohort.
Formative practice	Digital mission scores and immediate feedback were used only to guide repetition and progression.	Distinguish formative practice from formal outcome assessment.
Assessment timing	The proofreading skills assessment was administered after completion of the training program; no formal pretest or comparison group was used.	Maintain consistency with the one-group posttest-only design.
Assessment scope	The same three proofreading domains and scoring criteria were applied to all participants.	Support consistent reporting of post-training performance.
Analysis dataset	All 15 participants who completed the field implementation were included in the descriptive summaries.	Provide transparent reporting of the field cohort.

5. DATA ANALYSIS

Quantitative data were summarized using means, standard deviations, and percentages. Expert ratings and satisfaction scores were interpreted according to the five-point criteria defined in the original instruments. Proofreading performance was reported descriptively as percentage scores for language proofreading, technical proofreading, academic proofreading, and overall performance. Observations, reflections, and comments were summarized descriptively as supplementary implementation notes and were not treated as a formal qualitative outcome dataset.

Inferential pretest-posttest analysis was not conducted because the field design included only post-training performance measurement. Accordingly, the post-training scores describe the level of performance reached by the cohort but cannot establish the amount of change from baseline or isolate the effect of PROOFER from prior experience and other influences.

6. RESULTS

6.1 Specification of the PROOFER Training Model

The development process produced a model with three connected layers. The input layer combines digital game-based activities, deliberate practice, immediate feedback, progressive challenge, and authentic assessment. The process layer consists of the seven PROOFER stages from diagnosis to real-task transfer and reflection. The outcome layer defines three proofreading skill domains: language proofreading, technical proofreading, and academic proofreading.

The model positions digital games as the focused-practice mechanism within a broader professional training cycle. Goal setting occurs before game-based practice, feedback and error analysis occur immediately after practice, and repetition is extended through progressively more difficult challenges. The final stage moves beyond the game environment to work-like proofreading and reflection, linking game-based practice with professional application.

6.2 Expert Evaluation of the Model

Five learning-model development experts evaluated the appropriateness of the PROOFER model. Table 5 summarizes the dimension-level results. All dimensions were rated at a very high level. General appropriateness received the highest mean (M = 4.65, SD = 0.50), followed closely by accuracy and coherence (M = 4.64, SD = 0.50). Feasibility (M = 4.56, SD = 0.53) and utility (M = 4.57, SD = 0.52) were slightly lower but remained very high. The overall model rating was M = 4.61 (SD = 0.51).

Table 5: Expert Evaluation of the PROOFER Training Model

Evaluation dimension	M	SD	Level
Appropriateness of the model	4.65	0.50	Very high
Accuracy and coherence	4.64	0.50	Very high
Feasibility of implementation	4.56	0.53	Very high
Utility of the model	4.57	0.52	Very high
Overall	**4.61**	**0.51**	**Very high**

Item-level patterns indicated that clarity of the objectives, academic grounding of the model, alignment with proofreading development, use of digital game activities, deliberate practice, feedback, and transfer to real-task application received particularly favorable judgments. Items with comparatively lower ratings concerned the clarity of sequencing for all learners, available training time, adaptation to other contexts, and some academic-proofreading outcomes. Although these items remained positively evaluated, they indicated areas where implementation may need adjustment to learners' experience and local publication requirements.

6.3 Quality Evaluation of the Digital Game-Based Activity Package

The digital game-based activity package received very high ratings across all supporting components (Table 6). The digital manual received the highest component mean (M = 4.76, SD = 0.47), followed by the training activity plans and digital games (both M = 4.73, SD = 0.48) and the training website (M = 4.72, SD = 0.49). The overall quality rating was M = 4.74 (SD = 0.48).

Table 6: Quality of the Digital Game-Based Activity Package

Development output	M	SD	Level
Training activity plans	4.73	0.48	Very high
Digital games	4.73	0.48	Very high
Training website	4.72	0.49	Very high
Digital manual	4.76	0.47	Very high
Overall	**4.74**	**0.48**	**Very high**

Experts judged the package favorably in relation to content alignment, behavioral objectives, training activities, digital media, assessment, game mechanics, feedback, website access, and the clarity and sequence of the digital manual. These ratings support treating the package as an integrated set of training resources rather than as individual games used independently of the training model.

6.4 Post-Training Proofreading Performance

Post-training percentage scores were above 84% across all three proofreading domains (Table 7). Technical proofreading had the highest score (90.56%), followed by academic proofreading (85.83%) and language proofreading (84.22%). Overall proofreading performance was 86.87%.

Table 7: Post-Training Proofreading Performance

Proofreading domain	Percentage (%)
Language proofreading skills	84.22
Technical proofreading skills	90.56
Academic proofreading skills	85.83
Overall proofreading performance	**86.87**

Within the language domain, detection and correction of spelling errors received the highest score (86.67%), whereas the score for clarity,

concision, and continuity of text was lower (82.67%). In the technical domain, correct use of proofreading marks received the highest score (94.00%), followed by typography and type-style checking (91.33%) and document formatting (90.00%). In the academic domain, checking the accuracy of in-text citations received the highest score (87.67%), while checking headings, tables, figures, and captions was comparatively lower (84.67%). Descriptively, the item-level scores were generally higher for rule-governed technical tasks than for language tasks requiring greater contextual interpretation.

6.5 Participant Satisfaction

Participant satisfaction was very high overall (M = 4.78, SD = 0.42). The digital game-based activity package received the highest mean among satisfaction aspects (M = 4.82, SD = 0.39), followed by benefits and application (M = 4.79, SD = 0.41) and content and training activities (M = 4.73, SD = 0.45). Table 8 presents the aspect-level results.

Table 8: Participant Satisfaction with PROOFER

Satisfaction aspect	M	SD	Level
Content and training activities	4.73	0.45	Very high
Digital game-based activity package	4.82	0.39	Very high
Benefits and application	4.79	0.41	Very high
Overall satisfaction	**4.78**	**0.42**	**Very high**

The highest individual ratings were for the motivational value of the digital games and the perceived usefulness of immediate game feedback (both M = 4.87, SD = 0.35). The perceived usefulness of the model for developing proofreading skills also received M = 4.87 (SD = 0.35). Training duration had a lower mean than most other items (M = 4.60, SD = 0.51), although it remained within the highest interpretation category of the original instrument. This pattern identifies training duration as a practical issue for future refinement, particularly if more extended practice is needed for context-sensitive language proofreading.

7. DISCUSSION

7.1 Integration of Digital Game-Based Learning and Deliberate Practice

The first research question addressed how PROOFER components operate together. The model aligns five established design components, seven practice stages, and three proofreading domains. Unlike studies emphasizing general educational game outcomes [7]-[13], it specifies a task sequence for editorial work: standards review and goals precede digital missions, followed by error analysis, repetition, progressive challenge, and work-like transfer. This integration offers an adaptable design specification but does not isolate the effect of any component on post-training performance.

This relationship is consistent with deliberate-practice principles, which require focused goals, effortful practice, correction, and repetition rather than undirected exposure [5], [6]. It is also compatible with findings from digital game-based learning research showing that game mechanics are educationally useful when linked to the target content and performance process [7]-[11]. In PROOFER, the game therefore functions as a structured practice space in which error-detection and correction tasks can be repeated without separating engagement from skill criteria.

Immediate feedback is another central relationship in the model. Feedback is deliberately positioned before extended repetition so that participants analyze what was missed or corrected incorrectly before attempting similar or more difficult tasks. Research on feedback timing and human-machine feedback supports the value of feedback that is timely, interpretable, and linked to the next learning action [14]-[16]. The model applies this principle by treating error analysis as a distinct stage rather than an implicit outcome of game scoring.

7.2 Quality and Practical Structure of the Digital Game-Based Activity Package

The second research question addressed the expert evaluation of the model and its supporting package. Very high ratings for model appropriateness (M = 4.61, SD = 0.51) and activity-package quality (M = 4.74, SD = 0.48) indicate that experts judged the proposed workflow and resources favorably. The practical value lies in aligning standards, game missions, feedback, website access, digital guidance, and assessment within one training process rather than in the quality of standalone games. These ratings provide evidence of expert-judged appropriateness and development quality; they do not establish learning gains or superiority to another training approach.

The emphasis on progressive challenge and authentic tasks is consistent with evidence that meaningful performance develops when learners must apply criteria in increasingly complex and realistic contexts [17], [18]. Workplace-oriented gamification research similarly emphasizes the

need to connect engagement with retention, knowledge sharing, and job performance rather than assuming that game elements alone produce transfer [19]. The final PROOFER stage addresses this issue by moving from bounded digital practice to work-like proofreading tasks and structured reflection.

Expert ratings were slightly lower for items relating to feasibility, including training duration and adaptation to other contexts. This pattern is plausible because proofreading standards differ across publishers, document types, languages, and academic styles. A model that is structurally stable may still require local adaptation of error types, manuscript examples, reference styles, and difficulty progression. Reviews of workplace training transfer also indicate that transfer conditions and job context influence whether trained procedures are used beyond the training setting [3], [20].

7.3 Post-Training Performance and Satisfaction

The third research question examined post-training proofreading performance and satisfaction. The cohort obtained an overall post-training proofreading score of 86.87%, with technical proofreading receiving the highest domain score. The technical domain includes rule-governed tasks such as proofreader marks, typography, formatting, and document consistency. Such tasks are well suited to repeated practice because the criteria are comparatively explicit and feedback can identify correct and incorrect responses with relatively little ambiguity.

Language proofreading received the lowest domain score, although it remained above 84%. Items involving clarity, concision, continuity, and preservation of meaning require interpretation of context and authorial intention. These tasks are less easily reduced to a single correct answer and may require more extensive modeling, discussion, and expert judgment. This pattern suggests a differentiated practice strategy: digital missions may be particularly suitable for structured practice of rule-governed error detection, while complex language editing may benefit from richer examples, explanations of alternatives, and trainer-mediated discussion.

Participant satisfaction was very high, particularly for the motivational value of digital games and the perceived usefulness of immediate feedback. This accords with evidence associating gamification with motivation and engagement [21]-[24], although a meta-analysis reported more limited effects on competence than on motivation [23]. This distinction is important: satisfaction describes participants' experience of the training environment, whereas the separate post-training assessment describes proofreading performance at one time point. Neither measure establishes the amount of improvement attributable to PROOFER.

7.4 Practical Implications

For editorial and publishing organizations, PROOFER provides a structured approach for converting proofreading standards into repeated digital practice. Implementation should begin by defining the error categories and document conventions relevant to the organization. Trainers can then design missions that isolate specific skills, set individual practice goals, provide explicit error explanations, and gradually combine several error types in more authentic documents.

The model was designed for entry-level staff because it makes performance expectations visible and provides repeated opportunities to correct errors before novice staff work independently on higher-risk manuscripts. However, more experienced proofreaders may require a different challenge structure that emphasizes ambiguous language decisions, complex citation systems, cross-document consistency, and editorial judgment rather than basic error detection.

The website and digital manual should be treated as resources supporting practice rather than merely as content repositories. Resources are most useful when they support a response to a specific error, criterion, or next task. Organizations adapting PROOFER should therefore maintain a direct connection among standards, game missions, feedback messages, repeated practice, and authentic work products.

7.5 Broader Theoretical and Methodological Interpretation

Game-based learning emphasizes mechanics embedded in instructional tasks [25], while deliberate practice requires explicit goals, corrective feedback, and sustained refinement [26]. Foundational feedback research stresses information that informs the learner's next action [27], [28]. In PROOFER, these principles are expressed through focused digital missions positioned between individual goal setting and a distinct error-analysis stage.

Research on digital game-based learning has emphasized the need to assess observable outcomes with designs and measures that match the claim being made [29]. Evidence across workplace gamification and educational game-based learning

also shows that outcomes vary with design quality, context, learner characteristics, and alignment between game features and target performance [13], [19], [21], [22]. Comparative technology-enhanced training research further illustrates that changing the delivery medium does not by itself resolve questions about skill development and transfer [30]. Scoping evidence from digital game-based teacher training likewise identifies both facilitators and barriers that shape implementation [31]. Systematic reviews of intelligent and educational game-based environments indicate that feedback, navigation, challenge, and task structure should be interpreted as interacting design features rather than isolated causes [32], [33]. Accordingly, PROOFER contributes a domain-specific configuration of established design principles, while the separate causal contribution of its components remains to be tested.

Context influences game-based learning outcomes, as reported in a STEM meta-analysis [34]. Authentic assessment and workplace e-learning research link transfer to work-like tasks, opportunities for application, and follow-up measurement [18], [35]. Related workplace reviews likewise caution against assuming that immediate performance establishes later independent work quality [3], [20], [35]. PROOFER includes a transfer-and-reflection stage, but subsequent performance in actual editorial work was not measured; delayed assessments are needed.

Assessment quality remains unresolved. Rubric research supports explicit criteria for complex performance judgments [36], and reliability guidance calls for an agreement measure appropriate to the scoring design [37], [38]. Formative rubric literature also connects assessment criteria with feedback and self-monitoring [39]. Future evaluations should document scoring criteria, assessor training, and inter-rater agreement for independently evaluated editorial products.

7.6 Limitations and Future Research

The study has several methodological limitations. The field phase involved only 15 volunteers from one publishing organization and used a one-group posttest-only design. There was no pretraining performance measure and no comparison condition. The observed performance level therefore cannot establish how much participants improved, whether any change would exceed normal workplace learning, or whether PROOFER is more effective than another training design. Generalization to other publishers, languages, or document types is also limited.

The 18-hour program measured performance immediately after training and did not establish long-term retention or sustained workplace transfer. In addition, no inter-rater reliability coefficient was available to report for the final performance scoring. Future studies should include baseline and delayed measures, comparison or control conditions, larger and more heterogeneous samples, multiple organizational settings, and multiple independent assessors with appropriate inter-rater reliability reporting.

Open research questions include whether PROOFER yields greater learning gains than standards-based training without digital missions; whether post-training performance is retained and transfers to independently reviewed manuscripts; and which forms of feedback and challenge progression best support context-sensitive language corrections. Comparative and multi-site studies with baseline, delayed, and workplace-based assessments could address these questions. Further investigation could examine whether AI-assisted feedback provides accurate explanations without encouraging inappropriate editorial changes.

8. CONCLUSION

PROOFER addresses the first research objective by specifying how five established design components can be coordinated within a seven-stage professional proofreading workflow. The model links diagnosis, standards review, individual goals, focused digital missions, error analysis, repeated practice, and work-like transfer across language, technical, and academic proofreading. Its main contribution is a practical design specification for editorial training: it extends existing game-based and deliberate-practice approaches through a domain-specific sequence rather than proposing a new learning principle.

For the development and evaluation objective, experts rated model appropriateness (M = 4.61, SD = 0.51) and digital activity-package quality (M = 4.74, SD = 0.48) very highly, supporting their alignment for the intended training context. For the field objective, the 15 assistant editors achieved 86.87% overall on the post-training proofreading assessment and reported very high satisfaction (M = 4.78, SD = 0.42). Technical proofreading scored highest (90.56%), while language proofreading was comparatively lower (84.22%). This pattern suggests that context-dependent editorial judgments may require richer modeling and discussion than rule-based correction tasks.

The findings support the coherence and preliminary applicability of an integrated, standards-oriented workflow while identifying priorities for language-task complexity and training duration. They do not establish improvement or superiority over other approaches: the field phase had no pretest or comparison group and involved one small cohort. Scoring reliability and sustained workplace transfer remain unverified. Open questions include whether performance is retained, whether PROOFER produces gains under comparative conditions, and how feedback and challenge progression should be adapted across editorial settings. Such evidence is needed to establish value beyond expert evaluation and immediate post-training performance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Parwapun Kamtab was responsible for conceptualization, PROOFER model and digital game-based activity-package design, research methodology, coordination of expert review, participant recruitment, training implementation, data collection, data analysis and interpretation, preparation of figures and tables, and drafting and revision of the manuscript.

Naphee Pornnuam contributed to the technical design, development, and refinement of the PROOFER digital training environment, including the digital game-based activity package and training website. He also contributed to system testing, implementation support, and the preparation and revision of related technical and visual materials.

Both authors reviewed and approved the final version of the manuscript and agreed to be accountable for the accuracy and integrity of the work.

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