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RESEARCH ARTICLE

Pedagogical Content Knowledge in Action: A Comparative Study of Clustering within Blended and Flipped Writing Classrooms

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Abstract

This quasi-experimental study investigated the effect of integrating clustering pre-writing technique within blended and flipped instructional models on the writing performance of Iranian EFL learners. Framed by Pedagogical Content Knowledge (PCK) and cognitive process theory, the research aimed to determine how the interaction between a specific writing strategy and an instructional modality influences learning outcome. One hundred twenty intermediate-level learners were assigned to four groups: one using clustering in a blended model, one using clustering in a flipped model, and two control groups using traditional instruction in each model respectively. The intervention spanned ten sessions, with writing performance measured via pre- and post-tests using Jacobs et al.'s (1981) scale. Results revealed that both clustering groups significantly outperformed their control counterparts. Crucially, the Blended/Clustering group demonstrated superior improvement compared to the Flipped/Clustering group. The findings underscore that the efficacy of a writing technique is contingent upon the instructional context. It is concluded that a blended learning model provides the optimal synergy of structure, flexibility, and scaffolded interaction for techniques like clustering to flourish, offering a powerful PCK framework for EFL writing instruction.

Keywords: Clustering, Blended Learning, Flipped Classroom, EFL Writing, Pedagogical Content Knowledge (PCK).

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1- Introduction

Writing is universally recognized as a complex and demanding skill for English as a Foreign Language (EFL) learners, requiring a sophisticated integration of linguistic knowledge, cognitive organization, and rhetorical awareness (Graham & Perin, 2007). This challenge is particularly acute in contexts like Iran, where learners often navigate multiple languages (e.g., Turkish Azerbaijani L1, Persian L2), further complicating the process of generating and

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structuring ideas in English. Traditional writing instruction, often focused on the final product, has been criticized for providing insufficient scaffolding during the critical planning and drafting stages (Flower & Hayes, 1981).

In response, process-oriented approaches emphasize the importance of pre-writing strategies. Among these, clustering (or mind-mapping) has proven effective in helping learners externalize and visually organize their thoughts, thereby facilitating the translation of ideas into coherent text (Bukhari, 2016; Pratiwi & Istiana, 2024). Concurrently, technological and pedagogical evolution has popularized innovative instructional models like blended and flipped learning. These models redistribute learning activities across space (online vs. face-to-face) and time (synchronous vs. asynchronous), creating new opportunities for interactive, student-centered learning (Foldnes, 2016; Ali, Ahmadi, & Rezaei, 2023).

However, while the individual benefits of clustering and these instructional models are well-documented, a critical gap exists in understanding their interaction. Specifically, existing research has largely examined (a) the efficacy of clustering in traditional classroom settings (Bukhari, 2016; Khezrinejad, 2024) and (b) the general effectiveness of blended or flipped models on writing outcomes (Ali et al., 2023; Kawinkoonlasate, 2024) as separate lines of inquiry. What remains conspicuously absent is empirical evidence on whether and how these two pedagogical innovations—a specific pre-writing strategy and a particular instructional modality—interact to produce differential learning outcomes. This lacuna is problematic because simply transplanting a technique proven effective in one context into a new instructional environment without understanding their pedagogical fit may yield suboptimal or even counterproductive results (Hava, 2024). Moreover, the theoretical assumption that "good techniques work everywhere" has gone largely untested in technology-enhanced writing classrooms, leaving teachers and curriculum designers without evidence-based guidance on how to strategically align instructional strategies with delivery models. Simply using a good technique within a modern model does not guarantee optimal results; therefore, this study argues that empirical investigations must shift from examining techniques and models in isolation to testing their strategic integration, a core tenet of Pedagogical Content Knowledge (PCK). This study is grounded in the concept of Pedagogical Content Knowledge (PCK), which posits that effective teaching requires a fusion of content knowledge (e.g., the clustering technique) and pedagogical knowledge (e.g., how to deliver it within a blended or flipped structure).

Drawing upon the PCK framework, which posits that the strategic transformation of content knowledge into pedagogically appropriate forms is essential for effective instruction (Shulman, 1986), the present study advances the following hypothesis: The integration of the clustering technique within instructional models that provide optimal scaffolding, flexibility, and interactive support will yield superior writing outcomes. More specifically, it is hypothesized that the blended learning model, by virtue of its balanced distribution of asynchronous reflection and synchronous guidance, will provide a more conducive environment for the cognitive processes inherent in clustering (e.g., non-linear idea generation, iterative refinement, and visual organization) compared to the flipped classroom model, which

may impose higher cognitive demands during in-class application. Consequently, the Blended/Clustering group is expected to demonstrate significantly greater writing gains than the Flipped/Clustering group, while both experimental groups are expected to outperform their respective control groups. This hypothesis directly tests the PCK principle that pedagogical effectiveness depends not on the technique or the model alone, but on their strategic alignment. The research questions are derived from this hypothesis, operationalizing its predictions for empirical investigation.

This research, therefore, moves beyond isolated efficacy to examine the synergistic effect of combining a specific pre-writing strategy with specific instructional frameworks. It addresses the following questions in the context of Iranian EFL learners:

1. To what extent does the integration of the clustering technique significantly enhance writing performance within a blended learning environment compared to traditional instruction in the same environment?
2. To what extent does the integration of the clustering technique significantly enhance writing performance within a flipped learning environment compared to traditional instruction in the same environment?
3. Which instructional model—blended or flipped—yields a more pronounced positive effect on writing performance when integrated with the clustering technique?

2. Review of Literature

2.1. Theoretical Framework

2.1.1. Cognitive Process Theory of Writing and the Clustering Technique

Clustering is theoretically rooted in Flower and Hayes' (1981) cognitive process theory of writing, which conceptualizes writing as a non-linear process of planning, translating, and reviewing. Clustering operationalizes the planning stage, serving as an external "ideational scaffold" that mitigates cognitive load by allowing writers to map concepts and their relationships visually before constructing linear text. This process supports metacognitive awareness, enabling learners to plan, organize, and anticipate audience needs more effectively (Bereiter & Scardamalia, 1987).

In bilingual EFL contexts, clustering holds additional promise. It allows learners to organize semantic content conceptually, potentially transcending linguistic boundaries, before grappling with the syntactic and lexical demands of L2 text production. This aligns with constructivist principles, where knowledge is actively built and co-constructed, often through visual and collaborative means.

2.1.2. The PCK Framework and the Present Study

The theoretical lens for this study is Shulman's (1986) Pedagogical Content Knowledge (PCK), which argues that exemplary teaching requires a unique blend of subject matter knowledge and pedagogical knowledge. We posit that effective writing instruction is not merely about *knowing* a technique like clustering (content knowledge) or *using* a model like blended

learning (pedagogical knowledge); it is about knowing *how to adapt and present* that technique within the specific affordances and constraints of that model.

This study's framework, illustrated in Figure 1, proposes that the highest learning gains are achieved at the intersection of a robust writing technique and a complementary instructional modality that provides the necessary scaffolding, time, and interactive structure for that technique to be fully realized.

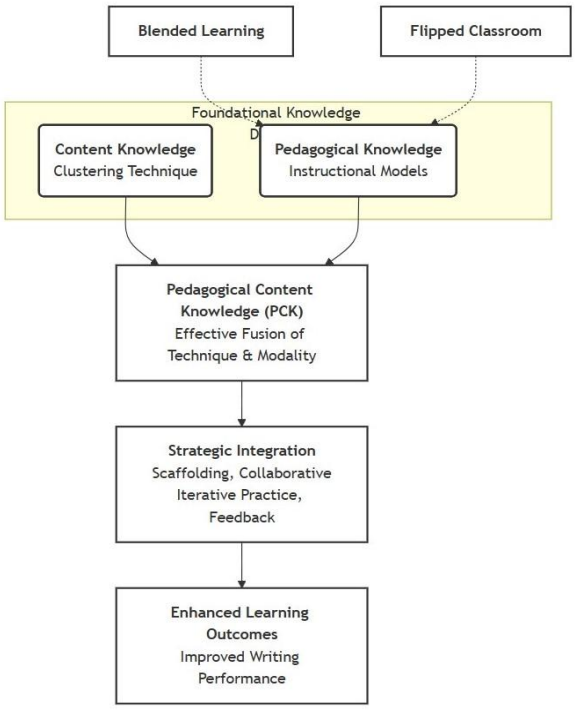


Figure 1. Graphic Model: Theoretical Framework of the Study.

***Note**: (Dashed lines represent the foundational knowledge that informs a teacher's PCK, while solid lines represent the active, causal pathway through which PCK influences learning outcomes via strategic integration.)*

This conceptual model illustrates the theoretical framework guiding the present study, grounded in the principle of Pedagogical Content Knowledge (PCK). The framework posits that Enhanced Learning Outcomes are not a direct result of merely applying Content Knowledge (the Clustering technique) or general Pedagogical Knowledge (knowledge of instructional models) in isolation.

Instead, effective teaching requires a synergistic fusion of these domains, resulting in true Pedagogical Content Knowledge (PCK)**.** This PCK, specific to writing instruction, involves understanding how to best adapt and present the clustering technique within the unique

affordances of specific instructional modalities like Blended Learning and the Flipped Classroom.

The model specifies that this PCK is operationalized through a process of Strategic Integration, which involves deliberate instructional design choices such as providing scaffolding, facilitating collaboration, and enabling iterative practice with feedback. It is hypothesized that the Blended Learning modality offers a more natural and effective environment for this strategic integration of clustering, leading to superior Learning Outcomes (Writing Performance) compared to its implementation in a Flipped Classroom model. The study empirically tests this hypothesized pathway.

2.2. Instructional Models in EFL Writing

2.2.1 Blended Learning in EFL Writing Instruction

Blended Learning synergizes face-to-face instruction with online components, offering flexibility, access to digital resources, and opportunities for sustained, reflective interaction with learning materials (Wang et al., 2024). For writing instruction, this model can extend the learning process, allowing for asynchronous brainstorming, peer feedback on clusters, and iterative revision.

2.2.2. Flipped Classroom Model in Writing Instruction

The Flipped Classroom model inverts the traditional sequence by delivering instructional content (e.g., lectures, videos) as pre-class homework, thereby freeing up in-class time for active learning, collaboration, and problem-solving (Tucker, 2012). In writing classes, this creates a dedicated space for interactive pre-writing activities, collaborative clustering sessions, and immediate teacher feedback on drafts (Kawinkoonlasate, 2024).

2.3. Empirical Framework

Recent empirical investigations have further solidified the role of visual pre-writing strategies, such as clustering and mind-mapping, in enhancing the structural and creative dimensions of EFL writing. For instance, Tarin and Yawiloeng (2022) demonstrated that learners utilizing mind-mapping techniques consistently produced more detailed and better-organized texts compared to those using traditional linear outlining. This improvement is attributed to the strategy's ability to facilitate creative brainstorming and vocabulary retrieval simultaneously. Similarly, Khezrinejad (2024) found that clustering significantly aids idea generation by allowing students to externalize complex semantic networks before the cognitive demands of L2 syntactic production take over. These findings suggest that the visual nature of clustering serves as a critical cognitive bridge, particularly for bilingual learners who must navigate multiple linguistic systems during the drafting process.

Furthermore, the integration of these strategies within digital and hybrid instructional landscapes has become a focal point of contemporary research. Kusumayanthi (2025) observed that when mind-mapping is combined with digital platforms, such as e-portfolios or collaborative online boards, student engagement and interest in the writing process are

significantly amplified. This digital synergy aligns with the broader findings of Hava (2024), whose systematic review underscored that while flipped and blended models offer increased practice opportunities, their efficacy is contingent upon the "pedagogical fit" between the task and the medium. Specifically, recent studies by Nezhad Mahdipour (2025) suggest that blended environments may offer a more robust framework for complex pre-writing tasks by providing a balanced distribution of synchronous guidance and asynchronous reflection, thereby preventing the cognitive overload often associated with rapid in-class activities in fully flipped models.

The evolution of teacher knowledge in these technology-enhanced environments is increasingly framed through the lens of Technological Pedagogical Content Knowledge (TPACK). Jiang (2025) argues that the successful implementation of writing techniques like clustering requires more than just technical proficiency; it necessitates a sophisticated transformation of content knowledge into pedagogical forms that are contextually appropriate for the specific instructional modality. Abubakir (2023) further emphasizes that mastery of TPACK enables educators to navigate the intricate link between the cognitive demands of writing and the logistical affordances of blended learning. Consequently, the strategic alignment of a pre-writing technique with an instructional model is not merely a logistical choice but a manifestation of a teacher's advanced PCK, which directly influences the quality of student learning outcomes in the digital age (Hang, 2025).

3. Method

3.1. Research Design

A quasi-experimental design was employed, utilizing a pre-test/post-test control group structure. The independent variable was the instructional method, with two levels: Clustering Technique and Traditional Instruction. This variable was cross-cut with the instructional modality (Blended vs. Flipped), creating four distinct groups. The dependent variable was writing performance, measured by scores on a standardized writing task.

3.2. Participants

The participants were 120 female Iranian EFL learners aged 17-24, selected from a larger pool of 240 students at a language institute in Tabriz. A multi-stage sampling procedure was employed. First, a convenience sampling approach was used to select the language institute, as it was accessible to the researchers and had the necessary technological infrastructure to support blended and flipped instruction. Second, from the initial pool of 240 students who volunteered to participate, a purposive sampling strategy was applied to select 120 learners who met the following criteria: (a) intermediate proficiency level as determined by the Oxford Placement Test (OPT), (b) no prior formal instruction in clustering or mind-mapping techniques, and (c) no previous experience with blended or flipped learning models. This purposive selection ensured that the sample was homogeneous in terms of language proficiency and prior exposure to the experimental interventions, thereby enhancing internal validity.

The single-gender sample reflects the institutional context of the study and controls for potential gender effects, though it may limit the generalizability of the findings. Their intermediate proficiency level was confirmed using the Oxford Placement Test (OPT). All participants were bilingual, with Turkish-Azerbaijani as their first language and Persian as their second. Following the selection process, participants were randomly assigned to one of four groups (n=30 per group) using a simple random allocation procedure (i.e., a random number generator) to minimize selection bias and ensure comparability across conditions: They were randomly assigned to one of four groups (n=30 per group):

Group 1 (Blended/Clustering): Received clustering instruction within a blended learning model (involving both face-to-face sessions and online activities on Moodle).

Group 2 (Flipped/Clustering): Received clustering instruction within a flipped classroom model (involving pre-class video lectures and in-class collaborative activities)**.**

Group 3 (Blended/Control): Received traditional instruction within a blended learning model (focusing on model text analysis and grammar instruction without pre-writing strategy training).

Group 4 (Flipped/Control): Received traditional instruction within a flipped classroom model (with pre-class videos and in-class product-focused writing activities).

3.3. Instruments

Three primary instruments were employed in this study. First, the Oxford Placement Test (OPT) was administered to ensure a homogeneous sample of intermediate-level learners. Second, parallel writing prompts of a descriptive and narrative nature were developed for the pre-test and post-test to guarantee the comparability of the writing tasks across both testing periods. Finally, writing performance was measured using Jacobs et al.'s (1981) ESL Composition Profile. This rubric provides a comprehensive assessment across five components: Content (30 points), Organization (20 points), Vocabulary (20 points), Language Use (25 points), and Mechanics (5 points). To ensure scoring consistency, inter-rater reliability was calculated, yielding high coefficients for both the pre-test (r = .834) and post-test (r = .921).

3.4. Procedure

The intervention was conducted over ten 60-minute sessions. Participants in the experimental groups received explicit training in the clustering technique. This training encompassed a structured process of brainstorming ideas, creating visual cluster maps, expanding these clusters with supporting details, and ultimately converting them into formal outlines and drafts. Specifically, the clustering training followed a five-stage scaffolded procedure adapted from Bukhari (2016) and Pratiwi & Istiana (2024):

Stage 1 (Sessions 1-2): Introduction and Modeling. The instructor introduced the concept and purpose of clustering as a pre-writing strategy, explaining its role in generating and organizing ideas before drafting. Using a think-aloud protocol, the instructor modeled the entire

clustering process on a sample topic (e.g., The Impact of social media on Education), demonstrating how to (a) write the main topic in the center, (b) generate associated subtopics and branch them outward, (c) add supporting details and examples to each subtopic, and (d) identify relationships between different branches.

Stage 2 (Sessions 3-4): Guided Practice with Simple Topics. Learners practiced clustering on familiar, low-stakes topics (e.g., My Favorite Holiday, Advantages of Learning English) under close instructor guidance. The instructor circulated, provided real-time feedback, and addressed difficulties such as generating sufficient subtopics or organizing ideas logically. Learners worked individually and then shared their clusters in pairs for peer discussion and refinement.

Stage 3 (Sessions 5-6): Independent Practice with Writing Prompts. Learners independently constructed clusters for prompts comparable to those used in the assessment (descriptive and narrative topics). They were given 20 minutes for cluster creation, followed by 40 minutes for drafting a paragraph based on their cluster. Written feedback was provided by the instructor, focusing on both the quality of the cluster and its translation into coherent text.

Stage 4 (Sessions 7-8): Collaborative Clustering and Peer Feedback. Learners formed small groups, collaboratively constructed clusters on assigned topics, and provided peer feedback on each other's clusters. This stage emphasized (a) evaluating cluster completeness, (b) assessing logical organization, and (c) suggesting additional ideas or supporting details.

Stage 5 (Sessions 9-10): Integration and Full Essay Writing. Learners were expected to independently construct clusters for longer, more complex prompts and produce full essays (approximately 250-300 words) based on their clusters. The focus was on seamless integration of the clustering technique into the writing process, with emphasis on time management and the effective use of clusters as a structural roadmap during drafting.

In contrast, the control groups were instructed using a traditional, product-based approach, which focused on the analysis of model texts and explicit instruction in grammar and vocabulary, without any structured pre-writing strategy training. Specifically, control group sessions involved (a) reading and analyzing sample essays for structure and language features, (b) completing grammar and vocabulary exercises related to the target writing topic, and (c) writing paragraphs or essays based on given prompts without any structured brainstorming or organizational pre-writing activities. The instructional modality was also varied: the blended model integrated face-to-face classroom instruction with supplementary online activities hosted on the Moodle platform, such as forum discussions and material downloads. The flipped model required learners to study pre-recorded video lessons prior to class, thereby dedicating in-person session time entirely to interactive exercises, collaborative clustering tasks, and peer feedback. To control potential teacher effects, the same instructors delivered instruction across all conditions.

4.Results

Data were analyzed using SPSS v.26. Descriptive statistics were calculated, and assumptions of normality and homogeneity of variance were met. A one-way Analysis of Variance (ANOVA) was conducted on the post-test scores to compare the four groups with the significance level set at $\alpha = .05$. The results are presented in sequence, beginning with the screening process and proceeding to the pre-test and post-test comparisons.

Table 1 presents the descriptive statistics for the Oxford Placement Test administered to the initial pool of candidates. This was used to select the homogeneous intermediate-level sample for the study.

Table 1. Descriptive Statistics for the Oxford Placement Test (Screening Sample, N=240).

Statistic	N.	Mean	Std. Deviation	Variance	Skewness	Kurtosis	KR-21 Reliability
OPT Score	240	19.23	8.08	65.27	-0.052	0.025	0.81

Note: *The score range for selected intermediate participants was 31-40.*

As shown in Table 1, the OPT demonstrated high reliability (KR-21 = 0.81). The selection of participants from the upper end of the score distribution ensured a homogeneous sample in terms of language proficiency before the intervention. Table 2 displays the descriptive statistics for the writing pre-test scores across the four experimental groups to establish baseline equivalence.

Table 2. Descriptive Statistics for Pre-test Writing Scores by Group (N=120).

Group	N	Mean	Std. Deviation	95% CI (Lower)	95% CI (Upper)
Blended / Clustering	30	33.50	5.50	31.30	35.70
Flipped / Clustering	30	31.80	5.10	29.80	33.80
Blended / Control	30	29.60	4.80	27.80	31.40
Flipped / Control	30	27.90	4.50	26.20	29.60

A one-way ANOVA conducted on the pre-test scores confirmed that there were no statistically significant differences between the groups at the outset of the study, F (3, 116) = 1.22, $p > .05$. This confirms that any differences in the post-test can be attributed to the intervention. Table 3 presents the descriptive statistics for the post-test writing scores.

Table 3. Descriptive Statistics for Post-test Writing Scores by Group (N=120).

Group	N	Mean	Std. Deviation	95% CI (Lower)	95% CI (Upper)
Blended / Clustering	30	71.47	8.88	68.15	74.78
Flipped / Clustering	30	63.13	9.72	59.50	66.76
Blended / Control	30	37.07	6.32	34.71	39.43
Flipped / Control	30	36.70	8.61	33.48	39.92

A one-way ANOVA performed on the post-test scores was statistically significant, $F(3, 116) = 84.31$, $p < .001$, with a very large effect size ($\eta^2 = .708$), indicating that the differences in group means were substantial. To pinpoint the specific differences between groups, a Tukey HSD post-hoc test was conducted. The results of these pairwise comparisons are presented in Table 4.

Table 4. Post-Hoc Comparisons (Tukey HSD) for Post-test Writing Scores.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	P	95% Confidence Interval
Blended / Clustering	Flipped / Clustering	8.34*	2.29	.001	[3.10, 13.58]
	Blended / Control	34.40*	2.29	.001	[29.16, 39.64]
	Flipped / Control	34.77*	2.29	.001	[29.53, 40.01]
Flipped / Clustering	Blended / Clustering	-8.34*	2.29	.001	[-13.58, -3.10]
	Blended / Control	26.06*	2.29	.001	[20.82, 31.30]
	Flipped / Control	26.43*	2.29	.001	[21.19, 31.67]
Blended / Control	Flipped / Control	0.37	2.29	.987	[-4.87, 5.61]

Note: *The mean difference is significant at the .05 and p < .001level.*

The post-hoc analysis provides direct evidence to address the research questions. Regarding the first research question, the clustering technique significantly enhanced writing performance within the blended learning environment, as the Blended/Clustering group significantly outperformed the Blended/Control group (Mean Difference = 34.40, $p < .001$). Similarly, for the second research question, the clustering technique also had a significant positive effect within the flipped environment, with the Flipped/Clustering group outperforming the Flipped/Control group (Mean Difference = 26.43, $p < .001$).

Critically, for the third research question, which compared the instructional models, the Blended/Clustering group's mean score was significantly higher than that of

the Flipped/Clustering group (Mean Difference = 8.34, p = .001). This indicates that the blended model was a more effective modality for implementing the clustering technique. Finally, the analysis confirmed that there was no significant difference between the two control groups (Mean Difference = 0.37, p = .987), indicating that the instructional modality alone, without the clustering technique, did not lead to differential outcomes.

5. Discussion

The findings of this study provide compelling evidence for the superior efficacy of the blended learning model when integrated with the clustering technique. This synergy can be explained through the lens of "technique-modality fit," a core component of Pedagogical Content Knowledge (PCK). While both experimental groups outperformed the control groups, the Blended/Clustering group's significant advantage over the Flipped/Clustering group (Mean Difference = 8.34, p < .001) suggests that the blended model provides a more conducive environment for the cognitive processes inherent in clustering. As noted by Tarin and Yawiloeng (2022), clustering requires a delicate balance between free-associative brainstorming and structured organization. The blended model, by offering an asynchronous online phase, provides the crucial "incubation time" necessary for these non-linear ideas to mature before they are refined in the face-to-face classroom (Flower & Hayes, 1981; Wang et al., 2024).

In contrast, the flipped model, while undoubtedly innovative, appears to impose a higher cognitive load during the in-class phase where students are expected to move rapidly from pre-recorded theory to active application. This observation aligns with Hava's (2024) systematic review, which highlighted that the success of flipped learning is heavily dependent on the learner's ability to manage the transition between out-of-class preparation and in-class collaboration. For a complex generative task like clustering, the compressed timeframe of a flipped classroom may not offer the same reflective space as the sustained, iterative interaction found in blended environments (Ali et al., 2023; Nezhad Mahdipour, 2025). Crucially, the blended model's structure seems to better support the difficult transition from associative thinking to linear text production, a process that Jiang (2025) identifies as a critical challenge for L2 writers.

A more granular analysis of the writing rubric's sub-components offers further insight into the specific mechanisms underlying the observed improvements. While the aggregated writing scores demonstrate the overall superiority of the Blended/Clustering group, examining the individual components of Jacobs et al.'s (1981) ESL Composition Profile—Content (30 points), Organization (20 points), Vocabulary (20 points), Language Use (25 points), and Mechanics (5 points)—reveals a more nuanced picture of the intervention's impact. The most substantial gains for the Blended/Clustering group were observed in the Content and Organization sub-components. This is perhaps unsurprising given that clustering is fundamentally a planning and idea-generation strategy; its primary function is to externalize and visually structure semantic networks before the act of drafting begins (Khezrinejad, 2024). The asynchronous phase of the blended model appears to have provided learners with the necessary time to develop richer

content and more logical organizational frameworks, as reflected in their ability to produce clusters with greater depth of ideas and clearer hierarchical structures. This finding aligns with Bukhari's (2016) observation that clustering enhances coherence and idea development when learners are given adequate time for reflective planning.

Improvements in Vocabulary and Language Use, while still significant, were comparatively more modest. This is consistent with the theoretical premise that clustering primarily targets the planning stage of the writing process rather than the linguistic encoding stage (Flower & Hayes, 1981). The visual nature of clustering may facilitate lexical retrieval by activating semantic networks and making associated vocabulary more accessible during drafting (Pratiwi & Istiana, 2024). However, the transfer of well-organized ideas into grammatically accurate and lexically sophisticated text remains a separate cognitive challenge that requires additional instructional support, particularly for intermediate-level EFL learners. Interestingly, the smallest gains were observed in the Mechanics sub-component (spelling, punctuation, capitalization), which is to be expected given that clustering does not directly target surface-level accuracy. These findings suggest that while clustering significantly enhances the macro-level features of writing (content and organization), its impact on micro-level features (language use and mechanics) is indirect and may require supplementary instruction.

This differential pattern of gains has important pedagogical implications. The substantial improvement in Content and Organization suggests that clustering is particularly effective for learners struggling with idea generation and text structuring—common challenges in EFL writing contexts (Graham & Perin, 2007). However, the more limited gains in Language Use and Mechanics indicate that clustering should be viewed as a complement to, rather than a replacement for, explicit language instruction. Teachers implementing clustering within a blended model should, therefore, ensure that online and face-to-face activities are designed to address both macro-level and micro-level writing features. For instance, while the asynchronous phase can focus on idea generation and cluster development, the face-to-face phase could incorporate targeted language-focused activities, such as peer editing for grammatical accuracy or vocabulary enhancement exercises, to address the full spectrum of writing competencies assessed by the rubric.

The very large effect size ($\eta^2 = .708$) observed in this study underscores the profound practical significance of strategic integration. It is not merely the adoption of a modern model or a popular technique that drives improvement, but the expert alignment of the two—a clear manifestation of TPACK in action (Abubakir, 2023). The substantial gains in the Blended/Clustering group demonstrate that when a pedagogical strategy is expertly matched to the unique affordances of an instructional modality, the impact on writing quality, particularly in content and organization, is dramatically amplified (Bukhari, 2016; Sinambela & Lumban Gaol, 2023). This research therefore reinforces the notion that the context of learning is as critical as the content of instruction, providing a robust framework for reimagining EFL writing pedagogy in the digital age (Hang, 2025).

6. Conclusion

This study set out to investigate the interaction between the clustering pre-writing technique and two technology-enhanced instructional models—blended and flipped learning—on Iranian EFL learners' writing performance. The findings conclusively demonstrate that while clustering significantly enhances writing outcomes in both instructional environments, its efficacy is not automatic. The full potential of the technique is strategically unlocked when integrated within a blended learning model. The synergy arises from the alignment between the technique's inherent requirement for iterative, reflective development and the blended model's unique structural affordance for both structured, synchronous guidance and flexible, asynchronous elaboration. Notably, the Blended/Clustering group significantly outperformed the Flipped/Clustering group (Mean Difference = 8.34, $p < .001$), indicating that the instructional modality plays a critical role in determining the effectiveness of a writing strategy. This research thereby shifts the focus from a debate on the superiority of individual methods to a more nuanced understanding of their complementary roles within a coherent Pedagogical Content Knowledge (PCK) framework.

The present study makes several theoretical contributions to the field of EFL writing pedagogy. First, it provides empirical validation for the application of Shulman's (1986) PCK framework in technology-enhanced writing instruction, demonstrating that the "transformation" of content knowledge involves strategically aligning a technique's cognitive demands with an instructional model's logistical and interactive capabilities. Second, the findings introduce and operationalize the concept of "technique-modality fit," advancing PCK theory by specifying that not all instructional models are equally conducive to the implementation of a given pre-writing strategy. Third, the significant interaction effect observed in this study challenges the prevailing assumption in the literature that effective techniques and modern models can be combined arbitrarily; rather, the results suggest that pedagogical decisions must be guided by a sophisticated understanding of how cognitive processes (e.g., clustering's reliance on nonlinear, reflective thinking) interact with environmental affordances (e.g., blended learning's balance of asynchronous and synchronous activities). This nuanced perspective extends both the cognitive process theory of writing (Flower & Hayes, 1981) and PCK theory by situating them within contemporary digital learning landscapes.

The findings also carry clear implications for EFL instructors and curriculum designers. Practitioners should prioritize and invest in blended learning formats for writing instruction that incorporates pre-writing strategies, as this model appears to provide the optimal synergy of structure, flexibility, and scaffolded interaction. Teacher training programs must move beyond simply introducing techniques like clustering and must explicitly train educators on how to scaffold them across both online and face-to-face environments. This involves designing specific online tasks for individual brainstorming and cluster refinement, and face-to-face activities for collaborative expansion and instructor-led feedback, thereby leveraging the distinct strengths of each component (Kawinkoonlasate, 2024). Furthermore, the findings underscore that instructional innovation is not merely about adopting new technologies or techniques in isolation but about understanding how to strategically integrate them within a

coherent pedagogical framework. Curriculum developers should, therefore, consider the cognitive demands of specific writing strategies when selecting or designing instructional delivery models.

Despite the robust evidence provided, several limitations must be acknowledged. First, the sample was limited to 120 female Iranian EFL learners from a single language institute in Tabriz, which restricts the generalizability of the findings to other populations, contexts, and gender groups. Second, the intervention was relatively short (ten 60-minute sessions), and the long-term retention of writing gains was not assessed. Third, the study focused exclusively on the clustering technique; it remains unclear whether the observed interaction effects would replicate with other pre-writing strategies (e.g., outlining, freewriting, brainstorming). Fourth, the use of a quasi-experimental design, while appropriate for the research questions, limits the ability to draw causal inferences compared to a fully randomized controlled trial. Fifth, the study did not collect qualitative data on learner perceptions or cognitive processes, which could have provided richer insights into why the blended model proved more effective.

Building on these limitations, future research should expand this interactionist paradigm in several directions. Investigations are needed to explore how other pre-writing strategies (e.g., outlining, freewriting, webbing) interact with blended and flipped models to determine whether the "technique-modality fit" observed in this study is specific to clustering or generalizable to other strategies. Research should also examine these dynamics across diverse learner profiles, including different proficiency levels (e.g., beginner, advanced), age groups (e.g., younger learners, adult learners), and cultural and linguistic backgrounds, to assess the transferability of the findings. Longitudinal studies are essential to evaluate the long-term retention of writing gains and the sustainability of the observed effects over extended periods. Additionally, mixed-methods designs incorporating qualitative data—such as interviews, think-aloud protocols, or stimulated recall sessions—could provide deeper insights into the learner perceptions and cognitive processes that underline the quantitative results, thereby illuminating the mechanisms driving the observed interaction effects. Future research could also investigate how the integration of digital clustering tools (e.g., mind-mapping software) within blended and flipped models further influences writing outcomes, building on the work of Wang et al. (2024). Finally, replication studies in different educational contexts are needed to establish the robustness and generalizability of the present findings.

To conclude, effective writing instruction in the 21st century requires a sophisticated PCK-informed understanding. It is no longer solely about what to teach, but about knowing how to adapt it and where to situate it within innovative learning landscapes to achieve maximum impact on student performance. By demonstrating that the context of learning is as critical as the content of instruction, this study provides a robust empirical foundation for reimagining EFL writing pedagogy in the digital age. The strategic integration of clustering within a blended learning model represents a powerful, evidence-based approach that can significantly enhance the quality of EFL learners' written output.

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