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Reimaging Argumentative Writing: Innovative Approaches with Digital Tools

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Abstract

This research compares the effectiveness of digital writing tools (DWT) and traditional paper-based writing (PBW) in optimizing argumentative writing abilities for secondary students. Eighty-five secondary students (ages 17–19) participated in this quasi-experimental, mixed-methods study, which divided them into three groups: a control group (n = 28) and two experimental groups (n = 31 and n = 26). Writing skills assessments administered before and after the experiment showed that the experimental groups developed significantly, with a mean score increase of 16.6% for group 1 and 18.7% for group 2, which proves that DWT achieves better argumentative writing skills in students. Research showed less conclusive findings regarding the relationship between DWT and PBW because students demonstrated different styles of skill development. The research results demonstrate how digital tools can transform argumentative writing instruction while providing original insights about DWT and PBW effects in Saudi Arabian educational settings. Educational practices need to integrate digital tools; in particular, educators should adopt scaffolded digital feedback cycles and training in AI-supported editing tools to motivate students with essential writing competencies to succeed in academic and professional fields.

Keywords: Argumentative writing skills, digital writing tools, paper-based writing, sustainability 2030, teaching pedagogy

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Introduction

Traditional paper-based writing (PBW) has long served as a foundational component of academic writing instruction. However, it restricts the development of essential writing skills because of its inherent constraints. Time-consuming feedback processes, limited opportunities for revision and collaboration, and restricted access to real-time support are certain limitations that have restricted students from effective learning. Within the digital world, these constraints hinder students from refining their writing skills alongside meeting the requirements and needs of modern environments within academic and professional settings. While digital transformation has brought ample learning opportunities through the apt usage of digital writing tools (DWT) and social networking resources, this has advanced into understanding the pivotal role of transforming the key concept behind active learning and enhanced communicational expertise (Dahlström, 2018). Hence, proficient advancements within the digital era have provided students with key skills that enhance learning motivation while attaining innovative knowledge and information. Per the conceptual narrative of Kress (2009), the transposition of the learning dialect from the teacher-led perspective to student-led strategies has played a vital role in providing students with the essential skills to diminish the essence of incompetent learning. Therefore, the gradual transformation from conventional teaching strategies to digitally equipped learning techniques has brought forth the conceptualization of DWT, which is hailed as a promising solution, offering features such as instant feedback, spell checkers, collaborative writing platforms, and access to various resources, alongside possessing the potential to enhance students' writing processes and learning outcomes. These tools are configured to foster more efficient, interactive, and flexible writing practices, providing students with essential guidance to improve the quality of writing and its throughput.

However, the initial step to transitioning conventional learning into active and in-focused learning through digital tools involves using newer methods and strategies in digital writing platforms (Björkvall & Jacquet, 2014). Such steps may eloquently be understood through the Affordance Theory introduced by Gibson (1979), which discusses primary students' perceptions of affordances and resources provided by digital tools and platforms. The theory represents the relationship between the instructor and the learner while assessing the quality of the learning methodology. Hence, from the education perspective, the affordance theory originates from perceptual psychology, which views learning environments and technologies as offering opportunities for action or action possibilities that redefine individuals' learning and interactive strategies. The theory, hence, within an educational setting, demonstrates the connection between teachers and students concerning language and writing enhancement. Across global technologization, the conceptual framework of the Affordance theory provides teachers and students with multiple platforms and opportunities to learn newer strategies through the apt usage of AI writing tools. Thus, Digital platforms provide teachers with numerous strategic methods and techniques that deliver competent learning requirements while enhancing argumentative writing skills. Per the survey analysis conducted by Nobles and Paganucci (2015), primary and secondary students prefer utilizing digital tools to rectify academic assessments while enhancing the practical usage of writing skills. The analysis suggested that teachers advance sufficient digital tools within the classroom for effective and inclusive learning, whether experiential, useful, or theoretical.

Furthermore, argumentative essay writing entails intricate activities and writing skills, which, when extensively applied in academia, intend to advance, propagate, and assess the individual's intellectual understanding. Written argumentation is an in-demand pedagogical procedure that enhances cognitive and meta-cognitive processes required for written and oral

argumentation (Benetos, 2023). The technological advancements, therefore, leverage opportunities for almost every domain. DWT allows students to contemplate and improve oral and verbal argumentative skills. For instance, numerous digital tools enhance the essential skills for developing argumentative essays. Hence, tools such as Grammarly, Google Docs, Evernote, and ProWritingAid leverage essential improvements in writing skills while developing critical thinking and problem-solving skills among students to compose argumentative drafts on an academic level (Benetos, 2023). According to Andriessen et al. (2013), contemporary technology advocates three major learning activities: arguing to learn, learning about argumentation, and learning to argue. Teachers and students must cooperate and obtain targeted goals to overcome complications during the learning process or acquire argumentative writing skills. Instead of the pertinent complications, Elborolosy and Almujali (2020) suggested that students face several complications when expressing perspectives or narratives in English. However, the students were often taught to translate Arabic sentences into English, causing numerous grammatical inconsistencies, which hindered the development and rendition of innovative ideas. Hence, the lack of commitment and focus inhibits the students' rigor in enhancing argumentative writing skills despite using digital tools in the global technologization era. Moreover, teachers still require an apt understanding of practical tools and methods to assist students in effective learning. Likewise, teachers must bridge the important gap between delivering students with effective strategies and developing experience through writing enhancement courses. Therefore, teachers are expected to employ contemporary teaching methods to enable students to effectively comprehend and manifest writing skills while overcoming barriers to effective learning.

However, per the educational narrative in Saudi Arabia, despite using digital tools, teachers still prefer using traditional methodologies to effectively advance the students' abilities in expressing, learning, and writing. An exemplary notion put forth by Allamnakhrah (2013) amplifies that the Middle East educational protocol, especially in Saudi Arabia, requires teaching methods that comprise didactic rote learning methods rather than learning through experiential processes. This includes using the first language (L1) as a fundamental instruction medium, which further involves the technique of grammar-translation (GTM) (Vireak & Bunrosy, 2024). The first language, or the native language, corresponds to L1, whereas the second, or foreign language, is usually termed L2. The GTM requires teaching students through language that involves learning through L1, which describes foreign languages through the important support of the native language that helps students advance language comprehension (Alharbi, 2019). However, there remains a need to employ contemporary teaching methods since traditional teaching methods prove relatively ineffective in modern education, which requires practical and efficient usage of digital writing tools.

Compared to digital writing tools, traditional paper-based learning restricts learners from effectively comprehending classroom lessons. This inhibits the development of the student's cognitive intellect, which delivers a sense of incompetence and insecurity among students. Furthermore, such learning methods hinder students from fostering skills requiring self-assessment or learning, restricting the accentuation of innovative ideas and creative mindsets. Therefore, to exempt inconsistencies from the radar, communicative language teaching (CLT) invigorates the usage of L2, offering various prospects for impactful communication that aims to develop and enhance the student's capabilities (Brown, 2014). The concept, evolved by Gumperz (1997) as "Communicative Competence," is derived from CLT, elucidating it as the foremost fundamental term for an individual's potentiality, asserting that language usage is efficient and appropriate

under diverse contexts. Similar to the affordance theory and its conceptual standing within educational contexts, Chomsky (1965), through his theory, advanced the understanding that language is born within "universal grammar," which is a mechanism across each individual's awareness when creating or innovating language. However, "communicative competence," initiated by Gumperz (1997), holds rather an opposite stance to "appropriateness," delivering the concept that language proceeds accordingly or appropriately rather than operating appropriately, dependent entirely on the speaker. Suitability is the fundamental factor of the CLT rules, employing the appropriateness philosophy, indicating its effective usage within classroom environments (Brown, 2014; Fraidan & Olaywi, 2024).

Considering the quality of English education and the assorted curriculum, the Saudi Arabian educational protocol and narrative encounters numerous hurdles and complications despite having access to multiple digital tools (Abahussain, 2016; Al-Nasser, 2015; Batawi, 2007; Khong & Saito, 2013). Per the analysis of Elborolosy and Almujali (2020), the research indicated that adaptive learning is highly preferred among students. The study acknowledged the effective usage of adaptive learning techniques and invigorated improved skills across argumentative writing. Hence, the Saudi government endeavors to reform the educational curriculum to enhance learning and teaching pedagogy through English. The updated curriculum requires practicing CLT foundations within the teaching process. However, the teacher's beliefs and practices are essential to address the demands of the Ministry of Education (Borg, 2017). Considering the mindset and interest of modern students in information communication technologies (ICT), it has become essential to modify traditional pedagogies (Ekmekçi, 2018). Despite having access to digital tools, Saudi Arabian students possess insufficient skills to use such platforms actively. The hindrance requires teachers to process the usage of conventional strategies, such as the GTM (Abahussain, 2016), which masks teachers' beliefs that may hinder the outcome of in-class activities. Research studies envisage the existence of an aperture between beliefs and actual procedures, affecting educational settings and pedagogical methods within Saudi Arabia (Alharbi, 2019; Aseery, 2023; Shah et al., 2013). Hence, traditional techniques have gradually declined and are considered outdated strategies that remain insufficient and incompetent to meet the requirements of the contemporary education sector. However, using DWT and modern techniques has helped students gain productive skills and enhance argumentative writing skills. As educators seek to equip students with the skills necessary for academic success, it becomes highly crucial to explore the effectiveness of DWT compared to traditional PBW methods. Despite growing interest in DWT, research examining their comparative impact on students' writing skills remains limited, especially in complex tasks such as argumentative writing. Much existing research has focused on either general writing skills or specific tools without directly comparing DWT and PBW for argumentative writing tasks. Moreover, few studies have explored the impact of DWT in non-Western educational contexts, such as in Saudi Arabia. Therefore, the research aims to fill this gap by explicitly comparing the effectiveness of DWT and traditional PBW in enhancing secondary students' argumentative writing skills. Specifically, the research examines how DWT impacts students' ability to construct coherent, well-supported arguments and the more traditional writing processes associated with PBW. By exploring how digital writing tools compare to paper-based writing in improving the argumentative writing skills of secondary students, the research seeks to provide insights into how DWT compares with PBW in improving secondary students' argumentative writing skills.

Research Objectives

- To compare the effects of DWT and Traditional Paper Writing to enhance Saudi secondary students' argumentative writing skills.
- To examine whether using DWT significantly improves the structure and argumentative writing quality compared to traditional paper writing among Saudi secondary students.
- To analyze the aspects of argumentative writing (e.g., clarity of claim, evidence support, coherence) that DWT and Traditional Paper Writing impact.

Research Question

- How does DWT compare to traditional PBW in improving secondary students' argumentative writing skills?

Research Hypotheses

While many studies highlight the potential benefits of DWT, particularly in providing real-time feedback and facilitating collaboration, the literature remains divided on their effectiveness in improving argumentative writing skills. Some studies show positive outcomes in general writing quality, but a lack of clear consensus remains inadequate on whether such tools significantly impact argumentative writing in secondary education (Nurfidah & Fandir, 2024). Therefore, the first hypothesis tests the potential efficacy of DWT in enhancing students' argumentative writing skills.

H_{01}: DWT does not significantly enhance argumentative writing skills in secondary students.

PBW is a traditional method that is used to develop writing skills. However, research studies suggest its inadequate usage in supporting higher-order skills required for argumentative writing. It encourages focus and individual reflection while lacking immediate feedback and interactive elements found within digital tools. Research studies indicate PBW's ineffectiveness in promoting student engagement or fostering revision practices, especially in constructing argumentative essays (Fareed et al., 2016). Therefore, the research examines PBW's effectiveness in developing skills compared to innovative methods like DWT. Thus, the study hypothesizes that,

H_{02}: PBW does not significantly enhance argumentative writing skills in secondary students

DWT and PBW aim to enhance writing skills. However, existing literature suggests the differing conceptualizations within both methods in supporting writing processes. DWT provides interactive and collaborative opportunities. However, PBW fosters individual and reflective writing practices. Given these differences in approach, it is unclear whether these two methods correlate in their impact on argumentative writing skills (Ramírez, 2014). Therefore, the third hypothesis explores whether these two methods of writing instruction are connected or if they operate independently in enhancing students' writing abilities.

H_{03}: DWT and PBW bear no correlation in enhancing secondary students' argumentative writing skills

Literature Review

Digital Writing Tools and Their Pedagogical Impacts

Argumentative writing skills are highly valued in digital writing as they require complex cognitive processes and various skills that contribute to conceptualizing arguments (Elborolosy & Almujali, 2020). Argumentative writing is a long-term intellectual endeavor where learners must organize ideas and apply rational methods to select content. With the rapid pace of technological advancements, the educational sector has emphasized the need to abandon outdated teaching methods in favor of contemporary pedagogies. Despite the growing demand for digital writing

tools, students must still adapt to traditional writing techniques, hindering their academic success (Elborolosy & Almujali, 2020).

The modern educational environment and the 21 st century, in particular, is dedicated to the acquisition of argumentative writing skills through the application of contemporary teaching methods. The change of what to teach to how to teach reiterates that basic educational skills should be taught in a way that makes students relate to real-life problems (McCoog, 2008). Therefore, academic sphere needs to switch to digital technologies and their real-life use to promote efficient learning processes (Kuhn et al., 2017). This transition is supported by the recent studies that critically assess the impact of digital writing tools on the practice of argumentation and the remaining gaps in design that should be filled (Benetos & Betrancourt, 2023). The combination of intellectual and pedagogical views facilitates the building of argumentative essays by students through the application and adoption of practical strategies (Mayoo & Eto, 2023).

Hirvela (2017) introduced a model of teaching argumentative writing to non-native English speakers that allows overcoming the issues arising in the quality writing process. Learning to argue and arguing to learn are the guidelines that emphasize the role of reasoning and inquiry in argumentation. In addition to these instructions, the model by Toulmin (2003) is central to the evaluation of the possibilities of argumentation in writing. The model divides arguments into six major parts, namely; claim, grounds, warrant, qualifier, rebuttal and backing, with the research conducted by Toulmin (2003) on the theory of argumentation offering useful potential in offering an organized method of constructing logical arguments. More recent advances in AI-aided feedback systems also indicate the usefulness of guided systems such as Toulmin model in assisting students to revise their arguments more efficiently (Liu et al., 2023). Although such frameworks can be used, students tend to experience difficulties when it comes to the building of argumentative essays in a second language (Tasya, 2022).

Challenges of Traditional Paper-Based Writing

The gap between argumentation theory and practical educational applications has garnered potential scholarly interest. Iordanou et al. (2016) highlighted the difficulty among students in acquiring and structuring argumentative knowledge and observing the effective support of reasoning and content. When constructing arguments and drafting argumentative essays, one requires philosophical and logical reasoning alongside a deeper understanding (Larrain et al., 2021). Traditional teaching methods constrain students' creative and analytical skills. Students in conventional classrooms behave as passive listeners, reliant on teacher instructions rather than experimenting or engaging with the content, which leads to lower productivity and experimentation levels (Sharma, 2012). Across such environments, traditional pre-writing strategies become less effective (Shafiee et al., 2013). Such methods fail to meet the student's diverse needs, enhancing discouragement and lack of motivation (Usher & Khober, 2013). More recent research highlights that digital tools can address this motivational gap by increasing student engagement and confidence, especially among young EFL learners (Al-Ahdal & Shariq, 2022). Hence, the research studies intend to update traditional teaching strategies to engage students better and enhance their problem-solving abilities (Akhtar & Hussain, 2019). Combining traditional classroom methods with online learning, hybrid instruction has become an innovative education approach, allowing for more flexible and interactive learning (Rovai & Jordan, 2004). Combined with digital tools, such strategies aim to foster better writing skills in argumentative, persuasive,

and narrative writing, encouraging active participation across classroom environments (Akhtar & Hussain, 2019; Fraidan, 2025).

Theoretical Underpinnings: Affordance and Communicative Competence

Digital competency in modern educational contexts reflects the essential need for digital tools across academic and professional environments. Acquiring digital literacy involves media, information, and ICT literacy alongside digital scholarship. These 21st-century skills help students navigate digital platforms (Mishra & Sharma, 2018). Similarly, remote learning environments have been shown to foster 21st-century skills such as autonomy, collaboration, and digital fluency through sustained use of digital tools (Al-Bargi, 2022). Digital writing tools, such as Google Docs, Grammarly, Wikispaces, and MediaWiki, aid students in developing argumentative writing collaboratively (Zhang et al., 2023). Li (2018) found that students with improved skills frequently used digital tools for collaborative learning in writing, allowing heightened interest in debates and the exchange of ideas while enhancing writing through the teacher's support and feedback.

Balasubramanian's (2023) theory underscores peer collaboration and its importance in guiding teachers through learning. Students learn from more knowledgeable peers or instructors to improve writing outcomes in a collaborative writing environment. The collective scaffolding approach supports collaborative learning to enhance argumentative writing competencies among students (Li & Zhu, 2011). Activity theory explains that goal-oriented actions enable effective learning, which produces better writing outcomes (Ahvenharju et al., 2021; Zhou, 2018). With the integration of digital tools, students obtain better argumentative writing skills.

Methodology

Research Design

Building on the gaps identified in the existing literature and the need for effective instructional strategies in secondary EFL settings, this research seeks to answer the question: "How does DWT compare to traditional PBW in improving secondary students' argumentative writing skills?" To address this, the study adopts a comparative design that evaluates the pedagogical impact of DWT versus PBW on students' argumentative writing performance. The methodology outlines the participants, tools, procedures, and criteria used to assess how each mode of writing supports the development of argumentative skills, with particular attention to coherence, clarity of claims, structure, and evidence integration in students' written output.

This study employed a quantitative, quasi-experimental research design - a widely used method in educational research when random assignment is not fully feasible (Creswell, 2014), incorporating pre-test, treatment interventions, and post-test procedures to investigate the effects of DWT compared to traditional PBW on developing argumentative writing abilities among Saudi secondary students. The research design can be summarized as follows:

- Pre-Test: All participants completed the IELTS Task II, a validated instrument for assessing argumentative writing skills in academic contexts (Green, 2005).
- Treatment Intervention: Participants were randomly divided into three groups: a control group (CG) engaged in traditional writing practices, and two experimental groups—Experimental Group I (EGI) using digital writing tools and Experimental Group II (EGII) engaging in collaborative writing activities.
- Post-Test: After six weeks of treatment, participants completed a second IELTS Task II to measure improvements in their argumentative writing skills.

Participants and Sampling Method

The study was conducted with 85 secondary students aged 17 to 19 from a single secondary school in Saudi Arabia. A random sampling method was employed to ensure the representativeness of the student population. The participants were divided into three groups based on the research design:

- Control Group (CG): 28 students received traditional PBW instructions.
- EGI: 31 students who utilized DWT for their writing tasks.
- EGII: 26 students engaged in collaborative writing activities.

While the participants were selected randomly, they all attended the same school, which may limit the generalizability of the findings to other educational contexts. The focus on secondary students from one school provides a specific context that may be useful for understanding how digital tools and collaborative writing interventions impact secondary education.

Instruments and Data Collection

The IELTS Task II was the primary writing task to assess students' argumentative writing skills before and after the treatment. This standardized writing task required participants to construct an argumentative essay on a topic within a specific timeframe. The essays were evaluated based on the IELTS Marking Criteria, which include aspects such as:

- Task Response: How well the student addresses the question and supports their argument.
- Coherence and Cohesion: The logical organization of ideas and use of linking devices.
- Grammatical Range and Accuracy: The variety and accuracy of grammatical structures used in the writing.
- Lexical Resource: The range and accuracy of vocabulary used in the essay.

The Oxford Placement Test (OPT) was also administered before the treatment to assess the participants' overall language proficiency. This test ensured that all participants had similar language abilities before the treatment intervention, helping to control for initial language differences (Thordardottir et al., 2015).

Data Collection Procedures

Pre-Test

All participants were given the IELTS Task II as a pre-test to assess their argumentative writing skills. The test was administered in a controlled environment to ensure consistency and reliability.

Treatment Intervention

- The control group (CG) was taught traditional argumentative writing techniques using paper-based methods with no digital tools.
- EGI received training on using various digital writing tools, including Grammarly, Google Docs, Microsoft Office, and Padlet. The focus was on utilizing these tools for real-time feedback, collaborative editing, and improving writing skills. Students were instructed on revising and structuring their essays using these tools.
- EGII also used traditional methods but emphasized collaborative writing. The students worked in pairs to peer review and provide constructive feedback to each other on their essays.

  Post-Test: After the six-week treatment period, participants took the same IELTS Task II again as a post-test to measure any improvement in their argumentative writing skills. The essays were evaluated using the same IELTS Marking Criteria as in the pre-test to maintain consistency.

- Standardization: To ensure consistency and reliability in scoring, two independent raters evaluated the essays. In case of discrepancies in scoring, a third rater was employed to resolve the differences.

Treatment Intervention

The treatment interventions were designed to improve the argumentative writing abilities of the students in each group:

- Control Group (CG): This group received traditional PBW instruction for six weeks. Writing tasks were structured with an emphasis on topic sentences, thesis statements, and supporting evidence. Peer feedback sessions were held, during which students exchanged and critiqued each other's essays.
- EGI: Students in EGI were trained on using DWT to enhance their writing process. The tools included:
    - Grammarly for grammar and style suggestions.
    - Google Docs for real-time collaborative writing and editing.
    - Microsoft Office for drafting and formatting essays.
    - Padlet for collaborative writing and feedback.

  Writing tasks were assigned, and students used these tools for drafting, revising, and finalizing their argumentative essays. The focus was on improving writing through real-time feedback and collaborative editing features. Each student was also given instructions on revising their work based on the feedback received through these platforms.
- EGII: This group received traditional paper-based instruction similar to the control group but focused more on collaborative writing. Students were divided into pairs or small groups to peer review each other's essays and provide feedback. Collaborative activities encouraged students to discuss, exchange ideas, and improve their writing through peer critiques.

Duration and Frequency

The treatment interventions were carried out over six weeks, with two weekly sessions (12 sessions). The treatment period provided ample time for students to engage with the writing tasks, receive feedback, and improve their essays.

Data Analysis

The data collected from the pre-test and post-test will be analyzed using statistical methods such as paired t-tests or analysis of variance (ANOVA) to compare the writing performance of the control and two experimental groups. The results indicate whether using digital tools or collaborative writing significantly affects students' argumentative writing skills compared to traditional paper-based writing.

Results

The test results of the pre- and post-test were gathered for the three groups. The collected scores were then analyzed through one-way ANOVA to examine the variances between the performances of the three groups. Post-hoc Tukey tests were also organized to investigate the variances between the specific groups. This section interprets the results. Multiple autonomous samples t-tests, paired samples t-tests, one-sample t-tests, Pearson's correlation, Multivariate Tests, and Mauchly's Test of Sphericity tests were carried out, and the test findings are tabulated in Table 1.

Table 1. *Paired sample statistics for the control group,* EGI, *and* EGII *of pre-test and post-test scores*

Paired Samples Statistics					
	Mean	N	Std. Deviation	Std. Error Mean	
Pair 1	CG-pretest	59.07	28	2.508	0.474
	CG-posttest	61.00	28	2.480	0.469
Pair 2	EGI-pretest	65.80	30	4.498	0.821
	EGI-posttest	76.70	30	5.633	1.029
Pair 3	EGII-Pretest	61.62	26	3.623	0.711
	EGII-Posttest	73.15	26	3.967	0.778

The paired samples statistics reveal differentiating patterns in the pre- and post-test results across the control and two treatment groups. The mean pre-test score of the control group is 59.07, having 2.508 as a standard deviation, which suggests that the control group has shown a relatively stable performance. After the intervention of the treatment plan, the post-test scores are seen to have increased to 61.00, having a slightly lower standard deviation of 2.480. This depicts a modest improvement in the overall performance. The pre-test score of EGI is 65.80, with a standard deviation of 4.498, suggesting a comprehensive variation in the initial performances among the participants. After implementing the intervention, the post-test mean score significantly amplified to 76.70, with a standard deviation of 5.633. This indicates a substantially positive impact of the intervention on overall participant performance.

The initial pre-test score of EGII was 61.62, with a standard deviation of 3.623, suggesting moderate early performance among the 26 participants. However, the post-test mean score increases to 73.15, with a standard deviation of 3.967. This indicates a substantial enhancement similar to EGI. The data suggests that both experimental groups gained significant scores and performance improvements. Meanwhile, the control group encountered only a minor change in the mean scores. This advocates that the implemented treatment intervention had a constructive outcome on EGI and EGII. Moreover, the variations in standard deviations demonstrate different levels of consistency among the respondents, with the Experimental Groups showing higher pre- and post-test means and variability.

Table 2. *Paired sample correlation for the control group, EGI, and EGII of pre-test and post-test scores*

Paired Samples Correlations				
	N	Correlation	Sig.	
Pair 1	CG-Pretest & CG-Posttest	28	0.995	0.001
Pair 2	EGI-Pretest & EGI-Posttest	30	0.976	0.001
Pair 3	EGII-Pretest & EGII-Posttest	26	0.970	0.001

Table 2 showcases the results for the significance level and the correlation coefficients of the pre-test and post-test mean scores for the control, EGI, and EGII), illustrating the reliability and relationship strength between these scores.

Pair 1¸which is the control group, illustrates a high correlation, depicting a highly positive relationship among the pre- and post-results of the control group. This indicates that the participants who performed well on the post-tests were initially the ones who performed well on the pre-test. Similarly, the significance level suggests that the control group scores are significant.

The scores can be depicted from the p-value, which is 0.001, demonstrating that this result is not possible due to random variation.

Similarly, the EGI showed a high correlation in pair two. This indicates a highly reliable connection among the respective groups' pre- and post-test scores. It suggests that the students who performed well on the post-test were the ones who initially performed well on the pre-test. These results also confirm that the correlation of the EGI is precisely significant, as depicted by the p-value, which is 0.001. Moreover, pair 3, the EGII, shows a high and strong positive correlation. Depicting a strong, reliable relationship among the group's pre- and post-test mean scores. Treatment group II also indicates the same results as previous participants who performed well on the pre- and post-test scores. Likewise, the implication level further reveals that the correlation of treatment group II is statistically substantial, as specified by the p-value of 0.001. In conclusion, all three groups display a robust and high correlation. Moreover, all three groups are statistically significant, depicting that the conditions applied or the treatment intervention plan effectively and consistently impacted the participants' scores.

Table 3. *Paired samples t-test for control group, EGI, and EGII of pre-test and post-test scores*

Paired Samples Test									
	Paired Differences Mean	t Std. Deviation	df Std. Error Mean	Sig. (2-tailed) 95% Confidence Interval of the Difference Lower	Upper				
Pair 1	CG-Pretest & CG-Posttest	-1.929	.262	0.050	-2.030	-1.827	-38.911	27	0.001
Pair 2	EGI-Pretest & EGI-Posttest	-10.900	1.583	0.289	-11.491	-10.309	-37.707	29	0.001
Pair 3	EGII-Pretest & EGII-Posttest	-11.538	.989	0.194	-11.938	-11.139	-59.479	25	0.001
Pair 4	EGI-Posttest- CG-Posttest	16.000	5.524	1.044	13.858	18.142	15.326	27	0.001
Pair 5	EGII-Posttest- CG-Posttest	12.038	4.952	0.971	10.038	14.038	12.397	25	0.001

The paired samples test results demonstrate substantial variances in mean scores across various comparisons. The control groups' pre and post-test mean scores were compared for the first comparison between the control group's pre and post-test mean scores; a mean difference of -1.929 was observed, with a standard deviation of 0.262 and an insignificant small mean standard error of 0.050. The confidence interval of 95% ranged from -2.030 to -1.827, at a t-value of -38.911, leading to a p-value of 0.000. The research findings suggest a fundamentally statistical decline in the control group's performance after the intervention.

When analyzing the EGI, the pretest and posttest scores yielded an average difference of -10.900, with a standard deviation of 1.583 and a standard mean error of 0.289. The confidence intermission for this difference spans from -11.491 to -10.309. The t-value of -37.707, along with a p-value of 0.000, indicates a highly significant improvement in EGI, highlighting the effectiveness of the intervention. For EGII, the paired comparison also reveals a notable mean difference of -11.538, with a standard deviation of 0.989 and a standard error mean of 0.194. The 95% confidence interval ranged from -11.938 to -11.139. The t-value here is -59.479, and the p-value is 0.001, reinforcing the conclusion that EGII experienced significant improvements due to the intervention.

When comparing the mean scores of the posttest of EGI and the control group, an average difference of 16.000 was found, supported by a standard deviation of 5.524 and a standard error mean of 1.044. The confidence intermission in this variance is between 13.858 and 18.142. The significant t-value of 15.326 and a p-value of 0.001 illustrate that EGI overcame the control group in the posttest. Similarly, comparing EGII-posttest scores with those of the control group yielded a mean difference of 12.038, with a standard deviation of 4.952 and a standard error mean of 0.971.

The confidence intermission is established between 10.038 and 14.038, and the t-value of 12.397, coupled with a p-value of 0.001, confirms that EGII also significantly overcame the control group in the posttest. Overall, the findings illustrate significant improvements in both experimental groups compared to the control group, underscoring the efficacy of the interventions.

Table 4. *Pearson's correlation between the post-tests of the control group, EGI, and EGII*

Correlations				
	CG-posttest	EGI-posttest	EGII-posttest	
CG-posttest	Pearson Correlation	1	0.222	-0.147
	Sig. (2-tailed)		0.256	0.475
	N	28	28	26
EGI-posttest	Pearson Correlation	0.222	1	-0.130
	Sig. (2-tailed)	.256		.525
	N	28	30	26
EGII-posttest	Pearson Correlation	-.147	-.130	1
	Sig. (2-tailed)	.475	.525	
	N	26	26	26

Table 4 indicates the Pearson's correlation between the post-test results of the control group and EGI and EGII. The results in the table above illustrate that none of the correlations among the post-tests of the three groups are statistically significant, as all the p-values are found to be more than 0.05. Moreover, the correlations are relatively weak, indicating that the results for one of the groups do not predict the results of the other two groups.

There are slight positive or negative tendencies in the three groups' relationships. However, they are still not statistically significant, which suggests that the treatment plan of making the students write using different methods does not significantly impact the outcome of their tests with one another.

Table 5. *Multivariate Test for the control group, EGI, and EGII*

Multivariate Tests							
Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	
factor1	Pillai's Trace	0.897	234.874[b]	1.000	27.000	0.001	0.897
	Wilks' Lambda	0.103	234.874[b]	1.000	27.000	0.001	0.897
	Hotelling's Trace	8.699	234.874[b]	1.000	27.000	0.001	0.897
	Roy's Largest Root	8.699	234.874[b]	1.000	27.000	0.001	0.897
a. Design: Intercept Within-Subjects Design: factor1							
b. Exact statistic							

Table 5 illustrates the results of a multivariate variance (ANOVA) analysis. ANOVA assesses the impact of a factor known as "factor1" on the multiple dependent variables. The results of the ANOVA have been depicted using different statistical tests, such as Wilks, Lambda, Roy's Largest Root, Pilla's Trace, and Hotelling's Trace.

The effect values of all four tests depict the strength of the independent variable on the dependent variable. A lower Wilk's Lambda value and a higher Pillai's Trace value indicate a strong effect. Similarly, the F-statistic value of 234.974 for all the tests indicates that the dependent variable's mean value is equal in all the groups defined by the independent variable. The value of hypothesis df, 1.000, indicates the number of groups to be minus one. On the other hand, the error df value of 27.000 suggests an association with the error team. The p-value is 0.001, which shows that the effect of factor 1 is statistically significant on the dependent variables. The values of partial

Eta squared being 0.897 for all the tests indicate that the effect size is substantial, depicting factor 1 strongly impacting the dependent variables. To sum it up, the results from Table 7 imply that factor 1 has a reflective effect on the results measured in this study, justifying further analysis and exploration.

Table 6. *Mauchly's Test of Sphericity within a subject design involving factor 1*

Correlations				
	CG-posttest	EGI-posttest	EGII-posttest	
CG-posttest	Pearson Correlation	1	0.222	-0.147
	Sig. (2-tailed)		0.256	0.475
	N	28	28	26
EGI-posttest	Pearson Correlation	0.222	1	-0.130
	Sig. (2-tailed)	0.256		0.525
	N	28	30	26
EGII-posttest	Pearson Correlation	-0.147	-0.130	1
	Sig. (2-tailed)	0.475	0.525	
	N	26	26	26

Table 6 shows Mauchly's Test of Sphericity for within-subject designs involving factor 1. Sphericity is an assumption necessary for repeated measures ANOVA, which states that the variances between related groups' combinations should be alike. Mauchly's Test of Sphericity suggests that factor 1 is met with the supposition of sphericity; W=1.000. Moreover, the absence of epsilon values and significant results affirms that corrections are not required for the degrees of freedom in the analyses. Hence, the within-subject results for factor 1 can be explained without violating the concerns of the sphericity supposition.

Table 7. *Results for within-subjects contrasts for factor 1*

Multivariate Tests							
Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	
factor1	Pillai's Trace	0.897	234.874[b]	1.000	27.000	0.001	0.897
	Wilks' Lambda	0.103	234.874[b]	1.000	27.000	0.001	0.897
	Hotelling's Trace	8.699	234.874[b]	1.000	27.000	0.001	0.897
	Roy's Largest Root	8.699	234.874[b]	1.000	27.000	0.001	0.897
a. Design: Intercept Within-Subjects Design: factor1							
b. Exact statistic							

Table 7 illustrates the analysis focused on factor 1 and investigates its linear effect. The type III square sum for factor 1 is 3584.000, indicating the dependent variable's variability that can be ascribed to factor 1's linear effect. Similarly, factor 1's degree is 1, which correlates with the level numbers minus one, presuming a two-group comparison. Moreover, factor 1's mean square is seen to be 3584.000, and the F-value is 234.874. It suggests a strong impact of factor 1 on the dependent variable. This value also represents the variance ratio, which is explained by the factor to variance, which is not explained. Besides, the p-value of factor 1 being 0.001 indicates that the outcome of the effect of factor 1 is statistically significant. Similarly, the partial Eta Squared value of 0.897 implies a large effect size. This means that around 89.7% of the variance of the dependent variable can be interpreted through factor 1, implying a vital significance. To sum it up, the analysis of Table 8 implies a highly significant effect of factor 1 linear on the calculated result [F

(1, 27) = 234.874, p<0.001]. Not only that, but the value of Partial Eta Square also suggests a substantial impact of factor 1 on the results, making it a significant factor for the analysis.

Table 8. *Tests for Between-Subjects Effects*

Transformed Variable: Average						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	266616.000	1	266616.000	12497.625	.001	.998
Error	576.000	27	21.333			

Table 8 depicts the findings of the tests to evaluate the effect of subjects on the transformed variable. The intercept displays 266616.000 of the type III sums of squares, with a value of 266616.00 being the mean value as well. This has resulted in a very high value of F, 12497.625, and 0.001 being the significance value, indicating an overall significant impact. 99.8% is the variance for the dependent variable, represented by 0.998, which is the partial Eta Square value.

Discussion

This study aimed to investigate how DWT compares to traditional PBW in improving secondary students' argumentative writing skills within a Saudi Arabian context. The findings clearly indicate that DWT is more effective than PBW, as demonstrated by significantly greater gains in the post-test results of students using digital tools. These outcomes suggest that DWT offers pedagogical advantages in supporting argument structure, coherence, and evidence-based reasoning. The following discussion interprets these results in light of previous research and theoretical frameworks outlined in the literature review.

Is there any substantial modification between the effects of two different modes of inquiry-based approach (DWT vs. Traditional PBW) on Saudi Arabian secondary students' argumentative writing enhancement?

The present research is intended to investigate the efficacy of DWT as compared to Traditional PBW in enhancing the writing skills of argumentative essays among secondary students in Saudi Arabia. The findings imply that DWT significantly enhanced the eminence and structure of students' writing skills in argumentative essays, as demonstrated by the considerable changes in the post-test and pre-test results across EGI and EGII. The statistical analysis of the results conducted on the three groups displayed a significant increase in the results for the students using digital writing tools, having a mean difference of 10.900, a p-value of 0.001, depicting vital support for the assistance of digital tools in cultivating their writing skills. The illustrated research findings are consistent with the existing literature of Alqasham & Al-Ahdal (2022) and Graham et al., (2020), where both studies have depicted strong support for incorporating digital tools in enhancing students' writing skills.

Mauchly's Test of Sphericity affirmed the supposition of sphericity, permitting a reliable interpretation of the recurrent analysis measures. The significant value of 0.897 for Pillai's trace test further highlights the efficacy of DWT in enhancing the students' argumentative writing skills. The following research findings are consistent with the earlier studies that underline the advantages of integrating DWT in fostering higher engagement and enhancing the quality of writing (Wen & Walters, 2022; Benzie & Harper, 2020). The considerable effect sizes with partial eta-squared values near 0.90 indicate that the treatment plan accounts for a vital percentage of the difference in writing performance.

On the contrary, the control group that utilized the traditional PBW displayed less enhancement, with a mean difference of 1.929 and a p-value of 0.001, which was relatively small.

As this group displayed growth, the growth shown by the groups that utilized DWT was significantly higher. These findings suggest that, as traditional writing methods are valuable, they might not be as impactful in encouraging skill improvement in writing argumentative essays as digital methods are. This finding aligns with the previous studies, which depict that digital tools can progress a more efficient process of writing and outputs with higher quality (Esfahani, 2024; Nazaria et al., 2021)

Furthermore, the high correlation coefficients of the pre- and post-test results in the control and experimental groups show a strong reliability measurement. However, the control and EGII had a low correlation between their post-tests, which indicates that the traditional approach could not achieve as much as the digital approach regarding the students' improved performance. This also underlines the need for the teachers to consider incorporating digital tools while giving writing instructions to the students so that the learning outcomes and student engagement can be maximized to their full potential. Previous studies have indicated the same thing, where the students utilizing DWT are observed to display improved creativity and critical thinking skills in their writing styles (Bereczki & Kárpáti, 2021; Li & Mak, 2022).

Moreover, the digital writing tools' potency of providing immediate assessment and assisting peer collaboration might have played a part in the improved learning results mentioned in this research (Cavalcanti et al., 2021). Since the students prefer to be involved in their learning activities with the assistance of digital tools, they take advantage of various features, such as sentence structuring suggestions, collaborative editing, and grammar checks, which are often not available in traditional writing formats. These DWTs can also be incorporated into various teaching and learning styles, making it more engaging and accessible for students from different backgrounds to indulge in writing tasks more efficiently (Yan, 2023).

The findings of this research have rejected the first and third hypotheses. The data for the first hypothesis shows a significant enhancement in the results of the students who utilized digital writing tools, having a mean difference had a p-value of 0.001, indicating it to be reliably consequential, which aligns with Johnson (2020), discovered that there is a positive effect of digital tools on the writing practices. Moreover, Mugisha et al. (2021 underlined the significance of Critical thinking in digital tools as it enhances students' performance compared to traditional methods. The tests run for the third hypothesis showed lower coefficients of the correlation between the post-test results of the control group as well as the EGII, which suggested that the relationship of PBW and DWT in advancing students' writing expertise is weak, indicating a significant difference in the impact that it has. The following impact is said to be constant in the research directed by Yayah et al. (2021), who recommended that the efficacy of writing tools varies. Tanrıkulu (2020) further focused on the disparities in improving writing skills while using digital tools compared to traditional methods, supporting the conclusion that the effect of these methods varies substantially.

Nonetheless, the study could not reject the second hypothesis, as the control group's test results improved slightly; the improvement was not particularly considerable compared to the digital writing tools, suggesting that traditional PBW might not be as efficient.

Research Implications

The research findings imply that the use of DWT in students' writing enhancement is far greater than that of paper-based writing. It is a relatively effective and innovative form for academic writing or for enhancing argumentative writing. Furthermore, the research findings may

also prove accommodating in helping teachers and educational administrators develop more space regarding implementing DWT in academic and classroom settings. The results further suggested that the DWT can be relatively convenient in addressing the learning requirements of the students. Furthermore, using Paper-based pedagogies can be quite effective in a few contexts; however, due to technological advancements, the educational sector prefers employing Digital Tools for positive outcomes. Compared to Digitized learning methods and tools, Archetypically, paper-based learning methods are considered an effective approach in the contemporary world. Additionally, the use of digital tools is effective and efficient. It offers numerous opportunities to teachers, students, or even corporate sector employees, as it is considered a diverse platform accessible to all.

Future Research Recommendations

- While this study provides valuable cross-sectional insights, tracking participants over a longer period would be useful to observe changes and trends in their behaviors, attitudes, or performance. Hence, future research could utilize longitudinal studies to explore the long-term impact of the variables under investigation and provide a deeper understanding of causality and temporal effects.
- The study focuses on a particular writing genre or academic domain. However, writing genres vary widely, and their requirements might shape different cognitive and linguistic processes. Hence, future research could explore the findings in other writing genres (e.g., creative writing or technical writing) to determine if the results are consistent across various forms of writing.
- The study, conducted in specific educational contexts, may not reflect the broader diversity of educational settings. Hence, future studies may examine public vs. private settings to explore the influence of DWT across different contexts.
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Research Limitations

- The study's sample size is limited, which could affect the results' generalizability. Future research could expand the sample size to ensure a more representative and comprehensive understanding of the phenomenon under investigation.
- The study, conducted within a specific cultural context (Saudi Arabia), may not deliver similar results across diverse contextual settings. Hence, future research could compare the findings in the Saudi context with those of other regions or countries to determine if the results are culturally specific or if there are universal patterns.
- The study employs a quasi-experimental design, which lacks the randomization that typically ensures stronger causal inference. This limitation could introduce confounding variables, making it difficult to draw definitive conclusions about cause-and-effect relationships. Therefore, future research could consider adopting a true experimental design with random assignment to improve the study's internal validity and causal claims.

Conclusion

The research investigated how DWT measures up against Traditional PBW when teaching argumentative writing skills to Saudi secondary students. DWT demonstrates superior educational results in argument construction among students compared to conventional PBW approaches through its additional features for argument management. The students who used DWT demonstrated comprehensive post-test score elevation, together with higher levels of engagement,

while getting immediate feedback and improving their revision methods. The positive research findings match existing academic evidence, which promotes technology infrastructure in academic writing education systems, especially for institutions using methods that restrict learner exploration and analytical thinking capabilities.

The research demonstrated how Saudi educational institutions continue to use traditional grammar-translation and rote learning methods, which require a transformation to student-focused learning environments. The study indicates that educators and learners need proper training and digital platform tools to achieve effective online navigation. Although paper-based methods contribute to the development of reflective writing skills and independence, they fail to provide enough interaction for refining complex argumentative abilities.

This research adds value to discussions of digital educational advancement and extends academic discussion about educational transformation in non-Western and minimally examined academic sites. Future surveys need to explore specific writing elements like coherence alongside evidence use and argument clarity to understand students' responses to various types of instruction. The growing importance of digital proficiency in academic achievement requires educational institutions to adopt Digital Writer Training programs for their writing classes.

The research findings demonstrate that digital tools have become essential for teaching writing. They are no longer optional but necessary for educational success. The research stresses the importance of adopting evidence-driven teaching methods with technological solutions because these approaches will help develop academic writing skills among students who need today's learning standards.

Pedagogical Implications

The research study introduces multiple vital instructional recommendations to enhance secondary school argumentative writing education. Students achieve better writing performance with DWT since these tools provide automated feedback and direct them through revised steps for grammatical and stylistic improvement. The technology delivers important assistance to students in developing better writing patterns and constructing structured argumentative papers. Students show increased engagement when DWTs are used because these tools create dynamic learning spaces that correspond to the digital literacy patterns of their students. The instructional tools enhance learning participation through their capability to drive students toward better academic performance. Students acquire fundamental academic competencies through writing instruction and digital tools because these tools automatically produce citations and reference lists. Students achieve better academic writing standards through these tools, which simultaneously decrease their mental workload. Students can learn essential digital competencies from writing instruction on educational digital platforms because these skills apply to their academic career and professional development. The implementation of technology in writing education creates multiple educational benefits that improve both technical writing abilities and student independence and involvement in academic communication.

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