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Research Article

A techno-pedagogical design for the production of academic essays in university students

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ABSTRACT

The aim of the research was to verify whether the techno-pedagogical design based on flipped learning and collaborative writing (TPD-FLACW) improves the level of academic essay production in university students. The research approach was quantitative, explanatory-experimental, and quasi-experimental in design. The sample consisted of 109 students enrolled in the faculty of engineering of a university in Tacna. In the experimental group (A=40) TPD-FLACW was implemented and in the control groups traditional individual writing (B=29) and traditional team writing (C=40) were applied. TPD-FLACW was validated by 16 expert judges (CVCtc=.934, k=.392, p=.000) and applied between September and December 2022-II. A rubric was used to assess the pretest and posttest. The results indicate that in the pretest there were no significant differences between the three groups (H=.286; p>.05), but in the posttest, the experimental group obtained a high and significant improvement in the level of academic essay production (H=24.863, p<.05, ε^2>.200) in comparison with groups B and C. There are also significant differences in the dimensions of superstructure, macrostructure, microstructure and textual stylistics. The students rate the proposal positively and recommend it. In conclusion, TPD-FLACW improves the level of academic essay production of university student.

Keywords: techno-pedagogical design, flipped learning, collaborative writing, academic essays

INTRODUCTION

Writing is a complex activity that has allowed the advancement and development of knowledge throughout history. Its process has taken place in different contexts and has served needs such as instant communication, paperwork, report writing, school and university work, among others. In the academic university context, it is the most widely used medium for communicating the findings of academic-scientific research. However, various studies (Amlatarneh et al., 2016; Iwasaki et al., 2019; Rey-Castillo & Gómez-Zermeño, 2021; Tan & Carnegie, 2022) warn that university students show a high degree of difficulty in writing academic texts in terms of vocabulary, difficulties in expressing ideas, organization of sentences, critical inability, limitations in textual revision, grammar and spelling.

In basic education in Peru, the National Education Curriculum considers the achievement of writing competence at the end of the VII cycle as part of the graduate profile (Ministerio de Educación [Ministry of Education], 2016). Many Peruvian students fail to strengthen this skill because teachers pay more attention to developing reading comprehension skills and neglect writing processes and strategies (Chanamé-Chira et al., 2022). The problem spills over into university higher education, resulting in poor quality written academic work (Rico Martín & Níkleva, 2016). However, the problem is more recurrent in engineering degrees due to the low importance given to activities related to the production of texts (Córdova Jiménez, 2015; Niswatin et

al., 2018; Vine-Jara, 2020), which causes the adoption of inappropriate behavior in the writing of final degree (thesis) or postgraduate works (Perdomo & Morales, 2022).

Academic writing plays a functional, practical, communicative and professional role in the university field (Marinkovich et al., 2018). In this sense, research has focused on proposing alternatives to improve text production through innovative strategies such as flipped learning (FL) (Santiago & Bergmann, 2018) or collaborative writing (CW) (Storch, 2005). FL model is adapted to students' pace and learning style (Casimiro Urcos et al., 2023), as well as to motivational achievements. This approach has been outperforming the traditional way of teaching writing (Khojasteh et al., 2021; Montaner-Villalba, 2021; Zhao & Yang, 2023), especially in argumentative (Daulay et al., 2021), expository (Mohammad & Khan, 2023), informative and narrative texts (Ozdemir & Acik, 2019). In some cases, satisfactory results have been achieved despite technological limitations (Ebron & Mabuan, 2021).

In general, the intervention of FL allows for the management of learning time and the active participation of students during the development of classes (Junio & Bandala, 2019). In the case of the development of writing skills (grammar and written fluency), these two elements (time management and active participation) are required, in addition to having efficient technological support that gives dynamism to the process (Adhami & Taghizadeh, 2022). The achievement of competence is manifested when texts are observed to show changes in coherence, cohesion, lexical resources and grammatical accuracy. However, a positive self-perception of the learner's learning achievement is required (Chura-Quispe et al., 2022) so that the implementation of teacher strategies with FL is fully appreciated and not understood as a result of random issues (Siswanto, 2021).

In relation to CW, peer-to-peer work constitutes an indispensable support in improving students' writing competence, critical thinking and behavioral engagement with their learning (Zou et al., 2022). During the three phases of writing: planning, textualization and revision (Cassany & García, 1999; Flower & Hayes, 1981), CW represents a way to favor the learning of discursive genres, stimulation of metacognition and execution of mental operators. For the writing of academic-scientific texts, CW allows the construction of collaborative comments and suggestions from the teacher (Corcelles et al., 2013). The development of this strategy also requires technological support, however, the role of the teacher during its implementation is more important, given that without the tutor's management, significant improvements cannot be achieved (Figueroa & Aillon, 2015). Improvement can be evidenced by assessing linguistic highlights such as coherence, cohesion, lexical and grammatical correctness aspects; it also activates commitment to the completion of academic work and strengthens the positive perception of its implementation (Ebadi & Rahimi, 2019). The literature has shown that the use of collaborative strategies such as note-taking (Baldwin et al., 2019) or peer review through shared documents (Moore & Chaisson, 2022) constitute elements that strategically favor the written communication process in an effective and efficient way (Anders, 2016).

The literature review shows that FL model and CW model have been explored separately in the production of academic texts. The works of Roohani and Rad (2022) and Shafiee Rad et al. (2022) are close to proposals that attempt to address the combination of both models. Most of the studies are oriented towards analyzing FL by introducing variants in its application (Adhami & Taghizadeh, 2022) or comparing it with individual/traditional writing (Fanguy & Costley, 2021). In other cases, they verify changes in attitude, quantity and quality of writing tasks (Khoynaroud et al., 2020). However, the proposals do not seem to follow the route of a design with the use of technologies that allows the integration of teacher and learner activities for the development of meaningful learning in writing. Moreover, studies focused on disciplinary fields, where writing is not a continuous activity -such as engineering- are insufficient (Vine-Jara, 2020). Therefore, we intend to determine how a techno-pedagogical design (TPD) based on the combination of FL and CW is able to improve the production of academic essays in undergraduate engineering students.

Definition & Structure of Academic Essay

The academic essay genre aims to convey the author's position on a topic in a disciplinary field, so it requires thematic mastery, technical command of the language in which it is written and the development of writing skills (Albertini et al., 2014). The author goes through a process of analysis, interpretation and evaluation (Pellicer, 2015), so it does not respond to social or controversial issues, but to problems within the framework of the discipline of study (Zunino & Muraca, 2012). The academic essay is characterized because

it has a global structure, and van Dijk (1992) indicates that this structure is independent of the topic. Fundamentally, the structure of the essay considers three elements: introduction, development and conclusion (Moreno-Fontalvo, 2020). However, the title and bibliographical references are added to characterize it as an academic text (Zunino & Muraca, 2012).

The title is the heading of any manuscript, it provides the identity of the document and represents the first reading that a reader makes of the text. It is precise, brief, complete and ranges between 10 and 15 words, omits abbreviations and maintains proper syntax (Castro-Rodríguez et al., 2018). The introduction represents the first paragraph of the document (Zemach & Rumisek, 2006) and comprises three sub-elements: contextualization, whose function is to draw the reader's attention; thesis statement is a statement or central idea of the written text (it can be analytical, argumentative or expository); and mapping, which constitutes the anticipation of the main ideas or future arguments (Núñez, 2018). The development represents the largest part of the document, it is structured by paragraphs that in turn contain the arguments linked to the author's thesis (Moreno-Fontalvo, 2020); in this section there are also the counterarguments that represent refutations to the opposing arguments or objections (Calsamiglia Blancafort & Tusón Valls, 2018). The conclusion constitutes the last paragraph of the essay, where the author takes up the main idea (thesis), synthesizes the arguments analyzed and proposes new lines for future research (Zemach & Rumisek, 2006). The bibliographical references record the different sources of the academic work (López et al., 2014).

Flipped Learning

FL is a model designed by Bergmann and Sams (2012), which consists of the development of interactive activities in the classroom and computer-assisted individual instruction activities at home (Bishop & Verleger, 2013). It is an alternative to traditional pedagogical practices, where the teacher is not required to conduct a lecture class for the development of conceptual content and allows more time to interact with students through active learning strategies such as discussions, problem solving, practical work and tutoring (Akcayir & Akcayir, 2018). FL model requires students to participate in pre- and post-class synchronous activities for the greatest benefit (Abeysekera & Dawson, 2015). Thus, its implementation has had great effectiveness in learning and motivation regardless of the discipline or level in which it is applied (Strelan et al., 2020; Zheng et al., 2020).

Collaborative Writing

CW is a design that requires the transversal participation of co-authors during the writing phases by adopting a responsible attitude (Fernández Dobao & Blum, 2013) and is distinguished from cooperative writing, which is characterized by the subdivision of individual tasks (Storch, 2019). It has its pedagogical bases in socio-constructivism (Vygotsky et al., 1978), the shared cognition model (Lave & Wenger, 1991), group cognition (Stahl, 2004) and connected learning (Ito et al., 2013). In addition, it must have technological supports, so that CW develops the processes of online interaction and feedback among students before, during and after writing (Abe, 2020; López-Pellisa et al., 2021). Writing processes are efficiently captured and maintained by virtue of tools such as Etherpad, Google Docs, Shimo, or Wikis (Zhang & Chen, 2022).

Techno-Pedagogical Design

The term "techno-pedagogy" or digital pedagogy associates concepts, ideas and practices that link didactic and pedagogical innovations in the educational field but supported with technology. Some researchers such as Shanks and Young (2019) define techno-pedagogy as the search for the integration of the contributions of digital technology in educational practices, specifically in teaching and learning processes. In this way, TPD is characterized as a very useful tool in the teaching and learning process (Pedroza & Crespo, 2017). Rodríguez de los Ríos et al. (2022) consider that TPD is a systematic and highly rigorous planning process of procedures and activities oriented towards the purpose of learning in an effective, efficient and sustainable manner, and therefore requires the following elements: human resources, method and technological resources.

Definition & Design of TPD-FLACW

Techno-pedagogical design based on flipped learning and collaborative writing (TPD-FLACW) is a set of guidelines and activities organized, coherent and based on the use of technological resources and

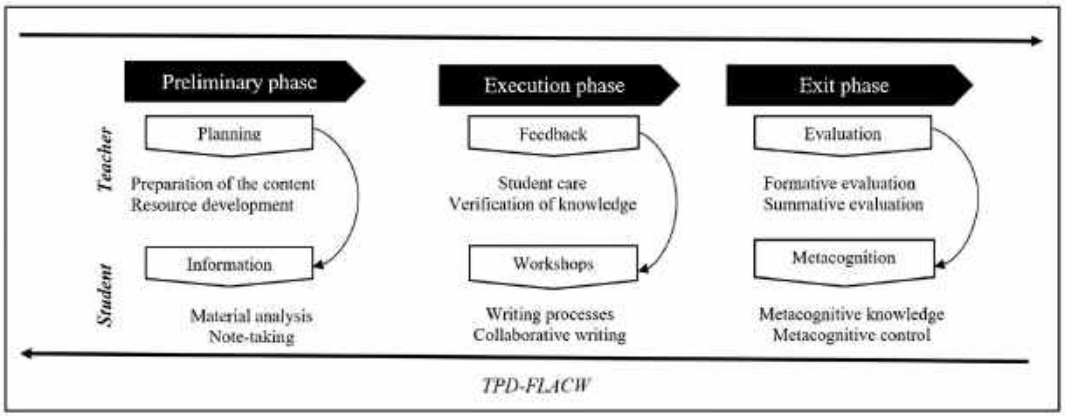

Figure 1. Techno-pedagogical design based on flipped learning & collaborative writing (Source: Authors)

pedagogical strategies of FL and CW oriented to the teaching-learning process of academic writing. TPD-FLACW proposal was based on the route proposed by the ADDIE model based on analysis, design, development, implementation, and evaluation (Torras Virgili, 2021). Considering the guidelines of the previous model, TPD-FLACW was designed by identifying the needs of the students, secondly, TPD was carried out based on pedagogical proposals (FL and CW), then, the contents linked to the production of the academic essay were developed. The implementation and execution of the pedagogical actions was carried out in three phases (pre-execution, execution and exit) and, finally, the evaluation made it possible to take new formative actions considering the students' assessments (**Figure 1**).

In this sense, **Figure 1** presents the proposal, which is based on three phases comprising teacher activities (planning, feedback and evaluation) and student activities (information, workshops, and metacognition). These are developed in a cyclical and continuous manner (arrows above and below). In other words, learning does not end at the exit phase, but returns to the preliminary phase to promote continuous learning.

In the preliminary phase (before the session), the teacher plans the content (selection of information, autonomous, and collaborative activities) and prepares resources (videos, texts, or audios). The learner analyses (text comprehension strategies) and takes notes of the resources (synthesis and formulation of questions). *In the execution phase* (during the session), the teacher verifies the knowledge acquired through forums, workshops, gamification, tutoring, question-answer, etc., and also applies feedback strategies to the students through student attention. Students consolidate their learning through writing workshops by planning, textualizing and revising their texts collaboratively. *In the exit phase*, the teacher provides feedback on student learning (formative evaluation) through self-evaluation, co-evaluation and hetero-evaluation; he/she also identifies academic progress at the end of the product (summative evaluation) based on the rubric developed. Students evaluate their own potential and limitations on the topics developed through questions asked by the teacher (metacognitive knowledge) and take an active and participative stance with the extension activities (metacognitive control).

MATERIALS & METHOD

Method & Approach

The study has a quantitative, explanatory-experimental level and quasi-experimental design (one experimental and two control groups), with input and output evaluation. The experiment was applied for four months. The experimental group consisted of 40 sample units to which TPD-FLACW was applied and two control groups, the first group of 29 students who followed the traditional individual writing methodology and the second control group of 40 students under the traditional team writing method.

Participants

Participants were selected by non-probabilistic convenience sampling. They are university engineering students enrolled in the second cycle of a private university in the City of Tacna (Peru) and belong to a medium-high socio-economic stratum. Initially, 123 students were selected, but for the final analysis 109

Table 1. Characteristics of the study sample

Features	Experimental group=40		Control group 1=29		Control group 2=40	
	n	Percentage (%)	n	Percentage (%)	n	Percentage (%)
Gender						
Female	13	32.50	8	27.59	16	40.00
Male	27	67.50	21	72.41	24	60.00
Professional career						
EPIAM	6	15.00	4	13.79	4	10.00
EPIC	28	70.00	7	24.14	21	52.50
EPII	1	2.50	11	37.93	12	30.00
EPIE	2	5.00	2	6.90	1	2.50
EPIS	3	7.50	5	17.24	2	5.00
Age						
M	19.53		20.24		19.98	
DS	2.650		2.516		2.896	

Table 2. Rubric fit indices

CMIN/DF	p	GFI	CFI	TLI	NFI	RMSEA	SRMR
1.737	0	.873	.977	.969	.947	.08	0.028

students were considered due to the exclusion of 14, who did not undergo the entry or exit evaluation and others who did not participate in at least 85.00% of the workshops. 33.94% are female and 60.05% are male. Their ages ranged from 17 to 27 years, with a mean age of 19.88, standard deviation [SD]=2.700 and 95% confidence interval (CI) lower 19.374 and upper 20.388. Group assignment is shown in **Table 1**.

Instruments

The Rubric was used as an instrument for measuring the production of academic essays. Based on contributions from the literature (van Dijk, 1992), the rubric was designed with 14 evaluation indicators distributed in 4 dimensions: superstructure (title, introduction, development-argumentation, development-counter-argumentation, conclusion, and bibliographical references), macrostructure (overall coherence, thematic progression), microstructure (lexical relations, referential relations, discourse markers, and connectors) and textual stylistics (lexical variety, spelling, and syntax).

The evaluations of each indicator on the text evidence are made using four scales: poor=0, fair=1, good=2 and excellent=3. The 14 indicators are grouped into four dimensions by equating scores on a centesimal scale, where textual superstructure (six indicators) is assessed from 0 to 35 points, macrostructure (two indicators) from 0 to 25, microstructure (three indicators) from 0 to 25 and stylistics (three indicators) from 0 to 15. The overall score of the academic essay ranges from 0 to 100 points. The final interpretation of the instrument is done using the scale: beginning (0 to 0.33), process (33.34 to 66.66) and satisfactory (66.67 to 100).

Instrument Validation

The content validation had the opinion of 12 experts, who evaluated the academic essay rubric under eight criteria: clarity, objectivity, timeliness, organization, sufficiency, relevance, consistency, and coherence with scores from 1 to 4. The agreement between the judges was moderate (V_{Aiken}=.926) and almost perfect (p>.05; 1<k>.41).

The exploratory factor analysis (EFA) involved four teachers specialized in academic-scientific writing, who evaluated 117 academic essays of university students using the rubric developed. EFA provided an adequate 4-factor model (Bartlett [p<.05], KMO=.952), correlation matrix>.7, with an explained variance of 93.74%. The instrument was also subjected to confirmatory factor analysis with the maximum likelihood method. A Chi-square/degrees of freedom (≤2 or 3), p-value (<.05), goodness of fit index, comparative fit index, Tucker Lewis index and normed fit index (>0.9 and <1), mean square approximation error (≤.08) and mean square standardized residual (<.05) were obtained. Factor loadings were greater than 0.5 (**Table 2**).

Reliability measures were calculated with three coefficients, Cronbach's alpha (>0.9), composite reliability index (>0.9) and extracted variance index (>0.5). The results showed excellent values, confirming an adequate internal consistency of the rubric for evaluating academic essays (Prieto & Delgado, 2010).

Implementation of TPD-FLACW

Stage 1: Elaboration of TPD-FLACW

The proposed design consists of four chapters:

(1) general aspects, including the presentation of the proposal such as objectives, justification, resources, methodological description and evaluation,

(2) pedagogical foundations, based on socio-constructivism, constructionism and connectivism,

(3) structure of the previous, execution and exit phases and

(4) learning session guide.

Stage 2: Validation of TPD-FLACW

The design undergoes a stage of content validity, where the criteria of 16 expert judges with doctoral degrees, more than five years of experience in university teaching, active in teaching and proficiency in academic writing were considered. Thirteen evaluation criteria were used: relevance, justification, rationale, coherence, structure, sufficiency, methodology, resources, updating, linguistic aspects, academic format, evaluability and feasibility. The content validity results were higher than .90 (CVC=.934), in addition, the inter-judge agreement was also acceptable ($p<.05$, KFleiss=.392) (Landis & Koch, 1977).

Stage 3: Implementation of TPD-FLACW (experimental/control group)

The implementation of TPD was carried out in nine learning sessions with a duration of four hours per session (total 36 hours). The thematic organization was presented in three phases:

Phase 1. Planning of the text: The phase was carried out in three sessions: academic essay (1), text properties (2), writing processes and planning (3). Students were introduced to the general structure and characteristics of the academic essay, as well as the textual properties: coherence, cohesion and appropriateness.

In group A (experimental), before the class, students received the material in video, text and slide format. At home, they reviewed the resources while answering the questions in the instructions provided by the teacher. At the beginning of the class, to verify what had been learned with student participation, the teacher used the gamification strategy and provided feedback. Then, they formed teams of four members and through brainstorming, they selected the topic and the thesis answering the question "What does the engineer of the 21st century need to exercise his profession?" Subsequently, they searched, read and selected at least 10 sources (each student) from different databases "Dialnet", "Google Scholar", "Redalyc", "Scielo", and "Scopus", elaborated the planning outline as a team for the writing of their essay. Then, they socialized their outline in the Moodle forum and critically assessed another team's outline. Finally, they carried out a metacognitive self-evaluation by answering, which procedure was the most complicated, how did we manage to overcome these difficulties, what will the elaborated outline be useful for?

In group B and group C (control), students entered the class without prior knowledge of the material. At the beginning of the session, they demonstrated their prior knowledge and the cognitive conflict with the topic was generated to start the session. Then, the teacher gave the class presentation with student participation through questions and contributions. Subsequently, they answered the same question as the experimental group. The answer gave rise to the choice of the topic, the thesis and the elaboration of the planning scheme making use of the different databases as in the experimental group. The activities described above, group B worked individually, and group C worked cooperatively.

Phase 2. Textualization of the text: In this phase four sessions were developed: textualization and introductory paragraph (4), quotations and references in APA (5), development of the academic essay (6) and counter-argumentation and conclusion (7). The students learned and applied the techniques of the process of transferring the outline to the text through referencing, cohesion and transcription, they wrote the introductory paragraph and development using APA standards in version 7. The product of this phase was the first draft of their academic essay.

In group A (experimental), students took the opportunity to read and analyze the structure, typology and examples of introduction, argumentation, counter-argumentation and conclusion paragraphs, as well as the recognition of the APA 7th edition. At the beginning of the class, they commented on the knowledge acquired and recognized the characteristics of each element and sub-element of the academic essay through a virtual questionnaire. Then, they generated a link in Google Docs and started to textualize according to the outline developed in the planning stage. First, they wrote the introduction, then they constructed the argumentative and counter-argumentative paragraphs of the development and, finally, the conclusion. They also used coloring to differentiate the sub-elements. During this phase, the teacher and students made comments or suggestions on the shared document. In this way, they completed their first draft of the academic essay. Afterwards, they answered the questions: what did we learn today, what was the most difficult thing to write, how did we overcome these difficulties? At the end, they shared their first draft in the Moodle forum so that it could be read by peers from other groups.

As for group B and group C (control), the students started the class by demonstrating their previous knowledge by answering the questions: what do we understand by introduction, what is the importance of argumentation and counter-argumentation, how should we write the conclusion, and how should we write the conclusion? Afterwards, the teacher gave a lecture on the thematic content and the students participated by asking questions and giving their contributions. In the practical stage, students in group B started to write their academic essays individually and if a query arose, the teacher answered it in the Google Meet room or asynchronously through the virtual classroom. While in group C, the writing of the essays was done through the distribution of paragraphs assigned to each student and then the paragraphs were unified giving rise to their first draft of the academic essay. The feedback process was also asynchronous in most cases.

Phase 3. Review of the text: In this phase, two sessions were developed: intergroup review process (8) and intragroup agreements and publication process (9). Students were introduced to and applied academic essay revision techniques using an evaluation matrix.

In group A (experimental), before the start of class, the students observed the multimedia material provided by the teacher, identifying the most frequent lexical, syntactic and spelling errors in academic texts, the main strategies for correcting them and the publication processes of journals. In the workshops, first the intergroup revision was applied with the help of the evaluation matrix and comments on the academic essay shared on the Google Docs link. Then, the intra-group review was carried out to obtain the final product. Finally, the academic essays were compiled, and an academic journal was produced and shared. At the end, they answered metacognitive questions: did you agree with the revisions, did you have difficulties in the revision, how did you organize yourselves to overcome the difficulties?

In group B and group C (control), students shared their knowledge about revision through answers to questions posed by the teacher: what is revising a text, how can we revise a text, why should we revise a text? The teacher then gave a master class on the contents of the session, answering the students' questions. In the practical part of the class, the students in group B revised their own work with the help of the evaluation matrix, while in group C the revision was done among the members of the team. Afterwards, both groups corrected the identified errors and submitted their work to Moodle on the indicated date.

Step 4: Evaluation of TPD-FLACW

In order to verify the appreciation of the students of the experimental group with respect to the implemented design, an ad-hoc questionnaire of assessment of TPD-FLACW was elaborated. This consisted of 10 items with a Likert scale from 1 to 5 applied to the whole group. In addition, an interview was conducted with 7 randomly selected students to obtain their assessment. In both processes, the informed consent of the participants was considered. The students expressed a positive appraisal of TPD-FLACW.

Data Collection Procedure

The data collection process began with the elaboration of TPD-FLACW, the "rubric for evaluating the academic essay" and a questionnaire and semi-structured interview guide to verify the students' perception. Subsequently, the necessary administrative steps were taken. Thus, permission was requested for the thesis project to be carried out virtually at the university of study and acceptance was registered on 23 September 2022.

Subsequently, the entry assessment was carried out on 23 September 2022 with a delivery date of 26 September of the same year. The question channeling your writing was "Why is the engineering you study so important for 21st century society?" The text had to be longer than 1200 words, in Times New Roman format, size 12, 1.5 line spacing and 2.54 cm margins on all sides.

The intervention process was developed between 26 September and 2 December 2022, where there were external evaluations to the research and civic dates that intervened in its development, however, managed to complete the nine sequences of sessions planned developed in two days (two hours per day), which in the end added up to a total of 36 hours without considering the evaluation of entry and exit. The period of application coincided with the beginning of unit II and the culmination of unit I. The implementation was carried out using the Google Meet platform and was supported by the Moodle virtual classroom.

At the end of the intervention process, the exit evaluation was applied on 6 December 2022, with a delivery date of 10 December 2022 under the same conditions as the entry evaluation for the experimental and control groups. However, the central question for the production of the academic essay was "What is the main problem in society that engineering X (that you study) should investigate in order to propose solutions?" At the end of the exit evaluation, TPD-FLACW proposal assessment questionnaire was applied to all participants of the experimental group (40 students) via Google Form on 10 December 2022, and seven randomly selected students were invited to be interviewed.

Data Analysis

In the previous analysis it was determined that the data do not conform to a normal distribution (Shapiro-Wilk normality test), for this reason non-parametric statistics were used. An intergroup comparison test with Kruskal-Wallis H was performed to verify equality and differences between groups (experimental group vs. control group B and vs. control group C). Intragroup analysis of repeated measures was performed with the Wilcoxon test to establish the differences between the results before and after the intervention. In addition, the Mann-Whitney U test was applied to establish differences between group pairs (SPSS version 26). Statistically significant differences are considered when $p<0.05$. To assess the magnitude of the changes, the effect size ε^2 and 1-ß were calculated to measure statistical power (G*power 3.1).

RESULTS

In **Table 3**, we can see that before the intervention in the results of the dimensions, more than half of the students have frequencies between 80.00% and 97.50% at the initial level. At the achieved level, only the dimension textual microstructure of group B has a frequency of 10.00%, while the rest of the dimensions and both experimental and control groups have a frequency of 0.00%. At a general level, the essay production of the experimental group (90.00%) as well as the control groups of individual work (79.31%) and the control group of cooperative work (90.00%) present similar percentages above half of the students.

After the intervention, the results of the dimensions show that at the beginning level the frequencies fluctuate between 0.00% and 44.84%. At the achieved level, the frequencies of the dimensions fluctuate between 10.00% and 52.50%. In the overall percentage of essay production, the experimental group shows 47.50% of students with achieved level, while the control group of individual work 0.00% and the control group of cooperative work 5.00%. This shows that after the experience, the experimental group has a higher percentage of students at the achieved level than the two control groups.

Table 3. Levels of academic essay production before & after intervention

Variable	Pre-test: $A_{(n=40)}$, $B_{(n=29)}$, & $C_{(n=40)}$			Post-test: $A_{(n=40)}$, $B_{(n=29)}$, & $C_{(n=40)}$		
	Start: n (%)	Process: n (%)	Successful: n (%)	Start: n (%)	Process: n (%)	Successful: n (%)
$PEA_{(A)}$	32 (80.00)	8 (20.00)	0 (0.00)	0 (0.00)	19 (47.50)	21 (52.50)
$PEA_{(B)}$	24 (82.76)	5 (17.24)	0 (0.00)	9 (31.03)	13 (44.83)	7 (24.14)
$PEA_{(C)}$	36 (90.00)	4 (10.00)	0. (0.00)	6 (15.00)	27 (67.50)	7 (17.50)
$SUP_{(A)}$	36 (90.00)	4 (10.00)	0 (0.00)	4 (10.00)	20 (50.00)	16 (40.00)
$SUP_{(B)}$	25 (86.21)	4 (13.79)	0. (0.00)	13 (44.83)	13 (44.83)	3 (10.34)
$SUP_{(C)}$	38 (95.00)	2 (5.00)	0 (0.00)	10 (25.00)	25 (62.50)	5 (12.50)
$SUP_{(A)}$	36 (90.00)	4 (10.00)	0 (0.00)	4 (10.00)	20 (50.00)	16 (40.00)
$SUP_{(B)}$	25 (86.21)	4 (13.79)	0. (0.00)	13 (44.83)	13 (44.83)	3 (10.34)
$SUP_{(C)}$	38 (95.00)	2 (5.00)	0 (0.00)	10 (25.00)	25 (62.50)	5 (12.50)
$MAC_{(A)}$	33 (82.50)	7 (17.50)	0 (0.00)	5 (12.50)	16 (40.00)	19 (47.50)
$MAC_{(B)}$	26 (89.66)	3 (10.34)	0 (0.00)	12 (41.38)	11 (37.93)	6 (20.69)
$MAC_{(C)}$	39 (97.50)	1 (2.50)	0 (0.00)	10 (25.00)	25 (62.50)	5 (12.50)
$MIC_{(A)}$	35 (87.50)	5 (12.50)	0 (0.00)	4 (10.00)	17 (42.50)	19 (47.50)
$MIC_{(B)}$	27 (93.10)	2 (6.90)	4 (10.00)	12 (41.38)	14 (48.28)	3 (10.34)
$MIC_{(C)}$	36 (90.00)	4 (10.00)	0 (0.00)	16 (40.00)	20 (50.00)	4 (10.00)
$EST_{(A)}$	36 (90.00)	4 (10.00)	0 (0.00)	0 (0.00)	21 (52.50)	19 (47.50)
$EST_{(B)}$	23 (79.31)	6 (20.69)	0 (0.00)	11 (37.93)	18 (62.07)	0 (0.00)
$EST_{(C)}$	36 (90.00)	4 (10.00)	0 (0.00)	11 (27.50)	27 (67.50)	2 (5.00)

Note. PEA: Academic essay production; SUP: Textual superstructure; MAC: Textual macrostructure; MIC: Textual microstructure; A: Experimental group; B: Individual work control group; & C: Cooperative work control group

Table 4. Intergroup comparison test of groups A, B, & C of pre- & post-test

Variable	$A_{(n=40)}$	$B_{(n=29)}$	$C_{(n=40)}$	H	p	ε^2
	Mean (DS)	Mean (DS)	Mean (DS)			
Pre-test						
SUP	5.01 (±5.74)	5.70 (±5.45)	5.78 (±4.39)	1.696	.428	.016
MAC	4.37 (±5.50)	4.02 (±4.79)	2.19 (±3.53)	3.791	.150	.035
MIC	3.26 (±4.91)	2.97 (±4.06)	3.26 (±4.70)	0.002	.999	.000
EST	2.17 (±2.62)	2.07 (±3.01)	2.12 (±2.90)	0.170	.918	.002
PEA	14.81 (±17.71)	14.76 (±16.25)	13.36 (±14.20)	0.286	.867	.003
Post-test						
SUP	23.29 (±8.50)	14.55 (±7.21)	16.92 (±6.44)	24.863	.000	.230
MAC	18.65 (±5.97)	12.21 (±6.39)	13.44 (±4.76)	18.774	.000	.174
MIC	17.71 (±6.15)	10.54 (±6.36)	11.32 (±4.60)	20.261	.000	.188
EST	11.17 (±2.75)	6.44 (±2.91)	7.29 (±2.61)	24.418	.000	.226
PEA	70.81 (±22.25)	43.74 (±21.18)	48.96 (±16.60)	38.409	.000	.356

Note. ε^2: Based on epsilon squared coefficient calculation

The intergroup contrast test before the intervention aims to test for similarity in the level of academic essay production. The results in **Table 4** reveal that the groups within the SUP, MAC, MIC, and EST dimensions are similar ($p>0.05$). The differences between the groups in these dimensions are minimal, reflected in the effect size $\varepsilon^2<0.04$. The overall test of the pre-intervention contrast between groups A, B, and C (academic essay production) reports that there is similarity between the groups ($H=0.286$; $p=0.867>0.05$).

At the end of the intervention, the levels of academic production within the SUP, MAC, MIC, and EST dimensions are different ($p<0.05$). The dimensions of group A report higher levels of essay production than group B and group C. The level of trial production indicates that there are differences between the groups ($p=0.00<0.05$), the mean of group A is higher than the two control groups. It can also be seen that group C, which received the intervention by doing cooperative work, obtains a higher level than group B, which received the intervention by doing individual work.

The results of the Wilcoxon intra-group test for group A (**Table 5**), on the level of academic essay production in the pre-test and post-test show that there are significant differences in favor of the post-test. An increase of 55.99 points is registered thanks to TPD-FLACW intervention. This is also the case with its dimensions whose increases range from 9 to 18.28 points. The result of group B had an increase of 28.97 points. In control group C the increase is 35.60 points. The experimental group has achieved a higher level of increase than the control group B and group C.

Table 5. Intra-group comparison between pre- & post-test results for groups A, B, & C

Variable	$Mean_{pre}$-$Mean_{post}$	SD	95% CI		z	p	g	1-ß
			INF	SUP				
$SUP_{(A)}$	-18.28	9.15	-21.20	-15.35	-5.490	.000	1.958	.99
$MAC_{(A)}$	-14.27	7.24	-16.59	-11.96	-5.209	.000	1.932	.99
$MIC_{(A)}$	-14.44	6.17	-16.42	-12.47	-5.522	.000	2.294	.99
$EST_{(A)}$	-9.00	3.04	-9.97	-8.03	-5.527	.000	2.904	.99
$PEA_{(A)}$	-55.99	23.91	-63.64	-48.34	-5.511	.000	2.295	.99
$SUP_{(B)}$	-8.85	8.21	-11.98	-5.73	-4,044	.000	1.306	.98
$MAC_{(B)}$	-8.19	6.91	-10.82	-5.56	-4,241	.000	1.367	.99
$MIC_{(B)}$	-7.57	7.04	-10.24	-4.89	-4,217	.000	1.337	.98
$EST_{(B)}$	-4.37	3.63	-5.75	-2.99	-4,193	.000	1.391	.99
$PEA_{(B)}$	-28.97	23.69	-37.98	-19.96	-4,276	.000	1.447	1.00
$SUP_{(C)}$	-11.13	6.46	-13.20	-9.07	-5,285	.000	1.903	1.00
$MAC_{(C)}$	-11.25	5.98	-13.16	-9.34	-5,405	.000	2.530	1.00
$MIC_{(C)}$	-8.05	4.86	-9.61	-6.50	-5,266	.000	1.633	1.00
$EST_{(C)}$	-5.17	3.60	-6.32	-4.02	-5,166	.000	1.767	1.00
$PEA_{(C)}$	-35.60	18.53	-41.53	-29.68	-5,443	.000	2.173	1.00

Note. g: Hedges effect size & 1-ß: Statistical power

Table 6. Pairwise comparison of groups A, B, & C in post-test

Variable	Groups	U	z	p	r	1-ß
PEA	A & B	229.00	-4.27	.000	.514	.946
	A & C	370.50	-4.13	.000	.462	.935
	B & C	488.50	-1.11	.266	.134	-
SUP	A & B	257.00	-3.94	.000	.474	.860
	A & C	468.50	-3.20	.000	.386	.640
	B & C	459.50	-1.47	.141	.177	-
MAC	A & B	274.00	-3.79	.000	.456	.790
	A & C	414.50	-3.80	.000	.425	.810
	B & C	501.50	-0.98	.325	.119	-
MIC	A & B	258.50	-3.95	.000	.475	.890
	A & C	346.00	-4.43	.000	.496	.960
	B & C	534.50	-0.56	.574	.068	-
EST	A & B	150.00	-5.30	.000	.639	.990
	A & C	269.50	-5.18	.000	.580	.990
	B & C	490.00	-1.12	.264	.134	-

Note. r: Size of biserial rank effect

The results of the Mann-Whitney U test (**Table 6**) at the level of academic essay production and its dimensions report that there are significant differences between the scores of groups A, B, and A, C. While between group B and group C, similar scores are obtained in the results of essay production. The same happens with the results of the four dimensions, the control group B and group C obtain similar scores.

DISCUSSION

Based on the results obtained, it is evident that TPD-FLACW produced better results in the production of academic essays by engineering students. The findings are supported by the difference obtained between the three groups ($p<0.05$), where the scores of group A were higher than those of group C, followed by group B.

The findings can be explained in that TPD-FLACW intervention allowed students to enter the classroom with content knowledge previously acquired through the class material in video, slides or text and according to the pace of each student, unlike the control groups (B and C) who did not have access to the resources. In addition, the teacher verified the learning acquired and this was fundamental at the beginning of each session, allowing teacher-student feedback through gamification tools such as Kahoot and student-student written or oral online feedback. The constitution of multidisciplinary teams and the use of collaborative tools such as Google Docs facilitated personalized attention to each team in the experimental group (Abe, 2020; Akcayir & Akcayir, 2018). Although control group B and group C also worked on the same thematic content, group C showed better changes due to the implementation of cooperative work, although the time allocated

to practical workshops was less, as part of the session was covered by the teacher's presentation. The virtual classroom is an environment for the construction of learning by doing when all activities are oriented towards the achievement of competence (Murrain et al., 2017).

The contributions of TPD-FLACW empirically verify what is transcribed by the pedagogical theories of socio-constructivism (Vygotsky et al., 1978), constructionism (Gergen, 2007), and connectivism (Siemens & Fonseca, 2007) in the processes of academic writing: planning, textualization, and revision (Cassany & García, 1999; Flower & Hayes, 1981). Furthermore, the findings are consistent with research indicating the significant impact of FL (Daulay et al., 2021; Ebron & Mabuan, 2021; Khojasteh et al., 2021; Mohammad & Khan, 2023; Montaner-Villalba, 2021; Zhao & Yang, 2023) or CW (Baldwin et al., 2019; Ebadi & Rahimi, 2019; Moore & Chaisson, 2022) on the production of academic texts. Studies that attempted to implement collaborative work in a FL model also found consistent results in written expression (Roohani & Rad, 2022; Shafiee Rad et al., 2022).

Some research (Altas & Mede, 2021) has not been able to confirm the effectiveness of FL, due to the neglect of formative feedback. The different proposals provided solutions in students' learning processes with respect to traditional forms of textual production (Adhami & Taghizadeh, 2022; Fanguy & Costley, 2021; Khoynaroud et al., 2020), however, they lack a replicable methodological orientation unlike TPD-FLACW, which does guide the roles of teachers and students. The teaching role is crucial in a competency-based learning framework (Murrain et al., 2017). Inadequate preparation before class may lead to student disinterest in reviewing previous materials (Chai et al., 2019). On the contrary, if planning is relevant and there is a positive perception, collaborative work and FL reduce cognitive overload in essay production (Syarifudin, 2023).

In contrast to previous work, the success of TPD-FLACW in producing academic essays in group A can be attributed to the commitment to collaborative work, motivation and technologically supported written (via Google Docs comments) or oral (in Meet room meetings) feedback (López-Pellisa et al., 2021; Zhang & Chen, 2022). In contrast, group B, who worked individually, scored lower than group C, who worked cooperatively. Peer feedback is substantially better than (individual) self-feedback in learning content, organization and conventions in text writing (Zou et al., 2022). Some soft skills and higher-order skills such as leadership, reflection, collaborative work and autonomy were put into practice and generated a shared awareness of the quality of their essay at each writing stage (Fernández Dobao & Blum, 2013; Owen & Dunham, 2015). Intergroup corrections favored the improvement of grammatical, syntactic and orthographic (stylistic) issues and greater awareness of coherence and cohesion.

Another of the relevant aspects of the research focuses on the role played by the teacher in the previous phases (planner), execution (promoter of feedback) and exit (learning monitor) of the sessions. Although, from TPD-FLACW, the student adopts an active role in his or her learning, the teacher does not exempt his or her work as a transforming agent (Figueroa & Aillon, 2015). It is necessary to consider the axes of the implementation of the flipped classroom model: change in the role of teacher and lecturer, integration of technologies, assessment processes and the development of autonomy (Del Arco Bravo et al., 2019; Ebadi & Rahimi, 2019). Therefore, the creation of group rooms favors interaction and attention to the needs or queries presented. Without the role of the teacher, pedagogical interventions may probably not reach the magnitude of the achievement found, so it represents a fundamental element in the teaching of writing, mainly when it comes to engineering students, who focus their attention on the numerical due to the curriculum (Vine-Jara, 2020).

As stated above, there are several reasons that support the potential of TPD-FLACW in the production of academic essays with the use of technology. The main rationale lies in the statistical findings of the output evaluation but is confirmed by the positive assessment and evaluation of the design by the students.

CONCLUSIONS

In the present research, the impact of the application of TPD-FLACW on engineering students has been studied. After nine intervention sessions, a significant progress in the level achieved by the students was evidenced. Significant effects were found in comparison with the control groups, mainly in microstructure and stylistic.

Based on these findings, it is pertinent to affirm that having the material in different formats before the synchronous class, having instruments that regulate individual learning, feedback at the beginning of the class, carrying out CW practices and analyzing what was learnt in each session are elementary factors for achieving greater success in academic production. In addition, motivation, acceptance and working atmosphere were favorable factors during the implementation. TPD-FLACW provides an efficient way forward that merits further empirical support in other more complex educational settings.

The researchers who constitute the literature support the favorable contributions offered by FL and CW model in text production; however, TPD-FLACW provides an efficient way for its implementation within the framework of formative assessment and the competency-based approach, which, together with the educational pillars (learning to know, learning to be, learning to live together and learning to do) (Delors, 1996), constitute the axes of education in the 21st century. Furthermore, it is aligned to updated pedagogical foundations and adopts a perspective that takes advantage of the use of technology and web-based information. It is an important proposal for bridging the gap between academic writing in basic and higher education.

Limitations of the Study

Despite the participation of students from different engineering disciplines, it was found that there were no intergroup differences in academic writing proficiency before the implementation of TPD-FLACW; the rigor was limited by relying on groups previously enrolled in certain sections at the beginning of the academic semester. Therefore, future studies can randomize the sample and have a better control of characteristics such as number of students per discipline, percentages of males and females or number of times the subject has been taken, which may be intervening variables. Although the sample size was representative, it suffered a decrease due to the exclusion criteria, therefore, in subsequent studies it would be advisable to place greater emphasis on induction work to avoid sample loss.

During the experimentation, the materials were provided through the Moodle platform, while the videos could be watched through Drive. However, some students found it difficult to access it immediately, so it was uploaded to YouTube. It is recommended that future research should consider a wider range of platforms with possibilities to disseminate the materials.

Recommendations for Future Studies

The study presents a positive image of the benefits offered by TPD-FLACW in academic essay writing at the level of superstructure, macrostructure, microstructure and textual stylistics. However, the present work highlights the need to continue implementing it in other educational settings such as basic education or in non-university higher education. Based on our findings, we suggest that future studies should

(a) experiment with TPD-FLACW in the writing of more rigorous texts such as monographs, scientific articles, technical reports, degree projects or theses,

(b) compare TPD-FLACW with other previously established TPDs to verify its impact,

(c) propose procedural improvements focused on strengthening the design,

(d) apply TPD-FLACW in face-to-face and blended learning scenarios,

(e) implement it inter-disciplinarily in social sciences, health, economics or humanities degrees to achieve a transdisciplinary study, or

(f) attend to the students' perception of learning after the intervention of TPD-FLACW.

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