



Optimizing SIM-Aril as a Smart Feedback Engine for Academic Writing in Open and Distance Learning

Milawati¹, Nuraziza Aliah², Maya Puspitasari³, Dwi Rezki Hardianto Putra Rustan⁴, Siti Hadiani⁵, Dewi Wardah Mazidatur Rohmah⁶

¹⁻²⁻³⁻⁴⁻⁵ Universitas Terbuka, Indonesia

⁶ University of New South Wales, Australia

e-mail: milawati@ecampus.ut.ac.id

Abstract:

Academic writing development in open and distance learning (ODL) remains challenging as students must manage complex writing processes independently, while existing digital platforms often focus on assignment submission rather than supporting iterative writing through feedback, reflection, and revision. This study aimed to develop and evaluate SIM-Aril as an online portfolio-based self-regulated feedback platform for supporting academic writing development in an ODL context. This study employed a quantitative survey approach involving 122 students and 38 tutors from Open University in Indonesia, with data collected through self-regulated writing questionnaires and tutor competency questionnaires. The process involved a series of rigorous, exploratory factor analysis (EFA), Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity to ensure the scale's validity, reliability, and contextual relevance. The findings demonstrate that SIM-Aril supports Zimmerman's (2000) Self-Regulated Learning theory in academic writing development through the integration of digital portfolio assessment, tutor scaffolding, and students' self-regulated writing processes. These findings emphasize that SIM-Aril functions not only as a digital submission platform but also as a self-regulated feedback ecosystem integrating learner autonomy, instructional support, and formative feedback. This study contributes to digital assessment research by integrating self-regulation, shared regulation, and feedback literacy in ODL writing environments.

Keywords: *academic writing, self-regulated learning, digital assessment, feedback literacy, ODL*

1. INTRODUCTION

Academic writing is a demanding academic literacy practice that necessitates students to construct knowledge, build an argument based on evidence, integrate references from scholarly sources, and also write in accordance with the conventions of academic communication (Lea & Street, 1998; Hyland, 2000). Besides, engaging in academic writing entails doing cognitive and metacognitive regulation in a continuous manner through planning, monitoring, evaluation, and revising (Zimmerman, 2000; Teng & Zhang, 2019; Harris, 2024). On the other hand, a lot of university students continue to struggle with aspects such as setting writing goals, organizing arguments, integrating sources, utilizing feedback, and making revising meaningful. Literature points out that the main factor behind successful academic writing is that students employ self-regulated writing strategies that encompass cognitive regulation, metacognitive monitoring, managing motivation, and feedback utilization (Teng & Zhang, 2019). Furthermore, it has been documented that students with better self-regulated writing skills are more capable of monitoring and improving academic texts (Wang, 2025).

In addition, these difficulties are exacerbated in open and distance learning (ODL) where students need a higher degree of autonomy while at the same time there should be possibilities for communication, engagement, access to feedback, and provision of support (Bozkurt et al., 2020; Martin et al., 2021). Thus, even though students can demonstrate their learning and development through portfolio-based assessment consisting of various drafts, feedback responses, and revisions (Lam, 2014), the focus of most digital platforms is actually on material distribution and assignment submission rather than facilitating students' self-regulated learning, reflection, and feedback engagement (Bearman & Ajjawi, 2021; Dawson et al., 2021). Feedback should be at the heart of the transformation of assessment into learning through an iterative process. Recent studies highlight that it is not only the provision but also the students' ability to interpret, judge and use feedback that affect writing development in technologically supported learning environments (Carless & Boud, 2018; Winstone et al., 2021). Studies on AI-supported writing environments have further proved feedback literacy and interactions of learners with technology contribute to engagement and self-regulated writing processes (Liu et al., 2026; Li & Geng, 2026). Furthermore, generative AI opens new opportunities for novel assessment approaches that focus on transparency, authenticity and evidence of learning processes instead of only relying on final products (Perkins, 2023; Cotton et al., 2024).

To address these challenges, this study developed SIM-Aril as an online portfolio-based self-regulated feedback platform for academic writing development in ODL. Unlike conventional learning management systems, SIM-Aril integrates features for writing planning, draft monitoring, tutor feedback, reflection, and revision documentation based on self-regulated learning theory (Zimmerman, 2000), scaffolding theory (Vygotsky, 1978), and feedback literacy theory (Carless & Boud, 2018). Previous studies have examined self-regulated writing strategies (Teng & Zhang, 2019; Wang, 2025), portfolio assessment (Lam, 2014), digital assessment transformation (Bearman & Ajjawi, 2021), feedback engagement (Carless & Boud, 2018; Winstone et al., 2021), and ODL challenges (Martin et al., 2021) as separate research areas. Limited research has explored how digital assessment environments integrate student self-regulation, tutor scaffolding, and formative feedback within large-scale ODL contexts. This study addresses this gap by conceptualizing SIM-Aril as a self-regulated feedback ecosystem connecting individual regulation, social regulation, and formative feedback. Based on the identified research gap and theoretical foundations, this study conceptualizes SIM-Aril as a self-regulated feedback

ecosystem that integrates individual regulation, social regulation, and formative feedback within a digital assessment environment. The conceptual model is presented in **Figure 1**. SIM-Aril Self-Regulated Feedback Ecosystem Model

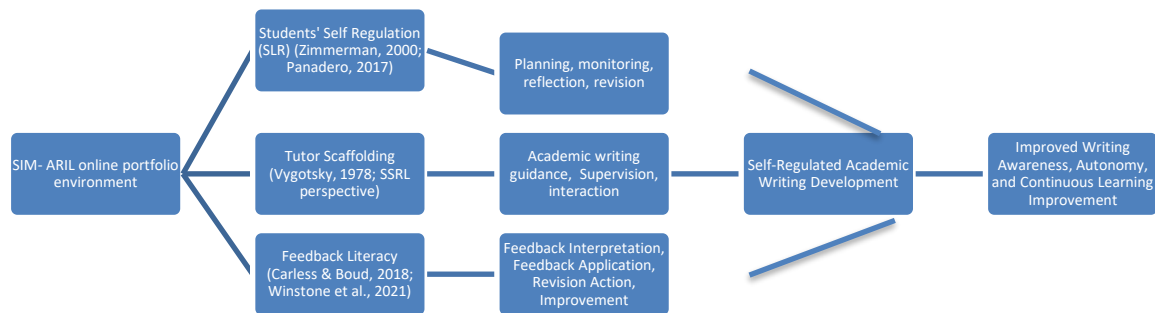


Figure 1: Conceptual model of SIM-Aril as a self-regulated feedback ecosystem for academic writing development in ODL

As illustrated in **Figure 1**, SIM-Aril positions technology as a mediator between student self-regulation, tutor scaffolding, and feedback literacy. This ecosystem supports students in planning, monitoring, revising, and improving academic writing within an ODL environment. Therefore, this study addresses the following research questions:

- RQ1. How can SIM-Aril be optimized as an online portfolio-based self-regulated feedback platform to support academic writing in ODL?
- RQ2. To what extent does SIM-Aril support students' self-regulated writing development?
- RQ3. How do tutor support and students' self-regulated writing processes contribute to academic writing development through SIM-Aril?

2. RESEARCH METHODOLOGY

2.1 Research Design

In this study, we used a quantitative survey research method to investigate both the implementation and the perception of effectiveness of SIM-Aril as a self-regulated feedback platform for academic writing, which is accessed in the form of an online portfolio-based platform in the context of ODL. The respondents were mainly taught by questionnaires designed to be structured in such a way that the different aspects of online portfolio as a self-regulated feedback platform, i.e. usability, feedback utilization, self-regulated writing activities, and instructional support were measured. The instruments validation was by exploration factor analysis (EFA), KMO, Bartlett's Test of Sphericity, and reliability analysis to ensure construct validity and internal consistency.

2.2 Setting and Participants

Participants were students and tutors of the Academic Writing course at Universitas Terbuka, a large-scale ODL institution in Indonesia. This course was selected for study because academic writing involves complex processes such as topic development, drafting, feedback utilization, revision, and manuscript preparation. There were 122 undergraduate students in their seventh semester, 38 tutors, and a team of academic writing lecturers and assessment experts who

participated in the study. The students used SIM-Aril and filled in a questionnaire on self-regulated writing which measured planning, monitoring, feedback utilization, revision, and reflection. Tutors reviewed SIM-Aril from the perspectives of supervision, feedback, interaction, and reflective activities. Lecturers and assessment experts gave feedback on its instructional relevance, assessment-alignment, usability, and feasibility before the actual implementation.

2.3 Data Collection Procedures

Two stages were involved in the data collection process. Firstly, the mapping of the present situation uncovered the major challenges in academic writing assessment in ODL that was found out by analyzing documents, questionnaires, and semi-structured interviews with representatives of the three groups: students, tutors, and lecturers. The study described learning objectives, assessment practices, writing regulation, feedback utilization, revision processes, and learner independence. Based on these findings, SIM-Aril was developed as an online portfolio-based self-regulated feedback platform following the Zimmerman (2000) SRL model, with features for setting goals, drafting, monitoring of progress, exchanging feedback, reflecting, and documenting revision. Additionally, expert panel validation was carried out, which included content reevaluation, instructional alignment, usability, and integration of SRL. After the final round of modifications, SIM-Aril was used for academic writing tasks such as planning, drafting, feedback, revision, and record-keeping of writing progress. Also, evaluation data from students and tutors has been acquired.

2.4 Research Instruments

Three main kinds of instruments were engaged in the study. First, tutor competency questionnaire was made up of 23 items evaluating the tutors' preparation for SIM-Aril launch. The instrument covered seven dimensions: tutorial planning, tutorial implementation, supervision of writing, assessment and feedback, time utilization and interaction, constraints and support, and finally self-reflection of the tutor. Second, student self-regulated writing questionnaire was made up of 39 items on the students' writing regulation processes. The instrument covered six dimensions: goal setting and progress monitoring, metacognitive monitoring and regulation, revision and feedback utilization, motivation and emotion regulation, collaboration and peer feedback, and writing strategies. Third, SIM-Aril evaluation instruments and qualitative interview protocols were used for the participant's perception about the platform's usability, feedback utilization, reflective learning, and learner autonomy.

2.5 Data Analysis

IBM SPSS was used for quantitative data analysis to fulfill research aims. Several statistical techniques were used in this field-based study, including descriptive statistics, reliability analysis, exploratory factor analysis (EFA), and inferential analysis. Participants' perceptions were profiled and patterns of interrelated variables were identified by calculating means, standard deviations, and percentages. Using Cronbach's alpha as a measure of internal consistency of the instrument, a reliability check was performed. Psychometric properties were interpreted following Nunnally & Bernstein (1994) and Taber (2018) recommendations. Confirmatory factor analysis (CFA) was then conducted to test the construct validity. Data suitability was given a final check before EFA by a KMO index and Bartlett's spherical test. Interpretation of extracted factors was done based on eigenvalues, factor loadings, and explained variance according to multivariate analysis operational procedures (Hair et al., 2019). Model fit was assessed with indices such as RMSEA,

CFI, TLI, and SRMR. Since the model exhibited good fit, it was concluded that the variables explained well the factors underlying them (Hair et al., 2019). We applied a Pearson correlation analysis to describe the relationships among the measured constructs. To quantify dependent variable variance explained by independent variables, multiple regression analysis was performed. The results of these analyses gave robust empirical support for the relationships between the tutor roles (competency, feedback, and reflection) and the students' writing supervision skills.

The methodological framework was designed to ensure alignment between the research questions, data sources, instruments, and analytical procedures. Each research question was addressed through specific measurement approaches and statistical analyses to examine the role of SIM-Aril as an online portfolio-based self-regulated feedback platform in supporting academic writing development within an ODL environment as it is seen in **Table 1**.

Table 1: Methodological alignment with research questions

Research Questions	Research Focus	Data Source and Instrument	Data Analysis Technique	Output
RQ1. How can SIM-Aril be optimized as an online portfolio-based self-regulated feedback platform to support academic writing in an open and distance learning environment?	Examining participants' perceptions regarding SIM-Aril usability, instructional alignment, feedback support, and portfolio-based assessment functions.	SIM-Aril evaluation questionnaire completed by students, tutors, and educational assessment experts.	Descriptive statistics (mean and standard deviation), reliability analysis (Cronbach's alpha), and construct validity testing using EFA, KMO, and Bartlett's Test of Sphericity.	Empirical evidence regarding the quality, usability, and contextual relevance of SIM-Aril as a digital assessment platform.
RQ2. To what extent does the implementation of SIM-Aril support students' self-regulated writing development in academic writing?	The study identifies self-regulated writing behavior of students that are being supported through SIM-Aril such as writing planning, monitoring, feedback utilization, revision, and reflection.	Student self-regulated writing questionnaire consisting of 39 items measuring writing regulation processes.	Descriptive statistics and exploratory factor analysis (EFA) to identify underlying dimensions of students' self-regulated writing processes.	Identification of self-regulated writing dimensions and evidence of how SIM-Aril supports students' writing regulation.
RQ3. How do tutor support and students' self-regulated writing processes explain the contribution of SIM-Aril in developing academic writing skills in ODL?	The research will explore whether tutor scaffolding, feedback practices, and students' self-regulated writing development are related.	Tutor competency questionnaire (23 items) and student self-regulated writing questionnaire.	Pearson correlation analysis and multiple regression analysis to examine relationships and predictive contributions among variables.	Evidence explaining the contribution of tutor support and self-regulated writing processes to SIM-Aril implementation.

3. RESULTS

3.1 SIM-Aril optimization as an online portfolio-based self-regulated feedback platform (RQ1)

The first research question dealt with the issue of whether and how SIM-Aril as an online portfolio-based self-regulated feedback platform could be optimized to support academic writing

development in open and distance learning environments. The needs analysis results showed that students had quite a few problems in managing academic writing practices, especially in planning writing tasks, tracking their progress, making use of feedback, and also when performing revising activities. Even though students received feedback during the learning activities, students and tutors indicated that assessment practices in place provide limited opportunities for the documentation of writing development as a continuous process. From the viewpoint of tutors, the principal challenges were related to monitoring students' writing progress, providing continuous guidance, and managing feedback interaction within a large-scale ODL environment. These findings point to the necessity of an assessment platform capable of integrating the writing process, support from tutors, and feedback documentation.

In response to all these challenges, SIM-Aril has been designed by blending the portfolio assessment method with the components of self-regulated learning. Furthermore, this assessment system is related to self-regulated learning theory to make it more effective and efficient. The team of experts was asked to give feedback about the module in terms of its content, usability and appearance. The extent of SIM-Aril usage was reflected and commented upon by tutors after receiving technical support and training for the implementation of SIM-Aril. Students and tutors filled up questionnaires to collect quantitative data on SIM-Aril usage. Validity of the questionnaires was checked by lecturers and experts.

Table 2: SIM-Aril Features Supporting Academic Writing Development

Feature	Function
Writing planning	Helping students to set their writing goals and plans
Draft monitoring	Tracking progress of writing development
Tutor feedback mechanism	Encouraging the provision of formative feedback
Reflection activity	Helping with a review of writing progress
Revision documentation	Keeping a record of changes throughout the different stages of writing

They integrated these features, which greatly changed the way academic writing activities were viewed as only a final product to be assessed into a documented writing growth process. With SIM-Aril, both students and tutors can have easy access to writing progress, feedback history, and revision records in one consolidated digital environment. After the development, SIM-Aril was evaluated through tutor competency assessment. The reliability analysis revealed that the tutor competency instrument had a very high level of internal consistency (Cronbach's α =.929) as seen in Table 3.

Table 3: Tutor competency profiles supporting SIM-ARIL implementation

Dimension	Mean	SD
Time utilization and interaction	4.614	.493
Tutorial implementation	4.612	.468
Academic article supervision	4.566	.499
Tutorial planning	4.553	.510
Assessment and feedback	4.535	.505
Tutor self-reflection	4.474	.512
Constraints and support	3.816	.692

The descriptive results reveal that tutors showed remarkable competencies in almost all dimensions. Time utilization and interaction came out as the top scored area ($M = 4.614$) followed by tutorial implementation ($M = 4.612$). This signified that tutors were highly prepared to handle online academic writing activities.

Tutors also rated themselves highly on academic article supervision ($M = 4.566$), which demonstrates a belief in their ability to assist students during writing development. On the other hand, the constraints and support factor got the lowest rating ($M = 3.816$), indicating that issues related to institutional and technological support need more attention during the digital assessment rollout. More analyses are in **Table 4**.

Table 4: Regression analysis predicting tutor self-reflection

Predictor	β	p
Academic article supervision	.540	.011
Tutorial implementation	.380	.189
Constraints and support	.188	.229
Time utilization and interaction	.029	.901
Tutorial planning	-.073	.743
Assessment and feedback	-.180	.499

Note. Model: $R^2 = .550$; Adjusted $R^2 = .463$; $F(6,31)=6.318$; $p < .001$

From the regression analysis it turned out that academic article supervision is the only significant predictor of tutor self-reflection ($\beta=.540$, $p=.011$). It means that tutors' participation in supervising academic writing activities was a key part of SIM-Aril implementation.

3.2 Students' self-regulated writing processes through SIM-Aril implementation (RQ2)

The second research question was about students' self-regulated writing processes when they were involved in academic writing activities supported by SIM-Aril. First, the data were collected from 122 students after they completed a 39-item self-regulated writing questionnaire. Cronbach's α was used to calculate internal consistency, and the reliability of the instrument (see table 5) was excellent: .975.

Table 5: Students' Self-Regulated Writing Dimensions

Dimension	Mean	SD
Revision, feedback, and information seeking	5.799	.778
Metacognitive monitoring and regulation	5.654	.788
Motivation and emotion regulation	5.634	.778
Collaboration and peer feedback	5.634	.866
Rehearsal and memory strategies	5.578	.925
Goal setting and progress monitoring	5.373	.965

The average level of students who self-regulated their writing was high (mean score 5.656, $SD = .79$), showing that they regularly carried out some form of regulation activity to manage their writing. While all six components scored relatively highly, revision, feedback and information seeking came out with the highest average score ($M = 5.799$), and metacognitive monitoring and

regulation was ranked second ($M = 5.654$). Indirectly, these scores reveal that students are involved in those activities related to re-examining their written work, replying to the feedback they receive, and keeping track of their writing performances. To uncover the inherent factors that underpin self-regulated writing of students, exploration factor analysis has been performed.

The whole set of students' self-regulated writing behaviors was best represented by six dimensions, as revealed by the EFA. 1) Revision, feedback, and information seeking; 2) Motivation and emotion regulation; 3) Metacognitive monitoring and regulation; 4) Goal setting and progress monitoring; 5) Collaboration and peer feedback; and 6) Rehearsal and memory strategies were the dimensions. The factors that were drawn collectively accounted for 67.59% of the total variance, indicating that the various aspects or characteristics of students' self-regulated writing have been taken into consideration during this study. Besides, correlation analysis also revealed that there were positive correlations amongst the various dimensions that were uncovered. The most robust association was observed between motivation and emotion regulation and metacognitive monitoring ($r = .753$), while metacognitive monitoring and rehearsal strategies came out second ($r = .724$).

3.3 Tutor support and student self-regulation explaining SIM-Aril contribution (RQ3)

The integration of tutor competency, self-regulated student writing, and qualitative evaluative data resulted in the findings being a combination of the three contexts. According to the results, SIM-Aril contribution happened via two mechanisms that were interrelated: regulation that is supported by the tutor and regulation of writing that is driven by the student.

The tutor rating revealed that supervising academic articles was the major source of contribution to the tutor self-reflection. This result implies that tutor participation in the act of writing development monitoring and guidance was the main aspect of SIM-Aril implementation. However, the student rating showed that SIM-Aril-augmented tasks motivated students to initiate writing regulation procedures, mainly revision, feedback usage and metacognitive monitoring. A summary of the integration of the findings is given in Table 6.

Table 6: Integrated mechanisms explaining SIM-Aril contribution

Component	Empirical Evidence	Contribution
Tutor supervision	Academic article supervision predicted tutor self-reflection ($\beta=.540$, $p=.011$)	Supported guided writing development
Tutor feedback	Assessment and feedback positively correlated with tutor reflection ($r=.584$, $p<.001$)	Facilitated improvement processes
Student revision	Highest SRL dimension ($M=5.799$)	Supported continuous writing improvement
Student monitoring	High metacognitive regulation score ($M=5.654$)	Supported writing awareness
Student feedback engagement	Strong relationship between revision and monitoring ($r=.710$)	Supported reflective revision

Regarding RQ3, qualitative analysis results showed that participants highlighted their experiences with SIM-Aril in terms of three main themes:

3.3.1.1 Visibility of writing development

It is discovered through result survey that SIM-Aril gave students and tutors a tool to keep track of writing Evolution via documentation drafts, feedback, and revisions. Apart from this, it is also reported that SIM-Aril gave students and tutors a tool to keep track of writing Evolution via documentation drafts, feedback, and revisions (see Figure 2)). This result is further proven by descriptive statistics that reveal that students strongly participated in revising and responding to feedback related activities. The factor centered on revision, feedback, and information seeking (F1) achieved the highest average score of all factors ($M = 5.799$, $SD = 0.778$) and demonstrated a high internal consistency (Cronbach's Alpha = 0.942), reflecting that students focused on the execution of activities related to reviewing and enhancing their writing at a high level of consistency.

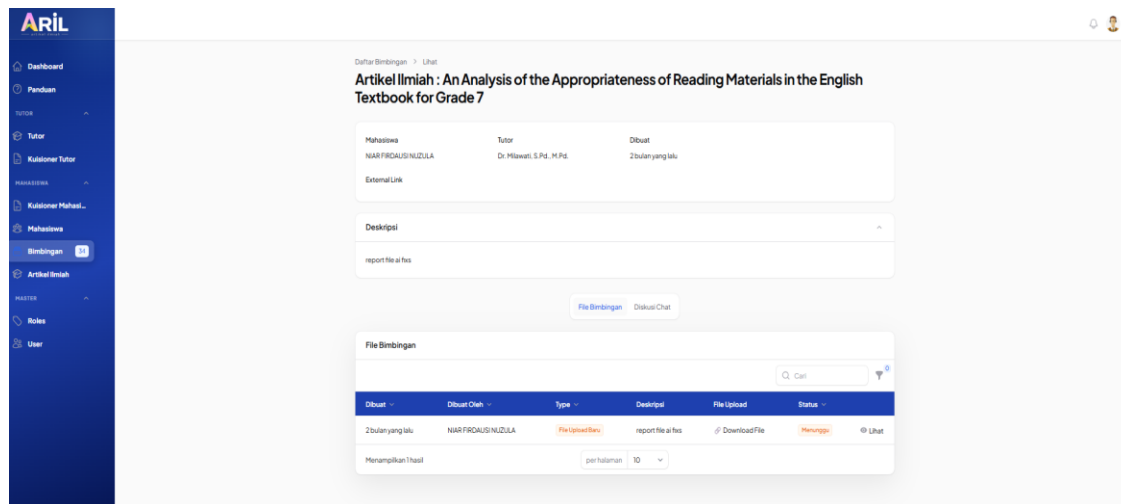


Figure 2: SIM-Aril Platform for Students' Academic Writing Consultations

More supporting data are found in the individual items. Students registered their significant agreement that their writing develops in response to tutor feedback (P25, loading = 0.716) and on the other hand, they are willing to listen to tutor feedback to improve their writing (P23, loading = 0.715). A high correlation between P23 and P25 ($r = 0.892$) also implied that students' processes of receiving and applying feedback were highly interlinked in their writing development. These findings show that drafting, feedback, and revision documentation through SIM-Aril are among the most tangible evidence of writing progression accessible to students and tutors who use these tools to track their growth;

3.3.1.2. Structured feedback interaction

The survey showed that the students and tutors found the feedback is easier to be obtained, reviewed, and applied because the feedback was part of the writing process (See Figure 3). The survey results demonstrate that tutors' perception of the incorporation of peer feedback, timely feedback, and feedback discussion reveals that these are regular practices with consistent positive ratings. The factor revision, feedback, and information seeking (F1) registered the highest mean score ($M = 5.799$) and reliability value ($\alpha = 0.942$), thus confirming that feedback was a key element of students' writing self-regulation.

4. DISCUSSION

4.1 SIM-Aril as a self-regulated feedback ecosystem for digital academic writing assessment

This study documents that SIM-Aril is not just a platform for handling academic writing tasks, rather, it acts as a self-regulated feedback ecosystem where student regulation, tutor scaffolding, and formative feedback are integrated into a digital assessment environment. It thus points out that technology-supported assessment is desirable to go beyond mere administrative functions such as assignment submission and to focus on meaningful learning processes, reflection, and feedback interaction (Dawson et al., 2021; Bearman & Ajjawi, 2021). Academic writing is a process that takes place through iterative cycles of planning, drafting, getting feedback, reflecting on that feedback, and revising writing. Hence, the assessment environment needs to be designed with the capability to facilitate both cognitive regulation and social interaction. Open and distance learning (ODL) is particularly a relevant case where students will have to be more autonomous while at the same time requiring instructional support and continuous interaction. The literature on distance learning has already pointed out that engagement, interaction, feedback accessibility, and instructional support are still challenging even in ODL environments (Bozkurt et al., 2020; Martin et al., 2021). As a result, SIM-Aril's strength lies in its capacity to balance learner independence and support by integrating writing processes, tutor guidance, and feedback imparting within one digital environment.

Such conceptualization expands the traditional idea of self-regulated learning (SRL). Learners' ability to regulate their learning through phases of forethought, performance, and self-reflection is well illustrated by Zimmerman's (2000) cyclical model. Academic writing involves these phases in terms of setting goals, preparing to write, monitoring progress, evaluating drafts, and revising written work. Reiterating, regression of writing ability is also highly dependent on one's mastery of cognitive and metacognitive processes such as planning, monitoring, evaluation, and revision (Harris, 2024; Teng & Zhang, 2019). Besides individual effort, regulation of learning activity is understood to be socially mediated through interaction between the learner and their environment (Panadero, 2017). Adopting this standpoint, SIM-Aril gives students external structures for the regulation that supports students in doing SRL activities consistently. Activities typical of writing planning kickstart forethought processes, draft monitoring continue addressing performance regulation, whereas feedback reflection and revision documentation are components of the self-reflection phase. Drawing on the idea of technology-supported regulation, digital environments can act as scaffolds that direct learners in managing the complexities of learning.

The findings further develop digital portfolio research by presenting the view that digital portfolios not only serve as places to store learning evidence but also as places that support regulatory functions of learning. Previous portfolio research has shown that portfolio assessment affords students opportunities to record learning processes, reflect on changes, and exhibit development through evidence such as drafts, responses to feedback, and revisions (Lam, 2014). This research takes this view further by demonstrating that combining portfolio functionalities with feedback interaction and self-regulated writing activities can turn digital portfolios into vibrant learning ecosystems that encourage continuous writing development. On the other hand, this outcome also contributes to the gap identified in previous digital learning research, with many platforms mainly operating as mechanisms for distribution of materials and collection of assignments, as opposed to supporting self-regulated learning, reflection, and feedback

engagement (Bearman & Ajjawi, 2021; Dawson et al., 2021). The integration of self-regulated writing activities, digital portfolios, and feedback processes within a single platform, are features that make up SIM-Aril and these features are mutually reinforcing components of writing development. In addition, the function of feedback within SIM-Aril is supported by related research on the notion of feedback literacy. Effective feedback delivery requires students' feedback literacy where students can understand, interpret, and use feedback to achieve learning goals (Carless and Boud, 2018). Winstone et al., (2021) echoed, students have to receive feedback actively to be able to use it, and not just the passive reception of feedback that focuses on here and now will do less to affect future performance. For this study, SIM-Aril encourages feedback engagement by linking tutor comments to drafts, revisions, and reflection.

Hence, a theoretical contribution of the present investigation relates to conceptualizing SIM-Aril as a self-regulated feedback ecosystem that combines three research areas, i.e. student self-regulated writing, tutor scaffolding, and feedback literacy. While some previous studies have individually addressed SRL, portfolio assessment, digital assessment transformation, and feedback engagement (Lam, 2014; Teng & Zhang, 2019; Carless & Boud, 2018; Winstone et al., 2021), this research identifies the possible operation of the combination of these components in a technology-supported academic writing environment. Indeed, this integration of components allows SIM-Aril not only to work as an assessment instrument but also as a learning environment that fosters learner autonomy, interaction, and continual progress.

4.2 Students' self-regulated writing development through technology-supported learning

Data show that students, on the one hand, were involved in several aspects of self-regulated writing when SIM-Aril was rolled out; and, on the other hand, they were motivated to develop revision, feedback utilization, information seeking, and metacognitive monitoring. This means that students were not only finishing writing tasks but also were actively organizing the processes engaged in the production of academic texts. This corresponds with the findings of other studies that writing instruction should guide students to regulate different processes such as setting goals, monitoring, evaluating, revising, and using feedback, instead of being only concerned with the final written product (Zimmerman, 2000; Teng & Zhang, 2019). Notably, Teng and Zhang (2019) have demonstrated that self-regulated learning strategies enable students to exercise better control over writing processes by strengthening planning, monitoring, and revision practices. Such an interpretation of today's SRL research is in line with the idea that regulation is a dynamic process going on at least on the cognitive, motivational, behavioral, and contextual levels (Panadero, 2017). Students' writing proficiency, therefore, is not merely a function of their individual capability but also depends on how learning environments offer opportunities for monitoring, reflection, and changing of strategies. This study supports this argument since it reveals that SIM-Aril provided the framework within which students were able to carry out writing planning, appraisal of one's drafts, reaction to feedback, and recording of revision activities.

This is in line with Zimmerman's (2000) cyclical SRL model, which involves three interconnected phases: forethought, performance, and self-reflection. In academic writing, students must continuously evaluate the quality of their arguments, identify weaknesses, seek relevant information, and modify their writing strategies. Harris (2024) asserts that writing skill development depends on explicit strategy instruction and self-regulatory processes that allow learners to monitor their performance and make strategic improvements. To write well, it is

crucial for learners to actively manage cognitive strategies, motivation, and writing behaviors at all stages of the writing process (Teng & Zhang, 2019). Consequently, the substantial presence of revising and feedback usage in this study suggests that SIM-Aril recognizes writing as an ongoing process rather than a single event of production.

4.3 Tutor scaffolding and socially shared regulation in ODL academic writing

Although student self-regulation represents an important component of academic writing development, the findings demonstrate that tutor support remains essential, particularly within large-scale ODL environments. The role of tutors identified in this study can be interpreted through the perspective of scaffolding and socially shared regulation of learning (SSRL). While traditional self-regulated learning emphasizes individual regulation, contemporary perspectives highlight that learning regulation may also emerge through interactions among learners, instructors, peers, and learning environments (Hadwin et al., 2018; Järvelä & Hadwin, 2021). Within SIM-Aril, tutors function as external regulators who guide students through academic writing processes by monitoring writing development, providing feedback, identifying weaknesses, and supporting revision decisions. This interpretation is consistent with Vygotsky's (1978) scaffolding theory, which emphasizes that learners develop higher levels of competence through structured guidance and interaction with more knowledgeable others. Therefore, tutor support in SIM-Aril does not replace student autonomy but provides the necessary conditions for students to gradually develop greater control over their own learning processes. This finding extends previous SRL perspectives that regulation is not only an individual cognitive activity but also a socially mediated process shaped by learning environments and interactions (Panadero, 2017). In technology-supported learning environments, external structures provided by instructors and digital systems can support students in performing regulatory activities that may be difficult to sustain independently.

This finding is particularly important in ODL contexts, where students are expected to demonstrate autonomy while still requiring academic guidance and interaction. Previous studies have identified that maintaining engagement, interaction, feedback accessibility, and instructional support remains a challenge in distance learning environments (Bozkurt et al., 2020; Martin et al., 2021). SIM-Aril addresses this challenge by providing a shared digital environment where tutor support and student regulation operate simultaneously. Thus, the contribution of SIM-Aril can be understood not only through individual SRL but also through socially distributed regulation, where academic writing development occurs through interaction among students, tutors, and technological environments.

4.4 Feedback literacy as a mechanism for academic writing improvement

The findings also demonstrate that feedback represents a central mechanism connecting tutor support and student writing development. Rather than functioning as final comments after assessment completion, feedback within SIM-Aril becomes part of an ongoing learning cycle involving interpretation, reflection, and revision. This finding supports the feedback literacy perspective proposed by Carless and Boud (2018), which argues that effective feedback requires students to understand, interpret, and use feedback information to improve future performance. First, feedback effectiveness depends not only on the availability of comments but also on students' ability to actively engage with feedback and transform it into learning actions. This perspective aligns with Winstone et al. (2021), who emphasized that meaningful feedback engagement requires learners to participate actively in feedback processes rather than passively

receive teacher evaluations. In SIM-Aril, feedback is directly connected with drafts, revision records, and reflection activities, enabling students to apply feedback within the writing development process.

Second, the integration of feedback and revision activities within SIM-Aril supports the concept of formative assessment as a mechanism for self-regulated learning. Nicol and Macfarlane-Dick (2006) argue that effective formative feedback should help students understand learning goals, monitor their performance, and identify strategies for improvement. The findings of this study extend this perspective by demonstrating that digital assessment environments can facilitate feedback uptake by embedding feedback within students' writing trajectories. Third, SIM-Aril contributes to feedback practice by shifting feedback from a teacher-controlled assessment activity toward a collaborative learning process involving students, tutors, and digital tools. This finding supports recent feedback literacy research, which emphasizes that learners' capacity to interpret and use feedback is an essential component of academic development (Yan & Carless, 2022). Therefore, SIM-Aril functions not only as a channel for delivering feedback but also as an environment that supports feedback engagement and continuous writing improvement.

5. THEORETICAL CONTRIBUTION: REFRAMING DIGITAL ASSESSMENT AS A SELF-REGULATED FEEDBACK ECOSYSTEM

The theoretical contribution of this study lies in reframing digital assessment as a self-regulated feedback ecosystem, where technology functions not only as an assessment tool but also as a mediating environment that connects self-regulated learning, social regulation, feedback literacy, and continuous writing improvement as seen in Table 7.

Table 7: Theoretical contribution

Theoretical Contribution	Brief explanation	Theoretical foundation
Digital assessment as a self-regulated feedback ecosystem	SIM-Aril proposes digital assessment as an ecosystem that integrates individual regulation, social regulation, and feedback processes in academic writing development.	Zimmerman (2000); Carless & Boud (2018)
Individual regulation	SIM-Aril supports students in planning, monitoring, and revising their writing through cognitive, metacognitive, and behavioral regulation processes.	Self-Regulated Learning Theory (Zimmerman, 2000); Teng & Zhang (2019)
Social regulation	SIM-Aril facilitates student-tutor interaction through scaffolding, progress monitoring, and instructional support to improve writing performance.	Hadwin et al. (2018); Järvelä & Hadwin (2021)
Feedback regulation	SIM-Aril enables a continuous cycle of drafting, feedback exchange, reflection, and revision, helping students transform feedback into learning actions.	Carless & Boud (2018); Winstone et al. (2021)
Assessment as learning	SIM-Aril positions assessment as a learning process that develops student awareness, autonomy, and continuous improvement rather than only measuring outcomes.	Bearman et al. (2023); Dawson et al. (2024)
Integrated pedagogical model	SIM-Aril extends previous digital assessment research by showing how technology mediates the relationship between learner autonomy, tutor support, formative assessment, and academic writing development.	Integration of SRL, feedback literacy, and digital assessment perspectives

6. PRACTICAL IMPLICATIONS AND FUTURE RESEARCH

The findings suggest that institutions implementing digital assessment systems should consider three interconnected aspects. First, digital platforms should be designed to capture learning processes rather than only final outcomes. Features supporting planning, reflection, feedback, and revision should become central components of academic writing assessment. Second, tutor preparation is essential because technology cannot replace pedagogical interaction. Tutors need competencies in providing digital feedback, monitoring student progress, and facilitating reflective writing practices. Third, students need support in developing self-regulated learning and feedback literacy skills. Digital platforms are most effective when students understand how to use available resources to improve their learning. Hence, future research should examine the long-term effects of SIM-Aril through longitudinal or comparative studies. Further research may also integrate learning analytics and digital trace data to investigate how students' writing regulations develop over time.

7. CONCLUSION

This study developed and evaluated SIM-Aril as an online portfolio-based self-regulated feedback platform to support academic writing development in an open and distance learning (ODL) environment. The findings demonstrate that SIM-Aril was optimized by integrating digital portfolio assessment, self-regulated learning mechanisms, tutor guidance, feedback interaction, reflection, and revision documentation, transforming assessment from a final-product approach into a continuous writing development process. The implementation of SIM-Aril supported students' self-regulated writing development through increased engagement in revision, feedback utilization, information seeking, metacognitive monitoring, motivation regulation, collaboration, and writing strategies. Furthermore, the findings indicate that SIM-Aril contributed to academic writing development through the interaction between tutor scaffolding and student self-regulation, where tutors provided structured guidance while students actively managed their writing processes. Therefore, this study conceptualizes SIM-Aril as a self-regulated feedback ecosystem that integrates individual regulation, socially shared regulation, feedback literacy, and assessment-as-learning principles. The findings suggest that digital assessment systems should move beyond assignment submission by supporting learning processes, feedback engagement, and students' regulatory capabilities in ODL contexts.

Declaration of competing interest

There are no conflicts of interest to declare.

Declaration of generative AI

ChatGPT was utilized as a brainstorming support tool and assisted in refining the structure, coherence, and clarity of the writing.

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