Statistical Analysis Plan (SAP)

Study Title:	Evaluation of the Effectiveness of the Genomics & Science DOJO 3.0 Learning Method in Improving Scientific Writing Skills and Critical Thinking among Researchers in Indonesia: A Randomized Controlled Trial
Study Registration Number	096/UN18.F8/ETIK/2026
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Intervention	DOJO 3.0 Learning Method
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STATISTICAL ANALYSIS PLAN APPROVAL SIGNATURE PAGE

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SAP Revision History
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SAP ROLES

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1. STUDY OVERVIEW

Introduction

Strengthening human resource capacity in biomedical and genomic research is a fundamental prerequisite for establishing an evidence-based and sustainable health system. In Indonesia, despite both the number of researchers and overall research output have increased, available evidence suggests that adherence to international standards of methodological rigor and reporting quality remains limited among studies conducted by Indonesian researchers (Widyahening et al., 2014). Highlighting the need for targeted capacity-building interventions that enhance technical skills, critical thinking, and scientific communication among researchers. However, there remains limited rigorous evidence on the effectiveness of such interventions in improving research competencies and outputs in Indonesia.

This study aims to evaluate the effectiveness of the DOJO learning method compared to a standard learning approach in improving scientific writing skills and critical thinking among researchers in Indonesia. The study is designed as a two-arm randomized controlled trial. Participants will be stratified based on their baseline test scores and subsequently randomized to ensure balanced allocation across study arms. The unit of randomization is the team participant.

Participants will be assigned to one of two study arms:

1. DOJO learning method (intervention group)
2. Standard learning method (control group)

The study is primarily quantitative, aiming to assess the effectiveness of the DOJO intervention by comparing changes in key capacity indicators, including critical thinking, knowledge improvement, data analysis, personal empowerment, manuscript quality, and quality of teaching, between the intervention group (DOJO) and the control group (Non-DOJO). The RCT design enables causal inference by randomly assigning participants into two study arms, allowing differences in outcomes to be attributed specifically to the DOJO methodology.

The purpose of this Statistical Analysis Plan (SAP) is to define the statistical methods that will be used to analyze the trial data. The SAP specifies the analysis populations, outcome definitions, and statistical models that will be used to evaluate the effects of the DOJO learning method intervention and related outcomes.

1.1 Study Objectives

Primary Objectives

The primary objective of this study is to evaluate the causal effect of the Genomics and Science DOJO 3.0 intervention on participants' competencies, including critical thinking and data analysis ability, Knowledge acquisition across key learning modules (e.g., Mixed-model Bioinformatics, Data Dive and Analysis, etc), and Scientific manuscript quality and progress toward publication.

These outcomes will be measured using standardized assessment tools, including case studies, scoring rubrics, and validated questionnaires (multiple-choice questions) administered via the Knowledge Gateway.

Outcomes will be evaluated as the change in scores from baseline (pre-intervention) to endline (post-intervention).

The primary analysis will estimate the intention-to-treat effect by comparing the mean change in each outcome between the intervention and control groups.

Secondary Objectives

The secondary objectives of this study are to:

1. Compare participants' experiences and perceptions of the learning process between the intervention (DOJO) and control groups;
2. Evaluate changes in self-agency and personal empowerment; and
3. Assess participant engagement, performance, and learning behaviors throughout the program

These outcomes will be measured using validated self-assessment questionnaires and structured feedback forms administered at post-intervention (endline), as well as structured observational metrics. Feedback forms will capture participants' overall impressions of the program and their evaluation of teaching quality across facilitators (sensei). Observational data will be systematically quantified to assess participants' performance, activeness, and engagement during program activities (e.g., frequency and quality of questions or contributions, and participation across learning sessions). Selected engagement and behavioral measures will also be tracked throughout the program where applicable.

1.2. Study Hypotheses

Participants receiving DOJO learning methods interventions will demonstrate significantly higher improvement in critical thinking, knowledge improvement, data analysis, personal empowerment, manuscript quality, and quality of teaching compared to those receiving in standard learning methods.

2. STUDY POPULATION

2.1 Inclusion Criteria

1) Registered participants of Genomics & Science DOJO 3.0
2) Teams consisting of two members
3) Submission of research concept note
4) Completion of screening and assessment stages (administratively, and substantially through blind concept note screening and the team's curriculum vitae)
5) Willingness & commitment to participate in the full program
6) Involvement/ attendance of the first author

2.2 Exclusion Criteria

1) Incomplete registration or documentation
2) Failure to meet team composition requirements
3) Withdrawal before intervention

4) Incomplete baseline data

2.3 Data Acquisition

Study design	The study is a two-arm randomized controlled trial, with participants' baseline test results serving as the unit of randomization. Clusters are allocated to one of two study arms: 1) the DOJO learning method, and 2) the standard learning method. **Design**: two-armed randomized controlled trial **Unit of randomization**: Baseline test **Unit of analysis**: Team of Indonesian researchers **Number of arms**: 2
Data source	Data will be collected as part of the study through primary data collection conducted at baseline-endline test, and daily pre- and post-test across the event. Information will be obtained at pre-intervention, during intervention, and post-intervention using a standardized data collection instrument administered by the DOJO committee. Data source will include baseline and endline results collected pre-intervention and post-intervention, and pre- and post-test results collected each day of the intervention. Baseline and endline tests will be collected through SUMMIT's Knowledge Gateway, while pre- and post-test data will be collected through Google Forms that will be given to participants.
Data transfer method	Data collected will be compiled into the study database and transferred to the statistical analysis team through secure electronic transfer after completion of data cleaning and verification procedures. The dataset used for statistical analysis will correspond to the final cleaned dataset. Data collected through electronic forms using the Google form will be synchronized to the spreadsheets across the scoring files. Data extraction and processing for analysis will be conducted within the scoring files environment. For data management and analysis activities, including data cleaning, recoding, and dataset merging, authorized

	analysts may access the database through a secure remote desktop environment using statistical software such as SAS 9.4.
Data storage	The dataset used for statistical analysis will be stored in spreadsheets across scoring file environments. Data management processes, including data validation, merging, and structured query operations (e.g., SQL queries), will be conducted within the scoring files environment to ensure data security and integrity. Access to the data will be restricted to authorized study personnel in accordance with data protection and study governance procedures.

3. OUTCOME AND EXPOSURE

3.1 Primary Outcome

Primary Outcome			
1.	Critical Thinking	Mean change score	The primary outcome is the improvement in critical thinking ability among participants. Participants' critical thinking abilities will be assessed based on individual capacity to analyze and identify problems, interpret information, evaluate reasoning, and construct coherent, well-justified arguments. These competencies will be measured quantitatively using the Holistic Critical Thinking Scoring Rubric (HCTSR). Scores derived from the rubric will be used to quantify participants' overall critical thinking performance.
2.	Knowledge Improvement	Adjusted mean difference	Participants' knowledge improvement will be assessed by comparing their individual understanding of the materials delivered each

			day. Total scores will be calculated separately for the pre- and post-tests. Knowledge improvement will be quantified by computing the difference between post-test and pre-test scores (post-test minus pre-test). A greater positive difference will indicate a higher level of knowledge gain.
3.	Data Analysis	Mean change score or Mean change personal score	Data analysis skills will be assessed at the team level, focusing on participants' ability to interpret data, apply basic quantitative analysis, draw evidence-based conclusions, and communicate key findings. The skills component will be evaluated using the scoring metric, with scores used to quantify team performance.
4.	Personal Empowerment	Standardize mean change score	Personal empowerment will be assessed based on participants' confidence and sense of agency in engaging with and completing program-related tasks. Scores from the Dojo-specific validated questionnaire will be calculated separately at pre- and post-assessment. Pre-to-post changes will be standardized (z-scores) to enable comparability across instruments with different scoring scales. Standardized scores from both measures will then be equally weighted and combined to generate a composite Personal Empowerment Index. Changes in the Personal Empowerment Index are compared between control and intervention groups to assess program impact.
5.	Manuscript Quality	Manuscript mean score change	The improvement in manuscript quality submitted by the team participants, comparing before and after to DOJO activity. This variable will be measured using previous DOJO's evaluator scoring
6.	Publication of Participants	Publication effectiveness score	This variable will be assessed based on efficiency and quality of participants' manuscript publications, including submission timelines, publication speed, and journal impact. Impact on publication outcomes will be

			measured using a composite scoring approach. The Submission-to-Publication Interval Score will be calculated based on the number of months between manuscript submission and publication, with shorter intervals receiving higher scores (≤3 months = 4; ≤5 months = 3; ≤7 months = 2; ≤9 months = 1; not published = 0). Journal quality will be assessed using quartile rankings, with scores assigned as follows: Q1 = 3, Q2 = 2, Q3 = 1, and Q4 or unindexed journals = 0. An optional Holistic Publication Effectiveness Score will be derived by averaging the Submission-to-Publication Interval Score and the Journal Quality Score. For analysis, scores will be aggregated and compared between intervention and control groups to evaluate differences in submission speed, journal quality, and overall publication effectiveness.
7.	Quality of Teaching	Mean feedback or satisfactory score	This variable measures participants' perceptions of how effective the teaching was, both overall and at the Sensei level (clarity, structure, engagement, and learning support). Average scores (1-5 scales) are calculated for overall teaching quality and per Sensei, then aggregated for comparison between intervention and control groups.

4. STATISTICAL ANALYSIS PLAN

4.1 Sample Size Calculation

This study applies a randomized controlled trial (RCT) design to evaluate the effectiveness of the Genomics & Science DOJO 3.0 learning method in improving scientific writing skills and critical thinking among researchers in Indonesia. Participants are randomly assigned to either the intervention group (DOJO learning method) or a control group (standard learning method or non-DOJO learning method). The sample size calculation is based on the expected effect size of the intervention on primary outcomes (critical thinking, knowledge improvement, data analysis,

personal empowerment, manuscript quality, and quality of teaching), anticipated attrition among participants, and statistical power considerations to ensure meaningful results. Taking these factors into account, it is estimated that approximately 48 teams or 96 individuals will be participating in this study. Detailed calculations for the sample size are as follows:

Unadjusted Sample Size Calculation

Instead of using the Lemeshow formula, the study allocated control and intervention into the same sample size from overall team numbers. Each control and intervention arm consists of 24 teams of participants, making 48 teams in total.

Design Effect

Given the relatively small number of the teams, formal design effect inflation was not implemented to substantially increase the recruitment target. Instead, clustering will be addressed analytically where it is appropriate during the analysis.

4.2 Randomisation, Stratification, Blinding, and Replacement of participants

Randomization is conducted among eligible participants based on their baseline assessment with a total of 48 teams and allocated into two arms, control and intervention. The randomization process utilizes data management tools to generate randomization numbers, followed by stratification based on participants' research stage to ensure balanced distribution across population characteristics.

Following this process, 48 teams are assigned to two clusters: 1) Standard learning method (Non-dojo), and 2) DOJO learning method. Participants are randomly assigned in 1:1 ratio to these two arms. The randomization schema is designed to be reproducible and minimize bias, providing a transparent framework for the assignment of intervention to one of the arms. Within each arm, participants are proportionally and randomly assigned to the DOJO learning method or non-DOJO learning method to maintain comparability and avoid systematic imbalance across arms.

4.3 Data Preprocessing

Following data collection, all data will be reviewed and cleaned to ensure completeness, consistency, and accuracy. This process will include checking for missing values, inconsistencies, and duplicate entries, with incomplete or invalid responses handled according to predefined criteria.

Data from multiple sources (e.g., assessment instruments, Learning Management System [LMS] logs, and publication tracking records) will be integrated into a unified database for analysis. Variables will be coded and transformed as appropriate; for example, multiple-choice responses

will be scored numerically, rubric-based assessments will be standardized, and composite indices (e.g., personal empowerment index and improvement scores) will be computed.

Statistical analyses will be conducted using the SAS 9.4 and R software environment where appropriate. All identifiable information will be removed or replaced with unique participant identifiers to ensure confidentiality. Only de-identified data will be used for analysis.

4.4 Handling Missing Data

The extent and patterns of missing data will be examined for all key variables. If the proportion of missing data is small, complete-case analysis will be used. However, if missingness exceeds a predefined threshold, multiple imputation methods may be considered under the assumption that data are missing at random.

4.5 Descriptive Analysis of Baseline Characteristics

Descriptive analysis will be conducted to summarise participants' baseline characteristics and study variables, including the baseline score of each participant before intervention begins. Continuous variables will be presented as means and standard deviations (or median and ranges, as appropriate), while categorical variables will be summarized using frequencies and percentages. Descriptive statistics will be used to report baseline characteristics, as well as pre- and post-intervention scores for all outcome measures.

4.6 Primary Outcome Analysis

Inferential analysis will be conducted to evaluate the effect of the intervention on study outcomes, following the intention-to-treat (ITT) principle, whereby all participants will be analysed according to their assigned groups regardless of adherence. All statistical tests will be two-tailed, with a significance level of $p < 0.05$, and 95% confidence intervals will be reported.

For continuous outcomes measured at baseline and post-intervention or endline (e.g., critical thinking, knowledge improvement, data analysis skills, personal empowerment, and manuscript quality), the primary analysis will be conducted using **analysis of covariance (ANCOVA)** to compare post-intervention scores between groups while adjusting for baseline values of the respective outcome variables. In addition, repeated-measures ANCOVA will be implemented, where appropriate, to assess within-participant changes over time and differences between groups. This approach offers a more precise estimation of the intervention effect by accounting for potential differences in baseline.

For supportive analyses, descriptive statistics (means and standard deviations) will be presented to summarise baseline, endline, and change scores within each group to support interpretation of outcome trends.

Categorical outcomes (publication status, paper completion, or workshop completion) will be analysed using chi-square tests or Fisher’s exact tests, as appropriate, and may additionally be examined using

logistic regression models. Ordinal outcomes (e.g., journal quartile rankings and Likert-scale teaching quality scores) will be analysed using non-parametric methods, the Mann-Whitney U test.

Time-related outcomes, such as time to publication (measured as days to publication), will be explored using survival analysis techniques.

All analyses will account for baseline participant characteristics, including stratification variables such as research stage and educational background, to improve comparability between groups and reduce potential confounding.

4.8 STATISTICAL PACKAGE

All analyses and tabulations will be performed using SAS Version 9.4 or higher on a PC platform, R Version 4.5 or higher may be used for statistical graphics and statistical inferences.

5. SCHEDULE OF EVENTS

To follow the sequence of events and timing of patient assessments, the schedule of events from the protocol should be reproduced here. It may be necessary to insert other statistical events into the schedule i

Events	*Month*											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Enrollment												
Monitoring												
Interim Analysis												
Final Analysis												
Study Termination												

Declarations

Ethics Approval and Consent to Participate

This Statistical Analysis Plan (SAP) does not involve direct interaction with human participants or access to identifiable personal data. Ethical approval and informed consent are therefore not applicable. The SAP is developed based on the study protocol, which has obtained the necessary ethical approvals.

Consent for Publication

Not applicable.

Availability of Data and Materials

No primary data were generated or analyzed as part of this SAP. The document outlines the planned statistical analyses for the study. All relevant methodological details are included within the manuscript.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors' Contributions

- ***Dsk Feby Inka Putri Author 1:*** *Conceptualization, Methodology, Formal Analysis, Investigation, Project Administration, Software, Visualization, Writing – Original Draft Preparation*
- ***Winditya Safira Fitri, Author 2:*** *Conceptualization, formal analysis Supervision, Writing – Original Draft Preparation, project administration. Project field supervision*
- ***Yuni Dwi Setiyawati, Author 3:*** *Conceptualization, Formal Analysis, Supervision, Validation,Writing – Review & Editing, project administration*

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Research Data for This Article

This article does not report results from data analysis. No datasets were generated or analyzed as part of this Statistical Analysis Plan. Therefore, no data are available for sharing.