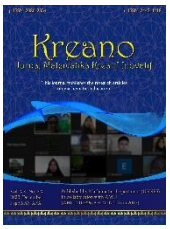
UNNES JOURNALS

Kreano, Jurnal Matematika Kreatif-Inovatif
Volume 17, number 1, 2026, pp. 247-265



Development of Canva-Based Student Worksheets (LKPD) to Support Students' Mathematical Communication Skills

Etika Khaerunnisa[1], Ilmi Solihat[1], Yayat Ruhiat[1], Lukman Nulhakim[1], and Heni Pujiastuti[1]

[1]Universitas Sultan Ageng Tirtayasa, Banten, Indonesia

Correspondence should be addressed to Etika Khaerunnisa: etika_kh@untirta.ac.id

Abstract

Low levels of statistical literacy, as indicated by an average statistical literacy score of 40.6% among prospective teachers, are caused by a lack of connection between the theory taught in class and its application in real life. The integration of Case-Based Learning (CBL) with hypermedia can create an interactive and contextual learning environment, thereby enabling the development of statistical literacy. The objectives of this study include describing the development process, assessing the feasibility, and evaluating the effectiveness of hypermedia-assisted CBL e-modules in supporting statistical literacy. This study uses the Research and Development (R&D) method with reference to the Lee and Owens model. The research subjects consisted of three subject matter experts, three media experts, and 30 students from the Chemistry Education Study Program at a state university in Banten Province. Data were collected through interviews, questionnaires, and statistical literacy tests. Data analysis was performed using descriptive and inferential statistics. The development process went through the stages of needs analysis, design, development, implementation, and evaluation. The results showed that the hypermedia-assisted CBL-based e-module was feasible, practical, and effective in improving students' statistical literacy. This is evidenced by expert validation results showing a feasible category (78.5%), positive student responses (79%), and a significant increase in statistical literacy scores after using the e-module. These findings imply that the integration of CBL and hypermedia can be used as an alternative learning strategy that is more interactive and contextual to strengthen statistical literacy. This model is recommended for adoption in the development of digital learning media in statistics courses and similar fields that require data analysis skills.

Keywords: Canva-based learning; hypermedia; e-module; literacy statistics.

Information of Article

Subject classification	*97C80 Technological tools and other materials in teaching and learning*
Submitted	*2 June 2025*
Review Start	*11 September 2025*
Round 1 Finish	*11 November 2025*
Round 2 Finish	*7 December 2025*
Accepted	*24 December 2025*
Scheduled online	*30 June 2026*
Similarity Check	*5%*

Abstrak

Rendahnya tingkat literasi statistika ditandai dengan rata-rata skor literasi statistik sebesar 40,6% pada calon guru disebabkan oleh kurangnya keterhubungan antara teori yang diajarkan di kelas dengan penerapannya dalam kehidupan nyata. Integrasi Case-Based Learning (CBL) dengan hypermedia dapat menciptakan lingkungan pembelajaran yang interaktif dan kontekstual, sehingga memungkinkan berkembangnya literasi statistika. Tujuan penelitian ini meliputi mendeskripsikan proses pengembangan, menilai kelayakan, dan mengevaluasi efektivitas e-modul CBL berbantuan hypermedia dalam mendukung literasi statistika. Penelitian ini menggunakan metode Research and Development (R&D) dengan mengacu pada model Lee dan Owens. Subjek penelitian terdiri atas 3 ahli materi, dan 3 ahli media, serta 30 mahasiswa Program Studi Pendidikan Kimia di salah satu Perguruan Tinggi Negeri di Provinsi Banten. Data dikumpulkan melalui wawancara, angket, dan tes literasi statistika. Analisis data dilakukan menggunakan statistik deskriptif dan inferensial. Proses pengembangan melalui tahapan analisis kebutuhan, perancangan, pengembangan, implementasi, dan evaluasi. Hasil penelitian menunjukkan bahwa e-modul berbasis CBL berbantuan hypermedia layak, praktis, dan efektif dalam meningkatkan literasi statistika mahasiswa. Hal ini dibuktikan melalui hasil validasi ahli yang menunjukkan kategori layak (78,5%), respons mahasiswa yang positif (79%), serta peningkatan signifikan skor literasi statistika setelah penggunaan e-modul. Temuan ini mengimplikasikan bahwa integrasi CBL dan hypermedia dapat dijadikan alternatif strategi pembelajaran yang lebih interaktif dan kontekstual untuk memperkuat literasi statistika. Model ini direkomendasikan untuk diadopsi dalam pengembangan media pembelajaran digital pada mata kuliah statistik dan bidang serupa yang menuntut keterampilan analisis data.

INTRODUCTION

Statistical literacy is an essential skill in various areas of life. The importance of statistical literacy is growing, especially in today's digital age, where individuals are constantly exposed to statistical data from various sources (Johannssen et al., 2021). Furthermore, statistical literacy, which includes the ability to understand, interpret, and apply statistical information in data-driven decision-making, is a highly sought-after competency in academic and professional circles (Clair & Chihara, 2017; Watson & Moritz, 2003; Weber Stein & Engel, 2025). Literacy encompasses a set of basic skills that are essential for understanding statistical information and research results, including the ability to manage data, compile and present it in tabular form, and utilize various forms of data representation (François et al., 2020; Hidayati et al., 2020; Koga, 2024; Sanchez, 2025). Mastering statistical literacy requires learning that focuses not only on mathematical procedures, but also on the context and comprehensive interpretation of data.

Statistical literacy is an important competency, but there are still many countries with inadequate levels of statistical literacy, where understanding of statistics tends to be uncritical. One contributing factor is the limited amount of research in the field of statistical education (Shobikhah et al., 2025). Many students have difficulty understanding and applying basic statistical concepts, especially concepts that are often considered abstract, such as hypothesis testing. Research results by Hariyanti et al., (2025) shows that the average statistical literacy competency of prospective teachers is 40,6%. Participants understood basic statistical terms and probability with a score of 63,2%. However, performance in data representation and interpretation was low, only reaching 36,8%, and decision-making skills were also very low, only 31,6%. The most significant deficiency was found in the aspect of critical evaluation of information, with a score of only 16,4%. A preliminary study conducted on chemistry education students also showed similar conditions, where 62% of students made mistakes in interpreting graphs and tables, and 72% were unable to interpret simple statistical analysis results in the context of learning.

These conditions indicate a gap between the expected competencies and the actual abilities of students in understanding and utilizing statistical information critically.

The low level of statistical literacy is largely due to students' tendency to draw conclusions based on personal experience and attitudes rather than using contextual reasoning appropriate to the task. In addition, low statistical literacy levels are caused by a lack of connection between the theory taught in class and practical applications in the real world (Andriatna & Kurniawati, 2021; Noviantari & Faridhoh, 2021). This indicates a significant gap in the ability to use statistics practically and meaningfully. In addition, research by Upadianti et al., (2018) shows that although students are taught statistical theories, they are not adequately trained in applying statistical knowledge in real-life contextual situations. Students tend to memorize statistical formulas and procedures without understanding how the results are used in data-driven decision making. This results in students lacking the skills necessary to tackle real-world problems that require critical and reflective thinking (Rodríguez & Francisco, 2025).

Therefore, it is important to use an approach that not only teaches statistical formulas and procedures, but also encourages students to think critically and connect theory with real-world applications in the professional world. In practice, it is necessary to present concrete concepts that make statistical literacy learning interesting for students (Johannssen et al., 2021). Clair & Chihara (2017) applied pedagogical strategies and team-based learning, revealing the effectiveness of this approach compared to individual participation. Various real-world problems were suggested to be explored through the process of finding statistical values from data, so that the process could support statistical interpretation skills (Woltman, 2017). In line with these findings,Irwan et al., 2023; Simbolon, 2022; Magwilang, 2022; Das, 2021; Vedi, 2021; Masko, 2020; Lyons, 2020 emphasize that the implementation of Case Based Learning (CBL) encourages active student participation, increases learning motivation, and extends the duration of attention during the lecture process.

CBL excels at training problem-solving skills, but is constrained by the limitations of learning media that are not very interactive or varied. Most previous CBL research has focused on the use of text-based case studies and has not optimized hypermedia as a means of data visualization and interactive exploration of statistical concepts. In addition, research on the development of CBL-based e-modules with hypermedia support in statistics courses in Indonesia is still limited and has not specifically examined its contribution to improving students' statistical literacy, which can reduce student engagement. To overcome this, various dynamically connected multimedia elements are needed to improve statistical literacy. Hypermedia is a collection of multimedia documents such as text, images, sound, animation, and video that are interconnected and can be easily accessed through a computer or other electronic devices using a navigation system (Awaludin et al., 2020). Recent studies show that integrating hypermedia into case studies can increase student participation and learning outcomes (Cai, 2022; Oliván-Blázquez, 2023; Yang, 2021). Therefore, hypermedia integration is essential to optimize case-based learning. In addition, the integration of technology in

learning has become an urgent need in today's digital age. The use of hypermedia, which includes interactive graphics, data simulations, and explanatory videos, allows students to understand concepts more easily (Koliasa et al., 2021). Through videos, data simulations can help students understand and apply statistical concepts such as hypothesis testing in a more visual and dynamic way. Research by Irwan et al., 2023; Kuswidayani et al., 2024 reveals that the application of a CBL approach supported by hypermedia in inferential statistics learning can significantly improve student understanding. Students involved in CBL-based learning demonstrated superior analytical skills and higher speed in solving statistical problems compared to students who followed conventional learning methods. In addition, student engagement and motivation to learn also increased significantly. From a cognitive perspective, several studies by Mahdi, 2020; Novalinda, 2023; Yang, 2021; Zhu, 2021 show that a CBL approach integrated with technology can develop students' critical thinking skills. Not only does it impact students, but this approach also has a significant influence on teachers' teaching skills, particularly in terms of encouraging active student engagement in the classroom, compared to teachers who do not implement CBL in their teaching (Tambak & Sukenti, 2024).

In the context of basic statistics learning, the integration of CBL with hypermedia can create an interactive and contextual learning environment. The results of research by Wardono et al., (2024) show that the use of the MathCityMap platform in case based mathematics learning has been proven to significantly improve students' mathematical literacy. A similar approach can be adapted for basic statistics learning, where students can interact with real-life cases through digital media, thereby strengthening their understanding of statistical concepts and their application in everyday life. Students can explore learning materials in greater depth, interact with data simulations, and see the application of statistical theory in a more realistic and practical context. This is in line with research findings that show that hypermedia-based learning not only improves understanding of abstract concepts but also increases student engagement in learning (Aisyah et al., 2024; Wang et al., 2023; Ajlouni, 2023; Awaludin et al., 2020; Mulwa et al., 2010;).

The development of CBL based digital teaching materials supported by hypermedia is a potential solution for improving students' statistical literacy. This approach not only addresses the limitations of traditional learning, which tends to be theoretical and lacking in context, but also utilizes digital technology to create an interactive, relevant, and meaningful learning experience. The systematic integration of the CBL model with hypermedia features in the form of e-modules specifically designed for inferential statistics material is a combination that has not been widely explored in previous research. These e-modules not only present contextual case studies but also provide hypermedia navigation that allows students to explore concepts, data, simulations, and visualizations independently and purposefully to support the development of statistical literacy. Thus, the research questions are: (1) What are the stages of developing hypermedia-assisted CBL e-modules to support statistical literacy? (2) What are the validity and practicality levels of hypermedia-assisted CBL e-modules to support statistical literacy?

and (3) How effective are hypermedia-assisted CBL e-modules in supporting statistical literacy?

METHOD

This study uses a Research and Development (R&D) approach with the aim of producing a hypermedia supported CBL e-module to support students' statistical literacy. The development model used refers to Lee and Owens' model, which consists of five systematic ADDIE stages, namely: (1) analyze, (2) design, (3) develop, (4) implement, and (5) evaluate (Branch, 2010). The stages of the research are presented in Figure 1.

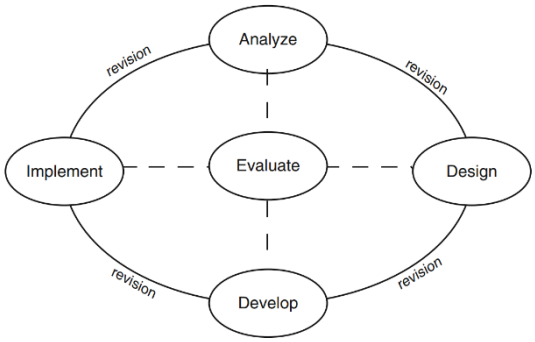


Figure 1. The ADDIE Concept

Stage Analysis (Analyze)
This stage aims to identify students' learning needs in basic statistics courses, as well as the extent to which students' statistical literacy needs to be improved. Activities carried out include: 1) Analysis of student characteristics, through a preliminary study of students' backgrounds, needs, and initial abilities in understanding statistical concepts, 2) Analysis of learning needs, to identify material that is in line with learning outcomes and expected basic statistical competencies, 3) Preliminary analysis of statistical literacy abilities, conducted by administering diagnostic tests or pre-measurement instruments to determine students' initial level of statistical literacy.

Design Stage
At the design stage, researchers developed the structure and content of the e-module based on the CBL approach and utilized interactive hypermedia elements. This stage includes: 1) Developing a case-based learning structure that is relevant to real-life contexts and in line with basic statistical material, 2) Developing storyboards and initial interface designs, which include plans for graphic visualizations, animations, and videos that support active learning, 3) Determining indicators and validation instruments as well as practicality criteria for the e-module to be used in the trial stage.

Stage Development (Develop)
This stage involves technology experts in the overall production process of e-modules based on the designs that have been prepared. The main activities include: 1) creating research data collection instruments, 2) creating case-based digital e-modules, which include case narratives, real or simulated data, analysis questions, and interactive features such as hyperlinks, videos, and digital media-based simulations, 3) Validation of e-modules by 3 subject matter experts and 3 media experts to test the content, visual appearance, and integration of the CBL approach with digital media.

Stage Implementation (Implement)
After the e-module was validated and revised, it was implemented in the classroom with 30 students majoring in Chemistry Education at a university in Banten Province as the research subjects. The implementation activities included: 1) pre-test, 2) use of the e-module by students in independent learning activities and in structured learning

sessions in the classroom, 3) data collection through a practicality questionnaire, 3) post-test of statistical literacy to evaluate the achievement of students' statistical literacy skills.

Stage Evaluation (Evaluate)

The evaluation is aimed at students and is conducted using the results of questionnaires given to students. The goal is to ensure that the e-modules developed are appropriate for use in learning and meet real needs in the field. Therefore, the products created are refined during the evaluation stage by taking into account feedback from students obtained during the implementation stage.

The research subjects were 30 second-semester students in the 2024/2025 academic year majoring in Chemistry Education at a state university in Banten Province who were taking a basic statistics course. The subjects were selected purposively based on the following criteria: (1) they had taken the prerequisite course, and (2) they were ready to participate in digital technology-based learning. Several instruments were used in the data collection process, as follows: 1) interviews were conducted for needs analysis, 2) validity questionnaires were used to measure the content, design, and pedagogy aspects of the e-module. These instruments were designed in the form of a Likert scale and filled out by subject matter experts and learning media experts, 3) a practicality questionnaire, which was given to student users to assess ease of use, appeal, and effectiveness in supporting the learning process, 4) a statistical literacy test, consisting of a pretest and posttest.

This test was developed based on statistical literacy indicators: 1) understanding data representation (being able to read and interpret data presented in various forms such as tables, graphs, and diagrams), 2) evaluating statistical claims (being able to assess the validity and reliability of claims made based on statistical data), 3) understanding basic statistical concepts (understanding concepts such as mean, median, variance, basic probability, and measures of data dispersion), 4) assessing data sources and methodologies (identifying data sources and evaluating data collection methods to assess the credibility of statistical information), 5) using statistics for decision making (being able to use statistical information appropriately to make decisions in everyday contexts) (Sabbag et al., 2018).

The data obtained from the questionnaire was analyzed descriptively and quantitatively by calculating percentages and assessment categories to assess the validity and practicality of the e-module. Data analysis used descriptive statistics and inferential statistics. After the questionnaire data was processed into percentages, the percentages from the subject matter experts and media experts were grouped into feasibility categories in Table 1.

Table 1. Product Feasibility Categories

Category	Score Range (%)
Highly Feasible	80 < N ≤ 100
feasible	60 < N ≤ 80
Less Feasible	40 < N ≤ 60
Not feasible	20 < N ≤ 40
Highly Not Feasible	0 < N ≤ 20

Next, an analysis was conducted for the pretest and posttest data using inferential statistics through a two-sample t-test for paired samples.

RESULT AND DISCUSSION

Results

This study aims to develop and evaluate a hypermedia-assisted Case Based Learning (CBL) digital e-module to support students' statistical literacy, particularly in basic statistics courses. The results of the study are presented based on the ADDIE model development stages: Analyze, Design, Develop, Implement, and Evaluate.

Stage Results Analysis

The analysis was conducted through interviews and diagnostic tests. The initial analysis of 23 students showed that students had difficulty understanding and applying parametric inferential statistics concepts. This was supported by the results of diagnostic tests, where the average initial statistical literacy score was 52.4 out of an ideal maximum score (SMI) of 100, indicating low statistical literacy, particularly in interpreting hypothesis testing results and drawing conclusions based on data. The results of the analysis related to student characteristics, environmental context characteristics, initial abilities, and achievements are presented in Table 2.

Based on the data in Table 2, it is evident that difficulties in learning basic statistics are mainly found in inferential statistics. Inferential statistics, which is the main domain for developing statistical literacy, needs attention in statistics learning. One effective solution is to present learning materials that are relevant and can be tailored to the needs of students so that learning becomes effective and meaningful. The development of e-modules equipped with various learning media such as videos, animations, and various real cases tailored to the students' ability levels, providing guided exercises and step-by-step guides can help students feel more

Table 2. Analysis Result Need

Aspect	Description Disadvantages and Limitations Student
Analysis Characteristics Learners	a. Knowledge beginning statistics Still varies and some Not yet control draft statistics inferential in a way deep b. A number of student not enough believe self in use device soft statistics. c. Learning styles part Still dominant independent, so that not enough interactions and discussions that can enrich understanding. d. Trend difficulty in overcome complex material without guidance direct.
Analysis Context Learning	a. Interaction online learning is lacking effective Because limitations technical (network, devices) and activity low students. b. Use device soft statistics as SPSS is considered complicated by some student. c. Lack of exercise practical and accompaniment in use technology learning. d. Environment online learning is lacking give experience optimal collaboration compared look at face.
Analysis Curriculum	a. The issues used in learning sometimes too complex for students who have not accustomed, so that make it difficult understanding. b. Discussion and practice time limited questions cause understanding material not enough deep. c. Required variation more problems contextual and relevant with background behind students for learning more effective.
Analysis Initial Abilities	a. A number of student Still not enough understand technique statistics inferential in a way deep, especially in application and interpretation results. b. Difficulty in choose method accurate statistics in accordance data characteristics. c. Not proficient enough in operate device soft statistics, especially in output interpretation. d. Preparation Study tend done in a way independent without guidance intensive, so that obstacle technical difficult overcome Alone.
Analysis Achievements Learning	a. Understanding to concepts statistics inferential Not yet even and still there is someone having trouble in connect theory with practice. b. Still found difficulty in interpretation results analysis device soft statistics. c. Not all yet student capable think critical optimally in select and evaluate method analysis. d. Challenge processing of non - ideal real data, such as data that is not complete or non - normal distribution.

confident in choosing statistical methods and interpreting data correctly.

Design Phase Results

At this stage of the research design, there were three specific activities carried out, namely product design, material preparation design, and research instrument design.

Product Design

At this stage, an analysis of the applications used has been carried out. The applications used in the creation of this e-module are Microsoft Office Word to compile the material and save it in PDF format, Canva to create the cover for the e-module, Google Forms to create online quizzes and collect assignments, Liveworksheet for assessment, and the Heyzine online platform, which is an online service for converting PDF files into digital flipbooks with realistic page effects. The advantages of this platform include various features, such as customizable layouts, the addition of interactive elements like videos and audio, and the ability to share or embed the flipbook on a website.

The product design utilizes interactive hypermedia elements such as data processing simulations using SPSS statistical software, short instructional videos, online quizzes, and online assessments. The following is a storyboard for the development of a hypermedia-assisted CBL e-module.

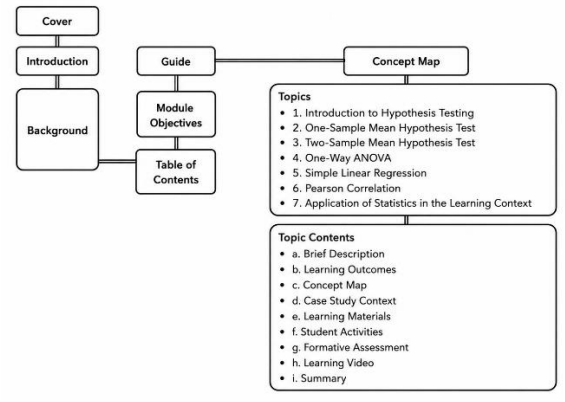


Figure 2. E-Module Product Storyboard

Designing Material Compilation

At this stage, based on references from various sources, the e-module structure was designed with seven main learning units in accordance with the topic of parametric inferential statistics for interval data in undergraduate programs, including: 1) Introduction to hypothesis testing, 2) One-mean hypothesis testing, 3) Two-mean hypothesis testing, 4) One-way ANOVA testing, 5) Simple linear regression test, 6) Pearson's correlation test, 7) Statistics applications in the context of learning. Each topic presents cases in the context of learning in schools. The final product is developed in the form of an electronic module (e-module) that is easy to use and accessible to users.

Research Instrument Design

The validity of e-modules is measured through questionnaires and assessment sheets from subject matter experts and media experts. Subject matter experts assess the aspects of content suitability, presentation, language, and statistical literacy, while media experts assess software engineering and visual appearance. Second, practicality measurement instrument. Practicality is measured using questionnaires filled out by students after using the e-module. Then, effectiveness measurement instrument. Effectiveness is measured using a statistical literacy test (post-test)

after students use the module. This is done by comparing the pre-test and post-test scores of students who use the e-module.

Development Stage Results

The third stage is where researchers compile, create, and apply product designs developed based on storyboards.

First, E-module Development. After creating the material in Microsoft Word, the file is converted to PDF format. Then the file is imported into Heyzine. The following is a preview of the e-module that has been created, divided into the front section, content section, and closing section.

Figure 3. Front Section of E-Module

The front section of the e-module is designed to provide clear orientation on the urgency and context of inferential statistics learning for prospective teacher students. There are important elements such as an introduction, background, learning objectives, and technical instructions for using the module. The opening narrative positions statistics as an essential skill in the process of data-based decision making in education. Students are encouraged to understand that statistics does not stand alone as an abstract theory, but rather as a relevant and meaningful tool in everyday teaching activities. The presentation of objectives, which include strengthening conceptual understanding, developing analytical skills, and applying academic ethics, provides a strong direction for improving students' overall statistical literacy.

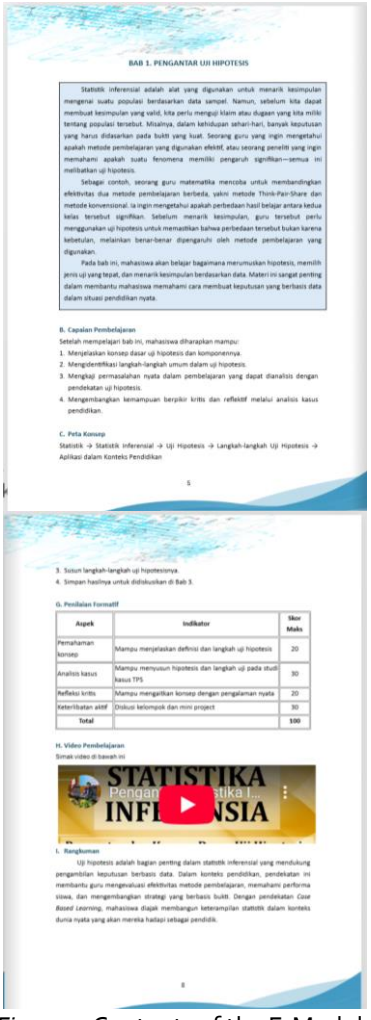


Figure 4. Contents of the E-Module

The core or content section of the e-module consists of seven chapters that systematically discuss the main topics in parametric inferential statistics, ranging from one-mean hypothesis testing to correlation and regression analysis. Each chapter is presented with a consistent structure that facilitates a logical learning flow, starting with a brief description, learning outcomes, concept maps, case study contexts, main material, reflective activities, formative assessments, and supporting media in the form of instructional videos. The application of CBL, reinforced with hypermedia elements, makes the learning process more interactive and contextual. Students are actively involved in solving real problems in the field of education with an applied statistical approach. This significantly supports the development of statistical literacy, especially in the ability to read data, reason statistically, and make evidence based decisions.

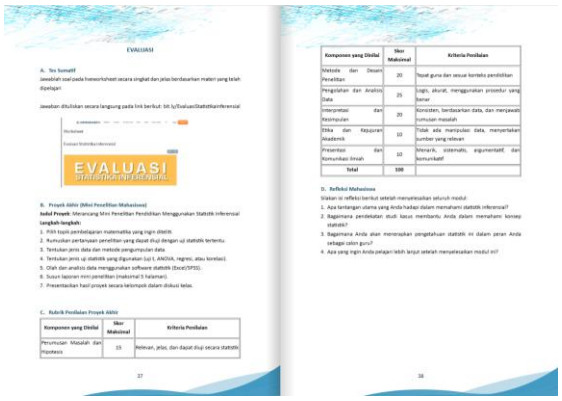


Figure 5. Closing Section of the E-Module

The closing section of the e-module serves as an integrative stage where students are given the opportunity to apply all the competencies they have learned through a mini research project. This activity not only emphasizes the technical aspects of data analysis, but also encourages students to compile scientific reports, interpret results accurately, and critically reflect on the learning process. Assessment is carried out using a rubric that evaluates aspects of problem formulation, research design, accuracy of analysis, interpretation, and academic integrity. This approach effectively strengthens students' statistical literacy at a higher level, namely as reflective, responsible users of statistics who are able to communicate the results of their analysis in an educational context in a professional manner.

Second, expert test result. The validation questionnaire for subject matter experts consisted of 24 questions divided into four aspects, namely content feasibility, presentation, language, and statistical literacy. The following is a summary of the validation results of three subject matter experts presented in Table 3.

Table 3. Expert Test Results

No	Aspect	Percentage (%)
1	Content suitability	82
2	Presentation	75
3	Language	80
4	Ability literacy statistics	79
	Total	79

The results of the subject matter expert review show that the e-module is of acceptable quality with a total score of 79%. The content aspect received the highest score (82%), indicating that the material is relevant and appropriate for learning needs. The presentation and language of the module were also deemed acceptable, although there is still room for improvement to make it easier to understand. The statistical literacy aspect received a score of 79%, which means that the module is suitable for supporting the development of students' statistical literacy, but needs to be strengthened further for optimal results. Overall, this e-module is suitable for use,

but there is still room for improvement, especially in terms of presentation and strengthening statistical literacy.

The validation questionnaire for media experts consisted of 15 questions divided into two aspects, namely device engineering and visual display. The following is a summary of the validation results from three media experts, as presented in Table 4.

Table 4. Media Test Results

No	Aspect	Percentage (%)
1	Device Engineering	76
2	Visual Display	80
	Total	78

The results of the media expert test show that the e-module obtained a total score of 78%, which indicates that the media quality is acceptable. The device engineering aspect received a score of 75%, indicating that the module has been developed with adequate technology, but there is still room for improvement in terms of technical aspects to make the module more responsive and easier to use. The visual appearance aspect scored 80%, meaning that the graphic design, colors, and layout of the module are attractive and support user comfort while learning. Overall, this e-module meets the standards for acceptable learning media, but technical aspects need to be refined to optimize the learning experience.

The product revision stage is a follow-up to the expert review of the e-module product, in which the e-module product is then improved according to the suggestions from the experts in Table 5.

Table 5. Expert Advice on Materials and Media

Aspect	Improvement Suggestions
Device Engineering	Add interactive online quizzes using liveworksheets; supplement with visual guides on how to use SPSS.
Visual Display	Include flowcharts, graphs, icons, and contrasting colors to emphasize the structure of the material; use attractive and consistent e-module templates; add case illustrations or visual data to support understanding.
Content Eligibility	Add additional material on non-parametric tests as a supplement; include further references from international journals; consider adding cases from various levels of education.
Presentation	Use summaries of key points at the end of chapters; avoid repetition.
Language	Use short, direct, and active sentences; be consistent in the use of foreign terms and translations.
Ability Literacy Statistics	Add exploratory exercises based on open datasets; develop activities for interpreting test results not only in terms of "significant/insignificant," but also in terms of their practical meaning in the context of education.

Result of the Implementation Phase

The e-module was implemented in one class that used the e-module for four meetings and completed case-based assignments at each meeting. The results of the pretest and posttest for each statistical literacy indicator are shown in Figure 6.

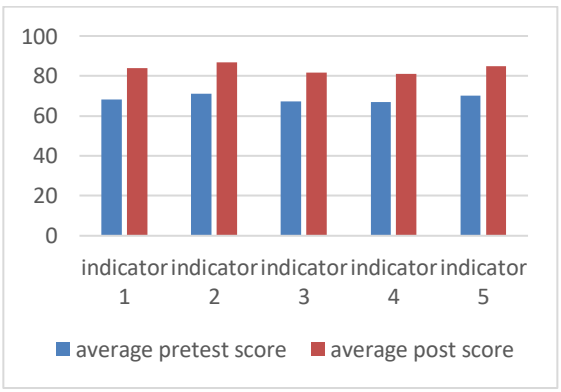


Figure 6. Comparion of Pretest and Posttest Statistical Literacy Indicators

Based on Figure 6, the overall average pretest score was 68.7 and the average posttest score was 83.66. For each statistical literacy indicator, there was an increase in scores across all statistical literacy indicators after using the hypermedia-assisted Case-Based Learning (CBL) e-module. This increase reflects the success of the treatment in developing students' statistical literacy skills as a whole.

On indicator 1 (understanding data representation), the pretest score was 68.3 and the posttest score was 83.9, with a score increase of 15.6 points. This shows that students experienced an increase in reading and interpreting data in the form of graphs, tables, and diagrams. Students were able to understand scatter plot data visualization and interpret the relationship between variables. In indicator 2 (evaluating statistical claims), the pretest score was 71.1 and the posttest score was 86.9, with a score increase of 15.8. This ability is closely related to the one-mean and two-mean hypothesis tests. Students were able to assess whether group A students were higher than group B students with statistical evidence. This significant improvement shows that students were able to use p-values and hypothesis testing to assess the validity of claims. Indicator 3 (understanding basic statistical concepts). The pretest score was 67.2 and the posttest score was 81.8, with an increase of 14.6. This increase indicates a deeper understanding of the basic concepts required in inferential testing, including the assumptions of normality and homogeneity. Indicator 4 (evaluating data sources and methodologies). Pre-test score: 66.9 and post-test score: 80.9 with an increase of 14. Students' ability to understand data collection methodologies and assess data credibility has improved. Students are able to assess data sources from several groups that require appropriate methodological justification.

The case studies in the module encourage students to question where the data comes from and whether the data collection methods are reliable. In indicator 5 (using statistics for decision making). Pre-test score: 70 and post-test score 84.8 with an increase of 14.8. This increase indicates that students are able to use statistical analysis results (from t-tests, ANOVA, regression, and correlation) to make relevant decisions in real-world contexts. Students are able to choose the right decision-making strategies in learning based on the correlation between learning outcomes and student motivation. This reflects the direct application of all inferential material in data-based decision making.
Data analysis continued with a normality test prerequisite test.

Table 6. Normality Test Result

Test of Normality			
	Shapiro Wilk		
	Statistics	**df**	**Sig.**
Pretest	0.971	30	0.561
Posttest	0.966	30	0.443

Based on the testing criteria, if Sig > 0.05, then the data is normally distributed. The results of the normality test using the Shapiro Wilk test show that the pretest Sig value is 0.561 and the posttest Sig value is 0.443. Therefore, it can be concluded that the pretest and posttest data are normally distributed. The next hypothesis test uses a parametric inferential statistical test, with a paired sample test.

Table 7. Paired Sample Test Result

	Sig. (2-tailed)
Pair 1 pretest-posttest	0.000

Based on Table 7, because the Sig (2-tailed) value is 0.000 < 0.05, it can be concluded that there is a significant difference in statistical literacy before and after using the hypermedia-assisted CBL-based e-module.

In addition to the posttest, the fifth meeting included a questionnaire to determine student responses to the e-module that had been developed. The results of the student response questionnaire are presented in Table 8.

Table 8. Questionnaire Response Result Student

No	Aspect	Percentage (%)
1	Practicality	79
2	Effectiveness	80
	Total	79

Based on Table 9, the results of the student response questionnaire to the e-module that has been developed based on practicality aspects obtained a percentage of 79%, which is included in the good category, and the effectiveness aspect obtained a percentage of 80%, which is included in the very good category. Overall, the average percentage of student responses to the questionnaire was 79%, which falls into the good category. Therefore, it can be concluded that the e-module developed is practical for use in the learning process.

Evaluation Stage Results

Referring to the standards proposed by Nieveen, 1999; van den Akker (1999) for product quality, the hypermedia-assisted CBL e-module learning media is declared suitable for use in the learning process because it meets the criteria of validity, effectiveness, and practicality. This study shows that hypermedia-assisted CBL-based e-modules can significantly support students' statistical literacy skills.

Discussion

The results showed a significant increase in students' statistical literacy (average pretest score of 68.7 and posttest score of 83.66). These findings are consistent with studies showing that interventions combining real-life cases and interactive media strengthen student engagement and understanding. One of the core domains in statistical literacy is inferential statistics, which is the ability to draw conclusions from sample data. Research by (Droogers et al., 2024) on Learning Trajectory shows that understanding statistical concepts from an early age, particularly the ability to make inferences from data, can improve students' overall statistical literacy. This is highly relevant to CBL-based e-modules on inferential statistics, which not only encourage students to understand data descriptively, but also facilitate students in making inferences from various real-life contexts. A study by Mariani et al., (2025) hows the effectiveness of the MathCityMap case and media platform in improving mathematical literacy. Other relevant studies show an increase in student engagement and satisfaction in learning using CBL with the help of technology (Oliván-Blázquez et al., (2023).

Through case-based instruments in learning faced by prospective teachers, statistical literacy can be developed. With interactive elements such as videos and simulations that are in line with the principles of repeated sampling and informal statistical problem solving, prospective teacher students are not only required to organize and represent data, but also to reason statistically and make decisions based on evidence, which is the core of statistical literacy. This is in line with the findings of Rodríguez & Francisco (2025) regarding assessment instruments for prospective teachers in Chile, which revealed that most of the

statistics questions used still focus on procedural aspects, such as calculating statistical measures or probabilities, and rarely encourage interaction with real data. These findings reflect the main challenge in developing statistical literacy, namely the lack of a learning approach that is capable of developing critical, evaluative, and contextual statistical thinking. Thus, the cases in the learning context presented in the developed e-module are relevant to the development of statistical literacy in prospective teachers.

The presentation of interactive material, contextual and applied cases, along with the support of interactive media, not only strengthens conceptual understanding but also promotes comprehensive statistical literacy through contextual and in-depth learning experiences. This is supported by Fawcett (2017) in the Case Project study, which shows that the use of real-case-based learning can increase student engagement, motivation, and understanding in statistics. In line with this, Bordovskaia et al., (2018) showed that the application of case study methods in developing the terminological competence of pedagogical students indicates that a case-based approach is effective in improving in-depth conceptual understanding. This is supported by by Christensen (2019) who states that the presentation of case studies in the form of examples can encourage statistical literacy.

Hypermedia is a technology for representing and processing information by integrating multimedia content into hypertext technology (He et al., 2021). Hypermedia contributes positively to several aspects of learning, enabling the use of mathematical software as an exploratory tool and fostering critical thinking among students (del Río et al., 2019). Hypermedia in the e-module functions as a cognitive scaffold that facilitates students' transition from procedural understanding to higher-level statistical reasoning. In line with Berndt et al., (2021), this study shows that prior to the intervention, students tended to be weak in the indicators of interpreting and evaluating claims. However, the use of the CBL-hypermedia e-module led to improvements across all indicators, particularly in students' ability to interpret graphs and make data-driven decisions. This study provides empirical evidence that the combination of CBL and hypermedia has the potential to enhance statistical literacy.

The components of the e-module integrate various forms of scaffolding within a single hypermedia platform to support students' statistical literacy. Cognitive scaffolding is reflected in the systematic explanation of inferential statistics concepts. Metacognitive scaffolding is embedded in the mini research project and formative assessments, while motivational scaffolding is provided through engaging visual design, animations, and real-world contextualization. This aligns with the findings of Gril et al., (2025), who stated that the combination of multiple types of scaffolding within hypermedia is more promising than the use of a single form of scaffolding alone.

Further research is recommended to integrate a variety of media aligned with current technological trends, such as VR and AI. The findings indicate that the integration of advanced technologies such as virtual reality, generative AI, and immersive learning platforms within CBL has been proven to enhance students' engagement, comprehension, and self confidence in mastering the material (Hassoulas et al., 2025; Liu et al., 2024).

Furthermore, a variety of media is needed to accommodate diverse learner profiles and adapt to students' preferences and skills. This aligns with the findings of Benfarha et al., (2025), which suggest that optimizing hypermedia systems by integrating individual learner behaviors within a truly adaptive learning environment one that values each learner's potential—can enhance both the learning experience and interaction.

Implication

For the future research, this study opens opportunities for the development of similar e-modules on other topics in statistics or in courses that require critical and applied thinking skills. Future researchers may explore the use of more advanced learning technologies, such as virtual reality (VR), augmented reality (AR), or interactive AI, to support the Case-Based Learning (CBL) approach.

For education practitioners, the findings provide a reference for lecturers or teachers in designing more interactive and contextualized learning. A CBL based e-module supported by hypermedia can be used as an alternative instructional strategy to enhance student engagement and understanding of abstract concepts in inferential statistics.

For policymakers, there is a need for higher education policies that support the development and implementation of digital learning media based on the CBL approach and hypermedia technology, particularly in enhancing students' statistical literacy as an essential 21st-century competency.

Limitation

This study has several limitations that need to be considered as a basis for further research development. The e-module developed is still limited to the use of digital media such as videos, online quizzes, and simulations based on the Heyzine platform, so it does not yet integrate immersive learning technologies such as Virtual Reality (VR), generative artificial intelligence, or real-time interactive simulations that have the potential to enrich the learning experience of students. Furthermore, this study was only conducted in one study program, namely Chemistry Education, with a relatively small sample size (30 students), so the results cannot be generalized to other study programs and institutions. The e-module trial was also conducted within a limited time frame, namely four meetings, so it was not able to provide an overview of the long-term impact on strengthening statistical literacy and transferring understanding in a real-world context. Therefore, further research with a broader scope, longer implementation duration, and integration of innovative learning technologies is needed to obtain more comprehensive findings.

CONCLUSION

Based on the results of the study, it can be concluded that the development of hypermedia-assisted e-modules was carried out through five stages of the ADDIE model, namely Analyze, Design, Develop, Implement, and Evaluate. This process includes analyzing student needs and characteristics, designing the structure and content of contextual case-based modules, developing interactive hypermedia-based e-modules with video, online quizzes, and data simulation features, and finally implementing and evaluating based on user responses and learning outcomes. The validation results show that the e-module is in the feasible category, with a validity score of 79% from subject matter experts and 78%

from media experts. The practicality aspect assessed by students is also in the good category with an average score of 79%, so that the e-module is considered practical to use and in line with learning needs. In addition, the use of e-modules proved to be effective in improving students' statistical literacy, as shown by an increase in the average score from 68.7 on the pretest to 83.66 on the posttest. The improvement occurred in all statistical literacy indicators, including the ability to understand data representation, evaluate claims, understand basic concepts, assess data sources, and use statistics in decision making. These findings contribute to future learning practices, particularly in the development of more interactive and contextual digital learning, and encourage the use of hypermedia-based media as an innovative alternative to improve students' statistical literacy in various study programs.

REFERENCES

Aisyah, N., Degeng, I. N. S., Sumarmi, S., & Toenlioe, T. (2024). The Effect of Hypermedia-Assisted Learning Organizing Strategies and Cognitive Styles on Student Learning Outcomes. *Al-Tanzim: Jurnal Manajemen Pendidikan Islam*, *8*(2), 664–674. https://doi.org/10.33650/al-tanzim.v8i2.8168

Ajlouni, A. (2023). The Impact of Instruction-Based LEGO WeDo 2.0 Robotic and Hypermedia on Students' Intrinsic Motivation to Learn Science. *International Journal of Interactive Mobile Technologies*, *17*(1), 22–39. https://doi.org/10.3991/ijim.v17i01.35663

Alkhafaji, S. (2017). *Educational Hypermedia Development Methodologies*. *July*.

Andriatna, R., & Kurniawati, I. (2021). Analisis Level Literasi Statistik Mahasiswa Calon Guru Matematika. *Transformasi : Jurnal Pendidikan Matematika Dan Matematika*, *5*(2), 619–632. https://doi.org/10.36526/tr.v5i2.1497

Awaludin, Wibawa, B., & Winarsih, M. (2020). The development of hypermedia based e-book for integral calculus subject. *International Journal of Online and Biomedical Engineering*, *16*(4), 109–127. https://doi.org/10.3991/ijoe.v16i04.13393

Benfarha, M., Lamarti, M. S., & Khaldi, M. (2025). Design and Modeling of a Dynamic Adaptive Hypermedia System Based on Learners' Needs and Profile. *International Journal of Advanced Computer Science and Applications*, *16*(4), 598–608. https://doi.org/10.14569/IJACSA.2025.0160460

Berndt, M., Schmidt, F. M., Sailer, M., Fischer, F., Fischer, M. R., & Zottmann, J. M. (2021). Investigating statistical literacy and scientific reasoning & argumentation in medical-, social sciences-, and economics students. *Learning and Individual Differences*, *86*, 101963. https://doi.org/10.1016/j.lindif.2020.101963

Bordovskaia, N. V, Koshkina, E. A., Tikhomirova, M. A., & Bochkina, N. (2018). Case method as a tool for evaluation and development of terminological competence of future teachers. *Integration of Education*, *22*(4), 728–749. https://doi.org/10.15507/1991-9468.093.022.201804.728-749

Branch, R. M. (2010). Branch, R. M. (2010). Instructional design: The ADDIE approach. In Instructional Design: The ADDIE Approach. Springer US. https://doi.org/10.1007/978-0-387-09506-6. In *Instructional Design: The ADDIE Approach*.

Cai, L. (2022). Implementation of flipped classroom combined with case-based learning: A promising and effective teaching modality in undergraduate pathology education. *Medicine (United States)*, *101*(5), 28782. https://doi.org/10.1097/MD.0000000000028782

Christensen, B. (2019). Anforderungen an eine Statistik-Ausbildung im 21. Jahrhundert vor dem Hintergrund von Statistical (Il-)Literacy. *AStA Wirtschafts- Und Sozialstatistisches Archiv*, *13*(3–4), 193–201. https://doi.org/10.1007/s11943-019-00263-7

Clair, K. S., & Chihara, L. (2017). Team Based Learning in a Statistical Literacy Class Team Based Learning in a Statistical Literacy Class. *Journal of Statistics Education*, *20*(1), 1–20. https://doi.org/10.1080/10691898.2012.11889633

Das, S., Das, A., Rai, P., & Kumar, N. (2021). Case-based learning: Modern teaching tool meant for present curriculum: A behavioral analysis from faculties' perspective. *Journal*

of Education and Health Promotion |, *10*(1), 1–7. https://doi.org/10.4103/jehp.jehp

del Río, L. S., Sanz, C. V., & Búcari, N. D. (2019). Incidence of a hypermedia educational material on the teaching and learning of mathematics. *Journal of New Approaches in Educational Research*, *8*(1), 50–57. https://doi.org/10.7821/naer.2019.1.334

Fawcett, L. (2017). The CASE project: Evaluation of case-based approaches to learning and teaching in statistics service courses. *Journal of Statistics Education*, *25*(2), 79–89. https://doi.org/10.1080/10691898.2017.1341286

François, K., Monteiro, C., & Allo, P. (2020). Big-data literacy as a new vocation for statistical literacy. *Statistics Education Research Journal*, *19*(1), 194–205. https://doi.org/10.52041/serj.v19i1.130

Gril, A., Podlesek, A., Komidar, L., Kavčič, A., Depolli Steiner, K., Pečjak, S., Pirc, T., Puklek Levpušček, M., Boh Podgornik, B., Hladnik, A., Bohak, C., Pesek, M., Lesar, Ž., Marolt, M., & Peklaj, C. (2025). The impact of different types of self-regulation scaffolds on learning science with hypermedia. *Computers in Human Behavior*, *169*, 108670. https://doi.org/10.1016/j.chb.2025.108670

Hariyanti, F., Budayasa, I. K., & Setianingsih, R. (2025). A portrait of prospective mathematics teachers' readiness in statistical literacy of school students. *Perspektivy Nauki i Obrazovania*, *73*(1), 190–201. https://doi.org/10.32744/pse.2025.1.12

Hassoulas, A., A, Crawford, O., Hemrom, S., de Almeida, A., Coffey, Marcus J.Hodgson, M., Leveridge, B., Karwa, D., Lethbridge, A., Williams, H., Voisey, A., & Reed, K. (2025). A pilot study investigating the efficacy of technology enhanced case based learning (CBL) in small group teaching. *Scientific Reports*, *15*(1), 15604. https://doi.org/10.1038/s41598-025-99764-5

He, H., Yin, L., & Liu, W. (2021). Research on intelligent teaching of finance based on hypermedia. *International Journal of Electrical Engineering and Education*, 1–14. https://doi.org/10.1177/0020720920983529

Hidayati, N. A., Waluya, S. B., Rochmad, & Wardono. (2020). Statistics literacy: What, why and how? *Journal of Physics: Conference Series*, *1613*(1), 1–7. https://doi.org/10.1088/1742-6596/1613/1/012080

Irwan, I., Sauddin, A., & Astuti, R. (2023). Pembelajaran Statistik Deskriptif dan Statistik Inferensial Berbasis Web dengan Shiny R. *Saintifik*, *9*(2), 211–219. https://doi.org/10.31605/saintifik.v9i2.413

Johannssen, A., Chukhrova, N., Schmal, F., & Stabenow, K. (2021). Statistical Literacy—Misuse of Statistics and Its Consequences. *Journal of Statistics Education*, *29*(1), 54–62. https://doi.org/10.1080/10691898.2020.1860727

Koga, S. (2024). Lessons to Demonstrate Statistical Literacy Skills: A Case Study of Japanese High School Students on Reading Statistical Reports. *Journal of Statistics and Data Science Education*, *33*(1), 77–89. https://doi.org/https://doi.org/10.1080/26939169.2024.2334903

Kuswidayani, N., Soepriyanto, Y., & Praherdhiono, H. (2024). Flipped classroom with a gamification case method approach for learning statistics. *Inovasi Kurikulum*, *21*(2), 571–582. https://doi.org/https://doi.org/10.17509/jik.v21i2.65405

Liu, P., Yang, Z., Huang, J., & Wang, T. K. (2024). The effect of augmented reality applied to learning process with different learning styles in structural engineering education. *Engineering, Construction and Architectural Management*, 2025. https://doi.org/10.1108/ECAM-06-2023-0596

Lyons, P. (2020). Skills needs, integrative pedagogy and case-based instruction. *Journal of Workplace Learning*, *32*(7), 473–487. https://doi.org/10.1108/JWL-12-2019-0140

Magwilang, E. B. (2022). Case-Based Instruction in the Forensic Chemistry Classroom: Effects on Students' Motivation and Achievement. *International Journal of Learning, Teaching and Educational Research*, *21*(3), 396–414. https://doi.org/10.26803/ijlter.21.3.21

Mahdi, O. R. (2020). The role of using case studies method in improving students' critical thinking skills in higher education. *International Journal of Higher Education*, *9*(2), 297–308. https://doi.org/10.5430/ijhe.v9n2p297

Mariani, S., Asani, F., Rachmani, N., Nino, D., & Wijayanti, K. (2025). *MathCityMap-Assisted Case-Based Learning with a Realistic Mathematics Education Approach to Improve Mathematical Literacy Reviewed from Adversity Quotient*. *15*(10), 2218–2235. https://doi.org/10.18178/ijiet.2025.15.10.2419

Masko, M. K. (2020). Using case-based learning to teach information literacy and critical thinking skills in undergraduate music therapy education: A cohort study. *Music*

Therapy Perspectives, *38*(2), 143–149. https://doi.org/10.1093/mtp/miz025

Mulwa, C., Lawless, S., Sharp, M., Arnedillo-Sanchez, I., & Wade, V. (2010). Adaptive educational hypermedia systems in technology enhanced learning: A literature review. *SIGITE'10 - Proceedings of the 2010 ACM Conference on Information Technology Education*, *October*, 73–84. https://doi.org/10.1145/1867651.1867672

Nieveen, N. (1999). Prototyping to Reach Product Quality. *Design Approaches and Tools in Education and Training*, 125–135. https://doi.org/10.1007/978-94-011-4255-7_10

Novalinda, R. (2023). Constructivist Computer-Based Instruction (CBI) Approach: A CBI Flipped Learning Integrated Problem Based and Case Method (PBL-cflip) in Clinical Refraction Course. *International Journal of Online and Biomedical Engineering*, *19*(5), 42–56. https://doi.org/10.3991/ijoe.v19i05.37707

Noviantari, I., & Faridhoh, F. (2021). Analisis Learning Loss Kemampuan Literasi Statistis Mahasiswa. *Jurnal Pendidikan Matematika Raflesia*, *6*(3), 112–120. https://doi.org/https://doi.org/10.33369/jpmr.v6i3.19104

Oliván-Blázquez, B. (2023). Comparing the use of flipped classroom in combination with problem-based learning or with case-based learning for improving academic performance and satisfaction. *Active Learning in Higher Education*, *24*(3), 373–388. https://doi.org/10.1177/14697874221081550

Oliván-Blázquez, B., Aguilar-Latorre, A., Gascón-Santos, S., Gómez-Poyato, M. J., Valero-Errazu, D., & Magallón-Botaya, R. (2023). Comparing the use of flipped classroom in combination with problem-based learning or with case-based learning for improving academic performance and satisfaction. *Active Learning in Higher Education*, *24*(3), 373–388. https://doi.org/10.1177/14697874221081550

Rodríguez, A., & Francisco. (2025). Evaluations In Statistics In The Training Of Mathematics Teachers: An Approach To Literacy And Statistical Thinking. *Interciencia*, *50*(3), 154–161.

Sabbag, A., Garfield, J., & Zieffler, A. (2018). Assessing statistical literacy and statistical reasoning: The reali instrument. *Statistics Education Research Journal*, *17*(2), 141–160. https://doi.org/10.52041/serj.v17i2.163

Sanchez, J. (2025). Improving the Teaching and Learning of Data Science, Statistical Literacy and the Science of Data. *Journal of Statistics and Data Science Education*, *33*(1), 1–2. https://doi.org/10.1080/26939169.2024.2426950

Shobikhah, A., Sukestiyarno, Y. L., Agoestanto, A., & Cahyono, A. N. (2025). Bibliometrics on the Development of Students' Statistical Literacy: A Scoping Review of Research Between the Years 2000 – 2024. *TEM Journal*, *14*(1), 871–886. https://doi.org/10.18421/TEM141-77

Simbolon, D. H. (2022). Pengaruh Model Case Based Learning (CBL) Terhadap Hasil Belajar Mahasiswa. *Bullet: Jurnal Multidisiplin Ilmu*, *1*(03), 181–184. https://doi.org/https://journal.mediapublikasi.id/index.php/bullet/article/view/314

Tambak, S., & Sukenti, D. (2024). Case-Based Learning Method in Learning: Is it Effective to Improve Teaching Skills of Madrasa Teachers in Indonesia? *Journal of Learning for Development*, *11*(1), 151–164. https://doi.org/10.56059/jl4d.v11i1.763

Upadianti, L. P. E., Arnyana, I. B. P., & Suma K. (2018). Pengembangan Modul Berorientasi Case Based Learning untuk Meningkatkan Keterampilan Berpikir Kritis. *Thinking Skill and Creative Journal*, *1*(1), 40–45. https://doi.org/https://doi.org/10.23887/tscj.v1i1.20337

van den Akker, J. (1999). Principles and Methods of Development Research. *Design Approaches and Tools in Education and Training*, 1–14. https://doi.org/10.1007/978-94-011-4255-7_1

Vedi, N. (2021). Students' perception and learning on case based teaching in anatomy and physiology: An e-learning approach. *Journal of Advances in Medical Education and Professionalism*, *9*(1), 8–17. https://doi.org/10.30476/jamp.2020.87332.1304

Wang, Y., Zhang, H., Wang, J., & Ma, X. (2023). The Impact of Prompts and Feedback on the Performance during Multi-Session Self-Regulated Learning in the Hypermedia Environment. *Journal of Intelligence*, *11*(7), 11070131. https://doi.org/10.3390/jintelligence11070131

Wardono, Asani, F., Mariani, S., Nuswowati, M., Wijayanti, K., Sari, V., & Agoestanto, A. (2024). Case-Based Learning Model with MathCityMap to Improve Mathematical Literacy. *Evolutionary Studies In Imaginative Culture*, *8*(3), 926–934. https://doi.org/https://doi.org/10.70082/esiculture.vi.2230

Watson, J. M., & Moritz, J. B. (2003). Development of understanding of sampling for statistical literacy. *The Journal of Mathematical Behavior*, *19*(1), 109–136. https://doi.org/https://doi.org/10.1016/S0732-3123(00)00039-0

Weber Stein, F., & Engel, J. (2025). Implementing Statistical Literacy in Civics Teacher Education. *Journal of Political Science Education*, *116*(2), 145–158. https://doi.org/10.1080/15512169.2025.2483786

Yang, F. (2021). Flipped classroom combined with case-based learning is an effective teaching modality in nephrology clerkship. *BMC Medical Education*, *21*(1). https://doi.org/10.1186/s12909-021-02723-7

Zhu, X. (2021). Case-based learning combined with science, technology, engineering and math (STEM) education concept to improve clinical thinking of undergraduate nursing students: A randomized experiment. *Nursing Open*, *8*(1), 415–422. https://doi.org/10.1002/nop2.642