Vidya Karya
https://ppjp.ulm.ac.id/journal/index.php/jvk
e-ISSN: 2614-7149 p-ISSN: 0215-9619
Vol 41 No 1 2026
DOI: https://doi.org/10.20527/jvk.v41i1.24815

Implementation of the RODE Model to Enhance Students' Science Numeracy Skills in Higher Education

Degi Alrinda Agustina[1*], Arief Ertha Kusuma[1], Suciati[2], Maulidah Nurislamiyah[2], Sri Radiatul Hikma[2], and Neni Novitasari[1]
[1]Primary Teacher Education, Universitas Borneo Tarakan, Tarakan, Indonesia
[2]Mathematics Education, Universitas Borneo Tarakan, Tarakan, Indonesia
*gygyalrinda@gmail.com

Article Info	Abstract

Article history:
Received: December 11, 2025
Accepted: April 4, 2026
Published: April 20, 2026

Keywords:
Discussion
Evaluation
Outline
Science numeracy
Read

This study examines the implementation of the RODE learning model in supporting students' science numeracy skills in a higher education context. The research was conducted in the Primary School Teacher Education department within the Basic Concepts of Astrophysics course, focusing on fluid materials. A qualitative design was employed to describe the planning, implementation, and assessment stages of the RODE model. Data were collected through classroom observations, semi-structured interviews, and documentation, and were analyzed using the interactive model of Miles and Huberman. The findings indicate that, at the planning stage, the lecturer team aligned course learning outcomes with science numeracy indicators and developed instructional materials, including lesson plans, teaching resources, student worksheets, and assessment instruments. During implementation, the RODE syntax was applied through four stages: Read (engagement with learning materials), Outline (concept organization and worksheet-based activities), Discussion (group presentations and interactive dialogue), and Evaluation (reflection and assessment activities). At the assessment stage, students' performance was evaluated through worksheet activities and essay tests designed to reflect science numeracy indicators. The results suggest that the RODE model can be feasibly implemented to support science numeracy by orienting learning processes in higher education. However, the findings are limited to a specific instructional context and do not imply generalizable causal effects. This study contributes by providing a context-specific description of how the RODE model can be integrated with science numeracy practices at the university level.

To cite this article: Agustina, D. A., Kusuma, A. E., Suciati, S., Nurislamiyah, M., Hikma, S. R., & Novitasari, N. (2026). Implementation of the RODE model to enhance students' science numeracy skills in higher education. *Vidya Karya, 41*(1), 106-120.

INTRODUCTION

One of the skills in the 21st century that every individual must master is numeracy. Numeracy is a skill that emphasizes the understanding and application of various numbers, symbols, and counting operations from basic mathematical concepts, presented in the form of tables, graphs, and diagrams (Rosalina & Febriandi, 2025). The application of numeracy skills does not only focus on the scope of mathematics but also on other fields such as science, economics, and social sciences. One of the applications of numeracy, namely in the field of science, is known as science numeracy (Listianingrum et al., 2023). Science numeracy is an individual's scientific ability to apply their knowledge to identify problems, acquire new knowledge, explain phenomena, draw conclusions based on scientific issues, and make decisions based on changes that occur in a natural activity (Nafaida et al., 2023; Viyanti et al., 2023) In science numeracy skills, what must be achieved is not only learning outcomes but also helps students to make the right and accountable decisions (Putra et al., 2023).

The Organization for Economic Co-operation and Development (OECD), through the Programme for International Student Assessment (PISA), assesses education systems in various countries, including Indonesia, which include competency evaluations in mathematics, literacy, and science (Choirunnisa et al., 2023) Based on the results of PISA data in 2022, it shows that science numeracy skills in Indonesia are ranked 67 out of 80 countries involved and are still in the low category with an average score of 383 (OECD, 2023). Compared to the score in 2018, science numeracy skills in Indonesia have decreased. Through this data, improving science numeracy skills is an important thing to do as a follow-up to achieve the expected success.

As global challenges become more complex, the importance of mastering science numeracy is increasing (Ferniawan et al., 2025). The World Economic Forum emphasizes that in the 21st century, science numeracy is included in the six basic numeracy skills that are important to master (Sole, 2021). For students, mastering science numeracy can be an important provision to face social problems. With this ability, students are better able to make the right decisions, are informed, and are effective in solving problems, so that the quality of life can improve (Rahmawati et al., 2023). According to Choirunnisa et al. (2023), students who have good science numeracy skills not only gain a deeper understanding but are also able to use scientific concepts to explain and analyze phenomena. Therefore, awareness is needed about the importance of science numeracy skills in daily life.

RODE is a learning model made to make the learning process more efficient, optimal, and effective, so that it can train communication skills and critical thinking skills in students (Kusuma et al., 2022). Through this learning stage, students are not only asked to develop a frame of thought but are also trained to understand the material, express opinions, and train to systematically retest understanding. Therefore, the learning process is not only focused on cognitive achievement but also encourages the development of active attitudes, social skills, and the ability to work together. In the implementation of RODE, students are used as learning centers, while teachers are only facilitators (Kusuma et al., 2022). The RODE learning model is not only applied at the high school level but has also been introduced at the college level. The RODE learning model has a clear system; this system shows the role between lecturers and students, the types of interactions that occur during the learning process, and the expected goals (Kusuma et al., 2020). This system also creates a more interactive and collaborative classroom atmosphere, so students have the opportunity to be directly involved in the learning process. This RODE learning model is designed with the principle of reaction, which is a guideline for lecturers to assess student participation, understanding, and work results (Kusuma et al., 2020). In this case, students' contributions to learning can be responded to in a fair and measurable manner. RODE is a new learning model designed to teach topics mainly in the field of science (Kusuma et al., 2024). Therefore, RODE can be one of the effective learning models to improve science numeracy skills and form better communication skills. The RODE learning model is claimed to be easy to implement, so that students can be active in the learning process, and the teaching materials can also be understood at a high level (Kusuma et al., 2024).

The existing body of research on the RODE learning model has primarily emphasized its general implementation and theoretical foundations, with limited empirical focus on its impact on specific higher-order competencies. In particular, there remains a lack of studies that explicitly examine how the implementation of the RODE model supports the development of science numeracy skills within higher education contexts. This indicates a clear research gap, not in the novelty of the model itself, but in its context-specific application and its measurable contribution to disciplinary competencies. Furthermore, prior studies have rarely addressed how the structured syntax of RODE facilitates numeracy-oriented learning processes in university-level science courses. In the Primary School Teacher Education department, the RODE model has been implemented in the Basic Concepts of Astrophysics course, specifically on fluid materials. However, its role in fostering science students' numeracy skills has not been systematically investigated. Therefore, this study seeks to examine the implementation of the RODE learning model with a particular focus on its contribution to enhancing science numeracy skills in higher education. The novelty of this research lies in its emphasis on linking the RODE instructional framework with science numeracy development in a specific disciplinary and higher education context, thereby extending existing studies beyond general pedagogical application.

METHODS

This research is qualitative. Qualitative research uses a naturalistic approach and focuses on the interpretation of meaning (Aspers & Corte, 2019). The purpose of this study is to describe the planning, implementation, and assessment of the RODE learning model on students' science numeracy skills. The focus and dimension of this research is the planning, implementation, and assessment of the RODE learning model on students' science numeracy abilities applied by lecturers to fluid material. The data collection techniques used in this study are observation, lecturer interviews, and documentation. The observation sheets and interview sheets used have been validated by experts. The implementation indicators of the RODE learning model are listed in Table 1.

Table 1 Indicators of implementation of RODE model learning

No	Learning Implementation	Indicator
1	Learning planning	1. Analyzing the learning objectives 2. Designing Learning Tools
2	Implementation of learning	1. Read 2. Outline 3. Discussion 4. Evaluation
3	Assessment	1. Formative assessment 2. Summative assessment

After completing the data collection stage, the next stage is the data analysis stage. The data analysis technique carried out by the researcher in this study is the data analysis of the Miles and Huberman model. Miles and Huberman in Raya et al. (2023) stated that activities in qualitative data analysis are carried out in a mutually active manner and carried out consistently until completion, so that the data obtained is saturated. The measure of data saturation can be seen by the absence of new data. Activities in data analysis are data reduction (data reduction), data display (data presentation), and conclusion drawing/verification (drawing conclusions). Interactive models from Miles and Huberman can be seen in Figure 1.

The data analysis in this study follows the interactive model of Miles and Huberman, consisting of data collection, data reduction, data display, and conclusion drawing and verification. In the data collection phase, data were obtained through classroom observations during the implementation of the RODE learning model, semi-structured interviews with students and lecturers, and documentation such as lesson plans and photos of student activities.

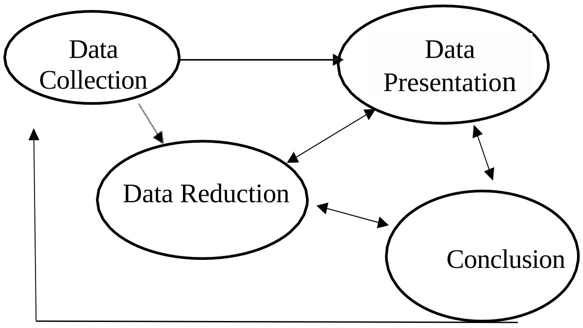

Figure 1 Data analysis techniques
Source: Miles and Huberman in Raya et al. (2023)

The collected data were then reduced through several steps, including transcribing interview recordings, conducting an initial reading, and coding the data using relevant keywords related to Read, Outline, Discussion, and Evaluation. These codes were subsequently grouped into categories and developed into broader themes. The reduced data were then organized and presented in narrative descriptions. Finally, conclusions were drawn by identifying patterns and relationships within the data, and these findings were verified through triangulation of multiple data sources, as well as consistency checking to ensure the validity and reliability of the results. Technical triangulation by comparing information or data in different ways. The data was confirmed by comparing the results of observations, interviews, and documentation. The entire process was conducted iteratively, allowing continuous refinement of the analysis.

RESULTS AND DISCUSSION

The lecturer team of the basic concepts of astrophysics course implemented the RODE learning model in the fluid topic across two instructional meetings. The first meeting addressed the concept of static fluids, while the second meeting focused on dynamic fluids. Each meeting was designed to achieve specific learning outcomes, namely: (1) students are able to demonstrate a conceptual understanding of static and dynamic fluid principles, (2) students are able to apply science numeracy skills in solving quantitative problems related to fluid phenomena, and (3) students are able to actively participate and communicate their ideas effectively during the learning process. The implementation of the RODE model in each session followed a systematic instructional syntax consisting of four stages. In the Read stage, students engage with relevant learning resources to build initial understanding. In the outline stage, students constructed structured summaries of key concepts to reinforce comprehension. In the discussion stage, students participate in collaborative problem-solving activities, during which the lecturer applies the principle of reaction to assess and respond to students' contributions. Finally, in the evaluation stage, students completed structured assessment tasks aimed at measuring both conceptual understanding and science numeracy skills. This consistent application of the RODE syntax across both meetings was intended to facilitate active learning and optimize the attainment of the defined learning outcomes. Fluid material was chosen because it includes concepts and calculations whose context is in accordance with scientific numeracy. The lecturer team is interested in the RODE model because the simple model and activities of each stage can be modified according to the characteristics of the material and the ability of the students to be measured. This is in line with the results of interviews with the following lecturers.

> "*RODE has simple stages, namely Read, Outline, Discussion, and Evaluation. Each stage of the activity can be adjusted to the material, whether it is a practicum or a group discussion with a worksheet"*
> *(TD, May 21, 2025)*

At the planning stage carried out by the lecturer team for the RODE model for students' science numeracy skills, it includes analyzing learning objectives and compiling learning tools. The lecturer team prepares learning based on the learning outcomes of the course and the learning sub-outcomes of the course, which are then adjusted to the context of science numeracy. As the following interview

> *"We compile Fluida learning objectives based on course learning outcomes and course learning sub-outcomes. The goal is adjusted to the numeracy of science, namely counting operations, choosing the appropriate formula, solving problems with calculations, and reading and interpreting graphs and tables." (TD, May 21, 2025)*

The lecturer team prepares learning objectives by relating to the numeracy aspects of science, which include calculation operations in the form of multiplication and division, choosing formulas that suit the problem, solving problems with complete calculations and units, and interpreting information with graphs and tables. The learning objectives are the basis for compiling materials, learning activities, and test questions. After compiling the learning objectives, the lecturer team designed teaching materials, student worksheets, and test questions equipped with assessment rubrics. Teaching materials include the concept of static and dynamic fluids and their role in daily life, sample questions, and practice questions. Teaching materials are designed in accordance with the RODE steps. The read stage contains the theory and application of fluids in daily life, an outline in the form of student worksheets, discussion in the form of practice questions, and evaluation in the form of presentations, paying attention to several aspects. The student worksheet includes a brief theory, practicum steps, recording results, analyzing data, and concluding. The test questions contain 5 descriptive questions that are in accordance with the learning objectives to measure students' science numeracy skills. The entire learning tool is used for fluid material lectures. The RODE model learning materials are shown in Figure 2.

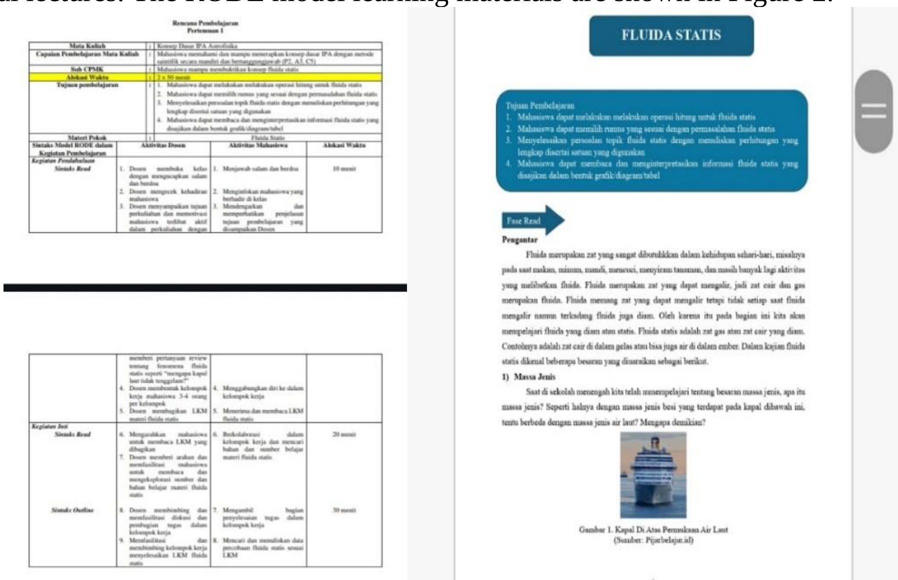

Figure 2 RODE model learning materials

The RODE learning model has four stages, namely read, outline, discussion, and evaluation. At the implementation stage, the RODE learning model begins with the Read Phase. In this phase, students are directed to read the teaching materials given by the lecturer. Outline phase, discussing in groups to complete the worksheet. In the discussion phase, students presented the results of the group discussion, followed by other groups who responded. In the evaluation phase, students are given the opportunity to conclude and give grades to presentations from other groups. Each of these phases directs students to actively engage in learning.

In the Read stage, students were directed to study the teaching materials prepared by the lecturer team, accessing them via their individual devices to accommodate different reading speeds and allow flexible self-paced learning. While reviewing the materials, students focused on identifying key concepts, relevant formulas, and quantitative examples related to static and dynamic fluids. This is in line with the following interview.

> "*I send the material to the students, and then they read on their respective cellphones, because if it is displayed on the board, there will be people who miss reading because the reading speed is different. In addition, students can also reread the material anywhere." (TD, May 27, 2025)*

Lecturers provided targeted explanations of fluid concepts and engaged students in questions and answers that required applying mathematical reasoning, such as calculating hydrostatic pressure or predicting flow velocity in practical scenarios. This approach enables students to connect theoretical content with numerical applications, fostering early development of science numeracy skills by encouraging them to interpret, calculate, and contextualize numerical information in real-world fluid phenomena. After the Read stage, lecturers divide groups to facilitate student collaboration in the Outline stage.

At the outline stage, students were provided with structured worksheets to conduct simple practical activities. In the static fluid session, the practicum focused on investigating hydrostatic pressure, enabling students to analyze the relationship between fluid depth and pressure. In the dynamic fluid session, students examined the velocity of water flow from different heights based on Torricelli's law, allowing them to quantitatively explore the relationship between fluid height and flow velocity. Students work collaboratively in small groups to complete structured practical tasks designed to enhance their science numeracy skills. Initially, they collect and organize the required tools and materials according to worksheet instructions, which reinforces their ability to identify relevant variables and quantify experimental requirements. During the experimentation phase, students observe phenomena related to static and dynamic fluids and systematically record raw data, fostering precision in measurement and attention to numerical details. In the data analysis stage, students calculate hydrostatic pressure and flow velocity using appropriate formulas, convert measurements into meaningful representations, identify patterns, and compare results across conditions. This analytical process directly develops quantitative reasoning, the ability to interpret numerical data, and the application of mathematical concepts to scientific contexts, core components of science numeracy. Following the analysis, students interpret and link results to underlying scientific principles, strengthening their ability to translate numerical observations into conceptual understanding. Throughout the practice, group discussions allow students to justify calculations, debate interpretations, and clarify misconceptions, which further cultivates logical reasoning, problem-solving, and communication of quantitative information. The outline stages are shown in Figure 3.

Figure 3 Outline stage

In the discussion stage, students presented the results of their group analyses to lecturers and classmates, focusing on the experimental data and calculations related to static and dynamic fluids. The discussion was structured using a “visiting” model, where one group acted as presenters while members of other groups rotated as guests. The presenting group explained their methodology, numerical calculations, hydrostatic pressure, and flow velocity using Torricelli's law, data tables, and interpretation of results, considering the connection between quantitative observations and underlying scientific concepts. Guest group members critically engaged with the presentation by asking clarifying questions, providing feedback on calculations, suggesting alternative approaches to data analysis, or adding relevant numerical observations. This interactive exchange encouraged students to justify their numerical reasoning, identify and correct errors in measurements or calculations, and refine their understanding of quantitative relationships in fluid phenomena. Through this structured discussion process, students actively practice science numeracy skills, including data interpretation, application of formulas, analytical reasoning, and communication of quantitative scientific information, thereby reinforcing both conceptual understanding and numeracy proficiency in a collaborative learning environment. The discussion stage is shown in Figure 4.

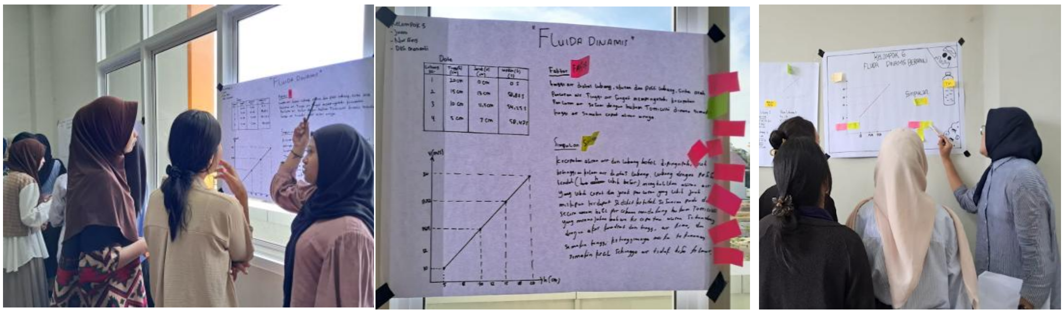

Figure 4 Discussion stage

In the evaluation stage, each student group was given the opportunity to present the conclusions they had drawn from the fluid material practice. These conclusions included the results of their data analysis, interpretation of experimental findings, and understanding of the underlying scientific concepts, such as the relationship between fluid depth and hydrostatic pressure or the application of Torricelli's law to flow velocity. During this stage, students were encouraged to explain the calculations, justify their reasoning, and highlight how their quantitative results supported their conceptual understanding, which directly reinforced their science numeracy skills. The lecturer provided targeted feedback, clarified misconceptions, and offered additional explanations to ensure that students could accurately interpret numerical data and apply mathematical formulas correctly. This process not only consolidated students' conceptual knowledge but also strengthened their ability to analyze, interpret, and communicate quantitative information, fostering more precise and confident use of mathematics in scientific contexts.

In the assessment of the RODE model, the lecturer team conducted a formative and summative assessment for this fluid topic. Formative assessments were conducted using student worksheets, with lecturers closely monitoring students' progress and providing targeted group feedback. During this process, lecturers focused particularly on students' data analysis of practice results, guiding them in performing accurate calculations, selecting appropriate formulas, and correctly interpreting numerical data. Students were also supported in reading and interpreting graphs and tables, identifying trends, and drawing connections between quantitative observations and underlying fluid concepts. This formative feedback helps students refine their analytical reasoning, enhance computational accuracy, and develop confidence in handling numerical information. Summative assessments were conducted at the end of the fluid material unit through science numeracy test questions designed to evaluate students' ability to apply mathematical operations, solve quantitative problems, select correct formulas, perform calculations with proper units, and interpret data from tables and graphs. Together, these formative and summative assessment activities directly strengthened students' science numeracy skills by integrating conceptual understanding with practical quantitative analysis and scientific reasoning.

> *"Some students have difficulty analyzing data with appropriate formulas, so I remind them of the concept and theory. In addition, in the interpretation of data with graphs, there are students who have difficulty determining variables on the X axis and the Y axis, so I convey that it is free to determine which X and Y axes are the origin of the scale you use so that the results are more accurate"* (TD, May 27, 2025).

During the worksheet activities, lecturers actively provided guidance, clarification, and feedback, ensuring that students could accurately perform calculations, apply appropriate formulas, and interpret experimental data, thereby building both competence and confidence in their science numeracy skills. This support also helps students prepare for the design and delivery of group presentations, reinforcing the connection between quantitative analysis and scientific communication. At the end of the fluid material unit, a summative assessment was conducted to evaluate individual students' science numeracy skills. Each student completed five descriptive questions that required them to perform calculation operations, select and apply the correct formulas, solve problems with accurate computations and units, and interpret numerical information presented in graphs and tables. To ensure consistency and transparency, lecturers also developed an assessment rubric covering four key aspects of science numeracy: computational accuracy, formula selection, problem-solving strategy, and data interpretation. This structured assessment process allowed students to demonstrate their ability to quantitatively analyze scientific phenomena, integrate mathematical reasoning with conceptual understanding, and communicate numerical findings effectively.

This study emphasizes that the success of the RODE learning model in enhancing students' science numeracy skills is rooted in well-structured instructional planning. The lecturer team regularly aligned course learning outcomes with science numeracy indicators, including basic operations, formula selection, problem-solving with appropriate units, and data interpretation through graphs and tables. This alignment ensured that numeracy was embedded as a core competency rather than an additional skill. Such an approach reflects the principle of constructive alignment, where learning objectives, instructional materials, and assessments are coherently designed to support targeted competencies. Prior studies have shown that explicitly integrating numeracy into learning objectives significantly improves students' quantitative reasoning and conceptual understanding (Perrin et al., 2025; Sari et al., 2023). Furthermore, the design of teaching materials, student worksheets, and assessment instruments based on the RODE demonstrates how planning can regularly scaffold numeracy development. Contextualized materials on static and dynamic fluids, combined with structured worksheets and rubric-based assessments, provide opportunities for students to engage in repeated quantitative reasoning and data interpretation. This is consistent with research indicating that carefully planned learning environments and structured tasks enhance numeracy through active engagement and iterative practice (Delima et al., 2025; Kusuma et al., 2022; Melissa et al., 2024). Therefore, the planning stage plays a meaningful role in ensuring that the implementation of the RODE model effectively fosters science numeracy skills in higher education.

The findings at the Read stage demonstrate that providing flexible, self-paced access to teaching materials through students' personal devices plays a crucial role in supporting the development of science numeracy skills. This approach accommodates individual differences in reading speed and allows students to revisit materials multiple times, thereby promoting deeper cognitive engagement. Such flexibility is particularly important in numeracy-oriented learning, where understanding requires not only conceptual understanding but also repeated exposure to quantitative representations. Recent studies confirm that self-regulated and technology-supported learning environments significantly enhance students' ability to interpret numerical information and build conceptual understanding in science (Eluemuno et al., 2025; Schindler et al., 2017). Effective reading skills involve the process of interpretation, analysis, and evaluation of information, which helps students understand the problem thoroughly before implementing problem-solving strategies. According to Boctot et al. (2025), it shows that reading ability plays a significant role in the ability to solve math story problems, where students who have better reading comprehension are able to identify important information, understand the structure of the problem, and formulate the right solution strategy. Directing students to identify key concepts, relevant formulas, and quantitative examples during the reading process reflects a structured approach to embedding numeracy within early learning stages. The lecturer's strategy of combining targeted explanations with question-and-answer sessions involving mathematical reasoning, such as calculating hydrostatic pressure and predicting flow velocity, facilitates the integration of conceptual and procedural knowledge. This is consistent with research indicating that explicit attention to mathematical reasoning within science instruction enhances students' ability to apply numerical skills in problem-solving contexts (Darling-Hammond et al., 2020; Rizki & Priatna, 2019). Additionally, engaging students in interpreting and applying formulas strengthens their ability to connect symbolic representations with physical meaning, a key component of science numeracy. By encouraging students to interpret, calculate, and contextualize numerical information, the Read stage functions not merely as an introductory phase but as a critical foundation for building science numeracy skills.

The outline stage illustrates how structured practical activities effectively link theoretical knowledge with quantitative reasoning, a central component of science numeracy skills. By engaging students in collaborative, hands-on investigations of static and dynamic fluids by measuring hydrostatic pressure and water flow velocity, students practiced not only observation and data collection but also quantitative interpretation and mathematical application. This aligns with research showing that laboratory-based learning with structured worksheets supports the development of scientific process skills and enhances quantitative reasoning by requiring students to identify variables, record data accurately, and interpret numerical patterns (Khairunnisa, 2025). Moreover, the collaborative nature of the practical tasks, by requiring group work, discussion, and justification of calculations, reinforces communication of quantitative information and critical thinking. Structured lab activities grounded in real scientific inquiry contextualize abstract mathematical concepts in meaningful phenomena, which has been shown to improve students' ability to use mathematics in science contexts and strengthen science reasoning when directly embedded in laboratory practice rather than isolated instruction (Bhoke, 2024). Similarly, (Rasheduzzaman et al., 2025) highlights that applying quantitative tasks within practical science contexts improves interpretation of data and conceptual connections between formulas and physical phenomena, which are key indicators of numeracy development. Beyond numeracy, the laboratory's emphasis on measurement precision and systematic recording also contributes to broader science process skills, which are fundamental to authentic scientific inquiry and reasoning (Hamid et al., 2022). Students' iterative analysis of pressure and flow data encourages them to translate numerical results into conceptual understanding, fostering mathematical sensemaking in science, which is a core goal of science numeracy that involves blending conceptual and quantitative reasoning to explain phenomena.

The Discuss stage demonstrated that structured peer interaction significantly strengthened students' science numeracy skills by facilitating critical evaluation of quantitative reasoning and collaborative interpretation of experimental results. During group presentations, students articulated methodological choices, numerical calculations such as hydrostatic pressure and flow velocity using Torricelli's law, and explanations that connected numerical data with underlying scientific concepts (Susanta et al., 2023). Furthermore, Laslo & Hartmann (2023) show that discussion helps students interpret numerical data more accurately. Peer engagement through questions and feedback enabled students to reflect on and refine their calculations, which aligns with studies showing that collaborative discussions enhance students' ability to analyze and quantitatively communicate scientific information (Emigh et al., 2023; Muana & Elhawwa, 2024). Similarly, Triwahyuningtyas et al. (2025) report that discussion-based activities enhance students' problem-solving and numeracy skills by promoting structured dialogue and peer explanation. Therefore, the Discuss stage was instrumental in reinforcing both conceptual understanding and science numeracy skills through collaborative evaluation, numerical justification, and communicative engagement with quantitative information.

In the evaluation stage, student presentations of data analysis, interpretation, and conceptual conclusions reinforced science numeracy skills by requiring students to articulate and justify their quantitative reasoning within scientific contexts. Students explained how their numerical results, such as the relationship between fluid depth and hydrostatic pressure or the calculation of flow velocity using Torricelli's law, supported their conceptual understanding, which aligns with research indicating that assessment tasks considering explanation and justification of quantitative outcomes promote deeper interpretation and application of numerical data (Listianingrum et al., 2023; Pratiwi et al., 2025). Targeted feedback from the lecturer helps students identify and correct misconceptions, which corresponds to findings that structured feedback supports students' ability to interpret numerical data more accurately and apply appropriate mathematical formulas (Suwarma et al., 2023). Study Ruf et al., (2024) showed that performance-based evaluation activities that integrate quantitative explanation and reasoning develop students' analytical thinking, reasoning processes, and confidence in communicating numerical results. Therefore, the evaluation stage functions as an essential mechanism for consolidating conceptual knowledge and strengthening students' abilities to analyze, interpret, and communicate quantitative scientific information with greater precision in scientific contexts.

The integration of formative and summative assessments within the RODE model contributed significantly to strengthening students' science numeracy skills by providing structured opportunities for students to engage with quantitative reasoning and data interpretation throughout the learning process. Formative assessment practices, such as the use of worksheets with continuous lecturer feedback, enabled the monitoring of students' analytical processes in calculating numerical values, selecting appropriate formulas, and interpreting graphs and tables. Studies on innovative and formative assessment in science education highlight how such practices enable teachers to adjust instruction based on students' responses and support learners in developing deeper numerical understanding linked to scientific concepts (Nakjah & Adawiyah, 2025; Unas & Buldur, 2025). The design of summative assessments in this study, which evaluated students' numeracy skills to solve quantitative problems, apply mathematical operations with correct units, and interpret numerical data, aligns with research showing that assessment tasks focusing on mathematical application within scientific contexts promote confidence and competence in communicating quantitative outcomes (Fitria & Ayani, 2025). Together, these assessment strategies created a coherent evaluative environment that strengthened students' numeracy skills to interpret and analyze quantitative information effectively while supporting conceptual learning in scientific contexts.

Overall, the implementation of the RODE model in the fluid topic demonstrated its effectiveness in strengthening students' science numeracy skills. The structured stages of RODE guide students to connect theoretical concepts with quantitative applications, interpret and analyze data, and communicate scientific information accurately. Formative and summative assessments embedded within the model provided continuous feedback and evaluation, enabling students to refine their numerical reasoning and build confidence in applying mathematics to scientific phenomena. These findings highlight the RODE model as a practical and adaptable framework for fostering science numeracy in higher education.

CONCLUSION

The study describes the implementation of the RODE learning model in the Basic Concepts of Astrophysics course, illustrating how its structured stages can support processes associated with science numeracy, including conceptual understanding, data interpretation, and collaborative reasoning. At the planning stage, the lecturer team aligned learning objectives with science numeracy indicators and prepared teaching materials, student worksheets, and assessment items. During implementation, the RODE learning model was applied in a structured manner: Read involved students engaging with teaching materials, an outline was created through practice activities and group discussions on student worksheets. Discussion consisted of group presentations and peer question-and-answer sessions, and Evaluation involved collaborative conclusion drawing. Formative and summative assessments were designed to monitor students' engagement with numeracy-related tasks. The study is limited by its single-class context, descriptive focus, and short duration, which constrain generalizability and prevent conclusions about long-term outcomes. Nevertheless, the findings provide insights into the practical application of RODE for structuring learning activities that can potentially foster science numeracy processes. Future research could employ multiple contexts, extend observation periods, and combine qualitative and quantitative approaches to more comprehensively investigate the model's impact on science students' numeracy skills.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, DAA, AEK, S; methodology design and development, AEK; formal analysis and data interpretation, DAA; writing—original draft preparation, MN and SRH; review and editing, S and NN; supervision and project administration, DAA, AEK; all authors have read and agreed to the published version of the manuscript.

ACKNOWLEDGMENTS

The authors would like to thank the Institute for Research and Community Service of the University of Borneo Tarakan for funding this research.

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AUTHOR PROFILES

Degi Alrinda Agustina
gygyalrinda@gmail.com
Universitas Borneo Tarakan
https://scholar.google.com/citations?user=_Hl3askAAAAJ&hl=en
Expertise in Primary Education and Science Education

Arief Ertha Kusuma
artha13qren@gmail.co
Universitas Borneo Tarakan
https://scholar.google.com/citations?user=XvZTOK8AAAAJ&hl=en
Expertise in Physic Education and Science Education

Suciati
cauchy_my@yahoo.com
Universitas Borneo Tarakan
https://scholar.google.co.id/citations?user=njNNJ2sAAAAJ&hl=en
Expertise in Mathematics Education and Educational Assessment and Evaluation

Maulidah Nurislamiyah
nurislamiyahmaulidah@gmail.com
Universitas Borneo Tarakan
Student of Mathematics Education

Sri Radiatul Hikma
sriradiatulhikma@gmail.com
Universitas Borneo Tarakan
Student of Mathematics Education

Neni Novitasari
Novitasari_neni@ubt.ac.id
Universitas Borneo Tarakan
https://sinta.kemdiktisaintek.go.id/authors/profile/6771876
Expertise in Social Education