VC-MER (Visualisation, Collaboration, Modelling, Explaining Mode, Report) Learning Strategy: Transforming Student Activities in Chemistry Learning

Wiwin Rewini Kunusa[1,*], Masrid Pikoli[1], Ishak Isa[1], Astin Lukum[1], Masra Ladjompo[2], Frida Maryati Yusuf[2], and Thayban Thayban[1]

[1] Department of Chemistry, Universitas Negeri Gorontalo, 96554 Bone Bolango, Indonesia
[2] Department of Biology, Universitas Negeri Gorontalo, 96554 Bone Bolango, Indonesia
*Corresponding author. wiwien.rewini kimia@ung.ac.id

Abstract. The VC-MER learning strategy is a student activity-based and student-centered learning strategy collaborated with problem-based learning in chemistry learning. The purpose of this study was to determine whether the VC-MER learning strategy can improve students' learning activities. This research is a class action research. The participants of this study were 124 students from the chemistry department and pharmacy department who took the analytical chemistry course. The results showed that increased student activity observed problems and gave predictions, discussed problems in small groups, clarified facts and identified problems, developed ideas and arguments based on prior knowledge, determined problem-solving action plans, became active investigators in experiments, collected data and literature studies including library databases, web sources, and observations, students presented their findings, and expressed opinions on the presentations made. The implication is that the VC-MER learning strategy can increase student activity.

Keywords: VC-MER learning strategy, transforming student activities, chemistry learning

1 Introduction

Analytical chemistry is the science of qualitative and quantitative chemical analysis. All fields of chemistry use analytical chemistry principles and techniques to gather qualitative and/or quantitative data about chemical systems of interest. Similarly, breakthroughs in other fields of science (for example, materials science) drive the development of new analytical methods and procedures. The current undergraduate analytical chemistry course curriculum teaches the fundamental principles and methods of chemical analysis, with a focus on laboratory practice in which students quantitatively prepare and analyze samples using various 'wet chemistry' methods (such as gravimetric and volumetric titrations) and instrumental methods (such as spectrophotometry, electrochemistry, and chromatography) [17, 20].

Analytical chemistry, as a course, remains both tough and vital in the curriculum [14]. Students must understand the working principles of analytical procedures and analyze and collect quantitative data using a variety of methodologies. The ability to con-

H. S. Panigoro et al. (eds.), *Proceedings of the 2nd International Conference on Sciences, Mathematics, and Education 2023 (ICOSMED 2023)*, Advances in Social Science, Education and Humanities Research 927,
https://doi.org/10.2991/978-2-38476-410-5_58

duct precise and accurate analyses is essential for ensuring product quality and compliance with regulatory standards [6]. As a result, it is critical that students not only receive appropriate instruction but also understand the nature, benefits, and uses of these strategies [20, 11]. Indeed, classes in analytical chemistry establish the framework for future laboratory work, which will continue throughout the study program and beyond. Thus, it is critical that the information presented is appropriate and that students participate in the course sufficiently to recall essential aspects and apply them practically [16].

Gorontalo State University's analytical chemistry program covers molecular spectroscopy (UV-VIS, IR, NMR, MS), atomic spectroscopy (AAS, AES, AFS, ICPES), and integrated analysis techniques (HPLC/HPLC-AAS, GC/GC-MS). Interviews with three analytical chemistry teachers found that students have difficulty understanding both molecular and atomic spectroscopy. This challenge is confirmed by student responses from interviews, which show that a lack of student participation in the learning process is the primary culprit. The low amount of pupil involvement during the learning process causes them to soon feel bored.

Lecturers are critical to the learning process's effectiveness because their key duties include learning design, management, and evaluation [18]. Student participation in learning activities is vital. Learning activities must also be created during the learning process to make the learning experience more meaningful. Active student participation in learning activities improves the learning process significantly. Optimal learning activities demonstrate that the learning process is effective and efficient, resulting in higher-quality education. When students participate actively in the learning process, they can attain the best learning outcomes.

Previous study has demonstrated that the cultivation of learning methods might enhance students' overall scientific proficiency in comprehending conceptual information. The creation of the VC-MER learning approach is supported by the perspectives of other researchers.

1.1 Visualization

Visualization entails the depiction of shapes by visual means, such as graphics, diagrams, tables, text, or other observable methods. Visualization is a crucial aspect of education as it facilitates the transmission of knowledge from the teacher to the learner [8].

Barron and Ivers (2002) define multimedia as the utilization of diverse forms of media, including text, graphics, animation, video pictures, and sound, to communicate information. Visualization aids in externalizing thoughts, enhances memory, and promotes information processing [10]. A study conducted by Abate et al. (2022) demonstrates that the utilization of visualization techniques in conjunction with problem-based learning methods has a substantial impact on enhancing students' attitudes [1]. A study conducted by Aiman (2019) found that using instructional videos can improve students' learning outcomes in electromagnetic wave materials and their engagement with the videos. The N-gain value reveals that the experimental class (0.72) fared better than the control class (0.61) [2]. Endriani et al. (2018) employed instructional videos as a means of assessing the critical thinking abilities of pupils. The survey showed that 13.3% of students were less critical, 60% were moderately critical, 20% were critical, and 6.67%

were highly critical. Learning becomes effective since students can take notes on the videos and provide feedback. The roles and functions of images in learning are: (1) providing physical references for ideas, (2) making abstract ideas concrete, (3) encouraging learners, (4) directing attention, (5) repeating information in different formats, (6) recalling past learning, and (7) lowering learning effort [5].

1.2 Collaboration

Collaboration skills are vital for overcoming students' problems in learning chemistry [9]. Problem-based learning is founded on the premise that student learning processes integrate the ability to collaborate with others [18, 4]. Ballantine and McCourt Larres (2007) claim that development cannot be divorced from the social setting, and collaboration is necessary for students to obtain strong academic achievement in problem-solving. According to Howe (2006), a notion cannot be developed without social contact [19].

1.3 Modelling

According to Bandura (1977) in Moreno (2010), modeling involves four processes: (1) attention, where students are given attention to provoke cognitive conflict with interesting information or phenomena, acting as a stimulus, (2) retention, where students remember observed behaviors to replicate them in the future, storing them in long-term memory, (3) production, where students are given opportunities to practice with feedback from the instructor, and (4) motivation, where students apply what they have learned for further development. Modeling allows students to visualize concepts through visuals or simulations [4].

1.4 Explaining

According to Taniredja (2015), Student Facilitator and Explaining is a learning approach where students offer ideas/opinions and acquire confidence to produce work exhibited to their peers (Tukiran et al., 2015). According to Huda (2014), the explaining mode method encourages students to repeat professors' explanations, drives them to be the best in explaining the subject matter, and tests students' ability to transmit concepts [7].

1.5 Report

Ohora (2007) says that the findings of modeling should be written, either qualitatively or quantitatively. According to Keeling et al. (2009), writing questions can assist learners focus attention and boost knowledge. Vacca (2009) claims that student motivation increases with interactions between lecturers and students and among students in completing tasks. Student compositions and reports receive comments from lecturers [12].

The research on the VC-MER (Visualisation, Collaboration, Modelling, Explaining Mode, Report) learning strategy is crucial as it transforms student activities in chemistry learning by promoting active engagement, critical thinking, and collaborative skills. This comprehensive approach integrates visual tools, teamwork, model creation, and scientific reporting, which enhances students' understanding of complex chemical concepts and fosters higher-order thinking. By aligning with modern educational standards and constructivist learning theories, the VC-MER strategy not only improves learning outcomes but also prepares students with essential 21st-century skills, making it a valuable pedagogical innovation in chemistry education. One endeavor to increase student learning activities is by employing the VC-MER learning approach. Therefore, this study intends to promote student activities in learning through the VC-MER learning approach.

2 Method

2.1 Research Design

Classroom Action Research aims to improve the quality of learning and focuses on classroom activities [15]. This research is collaborative or cooperative in nature. Collaborative Classroom Action Research is a model designed and conducted by lecturers [13].

2.2 Participants

The participants in this study were 124 students from the State University of Gorontalo who were taking the Analytical Chemistry course.

2.3 Research Procedure

The Classroom Action Research procedure consists of two cycles, each comprising four stages: planning, action implementation, observation, and reflection. If the first cycle does not successfully show an improvement in student activity, the intervention will continue with the second cycle as an improvement until the goal is achieved. Before the stages in cycle I, an initial reflection/observation activity is conducted to identify problems through the observation of learning activities. The following is the cycle model of Classroom Action Research according to Arikunto (2022) [3] shown in Figure 1.

2.4 Research Instruments

An observation sheet for student activities during learning is used as a guideline to observe student activities within predetermined time limits. Student activities are observed by observers every 3 minutes during 2×50 minutes of learning (each session). The observed student activities include: (1) Paying attention and listening to the lecturer's explanation, (2) Observing problems and making predictions, (3) Discussing issues in small groups, (4) Clarifying facts and identifying problems, (5) Developing ideas and arguments based on previous knowledge, (6) Determining problem-solving action plans, (7) Acting as an active investigator in experiments, (8) Collecting data

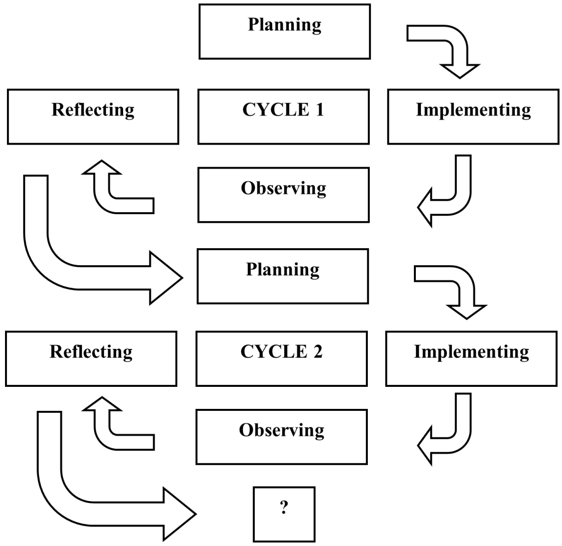

Fig. 1. Classroom action research cycle

and literature studies including library databases, web, speakers, observations, (9) Students presenting their findings, (10) Expressing opinions on presentations made and responded to by presenting groups.

The technique used to collect data on student activity observations during the learning process is direct observation by the observers. Direct observation is carried out by three observers by writing down the numbers of the categories that dominantly appear every 3 minutes in the provided rows and columns on the observation sheet.

2.5 Data Analysis

The data on student activity observations during the learning process are then analyzed and described. To find the average frequency of student activities during the learning process, the following steps are taken:

1. The frequency of student activity observations for each indicator in one session is determined, and the average frequency for three observers is calculated.
2. Calculating the percentage of student activity for each indicator by dividing the average frequency of student activity in class by the average frequency of observed student activity.
3. Describing student activities and outlining the development of student activities during the implementation of the VC-MER learning strategy.

3 Result and Discussion

Student activities were observed by an observer every 3 minutes during the learning activity. The results of the observation on ten types of student activities are presented in Figure 2.

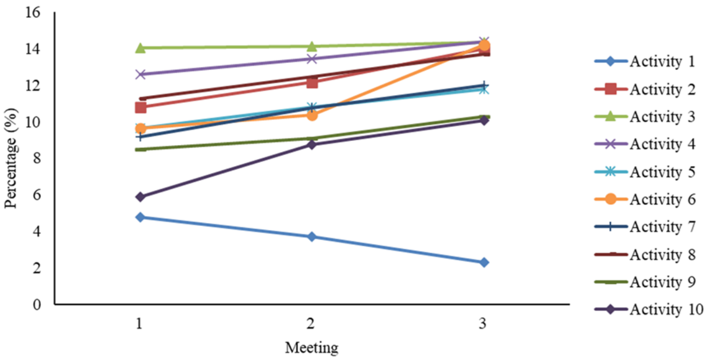

Fig. 2. Percentage of student activity observations in each learning activity

Activity description: (1) Paying attention and listening to the lecturer's explanation, (2) Observing problems and making predictions, (3) Discussing issues in small groups, (4) Clarifying facts and identifying problems, (5) Developing ideas and arguments based on previous knowledge, (6) Determining problem-solving action plans, (7) Acting as an active investigator in experiments, (8) Collecting data and literature studies including library databases, web, speakers, observations, (9) Students presenting their findings, (10) Expressing opinions on presentations made and responded to by presenting groups. Based on the data in Figure 2, the following analysis can be provided:

(1) Activity 1 (paying attention and listening to the lecturer's explanation) tends to decrease from learning session one to learning session three. This occurs because the learning strategy tested emphasizes more on students' active participation in group discussions to explore information through exploration activities. The provision of explanations by lecturers is limited when students observe the given problems initially. Students' activity in this activity is also indicated by activities 3 (discussing issues in small groups), 6 (Determining problem-solving action plans), and 7 (Acting as an active investigator in experiments), which tend to increase from one learning session to the next. Students' activity in presenting ideas, thoughts, and opinions in activities 5 (Developing ideas and arguments based on previous knowledge), 9 (Students presenting their findings), and 10 (Expressing opinions on presentations made and responded to by presenting groups) tends to increase from one learning session to the next. This fact indicates that the developed learning strategy can cultivate students' courage to express opinions or concepts they already have.

(2) Activities 2, 4, and 8, which are also manifestations of efforts to facilitate students in observing problems and making predictions, clarifying facts and identifying problems, as well as collecting data and literature studies including library databases, web, speakers, observations, are at a high percentage and tend to increase from learning session one to learning session two and then stabilize.

The VC-MER (Visualisation, Collaboration, Modelling, Explaining Mode, Report) Learning Strategy transforms student activities in chemistry learning by incorporating key elements that enhance understanding of chemical concepts. *Visualization*: Visualization plays a crucial role in understanding abstract chemical concepts. Using visual aids such as diagrams, graphs, and molecular models, students can conceptualize chemical ideas more effectively. *Collaboration*: Collaboration allows students to learn from each other. In the context of chemistry learning, collaboration can occur through group discussions or group projects that require collaborative problem-solving. *Modeling*: The use of models in chemistry learning helps students understand complex chemical phenomena. Students can create models and simulations to understand concepts such as atomic structure or chemical reactions. *Explaining Mode*: The ability to explain chemical concepts clearly is an indicator of strong understanding. By encouraging students to explain concepts to classmates or teachers, this strategy reinforces student understanding. *Report*: The process of reporting learning outcomes teaches students to organize and present information systematically. Through this process, students can reinforce their understanding of the chemical concepts they have learned.

Based on the results of the analysis of student activity data, it is obtained that the implementation of the VC-MER learning strategy is effective in increasing active student participation in learning. This indicates that the VC-MER learning strategy is a student-centered learning strategy. Observations of student activities by observers indicate that in general, the VC-MER learning strategy has been able to condition students' activities to show behaviors relevant to the learning activities.

4 Conclusion

The VC-MER (Visualization, Collaboration, Modeling, Explaining Mode, Report) learning strategy can effectively enhance students' activity in the Analytical Chemistry course. Students can observe problems and make predictions, discuss issues in small groups, clarify facts and identify problems, develop ideas and arguments based on prior knowledge, determine problem-solving action plans, become active investigators in experiments, gather data and study literature including library databases, web sources, speakers, observations, present their findings, express opinions on presentations, and respond to presentations by other groups.

5 Acknowledgements

The author expresses gratitude to the several parties who contributed to the completion of this research. The assistance rendered during the procedure is highly valued. Gratitude is also expressed for the financial assistance that facilitated this research.

References

1. Abate, A., Atnafu, M., Michael, K.: Visualization and problem-based learning approaches and students' attitude toward learning mathematics. Pedagogical Research **7**(2) (2022). DOI 10.29333/pr/11725
2. Aiman, U., Dantes, N., Suma, K.: Pengaruh model pembelajaran berbasis masalah terhadap literasi sains dan berpikir kritis siswa sekolah dasar. ... Pendidikan Citra Bakti (2019)
3. Arikunto, S.: Pengembangan instument penelitian dan penilaian program. Suharsimi Arikunto (2022)
4. Chen, I., Chang, C., Yen, J.: Effects of presentation mode on mobile language learning: A performance efficiency perspective. Australasian Journal of Educational Technology **28**(1) (2012). DOI 10.14742/ajet.887
5. Endriani, R., Sundaryono, A., Elvia, R.: Pengembangan media pembelajaran kimia menggunakan video untuk mengukur kemampuan berfikir kritis siswa. PENDIPA Journal of Science Education **2**(2) (2018). DOI 10.33369/pendipa.2.2.142-146
6. Hipolito-Najera, A.R., Moya-Hernandez, M.R., Gomez-Balderas, R., Rojas-Hernandez, A., Romero-Romo, M.: Introduction to validation of analytical methods: Potentiometric determination of co_2. Journal of Chemical Education (2017). DOI 10.1021/acs.jchemed.7b00252
7. Huda, M.: Model-Model Pengajaran Dan Pembelajaran. Eureka Media Aksara (2014)
8. Huron, S., Bach, B., Hinrichs, U., Keck, M., Roberts, J., IEEE, R., C, J.: In: IEEE VIS Workshop on Data Vis Activities to Facilitate Learning, Reflecting, Discussing, and Designing. IEEE VIS (2020)
9. Hwang, E., Shin, J., Choi, J., Choi, R., Han, J.: Study on basic chemistry class using flipped learning in non-face-to-face environments-focusing on differentiated collaborative learning. The Korean Association of General Education **16**(3) (2022). DOI 10.46392/kjge.2022.16.3.191
10. Ivers, K., Barron, A.: Evaluate. In: Digital Content Creation in Schools (2024). DOI 10.5040/9798400640568.ch-007. URL https://doi.org/10.5040/9798400640568.ch-007
11. Kearney, M., Larrañeta, E.: Exemplar case studies demonstrating why future pharmacists need to learn medicinal and analytical chemistry. Journal of Chemical Education (2021). DOI 10.1021/acs.jchemed.1c00705
12. Keeling, L., Jonare, L., Lanneborn, L.: Investigating horse-human interactions: The effect of a nervous human. Veterinary Journal **181**(1) (2009). DOI 10.1016/j.tvjl.2009.03.013
13. Kustiani, L., Brihandhono, A.: The relation of learning styles, learning interests and learning methods used by students with the level of emotional intelligence and grade among students: Case study of economy class at smk ma'arif malang, indonesia. Mediterranean Journal of Social Sciences **8**(5) (2017). DOI 10.1515/mjss-2017-0020
14. Masania, J., Grootveld, M., Wilson, P.B.: Teaching analytical chemistry to pharmacy students: A combined, iterative approach. Journal of Chemical Education (2017). DOI 10.1021/acs.jchemed.7b00495
15. Mulyatiningsih, E.: Riset Terapan Bidang Pendidikan dan teknik Endang Mulyatiningsing. UNY Press (2011)
16. Roche, V., Alsharif, N.: Staying alive. advancing medicinal chemistry by enhancing student responsibility for learning. American Journal of Pharmaceutical Education **66**(3) (2002)
17. Ross, M.: Active learning strategies in the analytical chemistry classroom. Journal of Chemical Education **71**(2) (1994). DOI 10.1021/ed071p141
18. Slavin, R.: Cooperative learning teori, riset dan praktik. In: Nusa Media (2015)
19. Wang, X., Wang, Q.: Investigating the effect of coopetition designs on students' perceived social support in collaborative learning. International Journal of Social Media and Interactive Learning Environments **5**, 292 (2017). DOI 10.1504/IJSMILE.2017.10012116

20. Wenzel, T.: The teaching/learning process in analytical chemistry. Microchimica Acta **142**(3) (2003). DOI 10.1007/s00604-003-0011-7