GRADIVA

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

Optimizing Student Engagement in Pharmaceutical Mathematics Learning: A Case-Based Blended Learning Approach

Sri Rahmawati Fitriatien[1]*, Mustaji[2] & Fajar Arianto[3]

1,2,3.Educational Technology, Universitas Negeri Surabaya, Jl. Raya Kampus Unesa, Lidah Wetan, Kec. Lakarsantri, Surabaya, Jawa Timur, Indonesia.
1.Mathematics Education, Universitas PGRI Adi Buana Surabaya, Jl. Dukuh Menanggal XII, Dukuh Menanggal, Kec. Gayungan, Surabaya, Jawa Timur, Indonesia.
Email: [1]sri.23035@mhs.unesa.ac.id (*Corresponding Author), [1]rahmawatien.srf@unipasby.ac.id, [2]mustaji@unesa.ac.id, [3]fajararianto@unesa.ac.id

Abstract

This study aims to determine pharmacy students' engagement in learning pharmaceutical mathematics using case-based blended learning. The engagement measured included cognitive, affective, and behavioral engagement. This study employed quantitative descriptive approach, involving 37 pharmacy students of Universitas PGRI Adi Buana Surabaya in a case-based blended learning. The blended learning which was focused on the material of concentration calculation was conducted with the assistance of Virlenda. There were two research instruments used in this study including a questionnaire to measure cognitive and affective engagement and an observation sheet to measure behavioral engagement. Both instruments have been validated by two pharmacy education experts and one psychometric expert, showing good internal consistency in the reliability test using Cronbach's alpha. The results of the study indicated that case-based blended learning assisted by Virlenda was effective in increasing student engagement since the majority students showed the ability to relate new material with previous knowledge. Meanwhile, students demonstrated behavioral engagement by actively participating in discussions and learning activities. At last, the Virlenda platform may help with the effective implementation of case-based blended learning by enabling a flexible and dynamic learning environment.

Keywords: *Engagement, Learning, Case-based, Blended learning, Virlenda.*

1. INTRODUCTION

Involving students in pharmaceutical mathematics learning is a great challange in Indonesian higher education, especially in the context of preparing competent pharmacist candidates. In learning pharmaceutical mathematics that combines mathematical formulas with chemical equations in creating formulas [1], [2], student engagement is the key to successfully mastering this complex material. Student engagement, which includes cognitive, affective, and behavioral dimensions, plays an important role in improving conceptual understanding, analytical skills, and practical applications of mathematics in the field of pharmacy to perform calculations involving [3] measurements, fractions, decimals, conversions, and ratios where a prospective pharmacist needs to convert metric measurements into simple measurements accurately to ensure patient safety [4]. However, previous studies show that students often have difficulty actively engaging in advanced mathematics learning [5]–[7] in higher education, which is considered quite difficult to learn due to the characteristics of mathematics itself, students' learning habits, and lecturers' teaching strategies. Moreover, the paradigm that mathematics at the university level tends to present more complex problems and demands high-

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

level thinking skills [8]–[11]. This makes learning innovations designed by lecturers a need for innovative learning approaches that may increase student engagement holistically.

Previous studies have demonstrated [12]–[16] that in mathematics learning, there are still many students who are not actively involved in class, including prospective pharmacist students who are less active in following learning courses related to pharmaceutical mathematics [4], [17], [18]. Therefore, a learning design is needed to foster student interest and motivation in order to remain motivated to learn and make students more involved in learning. Student engagement [5] in higher education has become a separate focus that has been consistently pursued and prioritized due to its significant influence on learning outcomes [19]–[21]. Furthermore, student involvement during the learning process in the classroom has become a separate focus not only for its significant influence on learning outcomes but also for students' success in completing studies [19], [22]–[24].

Engagement is the time and energy that students devote to educational activities, both in and out of class, as well as student participation in applying the theories and practices applied during the learning process [25]–[28]. Engagement consists of three dimensions, namely cognitive, affective, and behavioral engagement [29]–[34], including the emergence of ideas, recognition of values, self-regulation, metacognitive strategies, and the willingness to learn further. On the other hand, affective engagement [35]–[39] is defined as having positive relationships with classmates and teachers, feeling safe and at ease in the classroom, exhibiting excitement and enthusaiasm in learning, and thinking of school as a comfortable and safe environment. Rule compliance, learning reactions, teachers, peers, attendance, concentration or focus, participation or involvement, and learning reactions are just a few of the components that make up behavioral engagement [40]–[44]. To effectively evaluate student engagement during the pharmaceutical mathematics learning process, the elements need to be well-defined. According to prior studies [28], [36], [41], [45] there are four interconnected ways in which engagement can be characterized: (1) engagement with the learning process through active learning, (2) engagement with the object of study based on learning experiences, (3) engagement with the context of study that teaches multidisciplinary learning, and (4) engagement with the human condition in social interaction.

Multidisciplinary mathematics learning develops along with the development of technology and knowledge. Various media and strategies have been applied in mathematics classes and outside mathematics classes that involve mathematics as the basis of science, from elementary to high levels, including pharmaceutical mathematics learning for prospective pharmacist students. Current relevant learning activities refer to student-centered learning activities that allow learners more opportunities to engage in learning [46], [47]. Student-centered learning emphasizes that learning is implemented through strong social relationships and collaboration with fellow students and facilitators. By utilizing this approach, students are significantly involved in the classroom and become increasingly responsible for their learning [48]–[51].

Case-based blended learning is a learning model that has been developed and refers to a student-centered learning approach [52]–[55], which combines the strengths of case-based learning activities by presenting realistic pharmaceutical issues through face-to-face and online learning. Learning pharmaceutical mathematics allows students to apply the mathematical concepts that they have learned and implement them in clinical situations in the form of relevant cases and utilize digital resources to deepen students' understanding of the material and problems they face. In its implementation at Universitas PGRI Adi Buana Surabaya, this

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

learning model is supported by technology based on a learning management system [56], [57] called the Virtual Learning Environment of Adi Buana (Virlenda), which was built to support case-based learning in learning environments both inside and outside the classroom. The features provided in Virlenda are designed to increase cognitive engagement through interactive dosage calculation simulations, affective engagement through collaborative discussion forums, and behavioral engagement through practical tasks that require active student participation.

As a learning management system specifically designed to facilitate case-based blended learning in pharmacy, Virlenda offers unique features that have the potential to increase student engagement in learning pharmaceutical mathematics. The platform allows lecturers to present realistic pharmaceutical case studies involving complex mathematical calculations such as pharmacokinetics and pharmacodynamics. Moreover, students can access interactive simulations in Virlenda to practice drug dosage calculations, participate in online discussion forums to discuss applications of mathematical concepts in clinical scenarios, and take adaptive quizzes that test students' understanding of pharmaceutical mathematics material. The platform's collaborative features also allow students to work together on group projects, enhancing not only their cognitive engagement through collaborative problem-solving but also their affective and behavioral engagement through social interaction and active participation. Thus, Virlenda serves as a learning resource to enhance student engagement in learning pharmaceutical mathematics.

Figure 1: Front page of mathematics learning at Virlenda

Pharmaceutical mathematics learning using a case-based blended learning model assisted by Virlenda is able to facilitate students in expressing their opinions and ideas through the learning activities carried out. Case-based blended learning assisted by Virlenda also encourages class discussion activities and improves higher-order thinking skills [58]–[60], cooperative learning [61], and team building [62]–[67]. The steps in case-based learning assisted by Virlenda include (1) planning and preparation, (2) student orientation at the initial stages of learning, (3) providing problems in the form of case studies, (4) discussion and collaboration activities, (5) presentation and feedback, and (6) reflection and evaluation. In the planning and preparation stage, students are prepared to receive materials and participate in learning activities in safe and comfortable conditions. Furthermore, students receive an initial explanation of the learning objectives that will be followed by them. When offering problems in the form of case studies, certain topics are offered in the form of case studies with multiple

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

cases. Students are allowed to discuss and collaborate on the given problems, and the results of the conversations are then presented and discussed together to receive feedback from the lecturer as a facilitator. At last, the lecturer, as a facilitator, reflects on the learning process that has taken place and provides an evaluation to assess the success of student learning activities.

The implementation of case-based blended learning assisted by Virlenda in pharmaceutical mathematics learning is expected to improve student engagement as a whole. This approach aims to improve student cognitive engagement by solving realistic pharmaceutical problems, such as complex drug dosage calculations, pharmacokinetic analysis, and interpretation of pharmaceutical statistical data. This encourages students to apply mathematical concepts in real clinical contexts. In addition, this learning model is designed to strengthen affective engagement by creating an interesting and relevant learning environment. Through case studies that reflect real situations in pharmacies or hospitals, students can see the direct relevance of pharmaceutical mathematics materials, increasing motivation and interest in learning about the problems presented and relevant to everyday cases in the health sector. Furthermore, Virlenda-assisted case-based blended learning also aims to encourage behavioral engagement through active participation in discussion in and out of class, as well as completing collaborative assignments with peers, including students' ability to present results in groups regarding mathematical solutions to given pharmaceutical cases. The features in the Virlenda learning resources are expected to support independent learning, team collaboration, and continuous assessment in the context of pharmaceutical mathematics that can create a holistic and meaningful learning experience for pharmacy students as prospective pharmacists.

Although several studies have shown the effectiveness of case-based learning in improving students' problem-solving abilities [58] and blended learning in increasing learning flexibility [59], [60], there is still a gap in several references regarding the combined application of these two approaches, especially in the context of pharmaceutical mathematics learning in Indonesia. Previous studies have not comprehensively explored how the integration of case-based learning and blended learning can affect various dimensions of student engagement in a complex course such as pharmaceutical mathematics. This study is expected to fill this gap by conducting an in-depth study of how Virlenda-assisted case-based blended learning affects students' cognitive, affective, and behavioral engagement in learning pharmaceutical mathematics.

Through this student-centered learning activity, it is expected that the application of case-based blended learning assisted by Virlenda can optimize student engagement in learning pharmaceutical mathematics in pharmacy classes. This study aims to determine the engagement of prospective pharmacist students in pharmaceutical mathematics classes on the topic of concentration calculations. The engagement measured includes three dimensions, namely cognitive, affective, and behavioral. By knowing the engagement of students, lecturers get information that can be used as evaluation material for learning design applied in pharmaceutical mathematics learning. Specifically, this study analyzed the level of cognitive, affective, and behavioral engagement of students in learning pharmaceutical mathematics using the case-based blended learning model assisted by Virlenda. The results of this study are expected to provide valuable insights for the development of more effective and contextual pharmaceutical mathematics learning strategies in higher education. More broadly, this study aims to contribute to the global literature on student engagement in technology-based learning, particularly in the context of pharmacy education in developing countries.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

METHOD

This study employed a quantitative descriptive approach to analyze student engagement in learning pharmaceutical mathematics with a case-based blended learning model assisted by Virlenda. The subjects of the study consisted of 37 pharmacy study program students selected using a purposive sampling technique. The study focused on the material of concentration calculation. Measurements were made on three dimensions of student engagement: cognitive, affective, and behavioral. The research instruments used included a questionnaire with a Likert scale of 1-4 to measure cognitive and affective engagement and an observation sheet with a scale of 1-4 to measure behavioral engagement. Both instruments were content validated by two pharmacy education experts and one psychometric expert, demonstrating strong internal consistency ($\alpha > 0.80$) in reliability testing using Cronbach's alpha.

The student engagement was examined across three dimensions: cognitive, affective, and behavioral engagement. Table 1 shows the indicators of student engagement used in the Virlenda-assisted case-based blended learning method.

Table 1: Case-based student engagement indicators

Dimensions of engagement	Indicator
Cognitive	1) Self-regulation 2) Motivation 3) In-depth strategy
Affective	1) Interest 2) Achievement orientation 3) Peer orientation
Behavioral	1) Frequency of asking questions 2) Frequency of participating in group discussions 3) Frequency of explaining to peers

Data were collected by distributing questionnaires to students after the learning was completed, while observations were conducted by two trained observers during the learning session. Data were analyzed using descriptive statistics to calculate the percentage of student responses to each engagement indicator.

To increase the validity of the findings, data triangulation was conducted by comparing the results of the questionnaire and observations. This study has obtained ethical approval from the Integrity Committee Team of Universitas PGRI Adi Buana Surabaya, and all participants have given informed consent before participating.

Lastly, by employing this methodology, this study aims to provide a comprehensive quantitative picture of the level of student engagement in learning pharmaceutical mathematics using the case-based blended learning model, which can be used as a basis for optimizing learning strategies in the future.

RESULTS

This study analyzed student engagement in pharmaceutical mathematics learning using the case-based blended learning model assisted by Virlenda. The results and discussion are presented based on three dimensions of engagement: cognitive, affective, and behavioral. Table 2 presents the percentage of students' cognitive engagement in case-based pharmaceutical mathematics learning.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

Table 2: Percentage of cognitive engagement in case-based pharmaceutical mathematics learning

Indicator	Question items	Number of respondents (%)			
		Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly Disagree (SD)
Self-regulation	1) I try to relate today's learning topic to concepts I have learned (+).	52.81	47.19	0.00	0.00
	2) Today's pharmaceutical mathematics learning topic is not important to learn (-).	0.00	0.00	28.31	71.69
	3) I think a lot about today's mathematics learning (+).	21.47	62.64	15.89	0.00
Motivation	4) I tried my best to study today's pharmaceutical mathematics learning topic (+).	41.12	56.46	2.42	0.00
	5) I believe that I am able to improve my ability to solve pharmaceutical mathematics problems through today's activities (+).	18.72	58.15	23.13	0.00
	6) Today's learning activities make me less motivated to study pharmaceutical mathematics (-).	0.00	0.00	34.72	65.28
In-depth strategy	7) I try to relate today's learning topic to problems related to pharmaceutical mathematics (+).	41.89	58.11	0.00	0.00
	8) I will not re-study the topics that have been discussed today in my spare time (-).	0.00	7.85	65.81	26.34

Source: Primary data processed, 2024

Table 2 indicates that, in the self-regulation indicator, the majority of students attempted to connect learning themes with previously learned concepts. The pharmaceutical mathematics problems offered were based on case studies and used the notion of concentration calculation, pushing students to recollect previously studied material. This was reinforced by a positive reaction from pharmacy students who had worked hard to understand the problem topics connected to concentration calculation that were attached to the case studies offered. However, 28.31% of students felt that they had not tried well to study the topics taught. Most students believe that case-based learning activities can improve their ability to solve pharmaceutical mathematics problems. This activity is also believed by students to be able to increase their learning motivation. Moreover, the in-depth strategy indicator showed that the majority of students associate the concept of concentration calculation with pharmaceutical mathematics problems. Concentration calculation can be used to solve problems related to dosage and drug compounding, which are the main competencies that must be possessed by prospective pharmacist students. In their free time, most students stated that they would re-study the topics that had been discussed, and only 7.85% of students stated that they did not agree to study the topics in their free time. These findings indicate that students' cognitive engagement in case-based pharmaceutical mathematics learning is classified as good.

In the active learning process, cognitive engagement is manifested by the engagement of students in the learning process to create complex ideas and master difficult skills through self-regulation, metacognition, and in-depth strategies [68], [69]. The basic form of engagement related to what students think and will do in learning, according to the psychological

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

perspective [44], [70], defines cognitive engagement as psychological investment and student effort directed at learning, understanding, or mastery of knowledge skills. The percentage of students' affective engagement in case-based mathematics learning is presented in Table 3 below.

Table 3: Percentage of affective engagement in learning pharmaceutical mathematics using case-based

Indicator	Question item	Number of respondents (%)			
		Strongly Agree (SA)	Strongly Agree (SA)	Strongly Agree (SA)	Strongly Agree (SA)
Interest	1) I enjoy learning pharmaceutical mathematics in small groups (+).	72.51	27.49	0.00	0.00
	2) Today's learning is boring (-).	0.00	0.00	16.28	83.72
	3) I am interested in solving the pharmaceutical mathematics problems presented (+).	40.86	51.17	7.97	0.00
	4) Learning pharmaceutical mathematics with case-based model is fun (+)	79.14	20.86	0.00	0.00
Achievement orientation	5) I am happy to be able to solve the problems presented (+).	87.71	12.29	0.00	0.00
	6) I am satisfied to earn a good grade after trying hard (+).	85.26	14.74	0.00	0.00
	7) Attempts to solve concentration calculation problems are not useful to me (-).	0.00	0.00	33.58	66.42
Peer orientation	8) I understand better the math problems related to concentration calculation when studying with friends (+).	67.36	18.23	14.41	0.00
	9) Group discussions kill creativity (-).	0.00	5.63	81.44	12.93
	10) I feel closer to my group mates (+)	73.18	26.82	0.00	0.00
	11) I communicate well with my group mates and other groups (+).	88.36	11.64	0.00	0.00

Source: Primary data processed, 2024

The table above indicates that the affective engagement of pharmacy study program students shows a positive response on the interest indicator. This proves that the implementation of fun learning activities based on case studies is not boring for students. Most students stated that they enjoyed learning in small groups and were interested in solving problems presented in the form of cases. When the presented problem was successfully solved, most students expressed their happiness and satisfaction with their efforts in discussing. This indicates that the students' orientation towards achievement is quite good. Positive affective engagement might be shown by someone who values learning, values the process of acquiring knowledge and skills, and values student success [36]–[38]. Similar things are also shown in the orientation indicator towards peers. Pharmacy study program students feel closer to friends and are able to communicate well with fellow groups and between groups. Group discussions to complete concentration calculations spur creativity and make students understand

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

mathematical concepts better, thus, it can be concluded that student affective engagement in case-based pharmaceutical mathematics learning is classified as good.

The affective engagement dimension is a strength of the psychological approach [71] due to the existence of the commonly overlooked emotional intensity attached to the learning experience. Affective engagement is manifested by direct emotions, such as students' interest and comfort in completing assignments [72]. This engagement is directly related to students' emotions and feelings, which facilitate them to be more focused in implementing attention and encourage student participation and activeness during the learning process.

Student behavioral engagement is previously explained [73] as being closely related to the cognitive and affective engagement of each student. In general, the students' behavioral engagement in case-based pharmaceutical mathematics learning was classified as good. Observation results visualize that the number of students who actively ask questions was 37.16%, and some students who never asked questions was 11.28%. Some students never asked because they had understood the concept and were able to solve the problem, leading the students to explain more to other friends who needed help. All students were seen actively discussing at varying frequencies. 68.37% of students were frequently actively participating in discussions, and this sign was commonly observed when students attempted to solve concentration calculation issues. This case-based learning activity can require all students to grasp the outcomes of their peer discussions. Furthermore, each student can explain the outcome of the discussion to other groups. The results of observations on the frequency indicator of explaining to friends show that all students actively explain with a frequency of often of 70.58% and a frequency of sometimes of 29.42%.The observation data are presented in Figure 2.

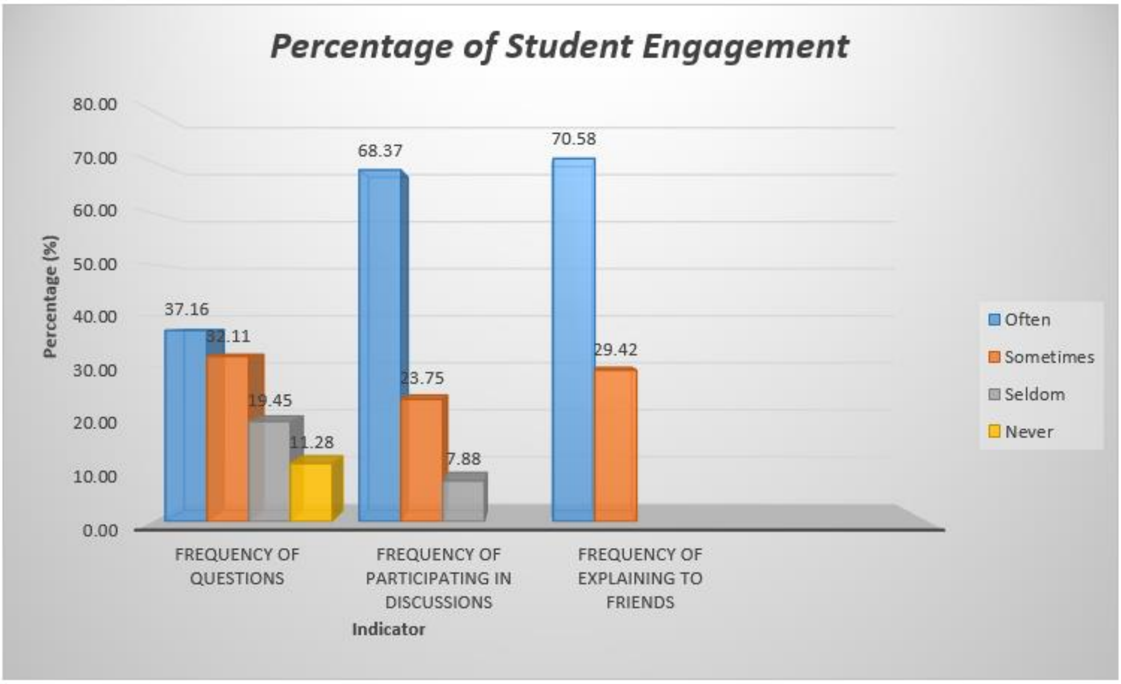

Figure 2: Percentage of behavioral engagement in case study-based pharmaceutical mathematics learning

A person who has good behavioral engagement has the characteristics of being positive in learning, actively participating, being involved in completing tasks, trying hard, and being

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

able to manage themselves well [74]. Students understand when to seek help and help others in need. This engagement includes several skills such as oral and written communication, planning, time management, and goal setting. Observations show that 68.37% of students are often actively involved in discussions. This indicates that case-based blended learning is effective in encouraging active student participation, which is a key component in student-centered learning.

Seen from a mathematical perspective, engagement arises when students are happy and comfortable while participating in mathematics learning activities, students appreciate the process of learning mathematics and see the relevance of mathematics to other sciences, and students see the relationship between the mathematical concepts that have been learned and the problems encountered in everyday life. Therefore, a learning design is needed with a fun strategy and content that links concepts to problems in other fields and is related to everyday life. In learning mathematics in higher institutions, the first consideration for learning design is to make students learn easily because the topic of learning mathematics in higher education is relatively more difficult. Case-based mathematics learning in this study aims to connect students with their peers and the topics taught in a variety of interesting and interactive ways. This supports a previous study [58] that in case-based learning, students are faced with a relaxed classroom situation and can psychologically reduce stress. Moreover, students are actively involved during group discussions and when lecturers walk around to see and understand the results of other groups' discussions.

Triangulation of data from questionnaires and observations showed consistency in the level of student engagement. For example, the high percentage of students who stated that they enjoyed learning in groups (questionnaire data) was in line with the high frequency of engagement in discussions (observation data). The findings of this study have several important implications for the development of pharmaceutical mathematics learning using the case-based blended learning model. First, although most students showed good engagement, there is still a need to strengthen learning strategies that can increase learning motivation in a small number of students who are still less engaged. This can be done by developing more relevant and interesting cases, or by integrating gamification elements into the Virlenda platform. Second, the high level of student engagement in collaborative learning emphasizes the importance of maintaining and even enhancing collaborative elements in pharmaceutical mathematics learning. Lecturers may consider increasing the proportion of group activities and team projects in the curriculum. Third, given the effectiveness of the Virlenda platform in supporting case-based blended learning, there is great potential for further development of this platform. The addition of features that support real-time interaction and more intensive online collaboration can increase student engagement, especially in the context of distance learning. The implementation of these recommendations is expected to further optimize student engagement and ultimately increase the effectiveness of pharmaceutical mathematics learning.

This study has provided an overview of student engagement in learning pharmaceutical mathematics using the case-based blended learning model, but this study still has limitations in terms of implementation and results obtained during the study. Some limitations emerged from this study. The first is the relatively small number of samples, namely 37 students, thus limiting the ability to generalize the findings of this study to a wider population. The results obtained may be specific to the context and characteristics of this group of students involved in this study alone. The second limitation is that this study was conducted in a single learning session, which provides a momentary snapshot of student engagement. This approach does not

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

allow for capturing the dynamics of changes in student engagement over time or identifying long-term factors that may influence their engagement. Moreover, the use of quantitative methods alone may limit an in-depth understanding of students' subjective experiences and perceptions of this learning model. These limitations need to be considered in the interpretation of the results and serve as a basis for improvement in future research.

Based on the findings and limitations of this study, several suggestions can be put forward for further research to deepen the understanding of student engagement in learning pharmaceutical mathematics using the case-based blended learning model. First, it is recommended to conduct a longitudinal study that covers a full semester or even more. This approach will allow for the observation of changes in student engagement levels over time, as well as the identification of factors that influence these fluctuations in engagement. Second, to gain a deeper understanding of student experiences, further research could combine quantitative methods with qualitative methods, such as in-depth interviews or focus group discussions. This will provide richer insights into the factors that influence student engagement and their perceptions of the effectiveness of this learning model. In addition, future research can also expand the scope of the sample, both in terms of the number and diversity of student characteristics, to increase the generalizability of the findings. Finally, a comparative study between the case-based blended learning model and other learning methods in the context of pharmaceutical mathematics can provide a more comprehensive understanding of the relative advantages of these approaches. The implementation of these suggestions is expected to enrich the literature on pharmaceutical mathematics learning and provide a stronger basis for the development of effective learning strategies.

CONCLUSION

This study analyzed the effectiveness of the Virlenda-assisted case-based blended learning model in increasing student engagement in pharmaceutical mathematics learning. The results show that this approach is generally effective in increasing the three dimensions of student engagement, namely cognitive, affective, and behavioral. In the cognitive aspect, the majority of students showed the ability to connect new material with prior knowledge. Affective engagement was seen from the high interest of students in learning, especially in a collaborative context. Meanwhile, behavioral engagement was demonstrated through active participation in discussions and learning activities. The Virlenda platform has been shown to help effectively integrate case-based blended learning, resulting in a flexible and dynamic learning environment.

However, this study did identify areas for improvement, such as a small number of students who had low levels of interest. Overall, these findings provide empirical support for the effectiveness of case-based blended learning in pharmaceutical mathematics learning, offering significant potential to improve the quality of learning. This study provides a strong foundation for further development of this learning model and highlights the importance of continued innovation in teaching methods in pharmacy higher education. With refinement and adaptation to the specific needs of students, Virlenda-assisted case-based blended learning has the potential to become a leading approach in improving the effectiveness of pharmaceutical mathematics learning in the future. Case-based blended learning can be applied to pharmaceutical mathematics learning in pharmacy study programs because it can optimize student engagement in learning. Based on the results of the research that has been conducted, it can be concluded that student cognitive engagement, including self-regulation, motivation,

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

and in-depth strategies, is classified as good. Affective engagement that measures interest in learning, achievement orientation and peer orientation are also classified as good. Behavioral engagement with indicators of frequency of asking questions, engaging in discussions, and explaining to peers also shows good results.

Acknowledgements

This research article was written by Sri Rahmawati Fitriatien, Mustaji, and Fajar Arianto (Educational Technology Study Program, Doctoral Program, Universitas Negeri Surabaya) funded by the Ministry of Education, Culture, Research, and Technology, Directorate General of Higher Education, Research, and Technology through the 2024 Doctoral Dissertation Research Grant Program with Contract Number 071/E5/PG.02.00.PL/2024 dated June 11, 2024. The writers take full responsibility for the content written in this article.

References

1) P. K. Sharma and A. Yadav, "Significance of Mathematics in Pharmaceutical Research," *SSRN Electron. J.*, 2023, doi: 10.2139/ssrn.4484053.
2) M. Hussain, S. Sahudin, I. Yussof, and N. Kaharudin, "The Teaching and Learning of Pharmacokinetic Subjects to Pharmacy Students: Review of Teaching Strategies," *J. Young Pharm.*, vol. 13, no. 4, 2021, doi: 10.5530/jyp.2021.13.85.
3) V. Petkova and J. Atkinson, "Pharmacy Practice and Education in Bulgaria," *Pharmacy,* vol. 5, no. 3, 2017, doi: 10.3390/pharmacy5030035.
4) R. Fika, "The effectiveness of Jigsaw and STAD (student teams achievement division) cooperative learning model on pharmaceutical mathematics," *J. Adv. Pharm. Educ. Res.*, vol. Vol 10, no. Issue 2, 2020.
5) F. C. Lane, L. R. Zientek, A. Sechelski, and S. Shupp, "Effects of Timely Enrollment in College-Level Mathematics on Degree Completion," *J. Coll. Student Retent. Res. Theory Pract.*, vol. 25, no. 1, 2023, doi: 10.1177/1521025120973949.
6) N. Hammerman and R. Goldberg, "Strategies for developmental mathematics at the college level," *Math. Comput. Educ.*, vol. 37, no. 1, 2003.
7) J. Paschal and A. Taggart, "An Examination of the Role of First-Year College-Level Mathematics in STEM Field Major Persistence at a Hispanic-Serving Institution," *J. Hispanic High. Educ.*, vol. 20, no. 3, 2021, doi: 10.1177/1538192719853464.
8) S. Suwarto, I. Hidayah, R. Rochmad, and M. Masrukan, "Intuitive thinking: Perspectives on intuitive thinking processes in mathematical problem solving through a literature review," *Cogent Educ.*, vol. 10, no. 2, 2023, doi: 10.1080/2331186X.2023.2243119.
9) M. P. E. Morales, R. A. Avilla, B. R. Butron, T. O. D. Ayuste, D. B. Masangcay, and R. A. Laureano, "Technology integration traditions, transitions and best practices in philippine higher steam education," *Philipp. J. Sci.*, vol. 150, no. 5, 2021, doi: 10.56899/150.05.36.
10) N. Karjanto and M. J. Acelajado, "Sustainable Learning, Cognitive Gains, and Improved Attitudes in College Algebra Flipped Classrooms," *Sustain.*, vol. 14, no. 19, 2022, doi: 10.3390/su141912500.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

11) J.-C. T. Amanonce, “Mathematics college readiness of grade 12 students: Basis for instructional enhancement,” *Asia Pacific J. Multidiscip. Res.*, vol. 8, no. 3, 2020.

12) Z. Chen and Carmina G. Joson, “Student Development Activities in Chinese Higher Education Institutions: From Assessment to An Enhancement Program,” *Int. J. Educ. Humanit.*, vol. 12, no. 2, 2024, doi: 10.54097/b5t2aa67.

13) M. A. Zayed and I. A. Elshaer, “Physical Activities and Learning Experience of Higher Education Students: Mediating Role of Quality of Life and Physical Self-Esteem,” *Int. J. Environ. Res. Public Health*, vol. 19, no. 20, 2022, doi: 10.3390/ijerph192013417.

14) H. D. T. Dieu and O. D. T. Kim, “Experiential learning activities of technical students at higher education institutions in Vietnam,” *Univers. J. Educ. Res.*, vol. 6, no. 10, 2018, doi: 10.13189/ujer.2018.061030.

15) F. Barrera, J. I. Venegas-Muggli, and O. Nuñez, “The impact of role-playing simulation activities on higher education students’ academic results,” *Innov. Educ. Teach. Int.*, vol. 58, no. 3, 2021, doi: 10.1080/14703297.2020.1740101.

16) S. R. Fitriatien, “Error description of the first year student in aljabar problems,” *Math Didact. J. Pendidik. Mat.*, 2019, doi: 10.33654/math.v5i2.655.

17) A. Soewandi, A. Rachmaulidya, B. Apriliano W, and M. Nur Prana, “Pengaruh Kecerdasan Matematis Logis Mahasiswa Terhadap Kemampuan Penalaran Dasar Matematika Dan Statistika Farmasi,” *J. Pharm. Sci. Herb. Technol.*, vol. 6, no. 1, 2021, doi: 10.35892/jpsht.v6i1.590.

18) M. Suliani, “Persepsi Siswa Terhadap Penggunaan Alat Peraga dalam Pembelajaran Matematika,” *SJME (Supremum J. Math. Educ.*, vol. 4, no. 1, 2020, doi: 10.35706/sjme.v4i1.3143.

19) D. A. Tholibon *et al.*, “The factors of students’ involvement on student-centered learning method,” *Int. J. Eval. Res. Educ.*, vol. 11, no. 4, 2022, doi: 10.11591/ijere.v11i4.22314.

20) A. Prianto, U. N. Qomariyah, and Firman, “Does Student Involvement in Practical Learning Strengthen Deeper Learning Competencies?,” *Int. J. Learn. Teach. Educ. Res.*, vol. 21, no. 2, 2022, doi: 10.26803/ijlter.21.2.12.

21) V. De Tran *et al.*, “Involvement of pharmacy students in scientific research activities in Vietnam,” *Curr. Pharm. Teach. Learn.*, vol. 14, no. 6, 2022, doi: 10.1016/j.cptl.2022.06.004.

22) C. Hache, S. Honoré, and G. Hache, “Active involvement of patients in pharmacist education has a positive impact on students’ perspective: A pilot study,” *BMC Med. Educ.*, vol. 20, no. 1, 2020, doi: 10.1186/s12909-020-02241-y.

23) M. Norhailawati *et al.*, “The power of social networking sites: Student involvement toward education,” *Int. J. Eval. Res. Educ.*, vol. 8, no. 3, 2019, doi: 10.11591/ijere.v8i3.20352.

24) Í. R. Jónsson, “Student involvement in assessment and power relations: teacher’s perspective,” *Pedagog. Cult. Soc.*, 2023, doi: 10.1080/14681366.2023.2186930.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

25) V. ILLasiak Domoff, Y. Poitras Pratt, M. A. Drefs, and M. Wick, "Challenging Definitions of Student Success Through Indigenous Involvement: An Opportunity to Inform School Psychology Practice," *Can. J. Sch. Psychol.*, vol. 38, no. 3, 2023, doi: 10.1177/08295735221149225.

26) S. E. Martens, S. N. E. Meeuwissen, D. H. J. M. Dolmans, C. Bovill, and K. D. Könings, "Student participation in the design of learning and teaching: Disentangling the terminology and approaches," *Med. Teach.*, vol. 41, no. 10, 2019, doi: 10.1080/0142159X.2019.1615610.

27) S. D. Mikkilineni, G. A. Cranmer, E. Ash, and B. E. Denham, "Collegiate Student-Athletes as Health Advocates: The Role of Issue and Source Involvement in Students' Information Processing about Binge Drinking," *Commun. Sport*, vol. 12, no. 2, 2024, doi: 10.1177/21674795231153013.

28) P. A. Hastie, A. Stringfellow, J. L. Johnson, C. E. Dixon, N. Hollett, and K. Ward, "Examining the concept of engagement in physical education," *Phys. Educ. Sport Pedagog.*, vol. 27, no. 1, 2022, doi: 10.1080/17408989.2020.1861231.

29) J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: Potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1. 2004, doi: 10.3102/00346543074001059.

30) A. ElSayary, L. Mohebi, and L. Meda, "The Impact Of The Relationship Of Social/Emotional, Cognitive, And Behavioral Engagements On Developing Preservice Teachers' Digital Competencies," *J. Inf. Technol. Educ. Res.*, vol. 21, 2022, doi: 10.28945/4982.

31) K. Skilling and G. J. Stylianides, "Using vignettes to investigate mathematics teachers' beliefs for promoting cognitive engagement in secondary mathematics classroom practice," *ZDM - Math. Educ.*, vol. 55, no. 2, 2023, doi: 10.1007/s11858-022-01431-w.

32) S. N. Kew and Z. Tasir, "Analysing students' cognitive engagement in e-learning discussion forums through content analysis," *Knowl. Manag. E-Learning*, vol. 13, no. 1, 2021, doi: 10.34105/j.kmel.2021.13.003.

33) S. Li and S. P. Lajoie, "Cognitive engagement in self-regulated learning: an integrative model," *Eur. J. Psychol. Educ.*, vol. 37, no. 3, 2022, doi: 10.1007/s10212-021-00565-x.

34) J. I. Rotgans and H. G. Schmidt, "Cognitive engagement in the problem-based learning classroom," *Adv. Heal. Sci. Educ.*, vol. 16, no. 4, 2011, doi: 10.1007/s10459-011-9272-9.

35) Y. Zhang, Y. Tian, L. Yao, C. Duan, X. Sun, and G. Niu, "Teaching presence promotes learner affective engagement: The roles of cognitive load and need for cognition," *Teach. Teach. Educ.*, vol. 129, 2023, doi: 10.1016/j.tate.2023.104167.

36) R. Maguire, A. Egan, P. Hyland, and P. Maguire, "Engaging students emotionally: the role of emotional intelligence in predicting cognitive and affective engagement in higher education," *High. Educ. Res. Dev.*, vol. 36, no. 2, 2017, doi: 10.1080/07294360.2016.1185396.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

37) A. R. Ribeiro, A. I. Pereira, and M. Pedro, "Predictors of school affective engagement during elementary school: A systematic review," *Analise Psicologica*, vol. 37, no. 2. 2019, doi: 10.14417/ap.1547.

38) W. J. L. Coetzee and S. Pourfakhimi, "Affective engagement as a contextual dimension for predicting intentions to revisit and recommend events–a multinational comparison," *J. Policy Res. Tour. Leis. Events*, vol. 12, no. 3, 2020, doi: 10.1080/19407963.2019.1695345.

39) T. Flowerday and G. Schraw, "Effect of choice on cognitive and affective engagement," *J. Educ. Res.*, vol. 96, no. 4, 2003, doi: 10.1080/00220670309598810.

40) I. Bråten, N. Latini, and Y. E. Haverkamp, "Predictors and outcomes of behavioral engagement in the context of text comprehension: when quantity means quality," *Read. Writ.*, vol. 35, no. 3, 2022, doi: 10.1007/s11145-021-10205-x.

41) M. A. Al Mamun and G. Lawrie, "Student-content interactions: Exploring behavioural engagement with self-regulated inquiry-based online learning modules," *Smart Learn. Environ.*, vol. 10, no. 1, 2023, doi: 10.1186/s40561-022-00221-x.

42) X. Pan, "Online Learning Environments, Learners' Empowerment, and Learning Behavioral Engagement: The Mediating Role of Learning Motivation," *SAGE Open*, vol. 13, no. 4, 2023, doi: 10.1177/21582440231205098.

43) L. Youssef, G. Chemsi, and M. Radid, "The Effect of Group Size on Students' Cognitive and Behavioral Engagement," *Int. J. Emerg. Technol. Learn.*, vol. 18, no. 15, 2023, doi: 10.3991/ijet.v18i15.40665.

44) N. Jiménez-Herrera *et al.*, "Computational Geotechnics," *Géotechnique*, vol. 17, no. 1, 2018.

45) S. A. Raza, W. Qazi, and B. Umer, "Examining the impact of case-based learning on student engagement, learning motivation and learning performance among university students," *J. Appl. Res. High. Educ.*, vol. 12, no. 3, 2020, doi: 10.1108/JARHE-05-2019-0105.

46) D. N. Marpaung and M. F. Azzajjad, "The Effectiveness of Student Centre Learning in Experiment Method on Acid and Base Solution to Increase Student Achievement," *J. Appl. Sci. Eng. Technol. Educ.*, vol. 2, no. 1, 2020, doi: 10.35877/454ri.asci2156.

47) Y. Pasambo and S. Tambuwun, "Effectiveness of Using Student Center Learning Methods in Nursing Department of Manado Health Polytechnic," *Media Kesehat. Politek. Kesehat. Makassar*, vol. 14, no. 1, 2019, doi: 10.32382/medkes.v14i1.721.

48) L. Musharyanti, R. M. Yusup, and H. Priyatnanto, "Teaching method to increase critical thinking in health profession student: a literature review," *Bali Medical Journal*, vol. 10, no. 3Special issue. 2021, doi: 10.15562/bmj.v10i3.2836.

49) S. Panggabean, *Konsep Student Center Learning dan Teacher Center Learning*. 2021.

50) S. Pangabean, S. F. Lisnasari, I. Puspitasari, L. Basuki, A. Fuadi, and H. Firmansyah, *Sistem Student Center Learning dan Teacher Center Learning*. 2021.

51) S. R. Fitriatien and N. Mutianingsih, "Peningkatan Kemampuan Belajar Mandiri pada Mata Kuliah Operasional Riset melalui Self Regulated Learning Mosharafa : Jurnal Pendidikan Matematika Rata-rata Mosharafa : Jurnal Pendidikan Matematika," *Mosharafa J. Pendidik. Mat.*, 2020.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

52) A. M. Bili, M. Mustaji, B. S, and B. Bachri, "Pengaruh Blended Learning Terhadap Hasil Belajar Mata Pelajaran Kimia Pada Siswa Sma Negeri 1 Waikabubak Sumba Barat-Ntt," *J. Ilm. Mandala Educ.*, vol. 9, no. 1, 2023, doi: 10.58258/jime.v9i1.4599.

53) M. Jamaluddin, M. Mustaji, B. S. Bachri, and A. P. Sutarto, "The Role of Gender and Self-efficacy on the Relationship between Flipped and Flex Blended Learning and Mathematics Abilities," *Int. J. Inf. Educ. Technol.*, vol. 13, no. 5, 2023, doi: 10.18178/ijiet.2023.13.5.1882.

54) R. E. Wijaya, M. Mustaji, and H. Sugiharto, "Development of Mobile Learning in Learning Media to Improve Digital Literacy and Student Learning Outcomes in Physics Subjects: Systematic Literature Review," *Budapest Int. Res. Critics Inst. Humanit. Soc. Sci.*, vol. 4, no. 2, 2021, doi: 10.33258/birci.v4i2.2027.

55) M. Jazuli, F. Arianto, and I. Y. Maureen, "Pengaruh Blended Learning Terhadap Efikasi Diri Peserta Didik dalam Pembelajaran Geografi di Madrasah Aliyah Negeri 1 Mojokerto," *J. Ilm. Mandala Educ.*, vol. 8, no. 2, 2022, doi: 10.58258/jime.v8i2.3248.

56) A. B. S. Mahardika, M. Mustaji, and H. S. Setyaedhi, "Pengaruh Materi Pembelajaran Digital Interaktif Terhadap Kreativitas," *Akademika*, vol. 11, no. 01, 2022, doi: 10.34005/akademika.v11i01.1906.

57) W. Hamsia, Y. Riyanto, and F. Arianto, "Utilizing A New Technology of English Discoveries Platform in Implementation of Blended Learning to Improve English Speaking Performance," *Jo-ELT (Journal English Lang. Teaching) Fak. Pendidik. Bhs. Seni Prodi Pendidik. Bhs. Ingg. IKIP*, vol. 7, no. 2, 2020, doi: 10.33394/jo-elt.v7i2.3191.

58) M. Jamaluddin, M. Mustaji, and B. S. Bahri, "Effect of Blended Learning Models and Self-Efficacy on Mathematical Problem-Solving Ability," *Int. J. Learn. Teach. Educ. Res.*, vol. 21, no. 7, 2022, doi: 10.26803/ijlter.21.7.7.

59) N. C. L. Indriani, M. Mustaji, A. Mariono, and F. Arianto, "The Effect of Blended Problem-Based Learning on Problem Solving and Scientific Literacy in High School Students," *Int. J. Soc. Sci. Hum. Res.*, vol. 06, no. 06, pp. 3822–3826, 2023, doi: 10.47191/ijsshr/v6-i6-76.

60) A. Kristanto, M. Mustaji, and A. Mariono, "The Development of Instructional Materials E-Learning Based On Blended Learning," *Int. Educ. Stud.*, vol. 10, no. 7, 2017, doi: 10.5539/ies.v10n7p10.

61) H. D. Pradana, M. Mustaji, F. Arianto, and A. Kristanto, "Increasing Competence in Compiling Teaching Materials through Assistance in the Development of Teaching Materials for Lecturers," *Int. J. Community Serv. Learn.*, vol. 7, no. 1, 2023, doi: 10.23887/ijcsl.v7i1.54243.

62) M. Furqon, P. Sinaga, L. Liliasari, and L. S. Riza, "The Impact of Learning Management System (LMS) Usage on Students," *TEM J.*, vol. 12, no. 2, 2023, doi: 10.18421/TEM122-54.

63) C. Lwande, L. Muchemi, and R. Oboko, "Identifying learning styles and cognitive traits in a learning management system," *Heliyon*, vol. 7, no. 8, 2021, doi: 10.1016/j.heliyon.2021.e07701.

Volume 64 | Issue 09 | September 2025
DOI: 10.5281/zenodo.17104139

64) J. Ohliati and B. S. Abbas, "Measuring students satisfaction in using learning management system," *Int. J. Emerg. Technol. Learn.*, vol. 14, no. 4, 2019, doi: 10.3991/ijet.v14i04.9427.

65) I. Maslov, S. Nikou, and P. Hansen, "Exploring user experience of learning management system," *Int. J. Inf. Learn. Technol.*, vol. 38, no. 4, 2021, doi: 10.1108/IJILT-03-2021-0046.

66) D. Turnbull, R. Chugh, and J. Luck, "An Overview of the Common Elements of Learning Management System Policies in Higher Education Institutions," *TechTrends*, vol. 66, no. 5, 2022, doi: 10.1007/s11528-022-00752-7.

67) A. N. Fatirul and S. Subandowo, "Development of Virlenda-Based Blended Learning with Problem Based Learning Strategy for Problem-Solving Ability for Students," *J. Pendidik. Teor. Penelitian, dan Pengemb.*, vol. 6, no. 12, 2021, doi: 10.17977/jptpp.v6i12.15155.

68) L. B. Aker and A. K. Ellis, "A Meta-Analysis of Middle School Students' Science Engagement," *Int. Dialogues Educ. J.*, vol. 6, no. 1, 2019, doi: 10.53308/ide.v6i1.46.

69) O. Alrashidi, H. P. Phan, and B. H. Ngu, "Academic Engagement: An Overview of Its Definitions, Dimensions, and Major Conceptualisations," *Int. Educ. Stud.*, vol. 9, no. 12, 2016, doi: 10.5539/ies.v9n12p41.

70) M. Moreno, "Perspectives of analytic psychology for short term psychotherapy.," *Riv. Psichiatr.*, vol. 2, no. 6, 1967.

71) U. Hasanah, I. Keperawatan dan Profesi Ners, S. Tinggi Ilmu Kesehatan Kendal, J. Laut, and A. Kendal, "Gambaran Psikologis Mahasiswa Dalam Proses Pembelajaran Selama Pandemi Covid-19," *J. Keperawatan Jiwa*, vol. 8, no. 3, 2020.

72) A. Mulyana, A. J. Senajaya, and D. Ismunandar, "Indikator-Indikator Kecemasan Belajar Matematika Daring Di Era Pandemik Covid- 19 Menurut Perspektif Siswa Sma Kelas X," *Prox. J. Penelit. Mat. dan Pendidik. Mat.*, vol. 4, no. 1, 2021, doi: 10.30605/proximal.v4i1.501.

73) Q. P. Kong, N. Y. Wong, and C. C. Lam, "Student engagement in mathematics: Development of instrument and validation of construct," *Math. Educ. Res. J.*, vol. 15, no. 1, 2003, doi: 10.1007/BF03217366.

74) M. R. Young, "The Art and Science of Fostering Engaged Learning," *Acad. Educ. Leadersh. Journal. 2010 Suppl.*, vol. 14, 2010.