Enhancing Online Problem-Based Learning through Learning Style Analysis

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Abstract. In the evolving digital landscape of education, online Problem-Based Learning (PBL) has emerged as a significant innovation in medical education, presenting challenges that demand professionalism and exposure to disease management for effective learning. This need is particularly pronounced during the COVID-19 pandemic when traditional learning activities face limitations. Students' dominant learning styles have emerged as influential factors shaping compelling learning experiences in PBL. This research aims to discern the impact of students' predominant learning styles on their academic performance during online PBL. Data for this study were collected from second-year medical students using the Honey and Mumford learning styles instrument. The results from 103 participants reveal a significant relationship between individual learning styles and performance in online PBL. Integrating personalized approaches is pivotal in enriching the learning journey for medical students, adequately equipping them to meet the evolving demands of modern healthcare.

Keywords: Online Learning, Problem-Based Learning, Medical Education, Learning Style.

1 Introduction

The global COVID-19 pandemic has accelerated the digital transformation of education, prompting educators to seek alternative methods of instruction in response to restrictions on face-to-face interactions. Among the innovative pedagogical approaches that have gained prominence is online Problem-Based Learning (PBL). Online PBL has become a cornerstone of undergraduate medical and health education during the pandemic, cultivating medical knowledge and emphasizing professionalism and critical thinking skills. This is achieved through active learning, problem-solving, and collaborative exploration of real-world medical cases.[1]

However, the effectiveness of online PBL is only consistent among some students, as some individuals encounter challenges when transitioning to online learning, especially in the context of group interaction.[2] These challenges can be attributed, in part, to differences in learning styles among students. Often described as individuals' unique approaches to processing and assimilating information, learning styles have gained recognition as critical elements in

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educational design and delivery. Unfortunately, there needs to be more research concerning learning style and its effect on performance during PBL, especially online PBL.

Extensive studies have been conducted to evaluate the learning styles of medical students, both in the preclinical and clinical stages. For instance, O'Mahony's (2016) research on medical students in preclinical stages uncovered a notable absence of a significant correlation between learning styles and subsequent anatomy test scores. Using the Honey and Mumford Model, O'Mahony (2016) found that learning styles formed in laboratory environments did not correlate significantly with anatomy test scores. [3] The Honey and Mumford learning style model categorizes learning styles based on learners' strategies for receiving and transforming information. Based on that, the categories include activists, reflectors, theorists, and pragmatists. [4]

As the pandemic necessitated the transition from face-to-face to online learning, students' dominant learning styles may influence their interactions during group discussions, significantly impacting their performance in online PBL. This research aims to discern the distribution of learning styles of medical students, students' performance during online PBL, and the impact of student's predominant learning styles on their academic performance during online PBL. Through a comprehensive exploration of these facets, the study aims to provide valuable insights into optimizing online medical education, ensuring inclusivity and effectiveness in the evolving landscape of virtual learning.

2 Methods

2.1 Research design

This research is a quantitative study of the observational analytical type, employing a cross-sectional approach.

2.2 Research Participants

Data for this study were collected from second-year medical students enrolled at Universitas Brawijaya in East Java, Indonesia. This particular cohort of students from the 2019 batch had been utilizing online Problem-Based Learning (PBL) since their first year of studies due to the challenges posed by the COVID-19 pandemic. A total of 103 students actively participated in this research.

2.3 Research Tools

Data for this study were gathered from second-year medical students using the Honey and Mumford Learning Styles Questionnaire (LSQ), which comprises 80 questions.[4] The questionnaire was distributed using Google Forms.

Online PBL in the Medical Faculty of Universitas Brawijaya was done in 2 synchronous sessions of 7-Jumps steps using the application Zoom Meeting. To assess online Problem-Based Learning (PBL) performance, we calculated the mean scores from the students' online PBL activities during the first and second semesters. This performance score encompassed several components, including how students managed themselves, interacted with others, and handled tasks. Additionally, it considered the quality of their learning reports, which included aspects such as referencing, presentation, and systematic organization. Furthermore, the assessment accounted for the student's achievement of Course Learning Outcomes and their ability to elaborate on conceptual understanding.

The collected data were subsequently analyzed using SPSS 24. This comprehensive approach allowed us to explore the relationships between students' learning styles identified through the LSQ and their performance in online PBL across multiple dimensions.

3 Results and Discussion

3.1 Distribution of Learning Style

Of 103 respondents, the majority consisted of 72 female respondents (70%), while 31 were male (30%). Individual learning styles were categorized based on the strength of style preferences, with the style displaying the highest strength considered the dominant learning style for each individual. Based on the respondent data, it was found that the dominant learning styles were as follows: 4 individuals identified with the activist style (4%), 59 with the reflective style (57%), 9 with the theorist style (9%), and 9 with the pragmatist style (9%). Additionally, 22 individuals (21%) exhibited a combination of more than one dominant learning style. The distribution of learning styles can be observed in Table 1.

Table 1. Respondent Gender and Learning Style Distribution.

Learning Style	Gender (n)		Total (n)
	Male	Female	
Activist	1	3	4
Reflective	15	44	59
Theorist	2	7	9
Pragmatist	3	6	9
Combination	10	12	22
Total	31	72	103

3.2 Students' Performance in Online PBL

The tutors who facilitated these sessions assessed students' performance during online PBL sessions. The scores from these serial PBL assessments were calculated throughout the semester. The average score derived from these assessments was the final PBL score, contributing to the student's overall Grade Point Average (GPA). This research uses this final score as a representative performance measure during online PBL. The respondents' online PBL performance scores were notably very good, with an average score of around 87 each semester, as depicted in Table 2.

Table 2. Online PBL Final Score Distribution for Each Semester.

	Minimum	Maximum	Mean
1st Semester	77.75	94.49	87.59
2nd Semester	72.78	96.25	87.80
Average	75.29	94.63	87.37

3.3 Correlation analysis

The correlation analysis, conducted using Pearson's correlation coefficient, between online PBL performance average score and learning style categories yielded a statistically significant result ($p = 0.003$, $r = -0.347$). This significant negative correlation indicates a meaningful relationship between learning style categories and online PBL performance. To further understand this relationship, we categorized learning styles: 1 for activist, 2 for reflective, 3 for theorist, 4 for pragmatist, and 5 for combination. These findings suggest that as students' learning styles shift from activist (Category 1) to more reflective, theorist, or pragmatist styles (Categories 2, 3, and 4, respectively), their online PBL performance tends to decrease. The result of the correlation tests can be seen in Table 3.

Table 3. Results of bivariate correlation analysis between medical students's learning style and online PBL performance.

		Online PBL Performance
Learning Style Category	Pearson Correlation	-.347**
	Sig. (2-tailed)	.003
	N	103

**. Correlation is significant at the 0.01 level (2-tailed).

An in-depth examination of the individual correlations between specific learning style categories and online PBL performance revealed intriguing insights, as seen in Table 4. The correlations between the activist and reflective learning styles with PBL performance were non-significant ($p = 0.815$, $p = 0.873$, respectively). This implies no statistically significant relationship between these learning styles and online PBL performance. However, a different pattern emerged for other learning styles. Both the theorist and pragmatist learning styles exhibited statistically significant negative correlations with PBL performance ($p = 0.021$, $r = -0.226$; $p = 0.010$, $r = -0.253$, respectively), suggesting that students with stronger inclinations toward these styles tended to achieve lower scores in online PBL tasks. Nevertheless, the combination learning style demonstrated a significant positive correlation with PBL performance ($p < 0.001$, $r = 0.380$), indicating that students with this learning style tended to excel in online PBL activities. These results underscore the complexity of the relationship between learning styles and online PBL performance, emphasizing the need for tailored instructional strategies to accommodate diverse learner preferences.

Table 4. Correlations between The Honey and Mumford Learning Styles and Online PBL Performance.

		Dominant Activist	Dominant Reflective	Dominant Theorist	Dominant Pragmatist	Combination
Online PBL Performance	Pearson Correlation	.023	-.016	-.226*	-.253**	.380**
	Sig. (2-tailed)	.815	.873	.021	.010	.000
	N	103	103	103	103	103

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

3.4 Discussion

The findings show that students' online PBL performance scores were notably excellent, which means the students performed excellently on their tasks, respected others, took responsibility, and made reports of individual learning between online PBL sessions. The respondents are in transition from 1st to 2nd year of the academic stage, which means the excellent performance is representative of their adaptability to the domination of learning style for facing various methods besides interactive lectures only. The observed negative correlation between learning style categories and online PBL performance ($r = -0.347$) sheds light on the dynamics between students' learning styles and their effectiveness in online PBL activities. This correlation suggests that as students' learning styles transition from being more activist to reflective, theorist, or pragmatist styles, their online PBL performance tends to decline. Notably, this implies that students with a stronger preference for theorist and pragmatist learning styles may encounter challenges or advantages when participating in online PBL activities.

Theorist students are inclined to engage in activities that involve models, statistics, narratives, quotations, background information, and the application of concepts in a theoretical manner. This type of student is inherently interested in comprehending the theories underpinning each activity and enjoys contemplating various aspects while understanding their real-world implications. Conversely, pragmatist students excel when they invest time in deep thinking about applying their learning in practical settings but may not resonate with abstract theories and games. They tend to seek practical techniques for implementing what they have learned in real-life situations.[5] Both styles require more guidance from tutors to make the PBL case scenarios more relatable and applicable. This challenge becomes particularly evident in online PBL, where interaction is limited, and tutors need help seeking timely and relevant feedback due to technical issues.[6] By knowing that some of the students have dominant theorists or pragmatist learning styles, tutors will be aware that during the discussion, the students who actively explain the theories and lead the group dynamic should be challenged with the question of the application of what students explain as theories. Therefore, the explainer will get an active and reflective point of their performance, while the others get the practical technique of what is explained.

Theorists, known for their analytical and reflective approach, may explore comprehensively. However, this disposition could also lead to slower responses, especially in the time-sensitive environment of online PBL. Conversely, pragmatists who prioritize practicality may find that their depth of analysis in complex scenarios needs to be improved, which can impact their overall performance. Given that PBL is an active-collaborative learning method that requires understanding the theory behind a problem and applying problem-solving skills, it becomes apparent that a combination learning style may yield more favorable performance results. In line with that, Faculty should consider the socialization and activities that train students in non-dominant learning styles and facilitate it with variation learning methods or consider universal learning to hinder learning styles as a disability factor for students' learning.

As the results indicate, more than half of medical students have a reflective learning style, with 21% exhibiting a combination learning style. This prevalence of combination learning styles among medical students is common, as observed in studies conducted at Taibah University.[7]

This distribution might be caused by the curriculum of medical schools, which uses PBL as the primary strategy for academic stage education. PBL itself nurtures not only reflective learners but also trains another learning style to be more active, at the same time, searching the foundation theorist for bridging the clinical phenomena in the scenario. Furthermore, in line with this, a study involving preclinical students in Thailand showed a correlation between solid academic performance and the reflective learning style. [8] Reflective students excel in gathering firsthand information, analyzing situations from various perspectives, and ultimately arriving at well-founded conclusions. This aligns with the collaborative nature of group interactions, a key factor for success in online PBL. [2]

Nevertheless, it would be advantageous if pragmatist and theorist learning styles could be nurtured alongside other styles during medical education. This holistic approach can lead to the development of a combination learning style. In the long run, students will require flexibility, motivation, and perseverance to adapt to various learning situations, including online learning, to maximize their learning experiences.[9] For example, in the future workplace, doctors will not only learn through workshop or reading recent journal, but they should also reflect to what wrong during their disease management and doctor-patient interaction continuously with reflect and act on solutions for improvement

Educators should consider adopting a multifaceted approach in their online PBL design, providing resources and activities catering to various learning styles. For example, incorporating interactive group discussions and self-paced research tasks into online PBL modules can create a more inclusive learning environment. Additionally, providing opportunities for students to reflect on their learning processes can benefit those with reflective learning styles.

However, it is imperative to recognize and address several limitations that may impact the generalizability and depth of the findings. Firstly, the study's context is a critical consideration. The research focused on a specific academic setting, and the findings may only be universally applicable across some educational environments. Variations in institutional structures, curricular designs, and technological resources could influence the dynamics between learning styles and online PBL performance.

Another noteworthy limitation is the study's reliance on a limited sample size. A more extensive and diverse participant pool could enhance the study's external validity, providing a broader perspective on how various learning styles manifest in online PBL scenarios. Additionally, using self-reported learning styles introduces the potential for bias, as individuals may not accurately represent their cognitive preferences.

In advance, future research could delve deeper into specific strategies and interventions catering to students' diverse learning styles engaged in online PBL. Understanding how instructional design can be tailored to accommodate different learning preferences may lead to more effective online learning experiences.

Furthermore, exploring the impact of instructor training and support in adapting to diverse learning styles is a promising avenue for future investigation. Educators equipped with the knowledge and skills to address varied learning styles could play a pivotal role in enhancing the overall effectiveness of online PBL.

In conclusion, while this study contributes significantly to the field, its limitations underscore the need for continued research to refine and expand our understanding of the complex

relationship between learning styles and online PBL performance. Addressing these limitations will strengthen the validity of findings and provide actionable insights for educators and instructional designers in diverse educational settings.

4. Conclusion

In conclusion, the majority of medical students are reflective learners. Moreover, the average online PBL performance score was notably excellent, even during a pandemic. This study emphasizes recognizing the significance of learning styles in the context of online problem-based learning (PBL), which is instrumental in shaping the trajectory of medical education. Indeed, medical students who predominantly exhibit theorist and pragmatist learning styles can greatly benefit from developing flexibility by activating other learning styles and creating a combination. This adaptability is essential for not only surviving but also optimizing their performance during online Problem-Based Learning (PBL) and throughout their medical education journey. As medical students are equipped with personalized learning approaches tailored to their styles, their performance in online PBL is enhanced, and they are nurtured as lifelong learners. This adaptability is crucial, ensuring that they remain agile and committed to continuous education throughout their careers. Even though the sample size and reliance on self-reported learning styles are limitations of this study, it is worth bridging the gap between learning style analysis and online PBL as it will trigger closeness for tutors by concerning the learning style of medical students. Future research could delve deeper into the specific strategies and interventions that can optimize online PBL experiences for students with diverse learning styles. Moreover, exploring the impact of instructor training and support in adapting to diverse learning styles could be a valuable avenue for research.

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