Analysis of Self-Regulated Learning and Learning Style Preference of First-Year Medical Students for E-Learning Optimization

Rena Fuji Erin Setyawati[1]; Bhakti Gunawan[2]; Matrissya Hermita[3*]; Ruddy J Suhatril[4]; Rama Dian Syah[5]

[1,2]*Department of Medical Education, Universitas Gunadarma, Indonesia*
[3]*Department of Psychology, Universitas Gunadarma, Indonesia*
[4]*Department of Informatics, Universitas Gunadarma, Indonesia*
[5]*Department of Information System, Universitas Gunadarma, Indonesia*
[3*]*Corresponding Email: matrissya@staff.gunadarma.ac.id, Phone Number: 0815 xxxx xxxx*

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Abstract: First-year medical students adapt to hybrid education, combining online and offline learning in the new standard era. The various features of e-learning need to accommodate students' skills in self-regulated learning and their preferences, such as learning style preference. Therefore, this research aims to analyze first-year medical students' self-regulated learning skills and learning style preferences in online learning to identify e-learning optimization needs that can facilitate their adaptation to medical education. A descriptive quantitative and qualitative narrative method was conducted through document analysis. The Online Self-Regulated Learning Questions (OSRLQs) were used to obtain quantitative descriptive data on students' self-regulated learning skills, and the learning style preference questionnaire was used to obtain data on first-year medical students. The results showed that first-year medical students require optimization in four domains of the self-regulated learning skills in online learning, including task strategies, time management, help-seeking, and self-evaluation. The analysis yielded 19 categories with three main learning style preferences: a combination of visual and auditory and a combination of visual, auditory, and kinesthetic. This analysis recommends optimizing several e-learning features to improve first-year medical students' self-regulated learning skills and learning style preferences.

Abstrak: Mahasiswa kedokteran tahun pertama beradaptasi dengan pendidikan hybrid, yang menggabungkan pembelajaran online dan offline di era normal baru. Berbagai fitur e-learning perlu mengakomodasi keterampilan mahasiswa dalam pembelajaran mandiri dan preferensi mahasiswa, seperti preferensi gaya belajar. Oleh karena itu, penelitian ini bertujuan untuk menganalisis keterampilan belajar mandiri dan preferensi gaya belajar mahasiswa kedokteran tahun pertama dalam pembelajaran online untuk mengidentifikasi kebutuhan optimalisasi e-learning yang dapat memfasilitasi adaptasi mahasiswa terhadap pendidikan kedokteran. Metode naratif deskriptif kuantitatif dan kualitatif dilakukan melalui analisis dokumen. Online Self-Regulated Learning Questions (OSRLQs) yang digunakan untuk memperoleh data deskriptif kuantitatif keterampilan self-regulated learning siswa dan angket preferensi gaya belajar untuk memperoleh data mahasiswa kedokteran tahun pertama. Hasil penelitian menunjukkan bahwa mahasiswa kedokteran tahun pertama memerlukan optimalisasi pada empat domain keterampilan self-regulated learning dalam pembelajaran daring, antara lain strategi tugas, manajemen waktu, pencarian bantuan, dan evaluasi diri. Analisis menghasilkan 19 kategori dengan tiga preferensi gaya belajar utama yaitu kombinasi visual dan auditori, serta kombinasi visual, auditori, dan kinestetik. Berdasarkan analisis tersebut, optimalisasi beberapa fitur e-learning direkomendasikan untuk meningkatkan keterampilan belajar mandiri dan preferensi gaya belajar mahasiswa kedokteran tahun pertama.

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A. Introduction

Medical education is a competency-based process that requires students to balance knowledge, psychomotor skills, and attitudes (Barrow et al., 2010; Modi JN et al., 2015). Medical education consists of a series of educational stages. First is undergraduate medical education, which is continued with a clerkship (Sá et al., 2021; Santoso, 2024). The two major stages in medical education aim to equip medical students in theory and practice according to the expected competency. Therefore, learning in medical education implicates a complex organizational and structural system in medical education institutions, followed by an appropriate curricular design, implementation, and evaluation (Prihatiningsih et al., 2021). Medical education's primary goal is to create a doctor with high clinical expertise who meets the standard of a five-star doctor (Siregar et al., 2024).

A shifting paradigm happened in medical education. Despite the curricular design, the implementation of education shifted from teacher-centered learning to student-centered learning (Dent & Harden, 2013). Learning in medical education is a long process, requiring the student's willingness to learn. It involves a concept called adult learning. Adult learning emphasizes independent and student-centered learning (Sharma et al., 2023). The complexity of material, time constraints, and the need to create lifelong learners in medical education encourage medical students to have their self-directed learning sessions (Charokar & Dulloo, 2022). They should find meaningful learning during medical education (Ovens & Fletcher, 2014). Hence, medical students must adapt to the educational process to achieve the expected competencies.

Adaptation in medical education is an uneasy process, especially for the first-year medical student. The transition from high school to university is challenging. The first-year medical student struggles and feels stressed due to some factors: being far from home, facing a competitive culture in medical education, fear of failure, and having problems with self-directed learning (Picton et al., 2022). Fabry's (Fabry & Giesler, 2012) research showed that novice medical students change their learning strategies during their first academic year. The adaptation process during the first year of medical students forces the medical institution to design suitable environments and programs that help students adapt (Datta et al., 2022). The importance of adaptation for medical students has led to several studies that have determined what efforts can be made to help with adaptation.

Some research was carried out to evaluate first-year medical students. The ability of self-regulated learning (SRL) of first-year medical students is essential to setting educational goals and strategies and reflecting on the learning process. The research showed that students had limited time to engage in SRL skills, and their previous learning strategies and skills were inefficient (Boyd et al., 2022). Other research has been conducted to examine the learning style preferences of first-year medical student and their academic performance. The results showed that learning style is associated with academic performance, and it will help students adapt some learning techniques related to their learning style. The first year of medical education is critical; therefore, exploring college adjustment and the contributing factors in the first year is essential. Another research reported that college adjustment

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involves some aspects, especially technology dependence, and culture, that faculty should prepare to support the adaptation of first-year medical students (Zhuhra et al., 2022). First-year medical students also faced extra adjustments during and after COVID-19. Students adjusted the new learning resources, spaces, and daily learning routines (Slivkoff et al., 2021).

The COVID-19 pandemic has impacted the adaptation process of medical education. The Covid-19 pandemic has transformed medical education (Lucey et al., 2022). The most transformation shaping medical education is integrating technology such as online learning modules, virtual interactions, e-learning, and flipped classrooms (Hoque, 2024). Some research about hybrid or distance learning in medical education, primarily first-year medical students, has been conducted. An investigation of first-year medical students' expectations about shifting education to distance learning showed they had high computer skills, so they did not worry.

On the other hand, they did not enjoy distance learning and needed the touch of human interaction in an authentic setting (Cicha et al., 2021). Other research revealed that students engaged in their role from social and cognitive aspects. However, their role needs to be supported by improving digital and information technology (Yu, 2022). Medical education can still be taught through hybrid learning. Therefore, hybrid learning needs to be improved (Lestari et al., 2021). The implications of several of these studies encourage the optimization of hybrid learning tools, especially after the COVID-19 pandemic.

The optimization of hybrid learning tools for first-year medical students can support their adaptation to medical education. The COVID-19 pandemic has changed the process from face-to-face to fully online learning during the pandemic, followed by the implementation of hybrid learning in the new standard era. Online learning is conducted through synchronous and asynchronous methods using cloud meeting platforms and e-learning. These two methods are expected to accommodate cognitive, psychomotor, and attitudes, specifically in students' self-directed learning sessions (Fabriz et al., 2021). Besides the fact that hybrid learning is applied in the new standard era, medical students are responsible for managing their learning (Kaufman, 2003). Proper learning strategies are part of self-directed learning sessions (Boyer et al., 2014). Therefore, educational institutions must develop adaptive measures to optimize learning (Daroedono et al., 2020).

E-learning uses electronic media to deliver, support, and enhance learning to make the environment more interesting (Volman, 2005; Solimeno et al., 2008). It provides various features that can help optimize the process to facilitate clinical and technical skill-focused materials (Morris & McKimm, 2009). Previous reports have found that web-based e-learning with videos can encourage students to listen and pay attention to specific materials. The lecturers assist students in analyzing the video or learning material (Huggett & Jeffries, 2010).

Several aspects influence the use of e-learning to achieve optimal results in supporting competency attainment. These include learning styles (El-Sabagh, 2021), student characteristics, learning environment, and methods needed to achieve learning goals

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(Venkatesh et al., 2020). These aspects need to be considered while designing and optimizing e-learning to accommodate students' learning needs due to their prior experience in high school attending most online education.

First-year medical students in the new standard era require extra adaptation during the learning process, as most of them have experienced complete online learning in high school. They not only should adapt to hybrid learning, but they should make adaptations to the transition from teacher-centered learning to student-centered learning in medical education (Javed et al., 2022), especially in self-directed learning sessions. The adaptation process can be supported by e-learning that accommodates the needs and characteristics of the students, such as the ability to regulate their learning process independently. This requires self-regulated learning skills, allowing students to control their stress (Varunki et al., 2017). The student skills can be optimized by providing e-learning that meets their needs. Students' learning styles are individual preferences (van den Berg, 2015) and must be accommodated in e-learning. Differences in learning styles affect how students receive learning, thereby influencing goal achievement (Chetty et al., 2019). E-learning makes it possible to bridge the differences in characteristics and preferences of students toward the delivery of materials (Van Seters et al., 2012; Nammakhunt et al., 2023).

Incorporating several learning style preferences is a crucial factor in e-learning design. By considering these styles, e-learning can be designed to increase the attractiveness and willingness of students to participate in the learning process (Elshareif & Mohamed, 2021; Lin et al., 2014). The provision of e-learning optimized by accommodating self-regulated learning skills and various learning styles possessed by first-year medical students can help adapt. However, there was some research about first-year medical students that revealed some factors affecting the transitions of medical students and the impact on academic performance had been conducted. All the results showed an in-line and essential point that first-year medical students need support during their transitions. However, first-year medical students require extra adaptation efforts (Ahmadi et al., 2009), specifically in hybrid learning during the new standard era after the COVID-19 pandemic. The shifting era brings us to make a strategy to support first-year medical students. The optimization of e-learning was affected by the student's learning styles and was expected to accommodate the student's self-regulated learning skills. There is much research about self-regulated learning and learning style preferences related to academic performance; however, there is not much research about self-regulated learning and learning style preferences related to e-learning optimization. Therefore, this research aims to analyze first-year medical students' self-regulated learning skills and learning style preferences to develop recommendations for optimizing e-learning used in the medical education process. Optimization through e-learning was expected to help the student optimize their learning process, especially in their first year of medical studies.

B. Method

This research used a mixed-method design incorporating quantitative descriptive and qualitative narrative using a document analysis approach. The subjects were Faculty of

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Medicine, Gunadarma University students who fulfilled the following inclusion criteria: First-year students of the 2020 and 2021 cohorts who participated in online learning and utilized e-learning. The number of subject samples was 59 students who fulfilled the inclusion criteria. The diagram that captured the research process can be seen in Figure 1.

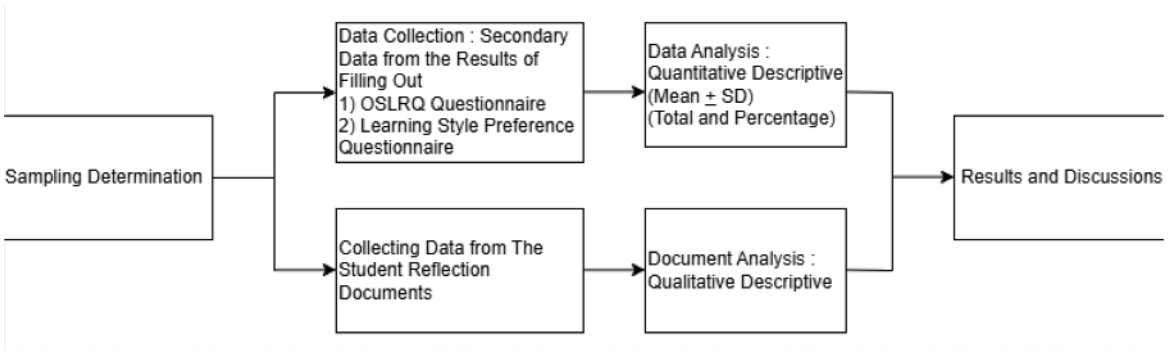

Figure. 1. Research Flow Diagram

Figure 1 briefly explains that after determining the samples, the data collection was conducted by collecting secondary data. The secondary data comprised the following documents: respondents' demographic data and some filled-out questionnaires. Respondents' demographic data included gender and academic year. Online Self-Regulated Learning Questions (OSRLQ) data will be used to evaluate students' skills in applying self-regulation in online learning. The questionnaire comprised six domains: goal setting, task strategies, help-seeking, environment structuring, time management, and self-evaluation. The questionnaire was completed using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)—questionnaire data on learning style preferences to measure students' visual, auditory, and kinesthetic learning styles. The last data was student reflection documents on their learning style.

Data collection resulted in two kinds of data: first, quantitative and the second qualitative data. The quantitative data from the OSRLQ questionnaire were processed descriptively using mean and standard deviation calculations. Meanwhile, the data from the learning style preference questionnaire were processed using weighting calculations according to the prescribed method for processing the questionnaire, which was presented descriptively. The qualitative data were obtained from student reflection documents on their learning style, which were analyzed through a coding process.

C. Result and Discussion

Result

1. The Needs of E-Learning Optimization Based on the Skill of First-Year Medical Students to Apply Self-Regulation in Online Learning

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Data from the OSRLQ questionnaire showed that 59 subject samples completed the questionnaire, and an 85.5% response rate was obtained. Based on gender data, there were 17 male and 42 female respondents. According to the academic year, 31 students were from the class of 2020 and 28 students from the class of 2021.

The results of the OSRLQ questionnaire data analysis are presented in Figure 2 according to the six domains listed below. Figure 2 shows that all five domains' average scores and standard deviations were above 4. The highest mean score and standard deviation were in the environment structuring domain, while the lowest score was in the task strategies domain, above three on a 5-point scale.

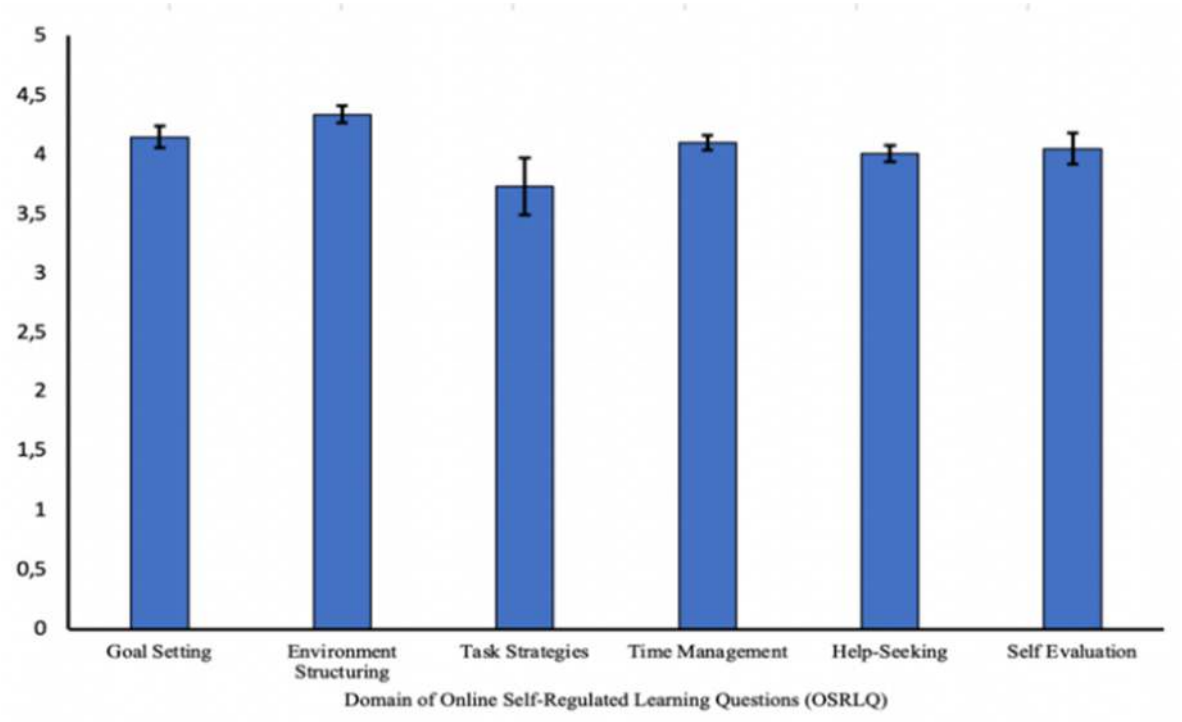

Figure. 2. Results of Measuring the Skill of First-Year Medical Students to Apply Self-Regulation

Table 1 showed more specific results based on individual items in several domains with average scores and standard deviations above three and under 4 on a 5-point scale. The lowest point in the Task Strategies domain was preparing questions before entering the discussion forum. Other points in the four domains listed in Table I were some areas that need improvement.

Table 1. The Skill of First-Year Medical Students to Apply Self-Regulation in Online Learning Based on OSRLQ Measurement Results

No	Domain	Mean ± SD
Task Strategies		

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No	Domain	Mean ± SD
1	I try to take complete notes while studying online because notes are needed more during online learning than face-to-face learning	3,98±0,92
2	I read material out loud to combat/overcome distractions	3,36±1,19
3	I prepared questions before entering the discussion forum	3,27±0,87
Time Management		
4	I try to schedule at the same time every day or every week to study online, and I review my schedule	3,97±0,81
Help-Seeking		
5	If needed, I try to meet my friends face to face to discuss problems in studying	3,85±0,83
6	I am persistent/consistent in seeking assistance from instructors/facilitators via email or other online communication media	3,98±0,68
Self Evaluation		
7	I communicate with my classmates to get information/input about my performance in online learning	3,81±0,88

2. E-Learning Optimization Needs Based on Learning Style Preferences of First-Year Medical Students

An analysis of learning style preferences data for first-year medical students indicated 19 preferences from a combination of 3 main types. The results were obtained from 59 subject samples, as presented in Table 2. Table 2 showed that the most dominant learning style preference was visual at 20.29%, followed by a combination of visual, auditory, and kinesthetic at 13.04%, which were equally balanced. The third most preferred learning style was a combination of visual and auditory, with a proportion of 7.25%. Based on the analysis of learning style preferences, students have an average combined of two or three main learning styles.

Table 2. Learning Style Preferences for First-Year Medical Students

No	Category	Total	Percentage
1	Visual and Auditory	5	7,2
2	Visual	14	20,29
3	Visual, Auditory (predominantly), Kinesthetic	4	5,79
4	Visual (dominant) and Auditory	4	5,79
5	Visual and Kinesthetic (dominant)	2	2,90
6	Kinesthetic	2	2,90
7	Visual (dominant) and Kinesthetic	3	4,35

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No	Category	Total	Percentage
8	Visual-auditory (predominantly) and Kinesthetic	3	4,35
9	Auditory and Kinesthetic	4	5,79
10	Auditory and Kinesthetic (predominantly)	1	1,45
11	Visual, Auditory, and Kinesthetic (predominant)	3	4,35
12	Visual and Auditory (dominant)	2	2,90
13	Visual (predominantly), Auditory, and Kinesthetic	2	2,90
14	Auditory	2	2,90
15	Visual and Kinesthetic	3	4,35
16	Visual-kinesthetic (dominant) and Auditory	1	1,45
17	Visual and Auditory-Kinesthetic (predominantly)	4	5,79
18	Visual, Auditory, and Kinesthetic	9	13,04
19	Auditory (dominant) and Kinesthetic	1	1,45
Total		59	100

After further evaluation of the student's preferences obtained from the document analysis, the following excerpts are extracted from student reflections on their learning styles:

1. How do you apply your learning style?
   Quote 1:
   ".... Because I consider myself slightly kinesthetic, I learn by moving my body a little, for example, my hands...."
   Quote 2:
   ".... In addition to reading, watching videos also helps me understand the material, but for certain videos...."
   Quote 3:
   ".... My usual learning strategy is that if I do not understand the learning material or a new term, then I will use learning videos and animations on YouTube, therefore it is easier to understand...."
2. What effects do you feel when applying your learning style?
   Quote 1:
   ".... I feel better when I use the learning style I mentioned, because the material I will learn is easier to understand and I feel comfortable or not bored when learning or in the process of studying...."
   Quote 2:
   ".... If I already understand through reading, I do not need to watch videos, maybe I still watch the video to strengthen my memory...."

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Quote 3:
".... In my opinion, I am comfortable with the learning style I described in points 1 and 2 because I am used to applying the method...."

Discussion

First-year medical students need to adapt from high school to medical school, especially to face the complexity of medical education (Picton et al., 2022). Competencies can be achieved through a series of learning processes, including face-to-face learning in class and optimizing self-directed learning sessions to help students gain more substantial concepts in lifelong learning as medical practitioners (K Nayak & Belle, 2020). E-learning is one of the learning media that facilitates self-directed learning sessions (Geng et al., 2019). Therefore, this study probes the first-year medical students' self-regulated learning skills and learning characteristics for optimizing e-learning design. Analyzing medical students' self-regulation in online learning and students' learning characteristics can provide resources to facilitate their learning and support students using technologies for learning (Zheng, 2022).

This study analyzed first-year medical students' self-regulated learning skills and learning style preferences. The study findings indicate that the students have good self-regulated learning skills based on six domains of online self-regulated learning (Figure 1). However, 4 out of 6 domains should be increased by optimizing e-learning (Table 1). This means that students can regulate their educational process, both cognitively and motivationally (Boekaerts, 1996). Another finding from this study showed that visuals dominate the preference for learning style, followed by a combination of visual, auditory, and kinesthetic (Table 2), which should be covered in e-learning design. Covering students' characteristics is needed by reshaping learning interaction through multimodal learning using digital technologies (Bouchey et al., 2021).

Self-regulated learning capability can be achieved through student awareness and self-reflection on their learning process (Cassidy, 2011; Boekaerts, 1996; Zimmerman, 2002). It is influenced by social interaction, including environment, peer study, and teacher (Berkhout et al., 2017; Alvi & Gillies, 2015). The student's online self-regulated learning skill showed their ability to manage environmental conditions during learning. As shown in Table 1, the domain of environment structuring created a mean score above four on a 5-point scale. This high score indicated that students could select and manage their environmental conditions to enhance focus (Hapsari & Fatmasari, 2022).

There is still a need for improvement in managing tasks and online learning, although the skills in all six domains showed a reasonable level. Figure 1 also revealed that the domain of task strategies showed the lowest mean score among the six domains. This domain may not be optimal because students are not entirely motivated that their strategies will affect learning goals (Filgona et al., 2020; Wu et al., 2020). Metacognitive skills in controlling learning strategies and their reasons for use can help students manage the task strategies domain (Kesuma et al., 2020).

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Table 1 shows that seven aspects of students' skills to regulate their learning process in online learning have an average score of 3 on a scale of 5. This indicated that some of these aspects can be optimized by using e-learning. Students' skill to manage their learning process independently is affected by learning facilities, environment, peer learning, and teachers (Berkhout et al., 2017). Therefore, e-learning optimization can facilitate self-directed and self-regulated learning (Uz & Uzun, 2018). The optimization plans can be designed, as illustrated in Table 3, by providing or optimizing features that can improve students' self-regulated learning skills.

The self-regulated learning domain must be optimized with e-learning, specifically task strategies. Medical education institutions can provide features to facilitate students in managing cognitive aspects of self-regulated learning, such as note-taking features, organizing mind maps, information search, collaboration, and communication skills, as well as guidance features with teachers (Winne et al., 2005). Developing an integrated learning schedule feature with teaching materials and reminders is also required to optimize self-directed learning outside face-to-face classroom meetings. According to (Ormrod, 2012), self-directed learning using the spacing effect, such as practice sessions and additional learning accomplished in spare time outside lectures, can improve material retention.

The results also showed that Time Management, help-seeking, and self-evaluation must be optimized. Based on Table 3, e-learning optimization can be accomplished by developing live meetings, chat, and feedback features. Moreover, feedback features need to be optimized. Additional feedback through e-learning is essential for medical students to perform better (Schwerter et al., 2022). Feedback from teachers and other students can become sources for reflection to improve students' capabilities (Mahini et al., 2012; Allaymoun & Shorman, 2022). Self-reflection is part of self-regulated learning. It involves self-management of thoughts, feelings, and behavior that can facilitate the achievement of learning goals (Zimmerman, 2002). Optimization of feedback, chat, and live meeting features on e-learning, such as the development of e-community features, can be used as one of the media to facilitate feedback through a chatting room or email as a replacement for face-to-face classrooms (Martínez-Argüelles et al., 2015). E-community facilitates collaboration, sharing, and engagement in e-learning communities (Ellaway & Masters, 2008). Discussion and feedback can be given as scenarios or questions uploaded and discussed in the e-community (Doherty & McKimm, 2010).

The analysis of learning style preferences (Table 2) showed that students have an average combination of two or three main learning styles, including visual, auditory, and kinesthetic. First-year medical students have a multimodal learning style (Samarakoon et al., 2013). The document analysis based on student reflection showed that students use multiple styles to optimize their learning process. Students may use multimodal styles because they feel more comfortable applying their preferred learning styles (Girón-García & Gargallo-Camarillas, 2020), as stated by a respondent in this research. The metacognitive aspect of students in the learning process management influences their learning style preferences (Stephanou & Mpiontini, 2017). Another consideration is that the students are

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already accustomed to their learning style, which reflects their ability in the process of organizing, demonstrating, combining, processing information, storing, and retrieving information (Fleming et al., 2006) as well as making a change according to needs and individual preferences.

Table 3. E-Learning Optimization That Can Be Designed to Improve Students' Skills in Self-Regulation in Online Learning

No	Domain	E-Learning Optimization Plan
Task Strategies		
1	I try to take complete notes while studying online because notes are needed more during online learning than face-to-face learning	Optimizing the mind mapping or note features
2	I read material out loud to combat/overcome distractions	Optimizing the features of teaching materials and reminders for students to read
3	I prepared questions before entering the discussion forum	Optimizing the features of discussion scenarios or cases for students to study the scenario before the discussion
Time Management		
4	I try to schedule at the same time every day or every week to study online, and I review my schedule	Optimizing the integrated calendar feature with lecture schedules and schedule reminder features
Help-Seeking		
5	If needed, I try to meet my friends face to face to discuss problems in studying	Optimizing the live meeting feature for students to discuss
6	I am persistent/consistent in seeking assistance from instructors/facilitators via email or other online communication media.	Optimizing chat features for consulting students and connecting to teaching devices or marked with incoming chat notifications
Self Evaluation		
7	I communicate with my classmates to get information/input about my performance in online learning.	Optimizing the feedback feature, hence, students can provide feedback to each other

The results of learning style preferences showed that e-learning needs to be optimized to accommodate all three learning styles, including visual, auditory, and kinesthetic. Multimedia e-learning can be developed to accommodate different learning styles and deliver various materials in e-learning (Santoso et al., 2021). According to (Maggio et al., 2012), online interactive tools such as 3D graphics that combine video and 3D graphics can facilitate memory retention and cognitive information processing. Another plan for optimizing e-learning includes providing teaching materials that accommodate text, video, or audiovisual formats. Health faculty students prefer visual learning styles with animations and videos, making learning easier (Parai et al., 2015). Simulation features for clinical skills can also be optimized to accommodate visual and kinesthetic learning styles. Web-based learning with skill simulations can allow students to learn more cases and repeat clinical

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skills without being limited by time, location, and patients (Morente et al., 2014).

D. Conclusion

Self-regulated learning skills and learning style preferences are two factors that influenced the optimization of e-learning in medical students, especially for first-year medical students in their adaptation process. The first-year medical students had a good self-regulated learning ability, especially in managing the learning environment and setting goals. However, some domains of online self-regulated learning need to be improved. The majority of first-year medical students had visual style as a learning style preference, and the combination of learning styles was common in their characteristics.

This research suggested that e-learning should optimize four out of six domains of first-year medical students' skills to apply self-regulated learning in online learning. The results showed that the learning style preference mainly combined the three learning styles. Therefore, optimizing the six e-learning features is recommended to improve self-regulated learning and learning style preference.

Further research is needed to explore more aspects that can fully optimize e-learning development in medical education, especially in the Gen Z era. Qualitative research methods such as focus group discussions or interviews can be used to fully explore the needs of students in self-directed learning sessions using e-learning. Characteristics and learning needs in medical education can be added as variables or data to thoroughly investigate the need for e-learning optimization in medical schools.

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