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Comparing Deep Self-Directed Learning and Teacher-Led Instruction in the Digital Era: Impact on Student Achievement, Learning Approach Preferences, and Expectations for Teacher

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Abstract

In the digital era, students can easily access and process learning resources, which enables them to engage in self-directed learning(SDL) and improve their learning skills. However, when comparing the effect of SDL with teacher-led instruction(TLI), it was found that SDL had no significant advantages regarding students' learning achievement. This study integrated the elements of deep learning into SDL and compared it with the TLI to see if there were significant differences in students' learning achievement. It also explored whether students have a preference for learning content regarding SDL or TLI and their expectations for teachers. The data was collected through six consecutive tests and a questionnaire. The findings revealed that the test results of TLI were usually better than those of SDL, but the difference in learning achievements between SDL and TLI was gradually smaller. It was suggested that the students need an adaptation period to deep SDL and a balanced approach incorporating SDL and TLI elements to maximize their learning achievements. Students tended to prefer SDL when the content was operational, specific, and practical. In contrast, they tended to prefer TLI when the content was abstract, theoretical, and complex. Those results highlighted the importance of adopting a flexible approach to accommodating diverse learning needs, content types, and evolving expectations for teachers.

Keywords: Self-Directed Learning, Deep Learning, Teacher-Led Instruction, Digital Era, College Students

Introduction

The digital era, also known as the digital age or information age, has the characteristic that information spreads rapidly worldwide without being restricted by space and time(Bania et al., 2020). The students can easily access, store, and process learning resources in this era, which enables self-directed learning(SDL). The significance of SDL for college students has been widely discussed and confirmed. It develops college students' essential learning skills for future careers and lifelong learning(Tekkol & Demirel, 2018). However, teacher-led instruction(TLI) continues in the digital era. Teachers have irreplaceable advantages in

providing targeted feedback, explaining complex concepts, and providing emotional value(Ruzek et al., 2016).

When comparing the effect of SDL with TLI, it was found that SDL had no significant advantages compared to TLI regarding students' learning achievement(Chen et al., 2023; Estaji & Jafari, 2022; LeFlore et al., 2007). SDL was a relatively positive model for improving students' learning skills and was more suitable for gifted and talented students than non-gifted ones(Leddo et al., 2017). It was evident that the process of deep learning was effective in improving students' self-study ability and self-regulation, which were the most critical factors influencing SDL effectiveness (Chen et al., 2023; Gorbunova et al., 2024; Panadero et al., 2021; Shalaby, 2024).

With the rapid development of network technology, access to learning materials is undergoing profound changes. Most college students in China have long been in the digital era. They can easily use computers, mobile phones, or laptops to obtain information anywhere and at any time. However, a study showed that some students mainly used mobile devices for information acquisition and consumption rather than active and deep processing(Lin & Su, 2020). Moreover, They have recognized the potential of self-directed learning in the digital era but still rely highly on teachers' instruction(Lin & Su, 2020). Another study also suggested that some students used digital tools primarily for communication rather than deep collaborative learning(Hu et al., 2023; Yin & Shi, 2022). Therefore, the digital era has changed the way we acquire and process information, thus necessitating a reassessment of self-directed learning and teacher-led instruction. This comparison helps us find the optimal balance between guidance and independence in the digital era, and enable students to better cope with the challenges of the ever-changing real world.

To avoid the passive or superficial self-directed learning that use mobile devices for quick information acquisition rather than engaging in active and deep learning processes, this study integrated the elements of deep learning into SDL and compared it with the TLI to see if there are significant differences in Chinese college students' learning achievement. This study will also explore whether students have a preference for learning content regarding SDL or TLI and their expectations for teachers in the digital era. Therefore, the research questions are: Are there significant differences in student achievement when continuously comparing SDL with TLI for Chinese college students? What kind of learning approach will Chinese college students prefer for learning content, SDL, SDL+TLI, or TLI? What are the expectations of Chinese college students for teachers when learning in the digital era?

This research may contribute to the ongoing development of teaching and learning practices, particularly how they apply to digital learning environments and deep learning processes. By comparing student learning achievements in self-directed learning (SDL) and teacher-directed instruction (TLI) over a longer time can help teachers recognize the changing trend and tailor their teaching methods to maximize student learning achievement. Understanding students' preferences for learning methods (SDL, SDL+TLI, or TLI) can guide educators in designing more engaging and effective classes according to the features of learning contents. Investigating what students expect of teachers in the digital era can help teachers develop the skills and strategies needed to meet those expectations. It also can help

teachers build stronger connections with students, leading to improved interaction with college students and more effective learning outcomes.

Literature Review

Self-directed learning (SDL) was described as a process whereby learners independently identify their needs, set goals, access resources, implement learning strategies, and evaluate learning outcomes(Estaji & Jafari, 2022). TLI was a traditional approach to education in which teachers lectured in class and provided explicit instructions and explanations, playing a central role in the student's learning process.

Regarding the comparison of SDL and TLI, SDL was a positive model for improving students' learning skills; TLI was a model for students to perform the same or better on learning achievement. Masoomeh Estaji found that SDL was more effective than TLI in improving English learners' oral proficiency and elevating their structure accuracy in speaking(Estaji & Jafari, 2022). A study of ophthalmic learning concluded that SDL improved students' self-study ability, and there was no statistical difference in average scores for the post-class tests compared to TLI(Chen et al., 2023). A medical simulation learning environment study showed no statistically significant differences between the SDL and TLI groups on the knowledge assessment test(LeFlore et al., 2007). Khalid et al. revealed a strong positive correlation between SDL and academic achievement for online distance learning, but for conventional university students, it had a more negligible positive correlation(Khalid et al., 2020). Furthermore, it was argued that SDL was more suitable for gifted and talented students. The gifted students learned basic computer programming equally well through SDL and TLI, while non-gifted students performed better with TLI (Leddo et al., 2017). The factors influencing SDL effectiveness included students' self-study ability, self-regulation, and availability of learning resources(Chen et al., 2023).

In the digital era, the Internet gave students access to many online resources, e-books, and educational videos that exceeded traditional textbooks' limitations. But how can students improve their self-study ability and self-regulation in SDL? It was evident that the process of deep learning was effective(Gorbunova et al., 2024; Panadero et al., 2021; Shalaby, 2024). Deep learning was a multifaceted approach to education that went beyond surface-level understanding and passive engagement. Panadero et al. divided deep learning strategies into several parts: basic learning self-regulation strategies, visual elaboration and summarizing strategies, deep information processing strategies, and social learning self-regulation strategies(Panadero et al., 2021). Laird et al. proposed that deep learning combined higher-order, integrative, and reflective learning(Nelson Laird et al., 2006).

Those elements were also found in other literature related to deep learning. The activities of understanding, organizing information and summarizing, analyzing, and checking progress could promote deep learning by encouraging critical thinking, self-regulation, and reflection, all of which are essential for mastering complex concepts and skills(Behar-Horenstein et al., 2018; Haarms et al., 2018). Making diagrams, drawings, graphs, tables, or concept maps could help students visualize the text and relationship(Eberhard, 2023; Kaeppel, 2021). Moreover, the related research showed that interactive learning and deep learning were interrelated. A study evaluating student engagement and deep learning in interactive online psychology learning activities found that online activities were perceived

positively by students, facilitating affective, cognitive, and behavioral engagement while also stimulating deep learning(Sugden et al., 2021). U.S. Department of Education reviewed and evaluated the learning effects of variations in online learning practices, implying that interactive elements could influence deep learning(Means et al., 2009).

The literature provided evidence and suggestions for this study on deep self-directed learning. However, little literature compares the learning achievement between deep SDL and TLI. The research on the comparison can provide valuable insights into the more effective ways to contact the SDL and TLI in the digital era and prepare students for a rapidly changing world.

Method

Firstly, the quasi-experimental design was conducted. The participants were 146 second-year pharmacy students from a medical university in China. They came from the same class and were divided into SDL group and TLI group according to their odd and even student ID. Through Mann-Whitney U Test analysis of relevant professional courses in the previous semester, it was found that there was no statistically significant difference in the grades of the two groups of students($Z=-1.35$, $P=0.17>0.05$). This showed that the homogeneity of students learning ability between SDL and TLI group.

One student's test results couldn't provide sufficient evidence to show whether there was a significant difference between the two groups, nor could it reflect the long-term trends. Therefore, this study lasted for 1.5 months or six weeks for six different topics about hypertension, and the differences between the two groups were compared through six test results. The Repeated Measures ANOVA method was used to analyze the data, which allowed researchers to collect data from multiple points in time for each subject.

Secondly, a questionnaire was conducted to gather data on students' preferences for SDL or TLI and what students expect for teachers in the digital age.

Study Setting

The learning content for the pharmacy participants was about hypertension, including physiology, organ damage, measurement of blood pressure, drug mechanisms, health management, and patient counseling. Each topic had a corresponding multiple-choice test. Multiple-choice questions (with at least two correct answers) had more choices than a single-choice question (with only one correct answer), which can reduce the amount of guesswork, increase the complexity of the tests, and differentiate students better(Oc & Hassen, 2024). Therefore, the test was used to measure the students' learning achievement. When all the tests were completed, students completed the questionnaire online anonymously. Although the tests were the same for all the participants, the process of SDL and TLI were different, which can be seen in Table 1:

Table 1
The process of SDL and TLI

The process of SDL	Requirement for the SDL group	The process of TLI	Requirement for the TLI group
Assign learning tasks: topics and corresponding questions(teacher)	Search for information through the Internet with search Engines or AI tools, and break down the complex questions into understandable parts.	Clarify the learning objectives(teacher)	Listen carefully and take notes.
Complete the report(student)	The report is deeply processed, logical, and well-structured.	Lecture(teacher)	
Making the slides(student)	Except for the text, the figure or table, and its description for the function of explanation, analysis, and comparison.	Summary(teacher)	
Presentation in the group meeting(student)	The presentation is organized and confident in the web conference.	Answer the questions(teacher)	Ask questions or review the content.
Communication with the group members(student)	Ask or answer questions in the group meeting to enhance the understanding of knowledge in the web conference.	None	
Draw the mind map(student)	Reconstruct a comprehensive and personal knowledge system, connecting the existing knowledge with new knowledge.	None	
Test(student)	10 minutes for six multiple-choice questions in the online test.	10 minutes for six multiple-choice questions in the online test.	
Reflection report(student)	Summarize the strengths and weaknesses, and make the learning plan for the next time.	None	
Teacher's feedback on the assignment and test		Teacher's feedback on the test	

Results

The Comparison of the Student's Achievement between SDL and TLI Group

The repeated measures ANOVA was conducted to examine the effect of different time points on students' test performance. The analysis included six time points (T1, T2, T3, T4, T5, T6) as within-subject factors and two groups as between-subject factors. Mauchly's test indicated that the assumption of sphericity was violated for the main effect of time, $\chi 2=53.05$, $P=0.00<0.05$. Therefore, a Greenhouse-Geisser correction was applied to adjust the degrees of freedom.

Time had a significant effect on test performance, F=96.88, P=0.00, suggesting that students' performance significantly changed across the six-time points. There was also a significant interaction effect between group and time, F=54.79, P=0.00, indicating that the changes in performance over time differed between the SDL and TLI groups. Mean scores for each time point were summarized in Table 2. The Mann-Whitney U Test was used to compare the test scores of the two groups at each time point, comparing two independent groups with non-normal data. The significant p-values ($P < 0.05$) indicated the significant difference in test scores between the groups for the first five tests.

Table 2

Mean scores for each time point in SDL and TLI group

Time point	Group	Mean	S.D.	Z	P
Week1	SDL	2.58	1.07	-6.94	0.000
	TLI	4.21	1.22		
Week2	SDL	3.27	1.22	-3.13	0.002
	TLI	3.93	0.98		
Week3	SDL	3.29	1.31	-3.34	0.001
	TLI	4.08	1.34		
Week4	SDL	2.99	1.48	-2.99	0.003
	TLI	3.77	1.58		
Week5	SDL	4.08	1.37	-2.53	0.011
	TLI	4.63	1.33		
Week6	SDL	5.44	0.94	-1.23	0.198
	TLI	5.63	0.70		

It can be seen in Figure 1 that the mean scores of both groups showed a trend over time, with some fluctuation during the first four tests but significant improvements in the last two tests. The scores of the SDL group fluctuated greatly, while those of TLI group were relatively stable. The TLI group generally scored higher than SDL group in the first five tests, but the scores of the two groups were close in the sixth test. It was worth mentioning that the scores of both groups in the fourth test were relatively low, which was related to the topic of the fourth test: the mechanism of drug action. It was a relatively difficult content for all the participants.

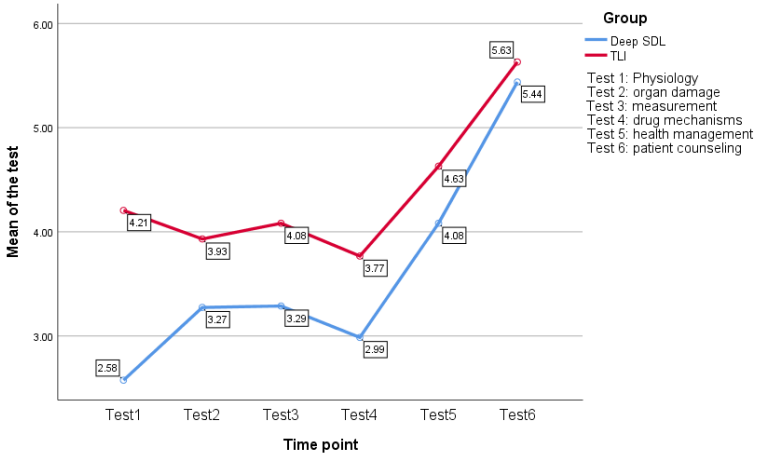

Figure 1 Trends of average test scores for each group over time

It was evident that the process of SDL included the main elements of deep learning and had procedural requirements for students. Compared with TLI, participants in SDL spend much more time on learning. However, the test scores for SDL were lower than those for TLI. On the one hand, Teachers' lectures delivered the knowledge points required for the exam more efficiently because teachers could accurately grasp the test points and provide targeted explanations. On the other hand, some students hadn't fully adapted to SDL in the short term. It should take a transition period from traditional passive acceptance to active exploration. However, The gap between the average scores of the two groups gradually decreased, and there was no statistically significant difference in the average scores on the sixth test, which showed that both groups had the basic application of knowledge.

Although the test scores for the SDL group were lower than TLI group, the feedback of the SDL experience was positive. Finishing the report based on the questions of the learning topic expanded and deepened their learning from basic to advanced knowledge; making slides and drawing the mind map further strengthened their construction of the knowledge system; communication with the group members not only increased the interest in learning but also allows them to feel the supplement of knowledge; the test allowed them to test and consolidate the learning effect, and the reflection report facilitated further improvement of learning later. This learning experience gave them a systematic understanding of hypertension and allowed them to apply the experience to other courses. Moreover, participants in the SDL group said their courage and confidence in facing new issues were enhanced through six different learning topics. Their adaptability and adjustment abilities were also improved through continuous independent thinking and reflection. On the contrary, participants in the TLI group mainly mentioned the systematic mastery of hypertension knowledge.

The Results of the Participants' Preferred Choice of three Different Learning Approaches according to the Various Learning Contents

The learning content for the pharmacy participants was about hypertension, including physiology, organ damage, measurement, drug mechanisms, health management, and patient counseling. When asked the question: If you had the opportunity to choose, which approach would you prefer to learn about the following content about hypertension? The results can be seen in Table 3.

Table 3
Results of all participants' choice of learning approach

Topics of learning content	Characteristics of the learning content	The preferred learning approach		
		Complete SDL	SDL+TLI	Complete TLI
physiology	Abstract, theoretical, and complex	14(9.6%)	54(37.0%)	78(53.4%)
organ damage from hypertension	Specific, abstract, and theoretical	12(8.2%)	44(30.2%)	90(61.6%)
measurement of blood pressure	Operational and practical	16(11.0%)	68(46.5%)	62(42.5%)
drug mechanisms	Theoretical, systematic, and complex	10(6.8%)	36(24.7%)	100(68.5%)
health management	Specific, systematic, and practical	28(19.2%)	56(38.4%)	62(42.4%)
patient counseling	Specific and pratical	24(16.4%)	63(43.2%)	59(40.4%)

The chi-square test showed significant differences in students' preferred learning approaches for different learning content(**χ^2=47.09, P=0.000**). The results suggested that students' choice of learning approach was indeed affected by the nature of the learning content. It can be seen in Figure 2 that the content of drug mechanisms showed the strongest teacher-led tendency, followed by organ damage and physiology. However, the content of blood pressure measurement, health management, and patient counseling showed a relatively balanced distribution between SDL+TLI and TLI. The proportion of participants who chose to learn entirely by themselves was relatively small in all learning contents.

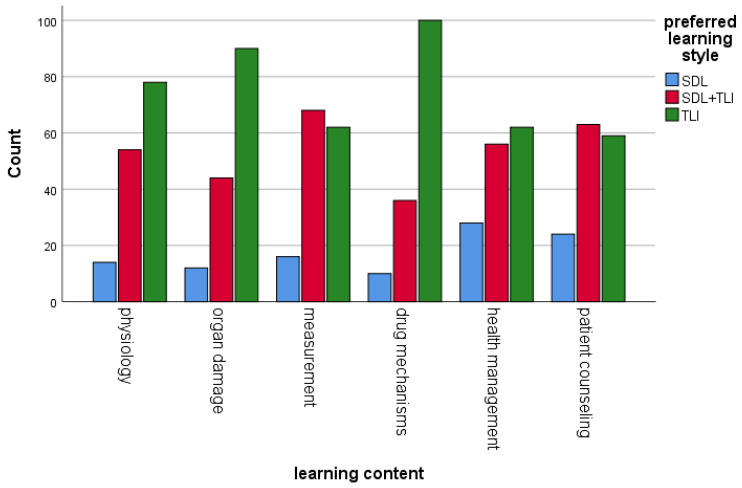

Figure 2 Bar Chart of participants' learning content and preferred learning approaches

Why did participants have such preferences? The questionnaire results revealed several reasons for the TLI preference for the drug mechanisms. For students, the content of

antihypertensive drugs' mechanisms was theoretical, systematic, and complex. It involved multiple human body physiological systems students couldn't see or sense. The interactions between these systems and the effects of drugs on them were very abstractive and complex, making it difficult for students to understand these concepts fully through self-directed learning. Moreover, understanding the mechanism of action of hypertension drugs required solid basic medical knowledge, including physiology, pharmacology, and pathology. As professionals, teachers could use their own teaching and work experience to understand the content better and deliver it to students vividly and purposefully, rather than boring theories or difficult-to-remember professional terms.

However, hypertension health management involved diet, exercise, emotions, etc., and was closely related to students' daily lives, which was more practical and specific. The students could understand them by searching for information on the Internet. However, some students still hope the teacher could supply more cases of patients with hypertension to enrich their learning experience. For blood pressure measurement, the operation videos on the Internet could intuitively show the specific steps and key points of blood pressure measurement, which was easier to understand than the teacher's verbal description. Students could also watch the key content of the video repeatedly as needed to deepen their memory. Based on video learning, students hoped teachers could provide on-site demonstrations and error correction to help students master the correct operating skills.

In the final consultation for patients with hypertension, students were very interested in the various problems that patients encountered, such as whether sustained-release tablets could be chewed eating, what to do if patients take medication irregularly, and how to help patients get support from family members. They were willing to try to use the knowledge they had learned to solve practical questions.

Therefore, in contemporary times, students are not passive recipients of learning. They have their own ideas about their needs and choose the appropriate learning approaches according to the learning content.

The Results of the Students' Expectations for Teachers when Learning in the Digital Era

When asked what difficulties they encounter in learning and what they expect from teachers, participants answered that the biggest difficulty was not knowing how to achieve the required process or results and what the examplier looks like. Their expectations for teachers can be seen in Table 4.

Table 4
The results on students' expectations of teachers

Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The clear standards and requirements for assignments.	1(0.7%)	1(0.7%)	8(5.5%)	65(44.5%)	71(48.6%)
The online screenshots and teacher's comments on selected students' assignments.	0(0%)	0(0%)	3(2.1%)	89(61.0%)	54(36.9%)
The on-site teacher's comments on students' performance.	0(0%)	3(2.1%)	13(8.9%)	80(54.8%)	50(34.2%)
Teacher's on-site demonstration.	0(0%)	0(0%)	1(0.7%)	81(55.5%)	64(43.8%)
Interact with the teacher for any questions in a free atmosphere.	0(0%)	1(0.7%)	1(0.7%)	76(52.1%)	68(46.5%)
The praise and small rewards from the teacher.	0(0%)	1(0.7%)	2(1.4%)	80(54.8%)	63(43.1%)

In Table 4, in the digital era, students' expectations of teachers go beyond textbooks and knowledge; they want a more engaging and interactive learning experience. They expect clear standards for assignments and timely interaction from the teacher. The role of the teacher is to find out the gaps between their performance and requirements and help them improve. Moreover, they also need praise and rewards from teachers, which belong to the category of emotional value. In the digital era, the Internet can provide richer information and knowledge but can't replace teachers' on-site demonstration, precise feedback, and emotional value. Students' expectations for teachers have shown that teachers need to play different roles for different content. Teachers should be interpreters and guides for abstract, theoretical, and complex content. Teachers should be on-site demonstrators and error correctors for operational and practical content. Teachers should be evaluators and feedback providers for content close to life and reality. In short, in the digital era, the role of teachers is changing from a single knowledge transmitter to a diversified educator.

Discussion

Deep learning can be divided into two aspects: deep learning process and deep learning results. The deep learning process focuses on students' behavioral, cognitive, and emotional engagement in the learning process(Delfino, 2019; Joshi et al., 2022; Liu et al., 2022). Deep learning results are reflected in the specific results after learning, such as knowledge structure, the ability to solve problems, and academic achievements(Chen & Singh, 2024). It was evident that the SDL group in this study had experienced the process of deep learning. However, regarding test scores, the SDL group didn't exceed those of TLI group.

It is usual for students to score higher or have no significant difference in TLI than SDL(Chen et al., 2023; Estaji & Jafari, 2022; LeFlore et al., 2007). This phenomenon doesn't mean that SDL should be abandoned. On the contrary, it reveals that we must think more carefully about effectively implementing and supporting student self-directed learning(Nasri et al., 2020). For undergraduates, both the process and results of deep learning are important, but it can be said that the process is more critical in some ways. Different students have different learning abilities, and some may take longer to progress significantly in deep learning results(Fawzia & Karim, 2024). The participants in this research were second-year pharmacy college students. Compared with post-graduates, this research focused mainly on their participation and involvement in the learning process and the understanding and basic application of knowledge.

To reduce the impact of accidental factors, this research conducted six tests over six weeks for different topics, and the test scores for the final one between the SDL and TLI were statistically indifferent. There are two main reasons for the final indifference. Firstly, the content of the sixth was patient consultation. The students had already learned the knowledge system of hypertension through the previous five tests, including physiology, organ damage, blood pressure measurement, drug use, and health management. Therefore, they could deal with patients' consultations more competently. Secondly, through the previous five SDL processes, the participants in the SDL group had more learning experience and self-regulation. They were more flexible and competent in handling learning content of average difficulty, so the test scores were significantly improved. That is consistent with the findings from the literature suggesting that deep learning strategies significantly enhanced students' capacity for independent study and self-regulated learning(Chen et al., 2023; Estaji & Jafari, 2022; LeFlore et al., 2007).

Therefore, we must acknowledge the direct advantages of teacher-led instruction (TLI) in terms of students' learning achievements. However, we must also highlight the trend of improving self-directed learning (SDL) outcomes over time, indicating its potential long-term benefits. Initially, the participants faced discomfort and challenges in adapting to deep SDL, especially when some participants had already developed a reliance on traditional teacher-led instruction. It was evident that the difference in learning achievements between SDL and TLI was gradually smaller. The participants could be more familiar with online tools, and increase adaptability to self-directed learning strategies. Students need an adaptation period to deep SDL, especially in the digital age where they need to master new online learning tools and deep processing methods of information.

Combined with the results in Table 3 and 4, participants had a lower responding frequency to complete SDL, which shows that even in the digital age, college students are optimistic about the functions of teachers. However, the traditional function of teachers only to transfer knowledge is not what college students expect. In the digital age, students have higher expectations for teachers. The role of the teacher can be flexibly adjusted according to different learning content or student performance. In addition to being a lecturer, the teacher can also be an explainer, supervisor, on-site demonstrator, error corrector, etc. Students expect teachers to provide more than just textbooks and information; they seek engaging and interactive learning experiences. Therefore, SDL and TLI are not opposing teaching methods; they can complement each other. Although teacher lectures may produce better results in the short term, cultivating students' self-learning ability in the digital age is crucial to their long-term development. Creating a supportive learning environment that balances teacher guidance and student autonomy is necessary(Sharma et al., 2024). It will help improve academic performance and lay the foundation for their future success.

What can teachers learn from the findings? In the digital era, teachers face new requirements to effectively educate students in their pedagogical practices. These requirements focus on enhancing student interaction and improving teachers' skills and competencies. Firstly, teachers must be willing to learn new tools and technologies and incorporate them into their daily work. Secondly, teachers need encourage the students' active and critical learning using diverse resources. Thirdly, teachers are now required to deeply interact with students in their learning journey, online or offline. This places higher demands on teachers. In addition to having high professional knowledge, skills and experience, teachers are also required to have high emotional intelligence and communication skills. In short, teachers should actively embrace the changes of the digital age, and create a proactive, free, fair, and interactive learning atmosphere.

Conclusion

This research indicates that TLI generally outperforms SDL in terms of student achievement. This finding underscores the importance of effectively implementing and supporting students' self-study. By doing so, educators can improve academic performance and cultivate students' lifelong learning abilities. Students prefer SDL for operational, specific, and practical content while favoring TLI for abstract, theoretical, and complex material. It highlights the need for a flexible approach to accommodate diverse learning needs and content types. In the digital era, students have clear expectations for their teachers, emphasizing educators' evolving roles and the necessity for continuous professional development to meet student needs in digital learning environments.

In conclusion, educators must reconsider their roles and functions as education evolves in the digital age to create more effective and engaging learning experiences. This research is a foundation for further exploration into optimizing educational approaches in the digital era, ultimately contributing to developing more adaptable learners.

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