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# Investigation and analysis of clinical medical undergraduate learning behaviors under different teaching models

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Medical education plays a critical role in preparing future doctors, responsible for the well-being and health of individual patients. Given its unique significance, understanding how to enhance the intrinsic motivation of clinical medical undergraduates for a 5-year program is a key research focus in China. Based on this purpose, the transformation of higher education in the major of clinical medicine has been conducted worldwide. To evaluate the attitude of clinical medical undergraduates on the transformation of education, this study investigates the impact of different teaching models on the learning attitudes of students at Shantou University Medical School, aiming to provide insights into effective educational strategies. Within the set-up of different teaching models, involving active-learning classes, English-medium instruction classes, and conventional clinical classes, we employed a comprehensive survey targeting undergraduates enrolled in three distinct teaching models. The survey explored multiple dimensions of learning behaviors, including classroom engagement, study time, and overall motivation. Results indicated that students participating in active learning classes exhibited superior classroom engagement and devoted more time to their studies than those in English-medium instruction classes and conventional clinical classes, while the difference between English-medium instruction classes and conventional clinical classes was not significant. These students reported a higher intrinsic motivation towards their learning experience, suitable to apply self-directed learning methods. In conclusion, this study underscores the importance of adopting diverse and adaptive teaching strategies to cater to the varied learning attitudes of clinical medical undergraduates, suggesting conducting self-evaluation or pre-evaluation of the students for adapting to different clinical teaching methods. Meanwhile, enhancing teacher guidance and support throughout the learning process is essential. By implementing different educational approaches, medical schools can effectively enhance student motivation and educational outcomes, contributing to the advancement of medical education.

## KEYWORDS

clinical medicine, undergraduates, learning attitudes, intrinsic motivation, problem-based learning, active learning, teaching model

# 1 Introduction

Currently, medical education is undergoing significant reforms and innovations worldwide. These changes aim to equip medical students with advanced teaching methods and enriched learning environments, thereby enhancing their motivation and academic efficiency (Han et al., 2019). Regardless of the strategies employed in undergraduate clinical medical education, student intrinsic motivation remains a crucial factor in their learning process and outcomes (Siqueira et al., 2020). Evaluating medical student learning attitudes and enhancing their intrinsic motivation are important research topics in the field of medical education. Regarding this aspect, active learning was defined by Bonwell and Eison as anything that involves students in doing things and thinking about the things they are doing, attracting plenty of education investigations to promote and encourage the use of tasks, interactive presentations, assignments and creative activities of students with internal interests (Singh et al., 2019). For example, Singh *et al.* used an Active and Engaging Learning Strategy to assess the teaching focus shifting from knowledge transmission to knowledge construction by students, providing an effective learning tool in anatomy and opening a new door to medical education (Singh et al., 2019).

With the development of modern educational concepts, medical education reforms based on systemic teaching models are continually advancing (Huang et al., 2014). These reforms use different organ systems as primary modules to facilitate the transition and integration from basic to clinical education (Khalil et al., 2021). For example, our institution established an English-medium instruction program in 2007, for training clinicians in response to globalization, as English promising as the international language for academic communication (Yang et al., 2019). To evaluate the competency evolution in China, a holistic competency-based assessment was conducted among the graduates regarding three clinician competency developing domains, that is knowledge, skill and attitude (KSA), providing an evidence-based guide for the clinician's critical thinking and continuous development (Huang et al., 2022). For enhancing medical education, Amir et al. designed an anonymous online questionnaire and found that it is essential to incorporate diverse techniques and approaches into the teaching process, regarding student confidence, engagement and effective participation (Amir et al., 2024). Meanwhile, conceptual framework theory provides learning roadmaps for participants and facilitates the imagination and activity of their purposes, while praxis was proposed as a conceptual framework for participatory nursing research (Seng, 1998). As an important part of medical education, the major of clinical medicine also requires participatory research involving a conceptual framework.

Since the beginning of the 21st century, the focus of education has gradually shifted from being teacher-centered to student-centered (Yang et al., 2024). This shift is not merely a change in methodology, but rather a fundamental evolution in educational philosophy. It emphasizes the importance and uniqueness of students as the central subjects of education, while teachers play a supporting and guiding role in the learning process (Granger et al., 2012). This shift has been accompanied by the adoption of innovative teaching methods across various disciplines, including PBL, team-based learning (TBL) (Burgess et al., 2020), case-based learning (CBL) (Donkin et al., 2023), research-based learning (RBL) (Jiang et al., 2021), outcome-based education (OBE) (Yang et al., 2023), and the

flipped classroom (FC) (Cheng et al., 2017). These methods have proven instrumental in driving educational reforms and enhancing the learning experience. Among these, PBL stands out for its widespread application, enabling educators to transcend traditional lecture-based learning and explore more dynamic and interactive teaching models to meet educational goals more effectively (Dolmans et al., 2005).

The traditional instructional approach is applied worldwide, known as lecture-based learning. The teachers play an important directive role during the teaching-learning process, by transferring knowledge to students, while most of the students only accept the knowledge passively (Schwarz et al., 2004). To improve the internal active learning attitudes, among different education reforms, the incorporation of PBL into education curricula has brought about a significant improvement in the critical thinking of clinical medical undergraduates (de Andrade et al., 2024). PBL is an instructional method where students are divided into small groups to study, discuss, and learn about specific topics or clinical cases under the guidance of instructors (Khawaji et al., 2024). This method stimulates learning by presenting problems early in the educational process, thereby fostering critical thinking and systematic knowledge acquisition through problem-related case studies (Dolmans et al., 2005). PBL has been widely adopted to create a student-centered learning environment. However, responses to PBL vary significantly among students, with both positive and negative feedback observed (de Andrade et al., 2024; Nicolaou et al., 2024).

To fully utilize these methods, our institution has established active-learning classes (ALCs) aimed at maximizing the engagement and enthusiasm of clinical medical undergraduates. Most of the students in our institution still learn with lectures in both English-medium instruction classes (EMICs) and conventional clinical classes (CCCs) in different languages, respectively. As the teaching methods were quite different, it is curious to uncover the learning attitudes of students in different models, which can also reveal the adaptation of students to corresponding teaching methods. Based on the different teaching models in our institution, this investigation was conducted through an online survey, to explore the similarities and differences in the learning attitudes of clinical medical undergraduates under different teaching models. With the findings, this study tried to provide a theoretical foundation for improving teaching effectiveness and quality for higher education in clinical medicine.

## 2 Materials and methods

### 2.1 Set-up of different types of classes

In our college, clinical medicine is the main major for undergraduate students, so most of the students in this major are enrolled in CCCs, similar to other universities or medical colleges. After evaluating the scores of the National College Entrance Examination, the top students will be enrolled in EMICs, in which all the classes are entirely conducted in English. For students in CCCs and EMICs, lectures were the main methods for knowledge transmission. Except for the difference in teaching language between CCCs and EMICs, all the curricula are the same and primarily follow traditional theoretical instruction methods with 1–2 PBL cases each semester (Table 1).

TABLE 1 The characteristics of different teaching models.

|                         | Type of class |              |              |
|-------------------------|---------------|--------------|--------------|
|                         | EMIC          | ALC          | CCC          |
| <b>Language</b>         |               |              |              |
| Learning                | English       | Chinese      | Chinese      |
| Examination             | English       | Chinese      | Chinese      |
| <b>Teaching methods</b> |               |              |              |
| Lecture                 | All contents  | 30% contents | All contents |
| PBL                     | 1–2 cases     | 70% contents | 1–2 cases    |

As mentioned above, PBL has been applied in diverse majors for college education (de Andrade et al., 2024). During PBL sessions, instructors play an active role by participating in pre-discussion, discussion, and post-discussion phases. Instructors begin by setting the stage with essential background information and learning objectives, and during discussions, they facilitate dialogue, and encourage critical analysis, thereby ensuring focused, collaborative engagement among students. In the post-discussion phase, instructors conduct debriefings, reinforce key points, and assess student performance through group evaluations, considering participation, critical thinking, and practical application of knowledge. This active involvement ensures that PBL sessions are dynamic, interactive, and highly effective in enhancing student learning experiences and outcomes.

Besides CCCs and EMICs, ALCs were creatively set up in 2015 for students majoring in clinical medicine in our institute. The students enrolled in ALC were selected through a multi-step two-way selection process to ensure the most suitable candidates were selected for ALC. The steps were as follows:

- Introduction to active learning: initially, all freshman students underwent a training session titled “Introduction to Active Learning.” This session aimed to familiarize them with the principles and practices of PBL, emphasizing its benefits and methodologies.
- The practice of the PBL process: to reinforce their understanding, students participated in PBL practice sessions using new cases. These sessions were designed to provide hands-on experience with the PBL approach. At the same time, experienced faculty members observed and evaluated the students’ performances, focusing on their engagement, critical thinking, and problem-solving skills. All observations and evaluations were combined in a comprehensive review report for each student for further analysis.
- The submission of applications from students: after experiencing the practice sessions, students interested in joining the ALC could submit formal applications. These applications allowed students to express their interest and motivation for being part of this innovative learning environment. To ensure an internally attractive attitude toward learning, no additional scholarships were made available for the students in ALC.
- Selection process: based on the previous comprehensive review reports for each student, all student applicants were carefully evaluated by the core work group from the Office of Educational Administration. Finally, 30 students were enrolled in the ALC program.

- Curriculum structure: the ALC curriculum was the same as the EMIC and CCC curricula, with a distinct teaching model. Approximately 70% of the coursework consisted of PBL cases instead of traditional lectures. This structure design aimed to maximize the active learning of students and improve student engagement during class, as well as pre- and post-class.

There were 20 weeks of classes per semester with the same course for all classes, and the examination was also the same in classes with different teaching models, except for the used language (Figure 1). Our institute provides online databases free for all teachers and students, such as ClinicalKey, Osmosis, JoVe, Primal Pictures, Springer Nature, ScienceDirect, Web of Science, and so on. For lectures, Yuketang<sup>1</sup> was applied for all students, which can be labeled, responded and reviewed anytime, facilitating their learning activities. As this investigation focused on the learning attitudes of students majoring in clinical medicine, the presentation of the final examination was not evaluated in this study.

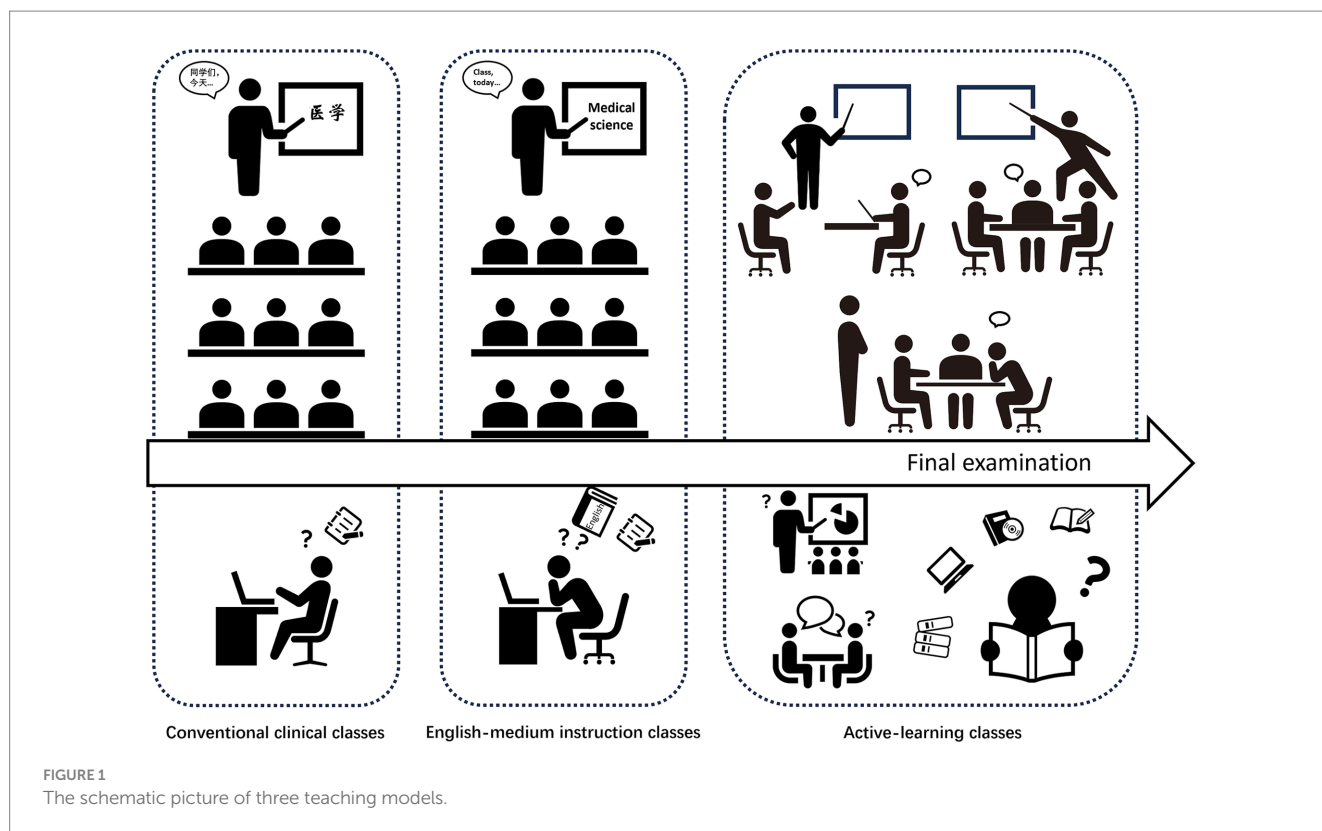
## 2.2 Questionnaire survey

This ALC program has been conducted since 2015, enrolling 30 students annually. To evaluate the intrinsic motivation and learning attitudes of students under different teaching models, we designed a self-assessment questionnaire. The questionnaire was designed based on the FAIMER program (Vyas et al., 2023), consisting of 34 multiple-choice questions and 2 open-ended questions. Multiple-choice questions included general information (grade, gender, and type of class), preferred teaching styles/learning method, pre-class preparation, in-class engagement, and post-class review, while open-ended questions presented as ‘What are the primary difficulty in self-directed learning in your opinion?’ and ‘What kind of help do you want to receive from teachers?’ in Chinese version. It aimed to evaluate the general information, student evaluation of instructors, self-assessment of learning status, and preferred learning methods. The survey was designed to focus on student learning attitudes without collecting personal information and delivered online to ensure anonymity and privacy. Before the distribution of the questionnaire, a pilot study was conducted to ensure its readability and appropriateness.

## 2.3 Inclusion and exclusion criteria

This study focused on the students who majored in clinical medicine from the 2015 to 2017 cohorts at Shantou University Medical College. Inclusion criteria were that the students who majored in clinical medicine were from three groups based on their class type, that is, ALC, EMIC, and CCC. Participation in the survey was voluntary, and the participants could quit this investigation at any time. Exclusion criteria were set as the students in other majors rather than clinical medicine for comparable data.

<sup>1</sup> [www.yuketang.cn](http://www.yuketang.cn)



## 2.4 Data collection

This study used the survey designed as an online self-reported method, making it easy to maintain confidentiality and allowing participants to easily answer the questions. To fulfill the aims of this research, the principal researcher distributed the questionnaires through the online software, Wenjuanxing<sup>2</sup>. The study was conducted in 2019, and the data collection process took place from September 2019 to October 2019. All the conduction adhered to ethical principles in medical research and received approval from the Ethics Committee of Shantou University Medical College (NO. SUMC-2019-71).

## 2.5 Statistical analysis

Data analysis was conducted using SPSS software for statistical analysis. Measurement data were expressed as mean  $\pm$  standard deviation (SD) and analyzed using the *t*-test to compare means between groups. Count data are expressed as percentages and analyzed using the chi-square test to assess differences in proportions. A *p*-value of less than 0.05 was considered indicative of statistically significant differences. The Bonferroni correction was applied to deal with the multiple comparisons, and the alpha level was set up as below 0.0025 with 21 *t*-tests conducted.

## 3 Results

### 3.1 Student evaluation of teachers and learning preferences

A total of 153 students were involved in this investigation. The cohort distribution was as follows, 38 students from the 2015 cohort, 62 from the 2016 cohort, and 53 from the 2017 cohort. The gender distribution included 67 males and 86 females. Among the participants, 31 were from the ALCs, 18 from the EMICs, and 104 from CCCs (Table 2 and Figure 2). Regarding a total population of 90 students were involved in the ALC program 2015 to 2017, the response rate in this investigation was estimated to 34% (31/90). The survey revealed significant insights into student preferences regarding their instructors and learning styles. The top pattern was humorous (57/153), followed by knowledgeable (51/153) and passionate (38/153). These characteristics are indicative of an engaging and dynamic teaching style that likely fosters a positive and stimulating learning environment. Only a small minority of students (7/153) preferred teachers who managed the classroom with strict discipline. This preference distribution highlights a trend toward favoring a learning environment where students feel more autonomous and self-directed (Figure 3A).

In terms of learning preferences, students across all class types demonstrated a strong inclination towards self-directed learning. Specifically, 26% of students expressed a preference for learning entirely under their control, while 62% preferred a combination of self-directed learning and some level of guidance. This indicates a significant majority (88%) who value autonomy in their learning process. Only a small portion (12%) of students expressed a desire for

<sup>2</sup> [www.wjx.cn](http://www.wjx.cn)

TABLE 2 The distribution of the participants.

|               | Type of class    |                 |                  | P-value |
|---------------|------------------|-----------------|------------------|---------|
|               | EMIC<br>(n = 18) | ALC<br>(n = 31) | CCC<br>(n = 104) |         |
| <b>Gender</b> |                  |                 |                  |         |
| Male          | 7                | 15              | 45               | 0.797   |
| Female        | 11               | 16              | 59               |         |
| <b>Grade</b>  |                  |                 |                  |         |
| 2015          | 4                | 5               | 29               | 0.052   |
| 2016          | 4                | 11              | 47               |         |
| 2017          | 10               | 15              | 28               |         |

continuous teacher guidance during their learning activities (Figure 3B).

These findings suggest that students value a balanced approach where they can exercise independence in their learning while having access to guidance and support when necessary. The preference for knowledgeable, humorous, and passionate teachers aligns with the desire for an engaging and supportive learning environment. Teachers who can effectively combine these traits are likely to create a more motivating and effective educational experience for students. Furthermore, the preference for self-directed learning reflects a broader trend in modern education towards student-centered learning approaches (Salih et al., 2024). These approaches empower students to take charge of their educational journey, fostering critical thinking, problem-solving skills, and a deeper engagement with the material. The findings underscore the importance of designing educational strategies that balance student autonomy with adequate support, allowing students to thrive both independently and collaboratively.

### 3.2 Differences in learning behaviors during classes

This study assessed student learning attitudes from multiple perspectives: before class (pre-class preparation), during class (in-class engagement), and after class (post-class review). The ANOVA analysis found a significant difference among different teaching groups (Table 3). With further t-test comparison, the results revealed that students in the ALC rated their self-directed learning abilities significantly higher than those in the CCCs ( $p = 0.0001$ , Table 4). This finding aligns with their engagement levels observed in all phases of the learning process. Students in the ALC dedicated more time to pre-class preparation compared to their counterparts in the CCCs ( $p < 0.0001$ , Table 4). However, after the Bonferroni correction was conducted, no significant difference was found between EMIC and ALC, or between EMIC and CCC ( $p > 0.0025$ , Table 4). This preparatory phase involved reviewing course materials, reading assigned texts, and completing preliminary research related to upcoming PBL cases. The increased preparation time suggests that ALC students are more proactive in equipping themselves with the necessary background knowledge, which enhances their readiness and confidence for in-class activities.

During class, ALC students were more engaged and actively participated in the learning process than students in the EMICs and

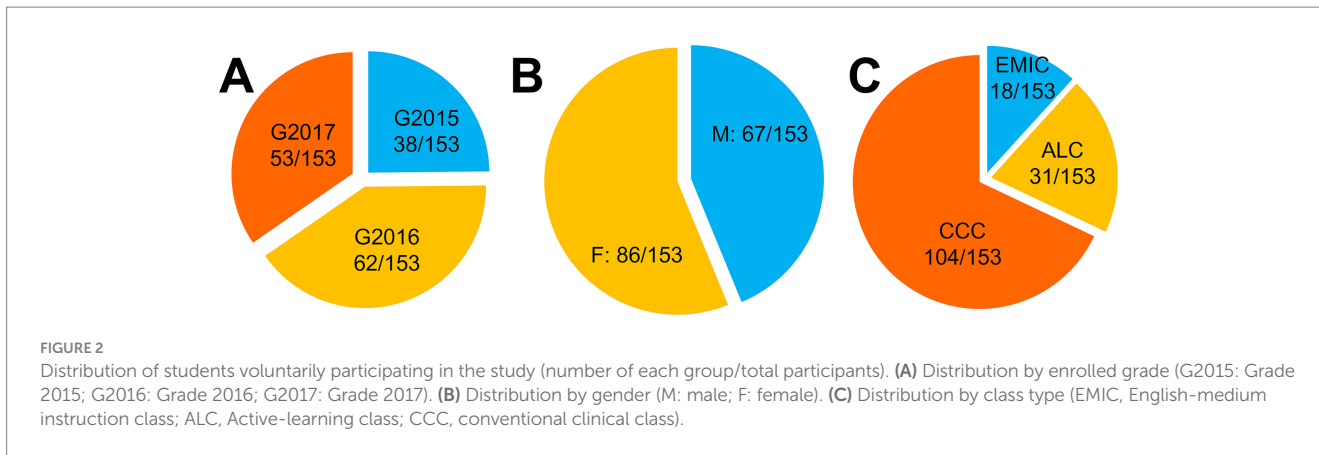
CCCs ( $p = 0.0024$  and  $0.0016$ , respectively, Table 4). This higher level of engagement can be attributed to the PBL approach, which requires students to collaborate, discuss, and solve problems in a group setting. The interactive nature of PBL fosters a more dynamic and participatory classroom environment, encouraging students to contribute their ideas and challenge each other's perspectives. Furthermore, ALC students also showed higher participation in class discussions than students in the EMICs and CCCs ( $p = 0.0002$  and  $< 0.0001$ , respectively, Table 4). The structure of PBL sessions, which emphasizes critical thinking and problem-solving, naturally encourages more frequent and meaningful student interactions. These discussions allow students to articulate their understanding, question assumptions, and synthesize information collaboratively, leading to a deeper comprehension of the subject matter.

ALC students reported greater benefits from PBL group discussions compared to students in the EMICs and CCCs ( $p < 0.0001$ , Table 4). This outcome reflects the effectiveness of PBL in promoting active learning and critical thinking. The autonomy and flexibility provided by the PBL approach enable students to explore topics more thoroughly and develop a more robust understanding of complex concepts. The collaborative nature of PBL also helps students to learn from their peers, gaining new insights and perspectives that enhance their overall learning experience. However, when comparing the EMICs and CCCs, although the comparison in pre-class preparation time reached  $p = 0.0205$ , no statistical significance was found for all the indicators after the Bonferroni correction ( $p > 0.0025$ , Table 4). It is interesting to find that language is not the main factor in encouraging their more positive involvement in the learning process.

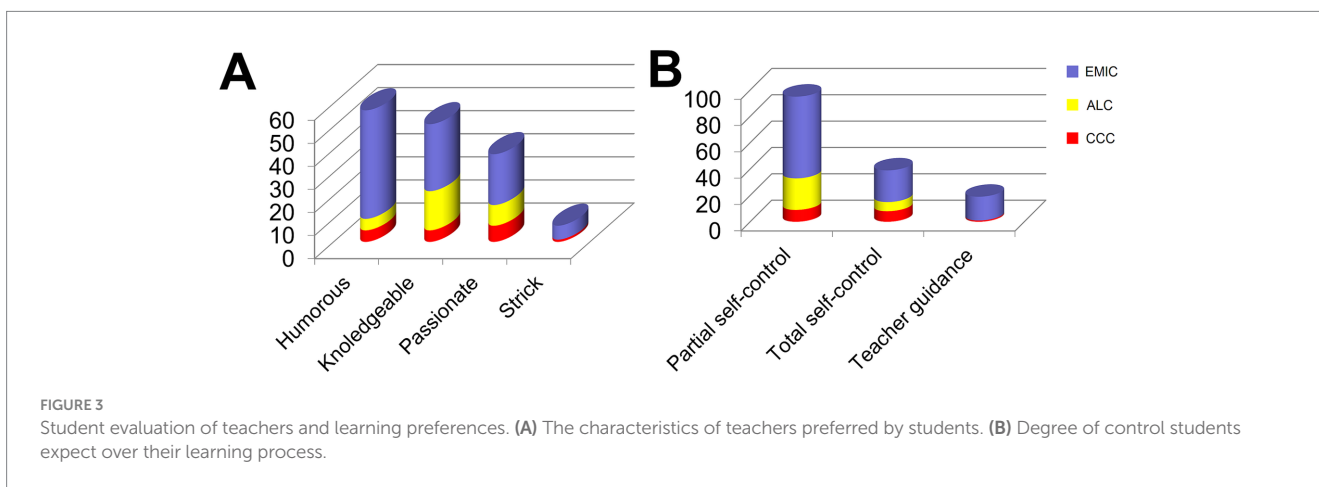
### 3.3 Extracurricular learning in different class types

In addition to in-class learning, extracurricular study is a crucial indicator of student self-directed learning abilities and overall engagement. The comparison of extracurricular study time among different class types revealed significant differences. The students from all teaching models reported similar extracurricular learning time, after Bonferroni correction ( $p > 0.0025$ , Table 4). This finding suggests that although ALC students reported spending more time studying outside of class, all the students utilized extracurricular time effectively, engaging in activities that enhance their understanding and retention of the material.

It is important to note, however, that the ALC curriculum consists of approximately 70% PBL cases. This structure inherently requires ALC students to engage in significant independent research and discussion between case sessions. Students must search for relevant information and engage in discussions based on predefined learning objectives. This substantial amount of self-directed study and collaborative work is integral to the PBL process, but is not included in the recorded extracurricular study time. Therefore, the reported extracurricular study time for ALC students may underestimate their total study effort and engagement. Regarding the small number of classmates in ALC, it was easy for them to find learning partners, share learning materials, and discuss during the extracurricular learning activities. For example, to organize complex clinical problems, they learned related software, such as X-mind, to draw mind maps for learning.



**FIGURE 2** Distribution of students voluntarily participating in the study (number of each group/total participants). **(A)** Distribution by enrolled grade (G2015: Grade 2015; G2016: Grade 2016; G2017: Grade 2017). **(B)** Distribution by gender (M: male; F: female). **(C)** Distribution by class type (EMIC, English-medium instruction class; ALC, Active-learning class; CCC, conventional clinical class).



**FIGURE 3** Student evaluation of teachers and learning preferences. **(A)** The characteristics of teachers preferred by students. **(B)** Degree of control students expect over their learning process.

**TABLE 3** The ANOVA analysis of self-reported learning behaviors among students in different teaching models.

| Indicators  | Values (Mean ± SEM) |                |                | F-statistic | P-value |
|---|---------------------|----------------|----------------|-------------|---------|
|   | EMIC                | ALC            | CCC            |             |         |
| Self-evaluation of self-learning ability          | 7.833 ± 0.2322      | 8.613 ± 0.1894 | 7.260 ± 0.1771 | 8.715       | <0.001  |
| Preview before class                              | 5.667 ± 0.4122      | 7.484 ± 0.3648 | 4.356 ± 0.2207 | 25.724      | <0.001  |
| Active learning time in class                     | 6.667 ± 0.3333      | 8.032 ± 0.2602 | 6.971 ± 0.1625 | 6.251       | 0.002   |
| The involvement situation during class discussion | 7.000 ± 0.4122      | 8.839 ± 0.2544 | 6.750 ± 0.1495 | 22.397      | <0.001  |
| The gains from group learning                     | 6.722 ± 0.4770      | 8.968 ± 0.2149 | 6.413 ± 0.1877 | 24.046      | <0.001  |
| Extracurricular study time ordinary               | 4.889 ± 0.3782      | 4.452 ± 0.2776 | 3.760 ± 0.1614 | 5.018       | 0.008   |
| The usefulness of self-learning                   | 9.556 ± 0.3636      | 9.742 ± 0.2020 | 8.375 ± 0.1953 | 8.714       | <0.001  |

### 3.4 Influencing factors

At the end, two open-ended questions were provided to gain deeper insight into the factors influencing student self-directed learning. Regarding the difficulties in self-directed learning, among the responses, “self-discipline” was the most frequently mentioned issue, cited 37 times. This indicates that a significant number of students struggle with maintaining the necessary discipline to manage their learning independently. Additionally, 12 students reported a lack of “goals” or “direction” as a major barrier to their self-directed learning. This suggests that without clear objectives, students may find it challenging to stay motivated and focused. Only 8 students indicated that they had

no difficulties related to self-directed learning, highlighting that such challenges are common among the majority of students.

For the issue of specific support from teachers, interestingly, 13 students, 1 from ALCs and 12 from CCCs, stated that they did not require any assistance from their teachers, implying a strong sense of independence or satisfaction with their current support systems. However, the majority of respondents expressed a need for various forms of support. The most common requests included “providing various forms of quizzes,” which can help reinforce learning and gauge understanding on an ongoing basis. Students also emphasized the need for “personalized guidance or direction,” reflecting a desire for tailored feedback and mentorship that addresses their individual

TABLE 4 The comparison of self-reported learning behaviors among students in different teaching models.

| Indicators  | Values     | Type of class  |                |                |                |                |                |
|---|------------|----------------|----------------|----------------|----------------|----------------|----------------|
|   |            | Comparison 1   |                | Comparison 2   |                | Comparison 3   |                |
|   |            | EMIC           | ALC            | ALC            | CCC            | EMIC           | CCC            |
| Self-evaluation of self-learning ability          | Mean ± SEM | 7.833 ± 0.2322 | 8.613 ± 0.1894 | 8.613 ± 0.1894 | 7.260 ± 0.1771 | 7.833 ± 0.2322 | 7.260 ± 0.1771 |
|   | P-value    | 0.0139         |                | 0.0001         |                | 0.1923         |                |
| Preview before class                              | Mean ± SEM | 5.667 ± 0.4122 | 7.484 ± 0.3648 | 7.484 ± 0.3648 | 4.356 ± 0.2207 | 5.667 ± 0.4122 | 4.356 ± 0.2207 |
|   | P-value    | 0.0027         |                | < 0.0001       |                | 0.0205         |                |
| Active learning time in class                     | Mean ± SEM | 6.667 ± 0.3333 | 8.032 ± 0.2602 | 8.032 ± 0.2602 | 6.971 ± 0.1625 | 6.667 ± 0.3333 | 6.971 ± 0.1625 |
|   | P-value    | 0.0024         |                | 0.0016         |                | 0.4644         |                |
| The involvement situation during class discussion | Mean ± SEM | 7.000 ± 0.4122 | 8.839 ± 0.2544 | 8.839 ± 0.2544 | 6.750 ± 0.1495 | 7.000 ± 0.4122 | 6.750 ± 0.1495 |
|   | P-value    | 0.0002         |                | < 0.0001       |                | 0.5310         |                |
| The gains from group learning                     | Mean ± SEM | 6.722 ± 0.4770 | 8.968 ± 0.2149 | 8.968 ± 0.2149 | 6.413 ± 0.1877 | 6.722 ± 0.4770 | 6.413 ± 0.1877 |
|   | P-value    | <0.0001        |                | <0.0001        |                | 0.5320         |                |
| Extracurricular study time ordinary               | Mean ± SEM | 4.889 ± 0.3782 | 4.452 ± 0.2776 | 4.452 ± 0.2776 | 3.760 ± 0.1614 | 4.889 ± 0.3782 | 3.760 ± 0.1614 |
|   | P-value    | 0.3513         |                | 0.0392         |                | 0.0080         |                |
| The usefulness of self-learning                   | Mean ± SEM | 9.556 ± 0.3636 | 9.742 ± 0.2020 | 9.742 ± 0.2020 | 8.375 ± 0.1953 | 9.556 ± 0.3636 | 8.375 ± 0.1953 |
|   | P-value    | 0.6285         |                | 0.0004         |                | 0.0183         |                |

learning needs and challenges. Furthermore, 42 students highlighted the importance of “problem-solving assistance,” indicating that they value help in navigating complex topics and overcoming academic obstacles. Interestingly, among them, the percentage of students (12/31, 38.7%) from ALCs was higher than that of students from EMICs (4/18, 22.2%) and CCCs (26/105, 24.7%). Effective “communication and interaction” with teachers was another frequently mentioned area, underscoring the need for open, constructive dialogue between students and educators. These responses collectively reflect a significant demand for appropriate teacher intervention, tailored to enhance the learning experience and address specific student needs.

### 4 Discussion

Education is a purposeful social activity aimed at cultivating individuals, a fundamental attribute distinguishing it from other activities (Chen et al., 2023). The process of how to cultivate students is a focal point and challenge in educational research. However, in the current study, we found that the intrinsic interests in learning are quite different individually and suitable teaching models may evoke their active learning and shift the education purpose from knowledge transmission to knowledge construction. The students with high self-reported learning attitudes would prefer the teaching models with more challenge, like PBL used in our institutes. They tend to spend more time on their study during the whole learning process, which is one of the active indicators to reflect the learning attitudes of students.

The dual-selection process for class enrollment allows students to directly confront and reflect on their learning attitudes and methods. This study evaluates student proactive learning attitudes and intrinsic motivation after the dual-selection process, suggesting that students in ALC exhibit significantly higher levels of intrinsic motivation and more

positive learning attitudes compared to those in traditional learning settings. This positive learning attitude is likely a result of the interactive and student-centered learning environments provided by these class types. These environments encourage active participation, critical thinking, and continuous learning, which are essential for developing competent and independent medical professionals. For example, besides the regular curriculum designed by the institute, the students in ALC were also interested in various research projects. In October 2019, the students from our institute attended PKU Medicine, Education Forum (2019), a high-level medical education academic conference in China, and won 7 prizes, while 5 of them were achieved by ALC students (Supplementary Table S1). The PBL approach, characterized by greater student autonomy and flexibility, enhances the learning experience, fostering critical thinking and problem-solving skills. Students with higher intrinsic motivation benefit significantly from the autonomy and freedom that PBL provides, becoming more engaged and self-directed in their learning (Yang et al., 2019). Future research should continue to explore the long-term impacts of these teaching methods on academic performance and professional development.

Medical education is inherently unique due to its direct impact on life and health, which needs lifelong learning for medical students and clinical practitioners (Hoang and Lau, 2018). However, student acceptance of PBL varies, influenced by diverse learning backgrounds and personality traits. Continuous practice and adaptation are essential to cultivate and enhance their intrinsic motivation for proactive learning. Understanding and applying medical knowledge necessitates a deep comprehension and appropriate application of complex concepts. Different levels of knowledge complexity demand varying degrees of background understanding, making the role of the teacher indispensable. In this context, teachers serve not only as providers of knowledge but also as facilitators of learning who can offer targeted assistance and foster an environment conducive to independent study (Hayat et al., 2020). By elucidating, analyzing, and

discussing key points through case-based discussions, educators can significantly enhance a student's ability to engage in self-directed learning, ultimately contributing to better educational outcomes and the development of lifelong learning skills. Rather than merely dispensing information, teachers need to create opportunities for students to engage in deeper, critical exploration, enabling them to identify real-world issues and correct misconceptions independently.

Although this investigation mainly focused on the learning attitudes of undergraduate students majoring in clinical medicine, the implementation of different teaching models should also be paid attention to, which will provide a more satisfying learning environment to improve the learner's engagement (Neufeld, 2023). For CCCs, although it seems to be the easiest model for educators, the curriculum and lecture design should be more interesting for learners and updated yearly with the newest research or current affairs, which also applies to EMICs. However, for EMICs, the language barrier is the most important one both for educators and learners. Standard training and lifelong learning are the same problems that educators need to face. To solve such a problem, a teacher training program and/or department focusing on equipping future teachers, as pre-service teachers, should be also designed for experienced teachers with cognitive flexibility (Janapati and Vijayalakshmi, 2024). In the conducting process of ALCs, the requirement of quite an amount of resources restricted the size of this class. It is hard to apply this teaching model for all students, so self-estimation and educator guidance could try to ensure ALC models are available to the more appropriate students.

## 4.1 Study limitations

The dual-selection method employed by ALC provides an open platform for assessing clinical medical undergraduate learning attitudes. The case-based learning approach offers abundant opportunities for proactive engagement with medical knowledge. However, the resource-intensive nature of PBL, requiring significant investment in teaching staff, learning environments, and online materials, limits the scale of ALC. So, the limitation is unavoidable in the current study.

Firstly, the sample size is relatively small, due to the limited enrolled students in ALC models. Despite this limitation, this study offers valuable insights into adopting different strategies tailored to various learning attitudes.

Secondly, our investigation only focused on the learning attitudes of medical students based on self-reports, which may lead to bias, due to subjective judgment individually. To provide a comfortable and confidential environment to participants, we did not include any personal information in this questionnaire. Meanwhile, the survey was conducted online to avoid face-to-face or eye-contact awkwardness and encourage participants with true responses. Further investigation will try to research the tools for assessing the learning attitudes of medical students objectively, while the prior academic performance or personality traits can facilitate more sophisticated analyses for multiple regression or structural equation modeling.

Thirdly, the duration of the research is too limited to observe the performance or educational outcomes associated with lifelong learning skills. Meanwhile, the student discussion based on the SDT framework will facilitate the identification of affecting factors that promoted and hindered learning activities and motivation of students majoring in clinical medicine.

Last not the least, this study was conducted only in one single institution. All the learning behaviors may be affected by the institutes and/or educational leadership, while how to apply this approach in other institutions should be evaluated comprehensively. Meanwhile, the responses from institutions, educational leadership, and teachers/tutors toward students under different teaching models should be investigated, combined with their performance or educational outcomes for improvement of clinical medicine education.

## 5 Conclusion and future perspectives

Medical education is a rigorous and demanding field, carrying the significant responsibility of life and health. Medical students of the 21st century will encounter numerous opportunities and challenges (Wang, 2021). This survey showed high self-recognition of positive learning attitudes in ALC students, underscoring the importance of adopting diverse and adaptive teaching strategies in clinical medical undergraduates. Enhancing teacher guidance and support throughout the learning process is essential, while the dual selection provided a potential method for evaluation. Assessing their learning attitudes and intrinsic motivation, implementing diverse teaching strategies, and ensuring effective teacher guidance are crucial steps toward advancing medical education. These efforts will also help instill proper worldviews, life perspectives, and values in medical students, laying a robust foundation for their comprehensive development.

The survey is a quite useful method to reveal personal thoughts and attitudes by collecting participants' views on a specific issue, such as distance learning (Alsehali et al., 2024). With the potential disadvantages of self-reported survey, like subjective, combination with other tools will improve the objectiveness for assessing learning attitudes. For example, the self-report of knowledge, testing, and examination can serve as relatively objective indicators to reflect the learning attitudes of students, whatever their purposes are (Stevens et al., 2024), while knowledge, skills, and attitudes (KSA) have been used as tools for evaluating medical students, physicians, nurses, and inpatients, related to medicine (Baker et al., 2021). Meanwhile, it is well known that internal driving forces and external influences, like scholarships and bursaries, can affect the outcomes of their learning (Ng et al., 2009). So the personality traits should not be ignored for future investigation, as well as academic performance, academic confidence, academic self-efficacy, and social support, which needs multiple regression or structural equation modeling to facilitate the comprehensive assessment of undergraduates majoring in clinical medicine.

## Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

## Ethics statement

The studies involving humans were approved by the Ethics Committee of Shantou University Medical College. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived



the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because as an anonymous investigation, the anonymous questionnaire began with a statement that students can choose whether participate in or not, and all data is only for research analysis. No personal information will be disclosed.

## Author contributions

Y-ZL: Formal analysis, Investigation, Visualization, Writing – original draft. W-TL: Formal analysis, Visualization, Writing – original draft. ZW: Formal analysis, Investigation, Writing – original draft. W-JC: Formal analysis, Visualization, Writing – original draft. DG: Formal analysis, Visualization, Writing – original draft. S-HL: Conceptualization, Supervision, Visualization, Writing – review & editing. JL: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2024.1458216/full#supplementary-material>

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