

Learning Outcomes and Student Perceptions of a Flipped Classroom in a Pharmacokinetics Course among Third-Year Pharmacy Students

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ABSTRACT:

Objective: To evaluate student perceptions, learning experiences, and academic performance following implementation of a flipped classroom model in an undergraduate Pharmacokinetics course.

Methods: A mixed-methods cross-sectional study was conducted among 169 third-year pharmacy students during the 2024–2025 academic year. Quantitative data were collected using a validated questionnaire and academic records, while qualitative data were obtained through semi-structured interviews with five students. Descriptive statistics and thematic analysis were performed.

Results: The questionnaire demonstrated excellent reliability (Cronbach's $\alpha = 0.968$ – 0.988). Students reported positive perceptions across all domains (mean: 4.11 – $4.23/5$). Overall, 64.5% of students liked or strongly liked the course. The mean final examination score was 7.86 ± 0.97 , and the overall course grade was 8.07 ± 0.67 . Interviews indicated that the flipped classroom enhanced learning motivation, self-directed learning, active participation, teamwork, and application of pharmacokinetic concepts, although increased pre-class workload was identified as a challenge.

Conclusions: The flipped classroom was well accepted by pharmacy students and supported positive learning experiences and satisfactory academic performance. These findings support its use as a learner-centered teaching strategy in undergraduate pharmacokinetics.

Keywords: flipped classroom; pharmacokinetics; pharmacy education; active learning; mixed methods.

INTRODUCTION

Flipped classroom has increasingly been adopted in undergraduate health professional education as a strategy to promote active, student-centered learning. In this model, foundational knowledge

is delivered before class through learning materials, videos, or online resources, whereas face-to-face classroom time is used for discussion, problem-solving, application exercises, and feedback. This design shifts students from passive reception of lectures

toward active preparation and higher-order learning activities during class (Cui et al., 2023; McLaughlin et al., 2014; Onódi et al., 2025).

In pharmacy education, the flipped classroom model is particularly relevant because many courses require not only knowledge acquisition but also calculation, reasoning, interpretation, and clinical application. Traditional lecture-based instruction may be insufficient for these competencies because it often limits student interaction, self-directed learning, and opportunities to apply concepts in realistic contexts (He et al., 2019; Peng et al., 2022). Pharmacokinetics is one such course, as students are expected to understand core theoretical principles and apply them to dosage calculations, regimen adjustment, and clinical decision-making. Therefore, flipped learning may provide an appropriate pedagogical structure for pharmacokinetics by allowing students to review basic concepts before class and use classroom time for case-based analysis, pharmacokinetic calculations, and guided problem-solving (Cui et al., 2023; Schneider et al., 2014).

Existing evidence suggests that flipped classroom approaches can improve learning outcomes in pharmacy education, although the magnitude and consistency of benefit vary across studies. Systematic review and meta-analysis findings indicate that flipped instruction is generally associated with better examination performance and course achievement among pharmacy students, but several reviews have also noted methodological limitations, heterogeneity in implementation, and potential risk of bias in the available studies (Aljaber et al., 2023; Cui et al., 2023). Evidence from broader undergraduate health professional education similarly suggests potential improvement in academic outcomes, but certainty remains limited because many studies are non-randomized and context-dependent (Naing et al., 2023). In pharmacokinetics specifically, studies have reported mixed findings, with some showing improved topic-specific or downstream performance and others finding no significant difference in major assessments, suggesting that

effectiveness may depend on course design, assessment type, and the alignment between pre-class and in-class activities (Onódi et al., 2025; Persky & Dupuis, 2014; Schneider et al., 2014).

Student perceptions are another important dimension in evaluating flipped classroom implementation. Previous pharmacy education studies have generally reported positive student feedback, including higher engagement, better perceived understanding, stronger self-learning ability, and greater satisfaction with active in-class learning (Aljaber et al., 2023; Bashir & Hamid, 2021; Peng et al., 2022). However, student acceptance is not universal. Some students report concerns related to increased pre-class workload, lengthy preparation materials, poor-quality recordings, unclear learning objectives, or weak integration between pre-class preparation and classroom activities (Khanova et al., 2015; Kugler et al., 2019; Wong et al., 2014). These findings indicate that both academic outcomes and learner experience should be assessed when a flipped classroom model is introduced.

At Dai Nam University, Vietnam, the flipped classroom model was implemented in the Pharmacokinetics course for third-year undergraduate pharmacy students. However, evidence regarding the implementation and evaluation of flipped classroom teaching in pharmacy education remains limited in the Vietnamese context. Evaluating student academic performance and perceptions after implementation is therefore necessary to provide practical evidence for course improvement and potential expansion of this teaching model. This study aimed to describe learning outcomes and student perceptions following implementation of a flipped classroom model in an undergraduate pharmacokinetics course.

MATERIALS AND METHOD

Study design and participants

A cross-sectional descriptive study employing a mixed-methods approach was conducted among third-year undergraduate pharmacy students (Cohort 16) enrolled in the Pharmacokinetics course during the 2024–2025 academic year. The

quantitative component consisted of a post-course survey and academic performance assessment, whereas the qualitative component involved in-depth interviews to explore students' learning experiences with the flipped classroom model. A total population sampling approach was adopted for the quantitative survey, including all students registered for the course who met the eligibility criteria.

Eligible participants were third-year pharmacy students who completed all learning activities and attended the final examination. Students who repeated the course or did not take the final examination were excluded. Student names were collected solely for the purpose of matching survey responses with academic performance data. Personal information was kept confidential and used exclusively for research purposes.

For the qualitative component, five students were purposively selected after completion of the course to ensure variation in academic performance and learning experiences. Individual semi-structured interviews were conducted to obtain a deeper understanding of students' perceptions of the flipped classroom, including its perceived benefits, challenges, and suggestions for improvement.

Flipped classroom implementation

The Pharmacokinetics course was delivered using a flipped classroom model. Before each class session, students were provided with learning materials, including electronic lecture slides and reference documents, through Google Classroom. Learning objectives and preparation guidelines were also posted to facilitate independent pre-class learning.

To assess students' preparation, mandatory pre-class assignments consisting of multiple-choice or short-answer questions were administered via Google Forms before each class. Students completed and submitted these assignments within the designated timeframe. Assignment results were used to monitor learning engagement and preparedness and to guide subsequent in-class discussions.

Face-to-face classroom time was devoted to active learning activities rather than conventional lectures. These activities included small-group discussions, case-based problem solving, and application exercises designed to reinforce and apply pharmacokinetic concepts. During these sessions, instructors served as facilitators by providing guidance, clarifying misconceptions, and offering feedback to enhance students' critical thinking and problem-solving skills. Student groups shared and discussed their work using the Padlet online collaborative platform.

Course performance was calculated according to the institutional grading policy using a weighted average comprising attendance (10%), continuous assessment (30%), and the final examination (60%).

Data collection

Quantitative data were collected from two sources following completion of the course. First, students completed an online questionnaire developed using Google Forms. The questionnaire consisted of six domains: (1) learning process (1 item), (2) course objectives and content (4 items), (3) teaching activities (5 items), (4) assessment methods (4 items), (5) perceived learning outcomes (6 items), and (6) overall interest in the course (1 item). Quantitative items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The internal consistency of the questionnaire was evaluated using Cronbach's alpha.

Second, academic performance data, including final examination scores and overall course grades, were retrieved from the university's academic management system. The final examination consisted of objective multiple-choice questions developed according to the course learning outcomes and an examination blueprint to ensure alignment between assessment content and intended learning objectives. Examination administration and grading followed institutional regulations to ensure fairness, transparency, and consistency.

Qualitative data were collected through face-to-face semi-structured interviews with five purposively selected students. An interview guide was developed to explore students' experiences with pre-class preparation, in-class learning activities, use of digital learning platforms, perceived learning outcomes, challenges encountered during the course, and recommendations for improving the flipped classroom model. Each interview lasted approximately 20–30 minutes, was audio-recorded with participants' consent, and subsequently transcribed verbatim for analysis.

Data analysis

Quantitative data were cleaned, coded, and analyzed using IBM SPSS Statistics version 27. Cronbach's alpha coefficients were calculated to assess the internal consistency of the questionnaire. Descriptive statistics were used to summarize questionnaire responses and academic performance. Continuous variables were presented as means and standard deviations, whereas categorical variables were summarized using frequencies and percentages.

Qualitative interview transcripts were analyzed using thematic analysis. Two researchers independently reviewed the transcripts, identified initial codes, grouped similar codes into themes, and reached consensus through discussion. Representative quotations were selected to illustrate each major theme identified from the interviews.

Ethical considerations

Students received information regarding the study objectives and procedures before participation. Participation in both the questionnaire survey and in-depth interviews was voluntary, and written informed consent was obtained from interview participants. All collected data were treated confidentially and used solely for research purposes. Personally identifiable information was accessible only to the research team for data management and linkage with academic records and was not disclosed in any publication or report.

RESULTS

The internal consistency of the questionnaire was assessed using Cronbach's alpha (Table 1). All questionnaire domains demonstrated excellent reliability, with Cronbach's alpha coefficients ranging from 0.968 to 0.988. The domains of course objectives and content, teaching activities, assessment and evaluation, and perceived learning outcomes achieved alpha values of 0.968, 0.972, 0.984, and 0.988, respectively, indicating that the survey instrument had excellent internal consistency and was appropriate for evaluating students' perceptions of the flipped Pharmacokinetics course.

Table 1. Internal consistency of the survey instrument

Domain	Number of items	Cronbach's α
Course objectives and content	4	0.968
Teaching activities	5	0.972
Assessment and evaluation	4	0.984
Perceived learning outcomes	6	0.988

A total of 169 third-year pharmacy students completed the post-course survey. Overall, students expressed highly positive perceptions of the flipped classroom approach, with mean scores ranging from 4.11 to 4.23 on a five-point Likert scale. Standard deviations ranged from 0.78 to 0.87, indicating relatively low variability and a high level of agreement among respondents (Table 2).

Students reported a high level of engagement in the learning process, with a mean score of 4.19 ± 0.79 for their effort throughout the course.

Regarding course objectives and content, all items received favorable ratings (mean: 4.13–4.17). Students perceived the learning objectives to be clearly defined (4.13 ± 0.78), the course content to be well organized (4.14 ± 0.79), the workload to be appropriate (4.14 ± 0.80), and the

balance between theoretical and practical components to be satisfactory (4.17 ± 0.80).

Teaching activities were also evaluated positively, with mean scores ranging from 4.11 to 4.23. The highest-rated item was instructors' subject expertise (4.23 ± 0.78), followed by instructors' ability to relate theoretical concepts to real-world practice and their willingness to engage with students' perspectives (both 4.17 ± 0.81). Students also considered the teaching methods effective in promoting active participation (4.15 ± 0.80). The lowest-rated item within this domain, although still highly positive, concerned the relevance of teaching activities to future professional practice (4.11 ± 0.84).

Assessment and evaluation received consistently favorable ratings (4.20–4.22). Students agreed that instructors assessed them fairly (4.22 ± 0.81), that assessment methods were aligned with the learning objectives (4.20 ± 0.82), that examination content accurately reflected their competencies (4.21 ± 0.80), and that continuous assessment feedback supported improvements in learning (4.22 ± 0.79).

Perceived learning outcomes were similarly positive (4.11–4.19). Students agreed that the course provided essential pharmacokinetics knowledge (4.19 ± 0.80), enhanced professional skills (4.16 ± 0.81), strengthened self-directed learning (4.15 ± 0.81), improved teamwork (4.18 ± 0.82), and enhanced communication skills (4.11 ± 0.87). Overall satisfaction with the course was also high (4.17 ± 0.81).

Table 2. Students' perceptions of the flipped Pharmacokinetics course (N = 169)

Content	Mean	SD
Learning process		
I made my best effort throughout the Pharmacokinetics course.	4.19	0.79
Course objectives and content		
The learning objectives were clearly defined.	4.13	0.78

Content	Mean	SD
The course content was well organized and appropriately planned.	4.14	0.79
The course workload was appropriate.	4.14	0.80
The balance between theoretical and practical components was appropriate.	4.17	0.80
Teaching activities		
Most instructors demonstrated strong subject knowledge.	4.23	0.78
The teaching methods were easy to follow and encouraged active student participation.	4.15	0.80
Most instructors listened to students' opinions and were willing to share their perspectives.	4.17	0.81
Most instructors helped students relate theoretical concepts to real-world practice.	4.17	0.81
Teaching activities were relevant to future professional practice.	4.11	0.84
Assessment and evaluation		
Instructors assessed students fairly.	4.22	0.81
The assessment methods were appropriate for the teaching approach and learning objectives.	4.20	0.82
The assessment content accurately reflected students' competencies.	4.21	0.80
Feedback on continuous assessment helped improve my learning.	4.22	0.79
Perceived learning outcomes		
The course provided me with essential knowledge.	4.19	0.80
The course helped me develop professional skills.	4.16	0.81
The course enhanced my self-learning and self-study skills.	4.15	0.81

Content	Mean	SD
The course improved my teamwork skills.	4.18	0.82
The course improved my communication skills.	4.11	0.87
Overall, I was satisfied with the quality of the course.	4.17	0.81

Students reported a high level of interest in the Pharmacokinetics course following implementation of the flipped classroom model (Table 3). Nearly two-thirds of respondents (64.5%) indicated that they either liked (41.4%) or strongly liked (23.1%) the course, while the remaining 35.5% reported a neutral level of interest. No students reported disliking the course, suggesting broad acceptance of the flipped classroom approach.

Table 3. Students' interest in the Pharmacokinetics course (N = 169)

Level of interest	n	%
Neutral	60	35.5
Like	70	41.4
Strongly like	39	23.1
Total	169	100.0

The final examination and overall course grades are presented in Table 4. The mean final examination score was 7.86 ± 0.97 , with scores ranging from 4.5 to 10.0. The mean overall course grade was slightly higher at 8.07 ± 0.67 , with a range of 5.8 to 9.7. These findings indicate that most students achieved satisfactory academic performance and successfully met the learning outcomes of the Pharmacokinetics course following implementation of the flipped classroom model.

Table 4. Academic performance of students enrolled in the Pharmacokinetics course (N = 169)

Outcome	N	Minimum	Maximum	Mean $\pm$ SD
Final examination score	16 9	4.5	10.0	7.86 ± 0.97

Overall course grade	16 9	5.8	9.7	8.07 ± 0.67
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Qualitative findings

To complement the quantitative findings, five students representing different levels of academic performance participated in semi-structured in-depth interviews after completing the course. Thematic analysis identified nine overarching themes related to students' experiences with the flipped classroom model (Table 5).

Overall, students perceived the flipped classroom as an engaging and student-centered learning approach that promoted active participation throughout the course. Participants consistently reported that the requirement to review learning materials before class encouraged greater responsibility for their own learning and increased their motivation to prepare adequately for classroom activities. They also perceived that the combination of pre-class preparation and interactive in-class discussions facilitated a deeper understanding of pharmacokinetic concepts than traditional lecture-based teaching.

Students emphasized that collaborative learning activities, including small-group discussions and case-based problem solving, enhanced their communication, teamwork, and critical thinking skills. The use of digital learning platforms, including Google Classroom for learning materials, Google Forms for pre-class assignments, and Padlet for collaborative discussions, was considered convenient and supportive of continuous learning. Participants further appreciated the instructors' role as facilitators who guided discussions, provided constructive feedback, and encouraged students to integrate theoretical knowledge with practical applications.

Despite these positive experiences, interviewees identified several challenges associated with the flipped classroom model. The most frequently reported concern was the increased time required for pre-class preparation and the need for strong self-discipline, particularly during periods with heavy academic workloads. Several students also

suggested incorporating additional clinical cases, practice exercises, and brief video summaries to facilitate pre-class learning.

Table 5. Themes identified from in-depth interviews with students following implementation of the flipped Pharmacokinetics course (n = 5)

Theme	Description	Representative quote
Increased learning motivation	Students reported that the flipped classroom motivated them to prepare before class because pre-class assignments and in-class discussions required active participation.	<i>"I used to study only before examinations, but with this course I had to prepare before every class. It made me more responsible for my learning."</i>
Better understanding of pharmacokinetic concepts	Participants believed that pre-class preparation followed by classroom discussion helped them understand difficult pharmacokinetic concepts more effectively than conventional lectures.	<i>"Reading the materials first and then discussing clinical cases in class helped me understand concepts that were difficult to grasp from lectures alone."</i>
Active participation and classroom engagement	Students appreciated the interactive learning environment,	<i>"I felt more comfortable asking questions and sharing my</i>

Theme	Description	Representative quote
	reporting that group discussions encouraged them to ask questions, express opinions, and participate more confidently.	<i>ideas because everyone had already prepared before coming to class."</i>
Improved self-directed learning skills	Students perceived improvements in independent learning, literature searching, and critical thinking as they were required to study learning materials before class.	<i>"The course trained me to search for information by myself instead of waiting for the lecturer to explain everything."</i>
Development of teamwork and communication skills	Collaborative learning activities promoted teamwork, communication, and presentation skills through group discussions and Padlet-based presentations.	<i>"Working with my group and presenting our answers improved both my teamwork and communication skills."</i>
Effective use of digital learning platforms	Students considered Google Classroom, Google Forms, and	<i>"Everything was available online, so it was convenient to review the materials</i>

Theme	Description	Representative quote	Theme	Description	Representative quote
Constructive role of instructors	Padlet useful for accessing learning resources, completing assignments, and sharing discussion outputs.	<i>anytime and submit assignments on time."</i>	Suggestions for course improvement	concurrent courses.	
	Students highlighted that instructors acted as facilitators rather than traditional lecturers, providing timely feedback and encouraging critical thinking during classroom activities.	<i>"The lecturers guided our discussions instead of simply giving answers, which made us think more deeply."</i>		Students recommended incorporating additional clinical cases, practice questions, and short review videos before class to support independent learning.	<i>"More clinical examples and short video summaries before class would make the preparation easier and more interesting."</i>
Challenges of the flipped classroom	Although students valued the teaching approach, they acknowledged that it required substantial preparation time and consistent self-discipline, particularly during periods with multiple	<i>"The biggest challenge was preparing before every class because sometimes several subjects assigned work at the same time."</i>			

DISCUSSION

The present study evaluated the implementation of a flipped classroom model in an undergraduate pharmacokinetics course using a mixed-methods approach. Overall, students demonstrated high acceptance of the instructional approach, perceived substantial improvements in active learning and professional competencies, expressed a high level of satisfaction with the course, and achieved favorable academic performance. Findings from the in-depth interviews further supported the quantitative results by providing insight into students' learning experiences and perceived benefits of the flipped classroom.

Students expressed highly positive perceptions of the flipped classroom, with all evaluated domains receiving mean scores above 4.0 on a five-point scale. The qualitative interviews reinforced these findings, with students consistently reporting that the learning approach increased their motivation, encouraged regular preparation before class, and created a more engaging learning environment. These findings are consistent with previous evidence demonstrating that flipped classrooms are generally well accepted in pharmacy education (Aljaber et al., 2023).

The high level of acceptance observed in the present study is comparable with previous pharmacy courses implementing flipped learning. Bashir and Hamid reported that approximately 90% of pharmacy students expressed positive perceptions of a flipped physiology course (Bashir & Hamid, 2021). Similarly, McLaughlin et al. found that students' preference for the flipped format increased substantially from 34.6% before the course to 89.5% after course completion (McLaughlin et al., 2013). Basheer and Almazrou also reported that over 70% of pharmacy students considered the flipped classroom useful and believed that it improved their learning outcomes (Basheer & Almazrou, 2021).

Although nearly two-thirds of students in the present study reported that they liked or strongly liked the Pharmacokinetics course after implementation of the flipped classroom model, this proportion was somewhat lower than that reported in several previous studies showing satisfaction levels approaching 90% (Gondal et al., 2024; Schneider et al., 2014). The interview findings help explain this difference, as students appreciated the instructional approach but also acknowledged that it required greater preparation time and stronger self-discipline than traditional lectures. Previous studies have similarly suggested that student acceptance depends not only on the flipped model itself but also on the quality of implementation, workload, and alignment between pre-class preparation and in-class learning activities (Aljaber et al., 2023; Chan et al., 2018).

Active learning and competency development

Students perceived that the flipped classroom enhanced self-directed learning, teamwork, communication, and the application of pharmacokinetic knowledge to practical situations. These findings were strongly supported by the qualitative interviews, in which students described becoming more responsible for their own learning, participating more actively in discussions, and developing greater confidence in communicating their ideas. Students also highlighted that collaborative learning through

case discussions and Padlet-based presentations improved their ability to connect theoretical concepts with clinical practice.

These findings are consistent with previous systematic reviews demonstrating that flipped classrooms improve learning enthusiasm, self-learning ability, communication skills, critical thinking, and learning efficiency among pharmacy students (Aljaber et al., 2023; Peng et al., 2022). The educational benefits are biologically plausible because flipped learning reallocates classroom time from passive content delivery to interactive learning activities, including case discussions, problem-solving exercises, and collaborative learning (Aljaber et al., 2023; Cui et al., 2023). In a randomized controlled trial, He et al. reported that the flipped classroom substantially increased student participation, with student talk accounting for 75% of classroom interaction compared with only 2.6% in lecture-based teaching (He et al., 2019).

The interview findings also demonstrated that students perceived pharmacokinetics to become more meaningful when theoretical concepts were integrated with practical cases. This observation is particularly important because pharmacokinetics requires students to perform dosage calculations, interpret drug concentration data, and apply theoretical principles to clinical decision-making. Previous flipped pharmacokinetics studies have similarly emphasized case-based learning and problem-solving activities as effective strategies for promoting higher-order cognitive skills and knowledge transfer (Schneider et al., 2014). Moreover, long-term evidence suggests that greater exposure to active learning in pharmacokinetics is associated with improved performance in subsequent clinical pharmacy courses (Persky & Dupuis, 2014).

Academic performance

Students achieved favorable academic outcomes, with a mean final examination score of 7.86 ± 0.97 and an overall course grade of 8.07 ± 0.67 , indicating successful attainment of the intended

learning outcomes. Although the present study did not include a traditional lecture-based comparison group, these findings are consistent with previous meta-analyses demonstrating that flipped classrooms generally improve academic performance in pharmacy and health-professions education (Cui et al., 2023; Naing et al., 2023).

Several individual studies have reported similar improvements in examination performance following implementation of flipped learning. Gondal et al. observed a significant increase in pharmacy students' class scores after adoption of the flipped classroom (Gondal et al., 2024), while He et al. found significantly higher examination scores among students receiving flipped instruction than those receiving conventional lectures (He et al., 2019). Likewise, Tangiisuran et al. reported substantial improvements in post-test performance after introducing flipped learning into a pharmacy course (Tangiisuran et al., 2017).

Nevertheless, the relationship between flipped classrooms and examination performance should be interpreted cautiously. Previous systematic reviews indicate that although flipped learning consistently improves engagement and student satisfaction, improvements in summative assessment are less consistent across studies (Aljaber et al., 2023; Naing et al., 2023). In pharmacokinetics specifically, Schneider et al. reported significantly higher student satisfaction but no significant difference in major assessment outcomes between flipped and traditional cohorts (Schneider et al., 2014). Similarly, a recent pharmacology study demonstrated improved knowledge retention without a corresponding increase in overall examination scores (Onódi et al., 2025). These findings suggest that examination performance depends not only on the instructional approach but also on assessment

design, constructive alignment between learning activities and examinations, and the extent to which students engage with pre-class learning materials (Spaić et al., 2025).

A major strength of this study is the mixed-methods design, which combined quantitative survey data, objective academic performance, and qualitative interviews to provide a comprehensive evaluation of the flipped classroom. The inclusion of in-depth interviews enabled triangulation of findings and offered valuable insights into students' learning experiences that could not be captured through questionnaires alone. Several limitations should also be acknowledged. First, the study employed a single-group cross-sectional design without a conventional lecture-based comparison group, preventing causal inference regarding the effectiveness of the flipped classroom. Second, the study was conducted within a single pharmacy program, which may limit the generalizability of the findings to other educational settings. Third, qualitative data were obtained from only five students and therefore represent illustrative rather than exhaustive perspectives. Finally, students' perceptions were collected immediately after course completion, and longer-term effects on knowledge retention and clinical performance were not evaluated.

CONCLUSION

Overall, the present findings indicate that the flipped classroom is a well-accepted and educationally valuable instructional approach for undergraduate pharmacokinetics. Students perceived improvements in engagement, active learning, and professional competencies, while academic performance was satisfactory and consistent with the broader evidence supporting flipped learning in pharmacy education.

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