COMPARING THE EFFECTS OF RAIN CLASSROOM, WECHAT AND MULTIMEDIA TEACHING TOOL ON AUTONOMOUS LEARNING AND COGNITIVE ABILITY AMONG BIOCHEMISTRY COURSE UNDERGRADUATES IN CHINA

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by

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AiED	Artificial Intelligence In Education
ALEKS	Assessment And Learning In Knowledge Spaces
ALS	Autonomous Learning Scale
ANOVA	Univariate Analysis Of Variance
APP	Application
AR	Augmented Reality
BP	Backpropagation
BT	Biochemistry Test
CAI	Computer-Assisted Instruction
ETS	Educational Testing Service
GPA	Grade Point Average
IELTS	International English Language Testing System
K12	Kindergarten Through Twelfth Grade
KR-20	Richardson Formula 20
MANOVA	Multivariate Analysis Of Variance
MOOC	Massive Open Online Course
PSSH	Physical Symbol System Hypothesis
RQ	Research Questions
SPSS	Statistical Package For The Social Sciences
TOEFL	Test Of English As A Foreign Language
UK	United Kingdom
USA	United States
USM	Universiti Sains Malaysia
VR	Virtual Reality
3D	Three-Dimensional

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Appendix X Lecturer's interview responses to perceive the existing teaching platform in Biochemistry course

MEMBANDINGKAN KESAN RAIN CLASSROOM, WECHAT DAN ALAT PENGAJARAN MULTIMEDIA KE ATAS PEMBELAJARAN AUTONOMI DAN KEBOLEHAN KOGNITIF DALAM KALANGAN PELAJAR KURSUS SARJANA MUDA BIOKIMIA DI CHINA

ABSTRAK

Kajian ini bertujuan untuk mengkaji kesan platform pengajaran Kecerdasan Buatan (AI: Rain Classroom), Platform WeChat, dan Multimedia serta bagaimana ketiga-tiga platform pengajaran ini meningkatkan pembelajaran autonomi pelajar dan keupayaan kognitif dalam kursus Biokimia. Kajian ini menggunakan reka bentuk kaedah bercampur penjelasan berurutan. Data kuantitatif dikumpulkan menggunakan Skala Pembelajaran Berautonomi (ALS) (untuk mengukur keupayaan pembelajaran autonomi pelajar kursus Biokimia), dan Ujian Biokimia (BT) (untuk mengukur keupayaan kognitif pelajar). Dengan menggunakan teknik analisis MANOVA dan ANOVA, dapatan kajian menunjukkan bahawa terdapat perbezaan yang signifikan dalam keupayaan pembelajaran autonomi dan keupayaan kognitif dalam tiga platform pengajaran yang dikaji. Keputusan menunjukkan bahawa platform pengajaran AI (Rain Classroom) dan platform WeChat dapat meningkatkan keupayaan pembelajaran autonomi pelajar dengan lebih baik daripada alatan pengajaran multimedia. Untuk keupayaan kognitif, platform pengajaran AI (Rain Classroom) mempunyai kesan terbaik, diikuti oleh platform WeChat dan alatan pengajaran multimedia. Data kualitatif yang dikumpulkan daripada temubual (dengan guru dan pelajar) dan semakan dokumen-dokumen yang berkaitan (buku teks, spesifikasi kurikulum, kursus) untuk menyiasat bagaimana tiga platform pengajaran mempengaruhi pembelajaran autonomi dan keupayaan kognitif pelajar

dalam kursus Biokimia dianalisis menggunakan teknik analisis tematik. Dapatan menunjukkan bahawa untuk platform pengajaran Kecerdasan Buatan (Rain Classroom), pelajar dan guru bersetuju bahawa ia meningkatkan pembelajaran autonomi dan keupayaan kognitif pelajar dalam kursus biokimia dengan memperkayakan kandungan pembelajaran, membantu pelajar meningkatkan kecekapan pembelajaran bilik darjah dan penilaian kendiri selepas kelas. Untuk platform WeChat, pembelajaran autonomi dan keupayaan kognitif pelajar dipromosikan dengan menyediakan saluran komunikasi dan pelbagai kandungan pembelajaran kepada pelajar, menarik mereka untuk meningkatkan masa pembelajaran selepas kelas. Alat pengajaran multimedia, sebaliknya, mempersembahkan kandungan pengajaran yang pelbagai untuk menarik minat pelajar, meningkatkan kecekapan pembelajaran bilik darjah dan membantu pelajar meningkatkan kebolehan mereka. Justeru, dapat disimpulkan bahawa platform pengajaran AI (Rain Classroom) dan platform WeChat adalah penting dalam merangsang pembelajaran autonomi dan keupayaan kognitif pelajar dalam kursus Biokimia. Dapatan kajian ini juga boleh dijadikan panduan untuk memperbaiki proses pengajaran dan pembelajaran kursus Biokimia bagi universiti-universiti di China.

COMPARING THE EFFECTS OF RAIN CLASSROOM, WECHAT AND MULTIMEDIA TEACHING TOOL ON AUTONOMOUS LEARNING AND COGNITIVE ABILITY AMONG BIOCHEMISTRY COURSE UNDERGRADUATES IN CHINA

ABSTRACT

This study aimed to investigate the effects of Artificial Intelligence (AI: Rain Classroom), WeChat platform and multimedia teaching tool and how these three teaching platforms enhance students' autonomous learning and cognitive ability in the Biochemistry course. This study used a sequential explanatory mixed methods design. The quantitative data were collected using the Autonomous Learning Scale (ALS) (to measure students' autonomous learning ability in Biochemistry course) and the Biochemistry Test (BT) (to measure students' cognitive ability). Using MANOVA and ANOVA analysis techniques, findings showed that there are significant differences in student's autonomous learning ability and cognitive ability in the three teaching platforms studied. The results showed that the AI (Rain Classroom) teaching platform and WeChat platform can improve students' autonomous learning ability better than multimedia teaching tool. For cognitive ability, the AI (Rain Classroom) has the best effect, followed by the WeChat platform and multimedia teaching tool. The qualitative data collected from interviews (with the teachers and students) and related documents (textbooks, curriculum specification, assignments of Biochemistry course) to investigate how the three teaching platforms affect students' autonomous learning and cognitive ability in the Biochemistry course were analyzed using thematic analysis technique. Findings showed that for the Rain Classroom teaching platform, both students and

teachers agreed that it improved students' autonomous learning and cognitive ability in the Biochemistry course by enriching learning content, helping students improve classroom learning efficiency and self-evaluation after class. For the WeChat platform, students' autonomous learning and cognitive ability were promoted by providing students with a communication channel and various learning content, attracting them to increase their after-class learning time. Multimedia teaching tool, on the other hand, presented diversified teaching content to attract students, improved classroom learning efficiency and helped students improve their abilities. Thus, it can be concluded that the AI (Rain Classroom) teaching platform and WeChat platform are important in promoting students' autonomous learning and cognitive ability in the Biochemistry course. The findings of this study can also serve as a guide for the betterment of the teaching and learning process of the Biochemistry course for universities in China.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Biochemistry is a subject that studies the chemical composition, structure, and chemical transformation process in the organism (Jafarkhani & Jamebozorg, 2020). It is an important and compulsory course in life sciences (Meng et al., 2019). In the traditional Chinese teaching method, where the lecturer teaches unilaterally while the students listen to the lessons, students are not interested in studying biochemistry(Wang et al., 2019). In addition, the Biochemistry course isahighly theoretical course with the characteristics of abstract content, multiple knowledge points, and overlapping multidisciplinary features. So, achieving good learning effects only through classroom teaching is hard, and students demand to do autonomous learning after class. Unfortunately, Chinese undergraduates generally lack autonomous learning ability and have poor cognitive ability in Biochemistry course (Yang, 2020).

Autonomous learning ability refers to completing learning tasks independently, actively and consciously (Wei, 2021). The individual learning levels of students majoring in bioscience vary greatly, and it is difficult for lecturers to consider the needs of all students during the teaching process. Therefore, the requirements for students' autonomous learning ability are high, and students must conduct self-study after class (Zhou & Li, 2020). However, students are accustomed to the lecturer-based teaching method, and they are accustomed to relying on lecturers to solve problems,

lack intrinsic learning motivation, and have poor independent learning performance (Ge & Zhang, 2021). Secondly, due to Biochemistry course'many and abstract content, students are prone to fear difficulties. Students often have bad study habits, such as less study time, poor time management, and procrastination in studying biochemistry (Shen, 2019). Thus, there is an urgent need to develop students' autonomous learning ability to improve students learning effectiveness in Biochemistry course.

In addition to autonomous learning ability, students also performed poorly on cognitive abilities in Biochemistry course (Yang, 2020). Due to the complexity and variety of reactions and metabolisms in the Biochemistry course, students need to spend much time in this course for memorization and understanding, and the effect is not good. Unfortunately, besides affecting their course grades, bioscience students' cognitive ability in Biochemistry course is also being examined in China's postgraduate entrance exams and job interviews. Therefore, cultivating students' cognitive ability is very important in Biochemistry course.

Advances in technology have brought changes in teaching and learning. In recent years, "AI + education" has gradually become the focus of attention in education (Pan, 2018). Researchers have used AI to stimulate the reform of teaching methods and the changes in learning methods (Cui & Li, 2019). AI can not only analyze students' knowledge mastery and send learning suggestions but also provide students with personalized learning content and strategies from brain thinking, individual personality characteristics, and environmental characteristics to stimulate students' desire to learn (Kulkarni et al., 2020). Rain Classroom is one of the AI

platforms. China is now gradually applying Rain Classroom to the teaching of Biochemistry course. Rain Classroom can recommend personalized learning resources according to students' different hobbies and learning levels, thereby enhancing students' learning effects (Shu et al., 2019).

In addition to the Rain Classroom, the WeChat platform has gradually emerged as a new teaching platform for Biochemistry course (Yin, 2019). WeChat platform is one of the main functions of WeChat, except that it has a powerful online discussion function. The platform can be used in conjunction with WeChat mini-programs to achieve online teaching and online exams.The learning content published on the WeChat platform is limited in length, suitable for short-term learning, and allows students to learn mobile (Yan, 2019). Students can use the WeChat platform to study in fragmentary time without being restricted by time and space. Students spend more time learning unconsciously, and they will not feel fatigued.

The evolution of Rain Classroom and the WeChat platform provides more teaching methods, makes up for the deficiencies of China’s traditional teaching methods(multimedia teaching tool), and improves the problems left by traditional teaching(Zhan & Lai, 2020; Zheng & Huo, 2019). The Rain Classroom and WeChat platform are now used in biochemistry teaching as new teaching platforms, and people do not know much about these two platforms.In order to clarify the advantages and disadvantages of Rain Classroom, WeChat, and multimedia teaching tool on the autonomous learning ability and cognitive ability in Biochemistry course among

Chinese biology undergraduates,it is necessary to compare them. The students may be positively or negatively affected by these platforms, so this study intends to focus on these differences and shed more light on the three platforms by comparing their strengths and weaknesses. In order to help lecturers better choose and use these platforms in the future teaching of Biochemistry course, it also provides suggestions for improving students' autonomous learning ability and cognitive ability in Biochemistry course by teaching platforms.

1.2 Research Background

Biochemistry is an essential course of life science that aims to explore the chemical composition, changes and regulation of life processes using the theory and method of chemistry and to unveil the essence of life phenomena (Hu & Yao, 2021). The content of the course mainly includes nucleic acid, protein, lipid, sugar, enzyme, sugar catabolism, biological oxidation, sugar biosynthesis, lipid metabolism, nucleic acid biosynthesis and degradation, protein biosynthesis and degradation and metabolic regulation (Tian et al., 2020). This course aims to enable students to systematically master the basic theories and knowledge of modern biochemistry, cultivate students' ability and technology to understand life phenomena from the molecular level, and train students to analyze and solve problems and understand recent developments in biochemistry (Zhou et al., 2021). The Biochemistry course is a compulsory course for undergraduates majoring in biology in China (Zhuang et al., 2022), which is the basis for their subsequent series of important courses, such as molecular biology, cell

biology, genetics, physiology, microbiology and other subjects. Furthermore, biochemistry knowledge also lays the foundation for students to engage in teaching, scientific research, and further studies related to life sciences after graduation. Therefore, it is very important for undergraduates majoring in biology to learn biochemistry well.

Nowadays, teaching Biochemistry course in China is mainly based on face-to-face teacher teaching (J. Chen et al., 2020). Students listen to the lecturer's explanation and complete the homework after class. Biochemistry course are knowledge-intensive and have lotsof information (Jiahui et al., 2021). During the learning process, students often feel bored, find it difficult to memorize, are prone to weariness and are often in a passive state of learning for exams. Inaddition, it is difficult for lecturers to explain all the content in detail only with limited class time (Shu et al., 2019). So, the Biochemistry course requires students to have good autonomous learning ability, requiring them to take the initiative to study independently after class.

Autonomous learning ability, also called self-directed ability, is a modern learning ability contrary to traditional passive acceptance learning. Autonomous learning ability refers to the learning method in which learners have the power or right to regulate and control their own learning activities, emphasizing that learners are the main subject of learning, allows learners to take responsibility and actively participate in teaching activities to improve their learning efficiency (Darling-Hammond et al., 2020; Holec, 1979). Study habits and independent learning are two important components in building learners' autonomous learning ability (Khotimah et al., 2019;

Macaskill & Taylor, 2010). Study habits are stable behavioral patterns learners form in their daily study life, manifested as attitudes toward procrastination, time management, and working alone (Macaskill & Taylor, 2010).. Good study habits can help learners maintain self-discipline, improve learning efficiency, and maintain lasting learning motivation. Independent learning emphasizes the learner's ability to make independent decisions during the learning process, requiring learners to take responsibility for learning and actively participate in the learning process, manifested in intrinsic motivation, learning responsibility, openness to experience and confidence in responding to new activities (Macaskill & Taylor, 2010). Autonomous learners are characterized by logical intelligence, self-discipline, self-motivation and independence (Evans, 2020). Autonomous students are more willing to take responsibility for their learning and have better study habits.

Biochemistry course involve many abstract and complex concepts, requiring students to deeply understand the nature and interrelationships of these concepts through autonomous learning, not just rote memorization. Moreover, research and knowledge in the field of biochemistry are constantly updated and expanded, and the contents of textbooks may become outdated. Autonomous learning allows students to keep up with the latest research results and developments (Geng et al., 2019). Students with good autonomous learning ability in the Biochemistry course are more likely to achieve their learning goals and are more likely to maintain a positive learning attitude in their future work and life. At the same time, cultivating students' autonomous learning ability can allow students to consciously construct biochemistry knowledge

independently (Gupte et al., 2021). Therefore, in the teaching of Biochemistry course, lecturers pay attention to cultivating students' autonomous learning ability so that students can learn to study independently, use their biochemical knowledge to solve problems and learn new biochemical knowledge in time with the development of the subject. Good autonomous learning ability can enhance students' sense of participation and improve students' learning enthusiasm and initiative (L. Lou, 2021). According to Winne and Hadwin (1998), autonomous learning includes four stages: task perception, goal setting and planning, enacting, and adaptation. However, the performance of most Chinese students in Biochemistry course is still in the second stage, which is the goal-setting and planning stage. In learning biochemistry, they show that their learning goals are unclear, and they do not know what to learn (Mo et al., 2019).

In addition to cultivating students' autonomous learning ability, cultivating students' cognitive ability is also very important for studying Biochemistry course (Rodriguez et al., 2019). Students' cognitive ability is a significant part of the academic quality evaluation (Madani, 2019). In China, the course assessment of biochemistry consists of two parts: the usual performance score and the final examination score (Mei et al., 2020). The lecturer grades the usual performance scores based on the student's attendance and homework completion, accounting for 30% of the course grade. The final examination score is the final test grade, which tests the students' cognitive ability and accounts for 70% of the course grade. Cognitive ability refers to the ability of the human brain to process, store and extract information involving perception, memory, attention, thinking, and imagination (Wu et al., 2021).

According to Bloom's Taxonomy, cognitive learning is divided into six levels: remember, understand, apply, analyze, evaluate, and create (Anderson et al., 2001). Butin China's biochemistry teaching objectives, apply, analyze, evaluate and create are uniformly classified as apply. Therefore, only study memory, comprehension, and application for cognitive ability in this study(Wei & Ou, 2019; Wu et al., 2021). Students are required to learn the theories of biochemistry, understand life phenomena at the molecular level, and improve their application skills to analyze and solve problems (Salame et al., 2022). Through this evaluation system, although students do not get good grades in final exams, students usually do well in the learning process as long as they attend classes on time and complete their homework conscientiously, and it is not difficult to pass the Biochemistry course assessment.

Biochemistry course often include practical cases and problems that require students to apply theoretical knowledge to practical situations (Klingenberg et al., 2020). Good cognitive ability can help students better analyze and solve biochemical problems, design and conduct experiments more effectively and analyze and interpret experimental results. Moreover, cultivating students' cognitive ability will help students better integrate interdisciplinary knowledge to understand biochemistry more comprehensively and also prepare students for in-depth learning and engagement in related professions. Nevertheless, Chinese students' cognitive ability in Biochemistry course is not good (Ren et al., 2022). Students tend to adopt a passive approach towards acquiring knowledge, relying on short-term memorization of test-specific key points just before the biochemistry exam to cope. Because they lack the skill to grasp

and apply biochemical knowledge comprehensively, these students exhibit limited skills in problem analysis and solving, coupled with a deficiency in cognitive ability (Qin et al., 2019). Consequently, they fall short of the expectations set by both universities and society for the proficiency and competencies of bioscience students.

Using the teaching platform to assist the Biochemistry course can help teachers present complex metabolic pathways in a simple and clear form, improving students' classroom learning effect (Xie et al., 2022). Theteaching platform can provide students with many learning resources. Students use the teaching platform to learn Biochemistry course after class, which positively impacts their memory, comprehension and application skill and helps cultivate students' habits of autonomous learning and independent learning. Nowadays, most Biochemistry course in China use multimedia teaching tool to assist teaching, WeChat platform and artificial intelligence teaching platforms represented by Rain Classroom, as new teaching platforms in recent years are gradually popularized and applied in Biochemistry course (Shu et al., 2019; Wang et al., 2017).

AI technology is a subject that makes computers do some intelligent works that can be done by humans only (De Brito et al., 2015; Ventos & Teytaud, 2017), such as perceptual ability (auditory perception, visual perception, tactile perception) and intelligent behavior (learning ability, memory and thinking ability, reasoning, and planning ability) (Kyllonen, 2021). In recent years, AI has greatly improved computer capabilities and developed deep learning algorithms and big data.

As one of the most important information technologies globally (Jarrahi, 2018), AI technology has also made breakthroughs in education. Among them, the AI teaching platform represented by Rain Classroom in China has an increasingly obvious influence on the teaching of Biochemistry course. Rain Classroom can help teachers quickly correct homework and test papers, analyze the students' learning situation in biochemistry class, and then generate reports to give feedback to teachers (Yang et al., 2018). Teachers can be liberated from repeated correction work. It also allows teachers to comprehensively understand each student, teach students according to their aptitude, and help students improve their memory, comprehension, and application skills in the Biochemistry course. When preparing lessons, Rain Classroom can help teachers search for relevant learning materials and videos based on the keywords entered by them (Huang & Wu, 2017). This makes the content that the teachers prepared became more interesting. In addition, students no longer learn biochemistry knowledge in the classroom, they can also learn online before or after the class. Rain Classroom can monitor their learning progress in real-time (Palombi et al., 2019), analyze the difficulties encountered in their learning, and remind students to study regularly to help them improve their cognitive ability and develop the habit of independent study. It can also analyze learners' learning levels (Nagao, 2019) and helpthem customize personalized learning plans and recommendations for student learning resources (Wang, 2019). Students can also interact with teachers in the Rain Classroom and ask questions about problems encountered during learning, thus

improving theircognitiveabilityin the Biochemistry course. Rain Classroom, as a representative of an artificial intelligence teaching platform, was studied in this study.

WeChat platform is a feature created in WeChat launched by Tencent in 2012. In addition to online teaching and online self-assessment for students, the WeChat platform also has functions such as broadcast messaging, one-to-one or one-to-many interaction, and sending notifications, which is very suitable for biochemistry teaching (Tu et al., 2018).

As knowledge of life science is developing and updating rapidly, teachers of Biochemistry course need much cutting-edge knowledge to meet students' learning needs. Nevertheless, with limited classroom time, teachers must utilize teaching platforms to help fulfill students' needs. When teachers use the WeChat platform to assist in biochemistry teaching, the WeChat platform generally provides features such as micro-course, micro experiment, micro test, teaching course, and biochemical frontier progress (Li et al., 2019). These functions expand classroom teaching knowledge, provide resources for students to learn autonomously after class, and help cultivate students' independent study habits. Teachers can set up a question bank to meet the needs of students' learning. In addition, teachers can also create and record biochemical songs, comics, and literary works to simplify complex biochemistry knowledge and help improve students' memory, understanding, and application skill, enhancing students' interest in learning the subject (Zhu et al., 2019). Besides, teachers can acknowledge students' problems and further explain them in the classroom based on students' questions through the WeChat platform to improve

students' classroom learning. At the same time, students use the WeChat platform to read and study the reading materials and resources that teachers upload. They can do autonomous learning anywhere, anytime, without time and space constraints. If they encounter problems or questions on a topic, students can leave a message on the WeChat platform and wait for the teacher's explanation. Online discussion can be carried out among teachers and students through the WeChat group chat feature.

With the popularization of multimedia technology and networks in China, using multimedia teaching tool to assist teaching has become the main teaching method in universities in China, and the Biochemistry course is no exception (Zhou et al., 2021). It integrates images, words, and sounds into PowerPoint, which can stimulate students' hearing and vision, dynamic, concrete and visualized static, abstract and boring material, and directly show various sugar metabolism and redox reactions in order to enhance students' cognitive ability, deepens students' understanding and memory of knowledge points (Abdurasulovich et al., 2020).

The use of multimedia teaching tool in teaching can help students understand the key points in biochemistry better, enhance students' interest in learning, and improve the quality of teaching (Yao et al., 2021). In addition, using PowerPoint in multimedia teaching saves the time for teachers to write on the blackboard. Compared with the traditional teaching method, which requires teachers to write on the blackboard, it greatly increases the knowledge in the classroom, improves the efficiency of Biochemistry lessons, and improves the teaching effect. In explaining protein structure and nucleotide metabolism, multimedia animation can be used in the

lesson to explain abstract knowledge points. In addition to actively participating in the teaching process in the classroom, for the knowledge points that are not understood in the classroom, students can re-read the teacher's lecture slides, use the multimedia teaching tool to conduct independent learning and cultivate their autonomous learning ability (Xu et al., 2021).

Rain Classroom, the WeChat platform and multimedia teaching tool positively assist teachers in teaching. Each of the three platforms has its characteristics in biochemistry course teaching. Rain Classroom is mainly used in online teaching, with rich course content and teaching resources, focusing on real-time interaction and teaching management. Courses can be recorded, and its personalized learning resource recommendations can guide students to learn autonomously. Teaching videos from different universities also allow students to choose suitable teaching methods. However, the Internet greatly affects the teaching effect of Rain Classroom. The WeChat platform focuses on message sharing and group discussions. Teachers use the WeChat platform to deliver course resources to students through micro-courses and short articles. The diverse learning resources and short and concise content facilitate students to study in fragmented time and improve learning efficiency. However, the WeChat platform has limited interactive functions during online teaching, and teaching resources are limited to content shared by teachers. Multimedia teaching tool focus on providing multimedia teaching resources, presenting teaching content in various forms, and optimizing teaching effects. The interactive multimedia teaching method mainly involves face-to-face communication between teachers and students,

which helps teachers promptly discover students' learning emotions, adjust teaching progress, and improve classroom teaching effects. However, the biochemistry courseware must be produced by teachers themselves, and multimedia teaching tools are mainly used in classroom teaching. Therefore, the teaching effect of multimedia teaching tool is greatly affected by teachers, and there is a lack of after-class learning resources for students. Exploring the teaching effect of the three platforms in the Biochemistry course is important.

1.3 Problem Statement

Currently, Chinese students have poor autonomous learning ability in Biochemistry course(Gao et al., 2019; Zhou, 2021). Students' autonomous learning ability in biochemistry courses is not high in the following aspects. First of all, students lack the study habit of self-assessment. The research results of Fan et al. (2018) and Chen (2020) show that most students have no study habits in after-class self-study. Most students cannot regularly evaluate their Biochemistry course learning, so they cannot review and adjust their learning methods in time. Secondly, students do not have a clear study plan when they learn independently, and their learning responsibility is not strong (Tian et al., 2020; Zhou & Li, 2020). Most of them rely on the lectures and explanations of the teachers in the classroom and complete the exercises assigned by the teachers to learn biochemistry(Xie et al., 2022).They are satisfied with the knowledge acquired in biochemistry class and lack the initiative to acquire biochemical knowledge or review after class.

One of the main reasons for this phenomenon is that there are few learning channels for students to learn biochemistry courses autonomously (W. Xiao et al., 2020). Students lack a learning tool, which is usually limited to teachers' lectures, resulting in a lack of biochemical knowledge accumulation. In addition, learning resources for students in Biochemistry course are lacking (Chen et al., 2020). Usually, there is only one textbook and one exercise book, which is far from meeting the needs of students' autonomous learning (Mo et al., 2019). These have led to the phenomenon that most Chinese undergraduates lack autonomous learning ability in Biochemistry course (Yang, 2020).

Chinese undergraduates have poor cognitive ability in Biochemistry course(Tian et al., 2020). First of all, students have memory difficulties in the Biochemistry course (Pang et al., 2020). Biochemistry courses need to memorize many biomolecular structures and reaction pathways, but Chinese students are more inclined to rote learning rather than understand the principles and concepts of biochemistry, which causes them to encounter problems in the long-term memory and application of knowledge. Second, students have difficulty in understanding the concepts of biochemistry (Lu & Ding, 2020), such as molecular structure, chemical bonds, function of biomolecules, etc. These concepts may confuse them, and it is not easy to establish connections between them. Third, Biochemistry course require students to apply knowledge to solve problems, analyze experimental data, and understand the connection between chemistry and biology, but most students struggle with these challenges and cannot effectively solve problems related to biochemistry

(Tang et al., 2020). At Xinxiang Medical College, there are many students whose final exam scores are 50-60 in consecutive years, and students performed the worst in applied questions (Nan et al., 2020). In the research of Yuan et al.(2019), only 13% of the students passed the Biochemistry examination. The teachers indicated that students did not perform satisfactorily in memory, comprehension and application skills, the average final exam score was not high, and the excellent rate was low.

Furthermore, theteachingprocessof the Biochemistrycourse is not effective currently. The teacher lectures the class too fast (Zhou et al., 2022). Biochemistry course need to cover much content in the limited class time, which causes students to feel too much pressure, it is difficult to keep up with the course progress, and it affects students' memory and understanding. Then, Chinese Biochemistry courses are mainly lecture-based, and teachers and students lack communication and interaction (Liang et al., 2017). This limits students' initiative in learning and leads to the passivity of students. Lack of opportunities for interaction, discussion, and problem-solving reduces student motivation and makes students less effective. In addition, Biochemistry course are taught in large class sizes, inhibiting individualized instruction (Chen, 2020). Students have different backgrounds and levels in learning biochemistry, but teaching is often standardized. Personalized learning support and feedback can help meet the needs of different students, but there is currently a lack of personalized teaching in Biochemistry course.

Today's teaching process is not conducive to improving students' autonomous learning and cognitive ability and affects the learning effect of students' Biochemistry

course in China (Zhang et al., 2021). Scientific teaching methods can help students cultivate and improve their autonomous and cognitive learning abilities (Polirstok, 2017; Su, 2021). At present, multimedia teaching tool have been widely used in biochemistry course teaching in China, Rain Classroom (AIP) and WeChat platform have appeared in biochemistry course teaching as new teaching platforms (Fu, 2020; Zhang et al., 2020). Using multimedia teaching tool as a control group, the researcher began to explore the use of Rain Classroom and WeChat platform to improve the teaching of biochemistry courses and improve students' autonomous learning and cognitive ability. It is important to compare the three teaching platforms that can better help students improve their autonomous learning and cognitive ability in the Biochemistry course. Comparing the impact of different teaching platforms on biochemistry teaching and learning helps discover the advantages and disadvantages of different teaching platforms and provides suggestions for improving different teaching platforms in the future and teachers' teaching methods. Therefore, this thesis aims to compare the effects of the Rain Classroom (AI teachingplatform), WeChat platform, and multimedia teaching tool on Chinese undergraduates' autonomous learning ability and cognitive ability in Biochemistry course.

1.4 Research Objectives

This study considers the following objectives:

1. To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on autonomous learning ability in Biochemistry course among Chinese undergraduates.

(a) To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on study habits in Biochemistry course among Chinese undergraduates.

(b) To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on independentlearning in Biochemistry course among Chinese undergraduates.

2. To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on the cognitive ability in Biochemistry course among Chinese undergraduates.

(a) To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on the remember level in Biochemistry course among Chinese undergraduates.

(b) To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on the comprehension level in Biochemistry course among Chinese undergraduates.

(c) To compare the effects of Rain Classroom, WeChat and multimedia teaching tool on the application level in Biochemistry course among Chinese undergraduates.

3.To investigate the effects of Rain Classroom, WeChat and Multimedia teaching tool on students' autonomous learning ability in the Biochemistry course.

4.To investigate the effects of Rain Classroom, WeChat and Multimedia teaching tool on students' cognitive ability in the Biochemistry course.

1.5 Research Questions

Based on its objectives, the study tries to elicit and deal with the following questions:

1. Are there any significant differences in the level of autonomous learning ability of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

(a) Are there any significant differences in the level of study habits of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

(b) Are there any significant differences in the level of independent learning of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

2. Are there any significant differences in the cognitive ability level of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

(a) Are there any significant differences in the remember level of Chinese undergraduates in Biochemistry course when using Rain Classroom WeChat and multimedia teaching tool?

(b) Are there any significant differences in the comprehension level of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

(c) Are there any significant differences in the application level of Chinese undergraduates in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool?

3. How do Rain Classroom, WeChat and Multimedia teaching tool affect students' autonomous learning ability in the Biochemistry course?

4. How do Rain Classroom, WeChat, andMultimedia teaching tool affect students'cognitive ability in the Biochemistry course?

1.6 Research Hypotheses

According to the study objective and the review of literature, the following hypotheses will be addressed:

H_{01}: There are no significant differences in the level of autonomous learning ability in Biochemistry course among the students when using Rain Classroom, WeChat platform and multimedia teaching tool.

H_{01a}: There are no significant differences in the level of study habits in Biochemistry course among the students when using Rain Classroom, WeChat platform and multimedia teaching tool.

H_{01b}: There are no significant differences in the level of independent learning in Biochemistry course among the students when using Rain Classroom, WeChat platform and multimedia teaching tool.

H_{02}: There are no significant differences in cognitive ability level of students in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool.

H_{02a}: There are no significant differences in remember level of students in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool.

H_{02b}: There are no significant differences in comprehension level of students in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool.

H_{02c}: There are no significant differences in application level of students in Biochemistry course when using Rain Classroom, WeChat and multimedia teaching tool.

1.7 Significance of the Research

The importance of this study is in comparing the effect of Rain Classroom, WeChat platform and multimedia teaching tool on autonomous learning ability and cognitive ability in Biochemistry course among Chinese undergraduates.

1.7.1 Theoretical Significance

This present study has the following theoretical significance. In the context of the era of Rain Classroom and WeChat platform, this research studies biochemistry education issues from a new perspective, which helps to broaden the new horizons of biochemistry teaching research and provides direction and reference for the transformation of biological undergraduate education in the era of Rain Classroom and WeChat platform. Furthermore, checking the relevant literature on the impact of Rain Classroom and the WeChat platform on undergraduate education in biochemistry, there is very little relevant literature, and no literature comparing Rain Classroom and the WeChat platform. Research on autonomous learning and cognitive ability is also limited to overall judgment, and the impact on study habits and independent learning, remember, comprehension, and application has not been carefully studied. This study enriches the literature on Rain Classroom, the WeChat platform, autonomous learning ability and cognitive ability. This study explores the role of important variables, such as Rain Classroom, the WeChat platform and multimedia teaching tool in Biochemistry course.

1.7.2 Practical Significance

This research uses the Rain Classroom, WeChat platform, and multimedia teaching tool in Biochemistry course teaching and studies the influence of these three different teaching platforms on students' autonomous learning ability and cognitive ability. It is hoped that the results of this research will be helpful as follows.

Firstly, the findings are expected to let students learn to use the Rain Classroom, WeChat platform, and multimedia teaching tool to fully play their learning initiative and improve their biochemistry learning effect. Under the background of the Rain Classroom and WeChat platform, contemporary education can stimulate students' learning potential and make students realize that they are the canter of teaching activities. Teachers can assist them in learning through the application of Rain Classroom, the WeChat platform, and multimedia teaching tool, allow students to participate in teaching actively, cultivate their autonomous learning ability and improve their cognitive ability, and lay a good foundation for students' future development.

Secondly, the findings are expected to enable teachers to realize the benefits of the Rain Classroom and WeChat platform in biochemistry teaching in order to inspire them to learn knowledge of the new technology and new teaching platforms, improve their teaching ability, change the way of teaching, and make better use of the Rain Classroom and WeChat platform in biochemistry teaching.

Thirdly, the findings are expected to promote university development. Rain Classroom and the WeChat platform have significantly impacted universities in recent years. This study explores the direction of the undergraduate education reform of Biochemistry course in the era of the Rain Classroom and WeChat platform. In reality, the result can provide methods for the educational reform of colleges and universities.

Finally, the findings are expected to guide the development of the Rain Classroom and WeChat platform in biochemistry undergraduate education. Rain

Classroom and the WeChat platform have been widely used in various fields of society, but their application in teaching is still in its infancy. This research will help inspire people to apply the Rain Classroom and WeChat platform in education to provide direction for how the Rain Classroom and WeChat platform can better serve undergraduate education in biochemistry.

1.8 Limitation of the Study

Only sophomores at three public second-tier universities in Guangdong Province, China, participated in the study. Because there are differences in the college entrance examination scores of public second-tier universities in different provinces in China, the level of students also varies. This has limited to generalize the findings to universities in other Chinese provinces. The study focused on sophomores at public second-tier universities, so the results of public first-tier universities, private universities and vocationalcolleges may differ. Therefore, to generalize the findings to universities at different levels and regions, it is recommended to replicate the study at various levels. Since this study was conducted in the context of a Biochemistry course, which applies to all Chinese sophomore biological science undergraduates, it is possible to replicate the study in different universities.

Rain Classroom and WeChat platform require students to complete the study using their mobile phones or computers. For students, using the Rain Classroom and WeChat platform for learning for the first time is not easy. They need the help and guidance of lecturers. Therefore, there are two assistants to assist the lecturers at the