

A Study on the Effectiveness of Online Learning under Complex Dynamic System Theory

Yuan Tian

Department of International Studies, Southwest University, Chongqing, China

yangjg@swu.edu.cn

Abstract. With the acceleration of informatization and the rapid development of Internet information and communication technology, mankind has gradually entered the "Internet +" era. The development of online media has led to continuous innovation in education methods, the speed of knowledge dissemination is increasing day by day, and the breadth of knowledge dissemination is also expanding. As an emerging learning model, online learning is a complete system consisting of teaching and learning, teaching content, learning habits and learning methods, platforms and approaches, and the management of learning resources. A systematic review method was utilized to examine the current state of online learning and make recommendations based on the theory of complex dynamic systems. The study discovered that online learning is complex and systematic, requiring the cooperation of many parties throughout the entire educational system; that it is dynamic and variable, necessitating that teachers update their teaching philosophies and methods for disseminating knowledge; and that its variation of online learning, advising that teachers use stratified teaching to increase students' autonomy and learning effectiveness.

Key Words: Complex Dynamic Systems Theory; online learning; complexity; dynamics.

1. Introduction

The development of Internet technology has empowered education, and education models relying on the Internet are gradually becoming more popular among teachers and students. In recent years, with the expansion of mobile media users and the gradual improvement of mobile network experience, online learning based on the optimization of educational efficiency has emerged. While online learning creates a new platform for teachers to improve their information capabilities and professional qualities, it also meets the needs of students for personalized learning. At present, online learning has spread across all subjects in primary and secondary schools in China and is widely used in course teaching. The transformation of teaching models has brought opportunities for the use of the Internet to realize educational informatization, but it has also brought new challenges to teachers and students. At the same time, online teaching has the characteristics of convenience, flexibility, diversity, and other characteristics [1]. Learners' language learning can be carried out in a way that is different from traditional offline classes without being affected by changes in time and space. At the same time, the development process of online learning is complex, dynamic, and non-linear, and the various subsystems are interconnected, influence each other, and adapt to each other [2]. As one of the important subsystems, individual variation among learners directly affects the effectiveness of online learning. Complex dynamic system theory believes that teaching does not exist independently from the social environment. Its comprehensive connectivity shows that teaching activities are a dynamic process affected by multiple variable factors. Therefore, the effectiveness of online learning is affected by learners, teachers, teaching equipment, classroom environment, and other constraints.

Therefore, based on the characteristics of online learning, it is very meaningful to study the teaching effectiveness of current online learning. This study is based on the theory of complex dynamic systems, based on their complexity, systematicity, dynamics, variability, and individual variation, trying to analyze the current situation of online learning, understand the dilemmas and problems of online learning, and propose effective suggestions for its current situation.

2. Complex Dynamic System Theory

2.1. Complex Dynamic System Theory

Complex dynamic system theory originally originated from the fields of natural sciences such as mathematics and systems science. It studies the changes and development of natural phenomena and social affairs. This theory regards the development of things as the dynamic changes of complex systems and focuses on the emergence of the interaction of various elements. The system has high overall change [3]. In terms of explaining human activities, the main point of complex dynamic system theory is that the spatiotemporal situations and fields of human activities constitute a complex system. This system has the characteristics of nestedness, connectivity, and interactivity. Due to the interactive relationship between individuals and the environment, human cognition and behavior show complex dynamics [4]. In complex systems containing "human" components, complex dynamic systems are consistent with the ecological point of view, emphasizing the interconnected and interactive relationship between individuals and their environment, paying attention to the role of spatiotemporal context in individual development. As the time and space situation changes, various factors related to the individual and their interrelationships fluctuate, and what the individual knows, thinks, and does changes accordingly. Therefore, individual heterogeneity and variability are ubiquitous [4]. In response to the complex phenomenon of student learning and development, the theory's view is that the motivation for student learning is the interactive relationship of the complex system in which students are located. In response to the complex phenomenon of students' learning and development, the theory holds that the motivation of students' learning is the interaction of complex system relations in which students are located, and the opportunities for students' learning and development are contained in this interaction relationship, which comes from the interaction between various elements. In the interaction, caring about the changes of individual students is the key point.

2.2. Characteristics of Complex Dynamic System Theory

2.2.1. Complexity and Systematic of Complex Dynamic System Theory

According to Geert in 1994, the complex system emphasizes that the system is composed of a large number of elements, and each element is interdependent, mutually influencing, and indivisible, so the system has the characteristics of nestedness, connectivity, and interactivity. A system is different from a "simple system". Its overall existence is not formed by the simple addition of various elements, components, and structures, but by the relationship between subsystems and their elements on multiple levels. Therefore, it is necessary to pay attention to all elements and their interactive relationships, it is also necessary to analyze the system as a whole [5].

Because a complex dynamic system is a series of components that change and interact with each other [6]. The concept of dynamics is twofold. First, a dynamic system changes with time, and the future development of the system depends to a certain extent on the current state of the system. Second, in a dynamic system, not only the subsystems within the system are evolving and changing, but also the interaction between subsystems Relationships between actions and subsystems, as well as environmental factors are also in a state of constant change. A complex dynamic system is dynamic and complex because it has many components, each of which can have sub-components. Based on the different stages of the development of the language system, several subsystems sometimes support each other and sometimes exclude each other [4].

2.2.2. Dynamics and Variability of Complex Dynamic System Theory

Larsen-Freeman pointed out that dynamism is the basic characteristic of all complex systems [6]. A dynamic system is always changing. The components in the system and their interrelationships as well as the overall state of the system are all changing [7]. From the perspective of the system as a whole, the system is always in a state from one state to another. In the process of flow and transformation of a state. Complex dynamic systems consider linguistic variability to be an inherent

property of dynamic systems [7]. In the process of language development, the stability of the system is not absolute, and variability is inevitable. There are many changing factors in a steady state. Mutation indicates that the learner is still learning and its subsystem is unstable. As the system evolves, the system needs to constantly self-organize. Therefore, changes are normal. From the perspective of complex dynamic systems, variation is the result of the system's flexible adaptation to the environment, and it is also the source of language system development. Without mutation, the system would be in a state where it would be difficult to evolve. Mutation acts as a facilitator when a system or subsystem moves from one attractor state to another [4].

2.2.3. Individual Variation of Complex Dynamic System Theory

Complex dynamic systems consider individual variation to be one of the essential properties of the system. The development path of the system is affected by the initial state. Due to the different initial states of each learner, even if they are in the same language learning environment, they will still show very different language development patterns.

3. Current Situation of Online Learning

3.1. Complexity and Systematic of Online Learning

Wang Nan and Qiao Ailing believe that online learning is a necessary part of network-based teaching activities, and it is the sum of learners' interaction with the external learning environment using the network [8]. This definition emphasizes that online learning is a part of network-based teaching, emphasizing the interaction between learners using the Internet and the external learning environment, focusing on the Internet and interaction. He Kekang pointed out that online learning is a complete system composed of teaching and learning, teaching content, learning habits, learning methods, platforms and approaches, and the management of learning resources. The various factors are arranged, emphasizing the systematic nature of online learning [9].

However, it is precisely because of the systematic and complex of online learning that it requires the cooperation of the entire education system. In traditional offline teaching, the completion of teaching and learning only requires cooperation between teachers and students. In online teaching, the online learning platform is the carrier for students to conduct online learning. Teachers publish learning courses on the platform, allowing students to log in to the online learning platform for exams, test practice, questionnaires, and communication. The learning traces of students can be tracked and managed throughout the process, and the online learning information of students can be fed back to teachers or students. This is not only beneficial for teachers to have a more comprehensive grasp of students' learning needs, and to realize remote supervision and management of students, but also to form a complete student learning file with the help of online learning materials collected by the platform, to provide teachers with a fair and accurate evaluation of student's learning, and provide strong data support for analysis and students' mastery of their online learning status.

However, the complexity of operating online learning platforms has led to an increase in education costs. Due to the complexity of online learning platforms, schools need to negotiate and communicate with online learning platforms to promote the further implementation of online learning through early preparation and coordination. In addition, the school's multimedia information system needs to cooperate with teachers and students and instruct teachers and students to use online teaching platforms proficiently and provide timely feedback on existing problems, thereby better providing possibilities for online learning. Finally, based on the online learning platform as an intermediary, teachers need to update their cooperation with students. Different from direct face-to-face communication offline, with the intervention of online learning platforms, teachers and students need to re-run and adjust to promote the smooth progress of online learning. Due to the complexity of multi-party cooperation in online learning, the manpower and material resources involved in online teaching are intricate, which invisibly increases the cost of education.

In addition, due to the large number of online learning platforms, the complexity of their use and their dynamic changes have also led to poor communication between teachers and students. Because there are differences in the operation and operation methods of each platform, online learning has extremely high requirements for students' independent learning. Because some students lack a systematic understanding of this model and have not found a learning method that suits them, this will, to a certain extent, restrict students' enthusiasm for participating in activities. A dynamic system changes over time, and its future state depends on its present state. In this system, everything is constantly changing and changing in action. Different from traditional offline face-to-face teaching, teachers cannot immediately pay attention to the small changes in students, let alone make timely adjustments, making it difficult to have a comprehensive grasp of students.

3.2. Dynamics and Variability of Online Learning

The process of online learning is complex, dynamic, and non-linear, and the various subsystems are also connected, influenced, and adapted to each other [2]. From the perspective of complex dynamic theory, variation is the result of the system's flexible adaptation to the environment and is also the source of the development of language systems. Without mutation, the system would be in a state where it is difficult to develop. Mutation plays a facilitating role when a system or subsystem moves from one attractor state to another [4]. However, many teachers' course arrangements and teaching methods copy the offline model. Judging from the current situation, the course schedule is not reasonable. The online course schedule is modeled on that of offline courses, and the schedule is very full. This is not in line with the rules of online learning, that is, teachers focus on guidance and cultivate students' initiative and independent learning ability. In addition, most teachers will copy the teaching styles and habits of offline classes into online classes. The above problems can easily lead to students' learning fatigue, lower learning enthusiasm, and difficulty in exerting students' active learning drive, which will eventually lead to a series of related problems such as low learning efficiency and even damage to students' visual health.

3.3. Individual Variation of Students

The language view of complex dynamic systems fully pays attention to individual variation. Complex dynamic systems believe that individual variation is one of the essential attributes of the system. The system development path is affected by the initial state. Due to the different initial state, each learner will still show a very different language development model even if they are in the same language learning environment. When analyzing the characteristics of the local foreign language teaching environment, Wu Shiyu and Huang Shaoqiang pointed out that there are huge individual differences among students, but the "one textbook, one test paper" model is commonly used in domestic online teaching to measure students' learning progress [10]. On the one hand, online learning is based on the spatial separation of teachers and students. In practice, teachers cannot provide help to students anytime and anywhere, nor can students ask teachers for help whenever they encounter problems. This is not conducive to the cultivation of students' independent thinking and independent learning abilities. On the other hand, there are differences in students' learning levels, learning styles, etc. To enable each student to adapt his or her learning style, abundant resources should be provided and students should be reasonably guided to develop their learning drive and conduct personalized learning. But the problems are as follows. First, teachers give students fewer opportunities for personalized learning. It is limited to preview before class and review after class. Students can study according to their own learning characteristics and learning styles. But the actual effect is average or even poor. Only about 10% of students have done a solid job in previewing and reviewing. This reflects that there are still major deficiencies in students' ability to learn independently. Second, there is an extreme lack of supportive learning resources and services for students, and the quality of existing learning resources is also uneven.

4. Application and Measures for Improvement

4.1. Strengthen the Government-Enterprise-School Collaboration

Many problems that students have during online learning are related to online learning platforms. The learning platform lacks certain functions, the stability of the platform is insufficient, and the operating threshold of the platform is high. The platform represents the enterprise, and the school represents the teachers and students. Therefore, issues between the platform and teachers and students should start with exchanges and cooperation between schools and enterprises. The positions of schools and enterprises are different, and there are sometimes disagreements in collaboration and exchanges between the two parties. What the government needs to do is to act as a coordinator between schools and enterprises, macro-control exchanges and cooperation between schools and enterprises, and solve existing problems. School-enterprise cooperation can be carried out from the following two aspects. First, enterprises should take the initiative to understand students' online learning needs. During the use of the learning platform, students can discover problems in the learning platform and generate new needs. Companies can publish questionnaires in the learning platform to collect students' suggestions or opinions during the use of the learning platform. Combined with students' feedback, the learning platform is adjusted and new functional areas are developed to meet students' needs. Second, schools must do a good job in docking with learning platforms, including personnel docking and information docking. Personnel docking means that a certain connection should be established between the school and the learning platform personnel. Online teaching is a new experience for many teachers. Teachers are faced with how to use the online learning platform, how to ensure the quality of online teaching, and how to communicate with students. Regarding issues such as online interaction and how to play the main role of students in learning, teachers' ability to master and use online learning platforms is still lacking. Therefore, companies can arrange relevant technical personnel in the learning platform to provide some training to school teachers to help teachers better conduct online teaching. Information docking means that schools and learning platforms can share students' online learning situations so that both schools and enterprises can understand the students' online learning process, which is beneficial for schools and teachers to make teaching decisions based on students' online learning situations. Timely adjustments can also allow the learning platform to optimize the platform according to the needs of students.

4.2. Update the Concept of Online Learning

Students believe that online learning has many unreasonable course arrangements and teaching methods. Fundamentally, this problem is because the ideological concepts of educators represented by teachers have not been updated promptly. The misunderstanding of online learning is that the same old offline teaching methods are used. But in fact, offline and online teaching is completely different whether from the perspective of teaching management, teaching implementation, or teaching evaluation. First of all, offline teaching management is a top-down structure, while online, because of the decentralization of the network itself, all information is easy to open and share. Secondly, in terms of teaching implementation, information such as eyes and expressions between teachers and students can be directly transmitted to each other offline; while online learning not only breaks the influence of space but also breaks the influence of time. Students can learn asynchronously. This does not exclude unified classes, but if all are live teaching, unified classes, and the daily schedule is full, this is copying offline teaching. Online learning further highlights the dominant position of students. As teachers, it is essential to combine the characteristics of online learning to carry out high-quality teaching design and stimulate students' learning drive. Finally, from the perspective of teaching evaluation, offline pays more attention to result evaluation, while online is easy to collect students' learning traces, Combined with rich resources on the Internet, it will test students' information literacy, so teachers should pay attention to process and performance evaluation. In-school training or joint regional training can thus be organized offline. It is useful to invite authoritative experts in the field of online learning to help teachers update relevant concepts and guide teachers on online learning teaching methods.

4.3. Stratified Teaching

Starting from the individual variation of students, teachers can choose to carry out online stratified teaching. Different teaching contents and teaching methods are set up for different students. According to the ability level and learning needs of students, different teaching strategies and methods are adopted, which are highly targeted and can meet the learning needs of students to the greatest extent. This kind of diversified teaching, according to different learning groups, adopts a variety of teaching methods, such as classroom teaching, group cooperative learning, personalized tutoring, online teaching, etc., so that students can learn and communicate in different environments and increase their interest in learning and operability. Because the teaching content and teaching methods are highly targeted, it can improve students' learning effect and mastery, so that students can obtain better learning results in a short period. Because the teaching content and teaching methods are adjusted according to the different needs of students, it can meet the learning needs of different students and improve students' learning enthusiasm and self-confidence. The teaching process is controllable because the formulation of teaching content and teaching methods is based on the actual situation of students, the teaching process is more controllable, and the quality and effect of teaching can be better guaranteed.

5. Conclusion

This study is based on the theory of complex dynamic systems and briefly analyzes the current situation of online learning. Through research, this article found that due to the systematic and complex of online learning, online learning requires the operation and cooperation of the entire education system. Based on this, strengthening the collaboration between government, enterprises, and schools is beneficial to the smooth promotion and operation of online learning. In addition, due to the dynamic and variability of online learning, a single, fixed teaching model cannot adapt to the ever-changing and developing network environment, and will also cause students to lack motivation to learn. Therefore, teachers are urged to update their online learning concepts and rationally transform knowledge presentation forms, using diversified teaching models to stimulate students' learning drive. Finally, because the level of online learners is uneven, one teaching method cannot meet the learning requirements of learners at different levels. Therefore, it is recommended to use a stratified teaching method to break through this bottleneck and improve student learning efficiency and effectiveness. This article analyzes the current situation of online learning effectiveness and proposes corresponding solutions. It is hoped that it can help solve some problems of online learning, give full play to the greater advantages of online learning, promote the balanced development of education in China, and accelerate the realization of the goal of educational modernization. Of course, there are still many issues regarding the effectiveness of online learning based on complex dynamic system theory that are not mentioned in this article, hoping that in the future there will be more in-depth research and analysis on the current situation of online learning and propose more effective solutions.

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