ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

Research on Visualization of High School Chemistry Online Courses Based on Large Language Models

Wen Yang[1], Lutong Wang[2,*], Feng Lin[3], Xin Wen[3], Ya Wang[4], Jiamin Li[5]

[1]*Hechi Senior High School, Chemistry Teaching and Research Section, Hechi, China*
[2]*Institute of Education, Guangxi Modern Polytechnic College, Hechi, China*
[3]*College of Accounting and Auditing, Guangxi University of Finance and Economics, Nanning, China*
[4]*School of Fine Arts and Art Design, Qiqihar University, Qiqihar, China*
[5]*School of Education, Guizhou Normal University, Guiyang, China*
[*]*Corresponding author*

Abstract: *This study aims to construct an ecological model of high school chemistry online courses through the use of large-scale language models, creating intelligent high school chemistry online courses primarily based on artificial intelligence. It seeks to interpret an intelligent question-and-answer teaching model based on natural language and to reshape the knowledge structure of high school chemistry through a human-machine interaction model. The research employs the scientometric software CiteSpace to visually analyze the co-occurrence of keywords in online courses and gradually explores the research hotspots and development trends in high school chemistry online courses.and research frontiers of high school chemistry online courses. The results show that large-scale language model technology has unique advantages in explaining chemical knowledge, experimental demonstration, and online course creation; organic chemistry, online courses, online teaching, and blended teaching become high school chemistry research trends. It is inferred that the high school chemistry online course based on large-scale language models gradually evolves into a new normal in chemical education research.*

Keywords: *Large language model, High school chemistry, Online course, Citespace, Visualization*

1. Research background and problem formulation

In January 2024, the World Digital Education Conference was held in Shanghai, China. The main focus of the conference is to enhance the level of educational informatization and promote the development of digital technology.enhance the construction intensity of digital resources, and comprehensively improve the information literacy and competitiveness of teachers. It is noteworthy that the current digital education transformation has greatly promoted the generation and development of large-scale language models, and the widespread use of these models has also accelerated the digitalization process of online courses. Large-scale language models use natural language processing and big data technology to become a multimodal, visual intelligent model. Not only promoting the rapid development of digital education.but also brings new possibilities for their development. As a result, high school chemistry online courses can be presented in richer and more intuitive ways[1]. Students can deepen their understanding of chemical concepts through concise graphics, tables, and animations during the learning process, enhancing their learning interest and comprehension effectiveness.

The application of these models in high school chemistry online courses not only improves the semantic analysis capabilities of the courses but also demonstrates their potential in machine translation, sentiment calculation, and text generation. High school students can use them to answer questions and receive targeted, effective, and real-time suggestions at any time. Meanwhile, high school chemistry teachers can utilize network resources selectively based on students' characteristics and their own teaching experiences to further innovate teaching methods and stimulate students' interest in chemistry. However, the construction of high school chemistry online courses also faces challenges, including insufficient digital teaching resources, lack of precise online learning monitoring and evaluation mechanisms, and uneven course quality. The construction focus includes determining teaching tasks, making courseware and micro-classes, improving teacher resources, building course platforms, refining teaching resources, applying virtual simulation technology, and integrating speech recognition and infrared sensing technology[2]. Therefore, to comprehensively strengthen the construction of high school chemistry online courses, it is necessary to continuously optimize teaching resources, establish effective

ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

learning monitoring and evaluation mechanisms, improve teachers' digital literacy, master relevant technologies for online course construction, and ensure course teaching quality.

2. Hot Topics in High School Chemistry Online Course Research

Through the analysis tool Citespace, the research dynamics and development trends of a certain field can be identified and tracked. This article analyzes the research trends and hot topics of high school chemistry online courses, and then predicts the hot topics, research trends, and key nodes of chemistry online courses. As shown in fig. 1, the analysis shows that the hot topics related to "online course" research mainly include organic chemistry, blended teaching, physical chemistry, and teaching reform.

Among them, blended teaching is closely related to online courses[3]. The development of online courses includes aspects such as linking online videos, network resources, and blended teaching online and offline. Blended teaching adopts various teaching modes to enhance the multimodal construction of high school chemistry online courses. Through the knowledge map of scientometrics, it is found that further research is needed on innovative technologies, nanotechnology, and biochemistry. As shown in table 1,For example, research on green chemistry, environmental materials[4], digital chemistry, and intelligent chemistry database construction, as well as the application of nanotechnology in various fields, such as nanomedicine, nanoelectronics, and nanoscience environmental protection.

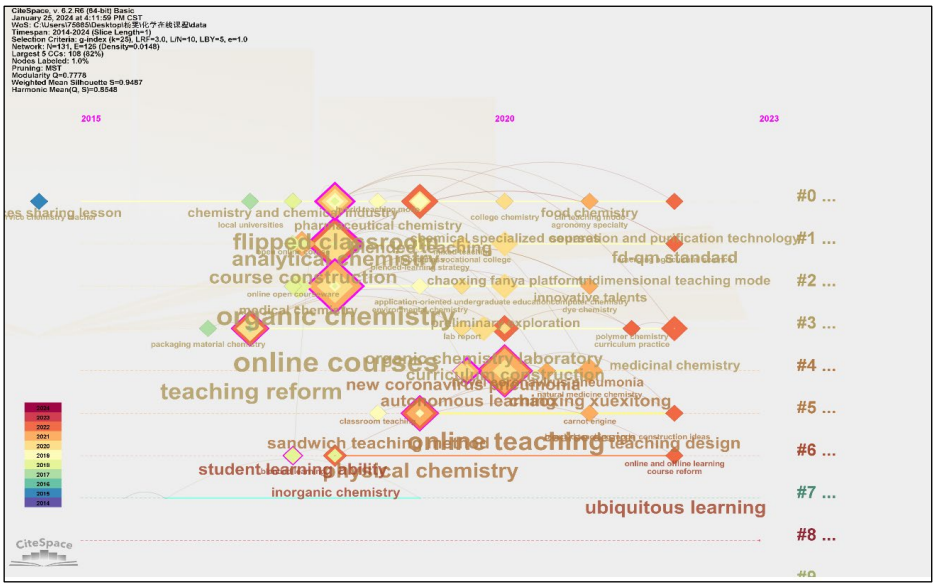

Figure 1: Research Hotspots in Chemistry Online Courses

Table 1: Research Hotspots in Chemistry Online Courses

No. Keywords	No. Keywords
1 organic chemistry	11 big data
2 blended teaching	12 inorganic chemistry
3 physical chemistry	13 medicinal chemistry
4 teaching reform	14 autonomous learning
5 flipped classroom	15 online education
6 analytical chemistry	16 chaoxing xuexitong
7 course construction	17 natural medicine chemistry
8 curriculum construction	18 preliminary exploration
9 inorganic chemistry	19 medical chemistry
10 ubiquitous learning	20 student learning ability

3. High School Chemistry Online Course Application Cases Based on Large Language Models

In the construction of high school chemistry online courses based on large language models, the application cases for learning related knowledge about "oxygen reduction reaction" are as follows:

1) Intelligent Q&A: Intelligent Q&A systems utilize the digital educational characteristics of large-

ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

scale artificial intelligence models and machine languages to automatically handle complex academic problems in online courses, providing students with in-depth explanation and answers to key points, helping students truly understand academic concepts and delve into the essence

2) Automatic reasoning: Automatic reasoning technology can answer chemistry online course. questions according to human thinking, imagination and behavior, and coordinate all aspects of knowledge for intelligent and scientific reasoning. Provide students with the reasoning process and solutions of relevant knowledge points. For example, when students ask questions about the nature of oxygen reduction reaction, the big language model intelligently infers the basic principle of oxygen reduction reaction and similar knowledge points, and provides various solutions in all directions[5].

3) Personalized recommendation: Personalized recommendation service relies on the big language model, and mines key information by collecting .Automatic recommendation includes learning resource recommendation and rich chemistry learning resources recommendation; Recommend chemical competitions, recommend international chemical competitions and provincial chemical experiments, and provide corresponding competition schemes. Chemical experiment recommendation, experimental process, experimental method and experimental result analysis. This artificial intelligence technology-driven model will conduct personalized analysis according to the feedback given by different students, make clear the students' learning progress and learning blind spots, so as to optimize the recommendation, and ensure the accuracy and effectiveness of the recommended content. For example, going back to the learning of the knowledge point of "oxygen reduction" in the above cases, the big language model can screen out chemistry teaching videos, WeChat official account articles on chemical WeChat, chemistry teaching cases, etc. related to oxygen reduction reaction from massive network resources, and then intelligently recommend learning resources that meet their learning goals and interests according to students' needs and interests[6]; At the same time, combined with students' learning situation, personalized teaching theories and classic cases suitable for them are recommended to help students better understand and master the relevant knowledge of oxygen reduction reaction.

4) Big Data Analysis: Big data makes decisions and judgments based on in-depth analysis and judgment of computer science, fully exploring and mining the ecological structure and text training model of chemistry.Please check the translation for any important changes or errors. Deep analysis of the collected large-scale data is conducted through artificial intelligence technology, and corresponding inferences are drawn. Based on the analysis of learner behavior enabled by data-driven intelligent data with a large language model, the usage frequency of teaching platforms, the interaction of query content, and real-time dynamic analysis of students' learning status[7], learning duration, online assessment, and learning progress can be presented with high refinement and visualization characteristics.

4. Strategy for Chemistry Online Courses Based on Large Language Models

1) Intelligent Teaching Platform: Chemistry Online Courses require the selection or development of teaching platforms with intelligent recommendation, data analysis, and context-aware teaching functions to support the construction of chemistry online courses based on large language models. Utilizing large language models to classify chemistry knowledge points, summarize course content, and provide intelligent question-answering functions, the platform aims to improve the level of intelligence and student learning experience. Deeply mining the dynamic interaction information of multi-level chemistry teaching platforms, a multimodal intelligent innovative interactive chemistry online course platform is constructed. Combining chemistry system data and algorithms, students can accurately download various chemistry learning resources through the intelligent platform; according to students' non-learning needs, chemistry online courses can achieve mobile and fragmented learning, allowing students to access key chemistry knowledge anytime, anywhere, even in different places such as high-speed railways, cafes, restaurants, etc. The intelligent teaching platform has built a rich content teaching resource library to assist teaching activities [8]. These platforms also provide personalized learning path planning and feedback mechanisms, enabling students to watch chemistry online course videos in real-time, helping them better understand chemistry course knowledge and improve learning outcomes. Teachers can also use these platforms for online teaching, assigning and correcting tasks, conducting teaching research and exchanges. The promotion of this teaching model has significantly expanded the teaching boundaries, improved teaching flexibility and efficiency, and made education more adaptable to rapid social development and individualized demands .Data analysis and mining: By comprehensively collecting and deeply analyzing students' online learning behavior data, we can better understand students' true needs, learning progress, and interests. Particularly in high school chemistry online courses, the application of big data is Extreme. From detailed chemistry experiment operations, in-depth understanding of chemical

ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

theories, to overall grasp of course structures, back-end data can be collected and processed to achieve the analysis functions of big data. At the same time, teachers can effectively use various teaching methods online[9], combining general lectures with personalized case analyses, and integrating theoretical explanations with experimental operations, to achieve the fusion of general and specific, theory and practice, and comprehensively stimulate students' interest in chemistry. Moreover, through self-learning on online courses and big data collection and analysis, it is possible to meticulously present students' learning situations and visually display the teaching flow and status, Unlike previous course evaluation methods that only focused on students' score reports, online course evaluation emphasizes the combination of process evaluation and outcome evaluation, and through developing classroom quizzes, online exams, collecting experiment reports, and classroom records, it comprehensively tests students' learning status and teachers' teaching quality, truly practicing "student-centered" education.

2) Virtual Reality and Augmented Reality: Augmented reality technology creates intuitive and vivid chemical experiment scenarios for students. Online chemistry courses convey systematic subject concepts and course knowledge to learners through the internet, such as electronic textbooks, experiment demonstrations, teaching videos, course construction, and electronic devices, providing resources for learners to master chemical principles and experimental techniques. However, to reduce experiment costs and ensure 100% safety during the experiment, fully guaranteeing their experience in completing experiment operations and learning chemical theories, and providing real and detailed student analysis for teachers[10].

3) Student privacy and security: On the one hand, it is necessary to improve relevant technical measures to enhance encryption technology and permission management to ensure the security of information data and course resources. On the other hand, we must always remember the "student-centered" and "experiment safety first" principles, especially when conducting chemistry experiments, paying attention to students' personal safety. Otherwise, some experiments may explode and harm students' physical health. Therefore, chemistry teachers themselves must establish a strong safety awareness, strengthen the standardized management of chemical substances, patiently explain specific operation procedures and precautions to students, Teachers need to patiently explain specific operation procedures and precautions to students, and use relevant warning cases for explanation when necessary, we can understand students' past learning situations, achieve intelligent assessment and diagnosis of students' learning outcomes, and provide personalized learning suggestions, including multimodal evaluation and diagnostic solutions. Artificial intelligence can answer various complex questions raised by students with high accuracy and possesses intelligent thinking activities, adjust their learning strategies in a timely manner, and improve their learning effectiveness[11].

4) School-enterprise cooperation strategy development and innovation: clarify cooperation goals: the construction of chemistry online courses should strengthen school-enterprise cooperation, clarify the vision, philosophy, and needs of both parties, and jointly formulate the overall plan for course development, promotion, the school provides teaching resources, teachers, and market demand, while enterprises provide technical support, capital investment. Course research and innovation: based on school-enterprise cooperation, develop practical and innovative high school chemistry online courses, combining enterprise technology and resource advantages. Teaching resource sharing: establish a teaching resource sharing platform, combining high-quality teaching resources of the school with enterprise technology resources. Talent cultivation and exchange: strengthen communication and cooperation between teachers and students and enterprises, give full play to the role of collaborative education, and provide targeted practice, employment guidance, and other services for students. Course promotion and market operation: enterprises are responsible for the market promotion and operation of high school chemistry online courses, expanding course influence through online and offline channels to attract more students and parents to pay attention and participate. Innovative teaching mode: explore diversified teaching modes, such as flipped classroom, online experiment, etc., combining enterprise technical support, improving the interactivity and interest of the course.

5) Online course ideological and political education: High school is an important period for students to learn scientific theoretical knowledge and a key stage for shaping their worldview and mastering methodologies. Therefore, chemistry online courses not only bear the responsibility of spreading scientific theoretical knowledge through digital intelligence, but also should fully excavate the ideological and political elements of the course to achieve educational goals. For example, when teaching chemistry knowledge, stories about scientists such as Marie and Pierre Curie and their research processes and life experiences in the field of chemistry can be told, allowing students to truly feel the strong patriotism and responsibility of scientists while listening to stories and learning knowledge. In this way, not only do students further understand related knowledge of the subject, but they also establish role

ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

models. It is worth mentioning that under the background of "double creation," society has higher requirements for the creative thinking and innovation capabilities of talents. Chemistry itself is a subject with an ever-updated, improved, and developing knowledge system. Therefore, teachers responsible for high school chemistry courses should keep up with the times, pay attention to the forefront of discipline theory, consciously explore and apply new teaching modes, and combine new energy technology, environmental protection technology, and other hotspot dynamics to impart new knowledge, guiding students to pay attention to the application and development of chemistry in modern society, and stimulating their innovative thinking and exploration spirit. In summary, the construction of chemistry online courses must align with ideological construction, thus cultivating more high-quality chemistry talents with innovation and responsibility for our country.

5. Conclusion

This study focuses on exploring the research hotspots of high school chemistry online courses based on large language models, and proposes a comprehensive framework for high school chemistry online courses based on large language models combined with the characteristics of chemistry education. On this basis, it deeply analyzes the challenges encountered in data collection, model training, and optimization during the training of large language models, and puts forward effective coping strategies to enhance the performance of the model in the field of chemistry. Meanwhile, it also pays attention to the legal, ethical, and equitable issues involved in online course development, aiming to provide valuable references for creating high-quality and personalized chemistry online courses. Devoted to promoting the development of high school chemistry online courses based on large language models, it is expected to make a greater contribution to improving the overall quality of chemistry education in China. It is hoped that the construction of high school chemistry online courses can closely follow the pace of technological development, and deepen the integration of chemistry education and modern innovative technologies. For example, online courses can integrate virtual simulation technology, big data application technology, and artificial intelligence technology to enhance the timeliness and effectiveness of teaching courses. Moreover, with education as the goal, students as the main body, attention should be paid to students' learning experience and feedback, adopting diversified teaching methods to realize the diversity of assessment and evaluation, and ensuring the safety and applicability of the learning platform. In summary, high school chemistry online courses based on large language models adopt advanced educational technologies to create a more flexible, efficient, and dynamic learning environment for students to learn high school chemistry courses.

Acknowledgement

Fund Project: 2022 Project of Improving the Basic Scientific Research Ability of Young and Middle-aged Teachers in Guangxi Modern Polytechnic College (Project No.:2022KY1440).

References

[1] Parsons Andrew F. Exploring Everyday Chemistry: The Effectiveness of an Organic Chemistry Massive Open Online Course as an Education and Outreach Tool. [J]. Journal of chemical education, 2020, 97(5).

[2] Haley Rebecca A., Ringo Jessica M., Hopgood Heather, Denlinger Kendra Leahy, Das Anushree, Waddell Daniel C. Graduate Student Designed and Delivered: An Upper-Level Online Course for Undergraduates in Green Chemistry and Sustainability [J]. Journal of Chemical Education, 2018, 95(4).

[3] Nitza Davidovitch, Margarita Belichenko. Facebook Tools and Digital Learning Achievements in Higher Education [J]. Journal of Education and e-Learning Research, 2018, 5(1).

[4] Andrew A. Tawfik,Todd D. Reeves,Amy E. Stich,Anila Gill,Chenda Hong, Joseph McDade,Venkata Sai Pillutla, Xiaoshu Zhou,Philippe J. Giabbanelli. Erratum to: The nature and level of learner–learner interaction in a chemistry massive open online course (MOOC) [J]. Journal of Computing in Higher Education, 2017, 29(3).

[5] Chitkushev Lou, Vodenska Irena, Zlateva Tanya. Digital Learning Impact Factors: Student Satisfaction and Performance in Online Courses [J]. International Journal of Information and Education Technology, 2014, 4(4).

[6] Essel Harry Barton, Vlachopoulos Dimitrios, Essuman Albert Benjamin, Amankwa John Opuni. ChatGPT effects on cognitive skills of undergraduate students: Receiving instant responses from AI-

ISSN 2663-8169 Vol. 6, Issue 2: 140-145, DOI: 10.25236/IJNDE.2024.060223

based conversational large language models (LLMs)[J]. Computers and Education: Artificial Intelligence, 2024, 6.
[7] Eglseer D. Development and evaluation of a Massive Open Online Course (MOOC) for healthcare professionals on malnutrition in older adults[J]. Nurse Education Today, 2023,123.
[8] Menasco Alexis,Shah Ruchi,Suhy Rebecca,Suhy Michael,Lowery Sarah, Goertz Jennifer,Hoyt Alice. State and Non-Profit Organizations Collaborate to Provide Food Allergy and Anaphylaxis Education to School Faculty and Staff, Enhancing School Safety Through a Free, Online Course[J]. The Journal of Allergy and Clinical Immunology, 2023, 151(2S).
[9] Floss Mayara,Abelsohn Alan,Kirk Aoife,Khoo Su-Ming,Saldiva Paulo Hilário Nascimento,Umpierre Roberto Nunes,McGushin Alice,Yoon Sojung. An international planetary health for primary care massive open online course[J]. The Lancet Planetary Health, 2023,7(2).
[10] Misiejuk Kamila,Ness Ingunn Johanne,Gray Robert, Wasson Barbara. Changes in online course designs: Before, during, and after the pandemic [J]. Frontiers in Education, 2023.
[11] Junhuan Hu. Research on Online Course of Career Planning from the Perspective of Practical Art Education [J]. The Educational Review, USA,2023,6(12).