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Digital Scaffolding: Online Learning Software and Knowledge Construction in English Language Learning Classrooms

Luming He [1,2] **, *Phawani Vijayaratnam*** [1*] **, *Norazrina binti Hamdan*** [1] **,**
Subashini K. Rajanthran [3] **, *Mehdi Manoochehrzadeh*** [4]

[1] *Faculty of Education and Liberal Arts, INTI International University, Nilai 71800, Malaysia*

[2] *Organization Department, Zhejiang Vocational Academy of Art, Hangzhou 310053, China*

[3] *Lasalle College of Arts, University of Arts, Singapore 227976, Singapore*

[4] *Department of Education, Zerodale Inc. Centre for Research in Entrepreneurship Education and Development, Toronto, ON M2K 2H6, Canada*

ABSTRACT

With the rapid development of science and technology, online learning software has become an important tool for English learning as it provides a large number of learning resources together with interactive functions. But how to help students effectively build a systematic English knowledge framework is still a key issue to be solved. Another major obstacle is making sure that students can translate this disjointed knowledge into effective communication skills. This study aims to explore how online learning software can help students integrate various knowledge points in English learning and improve learning efficiency through knowledge construction. Based on the theories of constructivism, cognitive load and self-regulated learning, this study explores how online learning software can achieve knowledge construction and improve learning efficiency by stimulating students' intrinsic motivation, reducing cognitive load, and promoting self-regulation. By doing this, it aims to offer both theoretical understanding and useful tactics for enhancing online English learning environments. The study's goal is to aid in the creation of learner-centered and more efficient online platforms. The key findings from the study illustrate that online learning tools improve English language proficiency by including

*CORRESPONDING AUTHOR:

Phawani Vijayaratnam, Faculty of Education and Liberal Arts, INTI International University, Nilai 71800, Malaysia;
Email: phawani.vijayaratnam@newinti.edu.my

ARTICLE INFO

Received: 6 June 2025 | Revised: 19 August 2025 | Accepted: 21 August 2025 | Published Online: 5 November 2025
DOI: https://doi.org/10.30564/fls.v7i12.10374

CITATION

He, L., Vijayaratnam, P., Hamdan, N.b., et al., 2025. Digital Scaffolding: Online Learning Software and Knowledge Construction in English Language Learning Classrooms. Forum for Linguistic Studies. 7(12): 290–302. DOI: https://doi.org/10.30564/fls.v7i12.10374

fundamental skills, providing individualized learning plans, and giving immediate feedback. Also, these platforms enhance efficiency, develop communicative competence, and build systematic knowledge based on the constructivist, cognitive load, and self-regulated learning theories and ultimately contribute to quality education as per United Nations Sustainable Development Goal 4.

Keywords: Online Learning Software; Knowledge Construction; Language Learning; Learning Efficiency; Quality Education

1. Introduction

With the ongoing advancement of technology, the embodied aspects of knowledge production in digital learning environments are becoming more immersive, which helps students grasp concepts and abilities more thoroughly [1]. The proliferation of online learning software has become an integral part of modern education, especially in the field of language learning. In recent years, more students choose to learn English through these platforms. With its flexibility, convenience and resource richness, online learning software makes full use of students' fragmented time to maximize, which is a major reform and breakthrough of traditional classroom teaching mode [2,3]. However, despite the large number of learning resources and interactive features provided by online learning platforms, many learners still face the problem of insufficient knowledge construction and low learning efficiency [4]. The core of language learning lies in the effective integration of vocabulary, grammar, listening, reading and other knowledge points to form a systematic knowledge framework, but the existing online learning platform often lacks the function of organically combining these knowledge points, resulting in the development of learners' language ability in a state of fragmentation [5]. How to promote students' comprehensive and in-depth language knowledge construction with the support of technology is an urgent challenge to be solved.

Several studies in recent years have shown that by dynamically tracking students' learning behavior and feedback, platforms can provide tailored learning content for each learner, greatly improving learning outcomes [6,7]. For example, based on learners' learning history and performance, the platform can intelligently recommend suitable learning tasks and exercises to help students master new knowledge points at the right time [8,9]. As such, interactive tasks and timely feedback mechanisms have become an indispensable part of modern online learning platforms. They not only enhance students' learning interest but also help students correct mistakes in time during the process and improve the accuracy and efficiency of learning.

This study analyses the learning trajectory of students when using different online learning platforms, and explores how personalized learning paths, interactive tasks and feedback mechanisms work together to help students improve their learning efficiency and achieve comprehensive improvement of language ability. Some of the online software include Youdou, Baicizhan, Duolingo, Bubeidanci, etc. The study aligns with the United Nations Sustainable Development Goal (SDG 4) in providing quality education and promoting lifelong learning [10] to advance educational technology and provide a more holistic learning experience for English learning in a globalized context.

2. Literature Review

Through virtual language communities, multimodal task collaboration, and instant feedback processes, online learning software provides English language learners with a dynamic field for interaction that allows them to construct language knowledge structures deeply through information recombining and viewpoint interaction in a real-world setting [1]. The integration of intelligent tutoring systems and chatbots has transformed static learning spaces into adaptable environments which deliver personalized interactive experiences to each user [8,9]. Multiple platforms designed specifically for English language education have emerged during the digital age to support learning through specialized software. The studies have revealed that online learning enhances communication, language skills and generates shared knowledge that makes language learning a constructivist education [1,11,12]. There are cognitive traits such as working memory capacity, information processing flexibility that are

at the center of the success or failure of learners in the building of linguistic knowledge. Hence, the ability to learn educational material and organize information is predetermined by various student capacities to handle complicated language-related issues [13,14]. Well-learned students are more adaptable to online learning environments and resort effectively to their cognitive resources when adapting multimedia and gamified learning situations [15,16]. In contrast, individuals who struggle with cognitive flexibility experience difficulties in discarding irrelevant information which leads to increased mental workload and negative effects on their educational outcomes [17,18]. However, the effectiveness of these strategies relies on how much effort learners put into the task, as simpler tasks may not show much improvement with these approaches [19]. Digital learning necessitates the use of self-regulation techniques and the combination of goal setting and time management to be able to engage in active learning and deep concepts learning [20,21], encouraging students to review their cognitive operations and alter their learning approaches using reflection may modify the behaviors of students [22,23]. The Chinese education system has a significant characteristic that indicates learning objectives of students based on their knowledge of the external environment [24]. With solid behavioral strategies in place, these students will be able to overcome the rigidity of traditional models and thrive in dynamic, data-driven digital learning environments that promote self-regulation, independent learning, and creative problem-solving [25].

Students who have high motivation level contribute greatly to the development of knowledge because of their ability and involvement in learning a particular language. The Self-Determination Theory defined the two major types of motivation. Firstly, extrinsic motivation, students motivated by the external factors of academic success and social power. Second, intrinsic motivation, which is based on the interest and curiosity of a person [3]. While extrinsic motivation can have immediate effect on performance but normally does not build profound knowledge on the specifics of the job, intrinsic motivation is associated with augmented creativity and extended memory [26]. In case of English language learners, particularly those in an organized academic context, this kind of autonomy will allow them to have personalized learning experiences, which boosts their engagement and continues to help them achieve success in other contexts [21,25]. However, when online platforms incorporate motivating and game-based features, those can trigger inherent curiosity and maintain engagement of the learners [27,28]. Recognizing this contrast and tailoring software features to motivate both external and internal motivators can optimize knowledge construction processes.

Cooperative learning, critical thinking and reflective processes in learning are cognitive tools required in language learning and they work well when carried into the digital space. Ways of encoding languages via communicative and meaningful task promote analysis, synthesis and critical approach to the content [5,29]. With the help of software learning, teaching can be polished through the instant feedback mechanism, cooperative learning, and meaningful activities [1,30]. All these nurtures learners to collaborate in groups to help them enhance their knowledge of the topic [11]. The encouraged activities allow learners to read, reflect and defend interpretations and this enhances their critical thinking and cognitive involvement skills [16,31]. The software's reflective functions allow students to track their progress, promoting ongoing education, sustained progress, and growth, rather than providing support at specific intervals [3,19].

Flexibility of learners in the culturally diverse learning environment has considerable influence on their effective knowledge building ability. In the context of English language learning among Chinese students, cultural norms tend to emphasize obedience, collectivism, and teacher centered instruction [32,33]. These elements may inhibit the freedom of the learners and minimize exploration and teamwork. However, internationalization through encounter with a global online learning environment also introduces alternative ideals of pedagogy, including student autonomy and peer contact, which may appropriately promote a greater extent of flexibility and imaginative thinking [34,35]. High culturally adaptive learners are more able to overcome learning inertia, integrate their varied perspectives, and provide exciting ideas to group initiatives that improve knowledge construction [24].

3. Theory Underpinning

The study uses a combination of three complementary theoretical models, namely the constructivist learning theory, cognitive load theory, and self-regulated learning theory. The selection of these theories is related to their application to

online learning and that they explain how learners can interact with the technology in building knowledge [14,32]. Constructivism relates to the active status of learners as they construct knowledge through the process in developing and maintaining a contextually rich experience through social interactions [36]. This three theory approach is employed to examine how online learning software supports the capacity of the students to connect different aspects of language learning environments including aspects of vocabulary, grammar, listening, and reading. Cognitive load theory describes how learners perceive and deal with information [13]. It discusses the possibilities of online learning software to minimize cognitive load by changing content and pacing in a manner based on the progress in learning a specific issue thus increasing learning efficiency [15,16,37]. The theory of self-regulated learning is concerned with the way learners take charge of their learning with regard to goal setting, progression monitoring and adaptation of strategy [21]. This theory directs the study in comprehending how the students manage their learning process through the use of the software evaluating their progress and making strategy adjustments based on the valuation. The combination of these theories influenced both the creation of the interview questions and the approach to data analysis. For example, constructivism explains how learners established connections between learners and various parts of a language, whereas cognitive load theory enables an understanding of how learners understood the information provided in the software. Self-regulated learning is used as the lens through which the students would handle their learning experience and goal-setting by relying on the feedback of the platforms [13].

A comprehensive examination of the ways in which constructivist, self-regulated, and cognitive load theories work together to scaffold the production of English knowledge for Chinese learners in digital contexts is lacking in the literature, despite the fact that individual learning theories have been the subject of much research. Additionally, qualitative details from student interviews conducted on appropriate software and real-world platforms are not taken into account in existing literature. This study attempts to close that gap by investigating the ways in which digital tools serve as mediators between theoretical domains to enhance learner engagement, strategy use, and depth of knowledge.

The research objective of this study is

i) To explore how online learning software enhances students' knowledge construction and boosts learning efficiency in English language acquisition.

4. Methodology

4.1. Research Design

In order to gain a deeper understanding of the impact of online learning software on students' knowledge construction in English learning, this study adopted a qualitative research method. Qualitative data were collected through interviews, providing a perspective on individual experiences.

The interview questions were drafted according to the theoretical framework of the study, which consists of three theoretical understandings, namely constructivism, cognitive load theory, and self-regulated learning theory [13,32]. Based on these theories, the interview questions were constructed to investigate the way in which knowledge construction is facilitated through the online learning software and how efficient learning is promoted using the software. Participants were asked whether online learning software adjusted content according to their learning progress and how online learning software helped them with knowledge construction. They were also asked about the frequency of using online learning software per week and the duration of each use. The study included a question about participants' expectations of online learning software for English learning to understand their needs and purposes for using such software.

4.2. Sampling Design

The participants in this study consisted of 15 high school and college students from China, aged between 15 and 21, representing a variety of educational levels. Purposive sampling was used to achieve diversity in educational background, whereby the sample included students of various field of study such as early childhood education, cultural management, and hotel management. The sampling method was selected to target participants that might shed insightful light into the research problem [38]. Through the interviews, data saturation was considered when no more themes were identified in regard to the theoretical concepts of constructivism, cognitive load, and self-regulated learning [39,40]. The thematic analysis of the interview results revealed that there were some consistent patterns according to the theoret-

ical framework implying that the theoretical saturation was reached. **Table 1** presents the demographic and academic details of the 15 student participants, providing contextual background for the qualitative insights gathered.

Table 1. Respondent Details.

Participant ID	Age	Major	Gender	Grade
R1	17	/	Female	Senior High School Year 3
R2	15	/	Female	Senior High School Year 1
R3	16	/	Male	Senior High School Year 2
R4	17	/	Female	Senior High School Year 3
R5	15	/	Male	Senior High School Year 1
R6	16	/	Female	Senior High School Year 2
R7	18	Early childhood education	Female	First Year college
R8	18	Cultural management	Female	First Year college
R9	19	Stage design	Male	Second Year college
R10	20	Hotel management	Male	Third Year college
R11	21	Cultural relic restoration	Female	Fourth year college
R12	20	Stage design	Female	Third Year college
R13	19	Hotel management	Male	Second year college
R14	21	Stage design	Male	Fourth year college
R15	20	Early childhood education	Female	Third year college

To comprehensively study the influence of online learning software on students' English learning knowledge construction, purposive sampling, a non-probabilistic sampling technique was adopted in this study as it matched with the research purpose and goal, thus improving the rigor of the research and the credibility of the data and results [38].

Key information such as age, gender, and cultural background were collected to identify respondents, as it affects the usage patterns and effectiveness of the e-learning software. To ensure sample representativeness, frequency and duration of use was included in the sampling criteria. This design allowed systematic study on how students with different backgrounds and learning habits learn English through software and reveal the specific influence of software on learning effectiveness and knowledge construction.

Survey questions were sent to the selected participants through WeChat, with a detailed explanation of the survey purpose and the principle of anonymous handling. Through the sampling plan and participant selection methods described above, it was possible to reveal the effectiveness and suitability of online learning software in different student groups, providing valuable references for future educational practices.

4.3. Interview Questions

Which online learning software do you use? Why?

How often do you use online learning software on a weekly basis? How many times per week? And for how long each time?

When using online learning software, which English learning problems do you most hope it can help you solve, i.e., vocabulary, grammar, listening ?

How do you think online learning software can help you connect different knowledge points such as vocabulary, grammar, listening and reading in English learning to form a complete knowledge system?

Most online learning software often adjusts the content based on your learning progress, which helps you build knowledge at your own pace. How can you gradually deepen your learning based on what you have already learned?

Did the feedback help you understand the point of English better, or did it help you identify blind spots in your learning? Explain.

Have you ever encountered incorrect feedback or prompts when using online learning software? Explain.

How do you think online learning software helps you improve your efficiency in learning English? For example, how does it help you better manage your study time, track your progress, or provide targeted review? Explain.

4.4. Data Collection

Data was collected in the first phase through online interviews using WeChat voice calls, which allowed the re-

searcher to interview 15 participants. The interviews were converted to textual form and the information was assembled in graphically represented Excel tables to make sure that the initial contents of the interviews and relevant data regarding the respondents are maintained.

4.5. Data Analysis

After the interview, data was carefully organized, and a comprehensive interview data table was constructed. The table not only included the basic information of the respondents but also recorded the key points in the interview process in detail based on themes, ensuring the systematic and traceable nature of the data. This analysis was done through thematic analysis, a qualitative research technique through which patterns (themes) are identified, analyzed and reported in the data [39]. The use of the three theories resulted in the grouping of themes that explored the areas of knowledge constructions, cognitive load management, and self-regulation in the use of online learning software [40].

Since no new information or trends pertaining to the three main concepts (constructivism, cognitive load, and self-regulated learning) were provided in the subsequent interviews, thematic saturation was attained. Constructivist themes emerged from learners' comments of how they linked the software's useful technologies with their varied language proficiency. Themes of cognitive strain were assessed by looking at user comments about how well the program reduced cognitive load and encouraged more efficient learning. The self-regulated learning themes were interpreted by analyzing the participants' comments about goal-setting, how they managed their learning processes, and the strategy adjustments they made after receiving feedback from the program [29]. Interviews and data analysis were conducted continuously until no more themes could be found in order to assess saturation [39].

4.6. Confidentiality and Ethical Considerations

Before data collection, it was necessary to clearly explain the purpose, methods, and specific procedures for data processing to participants, ensuring that they fully understand and voluntarily participate in the study. To protect the privacy of participants, all collected data were anonymized to ensure that personal privacy was fully protected. In addition, a strict data management regulation was established to ensure the safety and confidentiality of data in all stages of collection, storage, analysis, and presentation.

5. Results

Based on interview data collected from Chinese students about the impact of online learning software on knowledge construction in English learning, several key dimensions are revealed. The dimensions are: 1) frequency and duration of use, 2) learning needs, 3) construction of knowledge system, 4) personalized learning path, 5) influence of error feedback, and 6) improvement of learning efficiency.

5.1. Frequency and Duration of Use

The analysis shows that most respondents use online learning software on a weekly basis 3–5 times, with an average session duration of 20–30 minutes. This indicates that respondents tend to view online learning software as part of their daily learning routine. This frequent and short usage pattern suggests that respondents may prefer to spread their learning time across multiple sessions throughout the week rather than engaging in long, continuous study sessions. This distributed learning approach can help improve memory efficiency and learning outcomes because it allows learners to review and reinforce key concepts at different points throughout the week. R2 said, "*I use the Baicizhan software five times a week, with each session lasting about 20 minutes,*" indicating that online learning software is an indispensable part of her daily study. Another high school student, R4 mentioned that she uses Baicizhan and Leci "*once or twice a week; for 20–30 minutes each time,*" indicating that she uses it less frequently but is able to focus her attention on studying each time she does. This flexible learning approach allows students to adjust their study times according to their schedules and learning needs. Meanwhile, R6 mentioned, "*Four times a week; 30 minutes each time*" and emphasized the importance of Baicizhan in '*helping her build her knowledge framework*' and '*personalized learning path'*. Interestingly the freshmen from R7 to R15, expressed, "*using Baicizhan and Duolingo every day; for 25 to 30 minutes each time,*" which indicates that she has integrated the use of online learning software into her daily life and may use it as a continuous review and learning tool. From the

responses of these interviewees, although the frequency and duration of use vary, they all recognize the role of online learning software in improving learning efficiency and quality. They use online learning software to schedule their study time, track their progress, and conduct targeted review. This personalized and flexible learning method not only adapts to their busy lifestyles but also meets their specific needs for English learning. In summary, the interviewees tend to use online learning software for daily study, which has become part of their study habits, and they use this method to improve their English learning efficiency and effectiveness.

5.2. Learning Needs

The analysis shows that the main English learning difficulties that respondents hope online learning software can help address are related to 'vocabulary memorization', 'grammar comprehension', and ' 'listening improvement'. These needs reflect the core concerns of online learning software users and their expectations for the software's functions. In terms of vocabulary memorization, R6, senior student informed, "*When using the Baicizhan software, I hope it can help me solve my vocabulary memorization problems.*" She emphasized the challenges of memorizing new words and hoped that the software could help her remember words more effectively through repetition, vocabulary cards, and contextual application. Similarly R5, a freshman also mentioned: "*I always have problems with my language being too simple and my expression unclear when I write. The Youdou and Baicizhan software provides writing guidance to help me improve my sentence structure, vocabulary use, and article organization.*" In terms of grammar comprehension, R4, a high school student expressed: "*English grammar always confuses me, especially tenses, subjunctive mood, and conditional sentences.*" According to the respondent, the Baicizhan and Leci software can explain these complex grammar rules in a simple and easy-to-understand way and help her master them through interactive exercises. R12, senior college student also said, "*Grammar is one of the difficulties in learning English. The Shanbay word and Baicizhan software can help me better understand grammar rules through concrete examples and interactive exercises, and I can see how grammar is applied in real conversations and writing.*" Similarly, R12 also expressed a need for improved ability to catch details in listening comprehension: "*When I practice listening, I often only catch the main idea and miss some details. But the online learning software helps provide a breakdown of sentences or paragraphs to help me analyze the key words, grammar structures, and implied meanings of each sentence, helping me gradually improve my ability to catch details in listening comprehension.*" The above reveal the specific expectations of online learning software in providing personalized and targeted learning resources to solve the specific problems they encounter in their English studies such as their vocabulary, grammar mastery, and listening comprehension skills, thereby achieving better results in their English studies.

5.3. Construction of Knowledge System

It is necessary to combine vocabulary, grammar, listening and reading to form a complete knowledge system in the process of English learning. Respondents generally agreed that online learning software played an important role in this regard, helping them to integrate different learning content and build a systematic English learning framework. R5, a high school student claimed that "*Online learning software can integrate different learning content. For example, when learning a certain grammar point, the software can provide explanations of vocabulary, examples from listening materials, and applications in reading comprehension, so that I can master this knowledge at the same time and integrate them through continuous practice to form a closed loop of knowledge.*" This shows that she believes that the software helps her connect the language knowledge in practice through multi-dimensional practice. Similarly, R4, a high school sophomore highlighted the importance of automated feedback mechanisms: "*Online learning software helps me build a body of knowledge through automated feedback mechanisms. After each exercise, the software can give me specific explanations and suggestions for my mistakes, not only pointing out which vocabulary or grammar mistakes, but also telling me how to avoid similar mistakes in listening and reading, helping me to deepen my understanding and memory of the knowledge points through constant correction.*" This suggests that he believes instant feedback from software is essential for building a body of knowledge. R14, a fourth-year college student shared that "*Online learning software like Baicizhan and Duolingo can provide cross-skill exercises, such as listening combined with vocabulary*

and grammar, speaking combined with reading comprehension and grammar. In listening practice, the software can automatically mark important grammatical structures and vocabulary in the article, so that I can learn while listening to improve my understanding; While reading, the software will remind me of grammar difficulties and give explanations of relevant vocabulary, so that I can consolidate both grammar and vocabulary in reading." Her ideas were shared by the other respondents. This evidence illustrates how software can facilitate the building of a body of knowledge through cross-skill practice. Thus, we can see the importance of online learning software in helping learners build a knowledge system. By integrating different learning content, providing instant feedback, cross-skill exercises and cultural context, the software helps learners to connect knowledge points such as vocabulary, grammar, listening and reading to form a complete knowledge system.

5.4. Personalized Learning Path

Several respondents stressed the importance of online learning software adapting content to their learning progress, which helps them build knowledge at their own pace and gradually deepen their learning. This personalized learning path adjustment allows each learner to get the most suitable learning materials and challenges according to their own mastery and learning speed. "*The online learning software automatically adjusts the content according to my learning progress, helping me build knowledge at my own pace,*" said R2. She further explained that "*if she performed well on a certain grammar point, the software would recommend more difficult exercises, while when she struggled, the software would provide review tasks to help her consolidate the basics*". R4, a high school sophomore expressed similar views: "*The progress adjustment function of online learning software is very suitable for people like me who want to study at their own pace.*" The software, he says, "*helped him deepen his grasp by reducing the difficulty and providing more basic review material".* R11 a first-year college student also shared her experience: "*Online learning software helps me learn at my own pace, especially in vocabulary and grammar.*" She believes that the software's adaptation has allowed her to gradually improve her language skills according to her own mastery. In summary, the adjustment of personalized learning paths is crucial for learners. It not only adapts to the needs of different learners, but also stimulates their motivation, enabling them to effectively build and deepen their knowledge at their own pace. Online learning software provides customized learning experiences for each learner by accurately tracking their progress and adjusting content.

5.5. Influence of Error Feedback

Online learning software is not perfect, and there may be some incorrect feedback. Although this incorrect feedback may initially cause confusion, they encourage learners to think deeply and find the correct answers, which helps uncover blind spots in their learning. This process of reflection and self-correction is a valuable learning experience for learners. R6, a senior high school student mentioned, "*The wrong feedback sometimes confuses me, especially when the system gives hints that contradict my understanding." Although these errors didn't help me understand a particular point directly, they forced me to re-examine and verify my understanding. This critical thinking helped me to spot some blind spots in my learning, especially in the details of grammatical structure."* This indicates that the wrong feedback stimulated his critical thinking and pushed him to explore and understand the English points more deeply. R13, a college student also shared that "*Although the error feedback did not directly help me understand the knowledge point of English, Baicizhan promoted my self-correction ability. When the system gave inaccurate prompts, I began to proactively verify my answers and correct them by looking at the data. This process helped me to discover details that I had overlooked in the learning process and further deepen my understanding of English knowledge.*" This indicates that the error feedback has helped her develop the ability of self-correction and deepen her understanding of English learning. R12, a third-year college student echoed similar sentiments: "*Sometimes I get confused by the feedback from the online learning software such as Shanbay word and Baicizhan, for example in vocabulary questions where the system incorrectly rates my answers. Although this confused me at first, it also prompted me to look for other sources to verify my understanding. This process helped me discover my learning blind spots, especially for the use of some synonyms and phrases, and improved my self-learning ability in English learning.*" This shows how the error feedback prompted him to seek out additional learning resources to improve his language skills.

In conclusion, it is demonstrated that negative feedback has a positive role in online learning. Although negative feedback may initially cause confusion, it ultimately encourages learners to think deeply, correct their own mistakes, and discover blind spots in their learning, thereby promoting deeper learning and understanding.

5.6. Improvement of Learning Efficiency

By automatically arranging learning plans, tracking learning progress, providing targeted review and other ways, online learning software enables respondents to make use of fragmented time for effective English learning and effectively improves learning efficiency. Respondents generally agreed that these features enable them to manage their time and study content more efficiently, thus finding the time and motivation to learn in their busy schedules. R3 shared that "*Baicizhan helps me better manage my study time by automatically scheduling my study schedule. It adjusts the difficulty of the content according to my learning progress and mastery, ensuring that I can learn effectively without feeling too stressed.*" This shows that the software's personalized learning plan has helped her stay productive during her intense study schedule. This was echoed by R5 who shared, "*The online learning software tracks my progress and automatically recommends what to study next.*" She further explained that this personalized study recommendation not only improves learning efficiency, but also helps her to better focus on the areas that need improvement. R4 similarly shared that "*The progress tracking function provided by online learning software allows me to clearly see my learning results. I can check my study record at any time to see which modules have been completed and which points need more practice.*" This feedback helps him adjust his study schedule to make sure he's not learning too fast or too slow. R11 stressed the value of instant feedback from Baicizhan and Duolingo, as "*The online learning software provides instant feedback after I complete a task, which allows me to know right away where I went wrong and avoid accumulating mistakes.*" This instant feedback mechanism allows him to quickly correct mistakes and improve learning efficiency. Online learning software enables them to use their time more effectively and improve learning efficiency through features such as personalized learning plans, progress tracking and instant feedback.

6. Discussion

RO1: To explore how online learning software enhances students' knowledge construction and boosts learning efficiency in English language acquisition.

This study finds that online learning software plays an important role in helping students construct English knowledge, and its methods are diverse and effective. With the rapid development of information technology, especially the application of artificial intelligence and big data, online learning platforms have gradually become an important tool for students' language learning. Through these platforms, the network environment, learners, teachers and resources are combined to cultivate the comprehensive ability and knowledge construction level of English learners [36,41]. First, unified methods, terms and standards are established to improve learners' understanding of language structure [33]. Based on the constructivist learning theory, knowledge is constructed through social interaction and contextualized practice [36]. By offering an integrated learning platform that naturally blends essential English learning components like vocabulary, grammar, listening, and reading, these programs assist students in developing a methodical knowledge framework. Students' comprehension and recollection of linguistic information are improved by this integrated learning experience, which also encourages them to use what they have learned more freely in real-world situations [5,29]. To improve students' understanding of language structure, several online platforms, for instance, combine and repeat vocabulary, grammar, and listening in many dimensions through modular design [30,31]. This type of interdisciplinary learning integration helps pupils avoid the fragmented learning phenomena.

Secondly, the study found that the provision of personalized learning paths is another major advantage of online learning software. The theory of self-regulated learning emphasizes that learners achieve knowledge deepening through goal setting, strategy adjustment, and metacognitive monitoring [21]. The personalized learning paths featured in online learning software precisely embody this theoretical framework [27,28]. Use automated, data-driven personalized feedback in intelligent tutoring systems to improve student learning outcomes [9]. By intelligently adjusting learning content according to students' learning progress and mastery, online learning platforms are able to meet the individual needs of different students, enabling them to build and

deepen knowledge at their own pace. Specifically, based on learning data analysis, the platform can provide students with tailored learning plans, recommend suitable content and exercises, and help them fill knowledge gaps and strengthen weak points. Research has identified the potential of AI in higher education Settings to provide personalized, real-time support to college students aimed at improving learning outcomes and student engagement [12].

In addition, the study also found that the instant feedback mechanism is one of the key factors for e-learning software to improve learning efficiency. The role of timely feedback is closely related to cognitive load theory. Frequent automated feedback reduces extraneous cognitive load [14]. By providing immediate feedback and correction during the learning process, the software helps students quickly identify and correct errors, thereby deepening their understanding and memory of knowledge points [13,30]. Studies have shown that combining adaptive learning techniques with artificial intelligence algorithms is expected to enhance students' learning experience [7]. In oral English learning, artificial intelligence algorithm and oral spectrum algorithm can effectively improve students' English scores. This innovative approach addresses the shortcomings of traditional educational methods by incorporating technology to improve learning outcomes [12]. Students can adjust their learning strategies through continuous feedback, so as to improve the efficiency and quality of learning [27,28].

This study is unique because it offers a multifaceted examination of online English language learning by concurrently using three complementing learning theories: constructivism, cognitive load, and self-regulated learning. It combines academic rigor with real-world insights in both style and substance, connecting instructional concepts to useful technological applications that enhance global linguistic competitiveness. It goes beyond passive information reception by emphasizing the active development of linguistic knowledge through interactive exercises, situational simulations, and collaborative technologies [32,36]. It investigates how adaptive difficulty, multimedia integration, and organized learning designs maximize processing efficiency and cognitive resource allocation, drawing on the cognitive load theory [4,15,19]. Simultaneously, it emphasizes how self-regulated learning principles help students align language acquisition with the requirements of global academic and professional success by allowing them to establish goals, modify their tactics, and track their progress through analytics, tracking, and individualized feedback [22,25].

7. Conclusions

According to this study, using AI-powered online learning platforms into English language instruction can greatly increase knowledge development, allow for more individualized learning experiences, and boost productivity by providing real-time adaptive feedback. Teachers and developers can design settings that strike a balance between learner autonomy, structured guidance, and cognitive optimization by firmly establishing platform design in constructivist, cognitive load, and self-regulated learning theories. To better prepare students for the academic and professional challenges of a globalized world, these findings can inform curriculum design, teacher preparation, and policy development.

Interestingly, a study by Abdullah et al. [42] found that online feedback, interaction, teacher effectiveness, and personal well-being significantly influenced students' online learning satisfaction during the period of forced remote learning due to COVID-19. Higher online learning proficiency predicted greater usage intention, highlighting the need for continuous improvement. Since the pandemic, online learning platforms have further optimized their functions, to provide a more intelligent and personalized learning experience, and help students master English more effectively in the context of globalization.

8. Limitations and Suggestions for Future Research

The study on online learning software has limitations, including a small sample size of high school and college students in China, reliance on qualitative interview data, lack of quantitative data, and a cross-sectional nature. To improve the study's applicability, it should expand the sample size, incorporate quantitative data, consider more online learning software types, and conduct long-term follow-up studies.

Author Contributions

Conceptualization, L.H., P.V. and N.b.H.; methodology, L.H., P.V., N.b.H., S.K.R. and M.M.; analysis, L.H.,

P.V., N.b.H., S.K.R. and M.M.; validation, L.H., P.V., N.b.H., S.K.R. and M.M.; formal analysis, investigation, L.H., P.V., N.b.H., S.K.R. and M.M.; resources, L.H., P.V., N.b.H., S.K.R. and M.M.; data curation, L.H., P.V., N.b.H., S.K.R. and M.M.; writing—original draft preparation, L.H., P.V., N.b.H.; writing—review and editing, L.H., P.V., N.b.H., S.K.R. and M.M.; visualization and project administration, L.H., P.V., N.b.H., S.K.R. and M.M.; funding acquisition, P.V. All authors have read and agreed to the published version of the manuscript.

Funding

This research was funded by INTI International University.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

A Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data is unavailable due to privacy concerns.

Acknowledgments

The authors express their sincere gratitude to INTI International University, Malaysia, for providing all the facilities necessary to conduct this study.

Conflicts of Interest

The authors declare no conflict of interest.

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