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PAPER

Distributed Communicative Language Training Platform Using Automatic Speech Recognition Technology for Smart University

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ABSTRACT

The purpose of this research is to achieve the following objectives: 1) Synthesize documents and international research on the characteristics of a smart university. 2) Synthesize the processes of distributed communicative language training (DCLT). 3) Design the system architecture of a DCLT platform that utilizes automatic speech recognition (ASR) technology for a smart university. 4) Evaluate the appropriateness of a DCLT platform that utilizes ASR technology for a smart university. Nine experts were selected for this research. They were required to have more than five years of relevant experience in the field, including expertise in system architecture, distributed enterprise, language teaching, and ASR. The research instruments included a suitable assessment form for evaluating the system architecture of a DCLT platform that utilizes ASR technology for a smart university. The results of this research indicate that the DCLT platform, which utilizes ASR technology, was considered suitable for a smart university.

KEYWORDS

distributed enterprise, communicative language teaching (CLT), automatic speech recognition (ASR), smart university

1 INTRODUCTION

Nowadays, information and communication technology is propelling the world forward rapidly. Human beings require 21st-century skills to coexist harmoniously with global circumstances [1]. The continuous development of 21st-century skills requires investments in human resources and educational institutions, which are crucial factors in enhancing the country's future growth.

The development of higher education institutions into smart universities must involve the advancement of technologies that enhance the knowledge and skills of the workforce, enabling them to effectively utilize technology for economic and

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livelihood advantages [2]. Create an environment that fosters creativity and informal learning while also promoting social diversity and coexistence. English language skills are essential and important for further learning or accessing innovation [3]. The role of language skills is therefore related to the transition to a smart university as a tool that encourages individuals to learn and use English as a medium of communication worldwide [4]. Therefore, learning English as a universal language is an essential requirement for the advancement of higher education institutions.

Communicative language teaching (CLT) is an English language teaching method that emphasizes the importance of meaning over form and encourages the use of language in authentic, real-life conversations. It does not focus on reciting linguistic or grammatical rules but rather on learning to use descriptive language. It is equivalent to learning sentence structure, tones, and vocabulary. There are language exercises. The exercises that learners practice will focus on pronouncing words correctly rather than trying to pronounce them like native speakers [5]. All four language skills are practiced for fluency rather than accuracy. It is stimulated by creating different situations or environments for learners to use as much language as possible [6].

Automatic speech recognition (ASR) is a platform that converts audio files into text. It can transcribe the words spoken by a human into a microphone, telephone, or other input device [7]. It can understand every word. Correct words are evaluated independently based on the speaker's vocabulary size, speech volume, and pronunciation. The system listens to the voice and determines the words it hears. ASR consists of deep learning and natural language processing (NLP) technologies as its core components [8].

Currently, there is a problem with students and staff in higher education institutions. It was found that the majority of them were unable to communicate with individuals from other countries. Lack of confidence or limited English communication skills due to insufficient. It is highly challenging to construct sentences according to the principles of grammar that have been learned. In addition, there are very limited opportunities to practice listening, speaking, and communicating in English in everyday life, which hinders the development of comprehension skills. Therefore, it is essential to have a language teaching platform that can enable learners to effectively communicate by utilizing technology. This will not only provide economic and livelihood benefits but also create an environment that fosters informal learning and promotes coexistence with social diversity. It is necessary to conduct research to study, design, and develop a distributed communicative language training (DCLT) platform using ASR technology for smart universities. This platform will help promote higher education institutions to become more effective.

2 THEORETICAL BACKGROUND

2.1 Distributed enterprise

Working does not have to be limited to the office. The organizations must design and improve their technological infrastructure to meet their needs, thus creating an organizational model that emphasizes digital and remote work. This should be followed by the implementation of technologies that enhance the employee experience through digital tools. Distributed enterprises are organizations that support flexible work models. Enable employees to work both from the office and on-site using remote and hybrid work mechanisms [9]. Distributed enterprises have helped meet the needs of remote workers and service recipients who want to utilize virtual services and adapt to hybrid work [10]. Enterprise architecture (EA) is necessary for the systematic integration of information and communication technology (ICT) [11] into the business process. It encompasses the architecture level and the corporate roadmap, enabling the organization to effectively implement established policies and visions [12].

2.2 Communicative language teaching

Communicative language teaching is an approach to language instruction that emphasizes the learner's need to use English for practical, everyday communication. There is a hierarchy of learning based on the learner's cognitive processes, which encompass linguistic knowledge, language skills, and communication abilities [13]. Therefore, learners must take into account real-life communication. The activities and tasks associated with actual communication and the medium used are also real, but they do not neglect knowledge of grammar [14]. When there is a minor grammar mistake, it is still communicative. Instructors should not interrupt students to prompt for corrections. It should only be corrected when that mistake causes confusion or hinders effective communication. This is to foster a positive attitude among students towards using English for communication purposes [15]. The teaching process for communication is known as 3P, or P-P-P, which consists of three steps [16]. 1) Presentations provide language input to learners, which is one of the most important stages in teaching. At this stage, the instructor will present new material with a focus on providing learners with a sense and understanding of the meaning and patterns of commonly used language, as well as how it is used. 2) Practice trains learners to be accurate in their language usage so that it can be applied in further communication. After the learner has acquired knowledge of the language patterns and how they are presented, the next stage should focus on semantics. This is important because learners need to be able to use language effectively to convey meaning. A series of semantic-focused exercises, such as filling in gaps, role-playing, language-controlled gameplay, etc.; 3) Production is the practice of using language for communication, allowing learners to apply their language skills in practical situations outside the classroom. Learners are generally encouraged to practice their language skills in situations that simulate or are similar to real-life scenarios. The instructor is merely a guide on how to use language. The learner is responsible for producing the language. Activities for learners to practice should be designed to provide learners with the need and purpose to communicate. They should also offer them the opportunity to choose the language or content for themselves as much as possible. Learners should also evaluate their communication based on the feedback from their co-communicators to make it as realistic as possible.

2.3 Automatic speech recognition

Automatic speech recognition is a subfield of artificial intelligence [17] that converts audio signals into text transcription for speech. It can accurately count the words spoken by humans into the voice receiver and understand each one almost perfectly. The loudness of the voice includes the phonetic characteristics of the speaker, not its effect on the system [18]. The system will listen to the voices and determine which words it understands. The most widely used ASR system consists of five sub-modules: [19] 1) Acoustic preprocessing is the process of converting speech into a sequence of acoustic parameters; 2) The Pronunciation Model is a procedure that links the sequence of sounds; and 3) The acoustic model represents the relationship between sound signals and phonemes, or other language units used in speech. It is created by recording speech, transcribing text, and using software to generate statistical representations of the sounds that comprise each word. 4) A language model is a procedure for predicting the most likely sequence of words in a given context.

2.4 Smart university

A smart university is the evolution of a university, driven by technological advancements [20]. It provides education within an intelligent environment enhanced by smart technology [21], while also creating an enhanced academic environment for both teachers and students. The application and web-based tools offer a range of services, supported by a technological infrastructure to sustain and support operations. The university's endeavor to transform into a smart university aims to enhance the quality of life for campus inhabitants. This transformation will enable them to experience greater comfort and align with the strategic objectives of leading universities [22] as they adapt to emerging challenges in their pursuit of smart university status.

3 RESEARCH METHODOLOGY

For the purpose of this research, the methodology is divided into three distinct phases, as outlined below:

3.1 Phase 1

Development of a DCLT platform using ASR technology for a smart university. This phase involves creating a DCLT platform that utilizes ASR technology, specifically designed for a smart university environment. The platform's foundation draws from the characteristics of a smart university, the practices of distributed enterprise, and CLT. The methodology involves analyzing and synthesizing research articles obtained from the international research database, covering the years 2018 to 2022. This comprehensive process unfolds in these four key steps:

1. Synthesizing the characteristics of a smart university
2. Synthesizing processes for distributed enterprise
3. Synthesizing processes for CLT
4. Developing the DCLT process:
   a) In-depth study, analysis, and synthesis of concepts, research, and literature pertaining to the intricacies, components, and nuances of smart university characteristics, distributed enterprise processes, and communicative language training.
   b) Crafting a preliminary draft version of the DCLT process, leveraging the potential of ASR to enhance the smart university experience.

3.2 Phase 2

Designing the system architecture of a DCLT platform that utilizes ASR technology for smart universities. In this phase, the focus shifts to designing the system architecture for the DCLT platform, leveraging the capabilities of ASR technology within the context of a smart university. To accomplish this, the researcher chose the software development life cycle (SDLC) process as the guiding framework for system architecture design. The SDLC process, renowned for its systematic and structured approach, serves as the backbone for developing software solutions. The stages of the process include planning, design, implementation, testing, deployment, and maintenance. In the context of this research, the SDLC process is instrumental in shaping a coherent and efficient system architecture that aligns with the specific requirements of the DCLT platform.

3.3 Phase 3

Assessing the suitability of the DCLT process and system architecture. In this phase, the goal is to assess the suitability of both the DCLT process and the system architecture of the DCLT platform, which includes ASR technology, in the context of a smart university. To conduct this evaluation, a panel of nine experts has been convened. Each expert brings to the table over five years of extensive experience in various domains, including system architecture, distributed enterprise, language teaching, and ASR. To quantify the assessment outcomes and obtain meaningful insights, statistical measures will be used. Specifically, the standard deviation (SD). Average values will be calculated and examined. This evaluation is guided by the collective expertise of the panel members, ensuring a comprehensive and multidimensional analysis.

4 RESULTS

4.1 The characteristic of smart university

The characteristics of a smart university consist of five key elements, as follows: 1) Smart people [23–27] focus on developing personnel and students to acquire knowledge and apply technology for economic and personal benefits. This includes fostering creativity, informal learning, and promoting coexistence with social diversity. Smart people have three components: students, academic staff, and management teams. 2) Smart learning [28–32] refers to the institution's learning management system. A student-centered education that takes into account the diverse types and abilities of each learner can utilize all available learning methods, including learning from various smart communication technology devices. Smart learning consists of two components: the classroom and the curriculum. 3) Smart environments [33–37] focus on quality improvement, increasing management efficiency, and effectiveness monitoring to systematically manage the environment. This includes water management and climate disaster monitoring, as well as increasing public participation in natural resource conservation. Smart environments consist of two components: sustainable development goals (SDGs) and buildings. 4) Smart technology [38–42] refers to the use of modern technology that enables devices or systems to be smart. The system can think for itself. Educational institutions have appropriately utilized technology to facilitate and provide benefits to staff and students. Smart technology consists of three components: the Internet of Things, artificial intelligence, big data, and 5) Smart security [43–47] is an intelligent system that enhances security in life and property, increases flexibility at work, and improves the university's image. It includes monitoring the behavior of students and staff and consists of three elements: security technologies, cyber security, and disaster prevention, as shown in Figure 1.

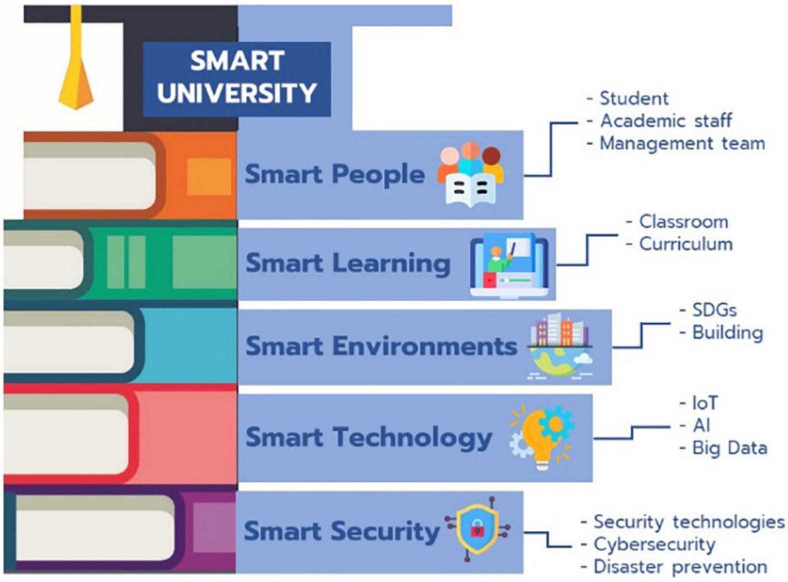

Fig. 1. The characteristics of a smart university

4.2 The DCLT process

The synthesis of documents and research related to the DCLT process involves:

The compositions of distributed enterprise. A distributed enterprise consists of four components: 1) Distributed business [48–52] is the organization's main strategy, which takes into account the goals, vision, mission, and business operations of each campus. It consists of two sub-components: (1.1) strategy and (1.2) business process. 2) Distributed application [53–56] is an information system within the organization that supports the university's strategy by connecting the work processes and information of all campuses. It consists of three sub-components: (2.1) business applications, (2.2) supporting applications, and (2.3) application programming interfaces. 3) Distributed information [57–61] is the management of all data from organizational processes on every campus. It consists of two sub-components: (3.1) relational information and (3.2) non-relational information. 4) Distributed technology [62–66] is related to the infrastructure (hardware, software, network, and security infrastructure) that covers all campuses. It consists of three sub-components: (4.1) infrastructure, (4.2) facilities, and (4.3) governance.

The communicative language teaching process. A communicative language teaching process consists of three steps: [67–71] 1) Presentation: The instructor will present new content, focusing on helping learners understand the meaning and style of language that is commonly used. Including the use of language in terms of pronunciation, meaning, vocabulary, and grammatical structures that are suitable for various situations simultaneously; 2) Practice is aimed at training learners to be accurate in the form of language so that they can use it effectively in future communication. After learners become familiar with the language structure and means of communication during the presentation stage, the next step should be focused on meaningful drills. This is because learners need to use language to convey meaning in various ways. 3) Production is the practice of using language for communication. It is similar to transferring language learning from classroom situations to real-life situations. Communication language practice aims to enable learners to use the language in simulated or real-life situations independently.

The DCLT. The DCLT process consists of three main processes: 1) Distributed presentation, which consists of two stages: (1.1) Motivation, which is the process of deliberately stimulating learners with stimuli to encourage them to act or strive towards achieving specific learning objectives; and (1.2) Teaching objectives, which describe the attributes, knowledge, and skills that the instructor expects the learner to acquire after completing the learning process. In a particular subject, the learner can recognize and understand the subject to be learned. 2) Distributed practice consists of three stages: (2.1) Mechanical practice, which involves subject-based exercises defined in various ways, such as multiple substitution drill, transformation drill, yes/no question-answer drill, sentence building, rub out and remember, ordering dialogues, predicting dialogue, completing sentences, and split dictation. It also includes speaking according to a given situation or narrating a picture or situation and then painting a picture as it is spoken. (2.2) Meaningful practice is a more semantic-oriented, subject-based practice. This practice has several characteristics. Firstly, it involves creating comparative sentences using images. Secondly, it involves forming sentences based on a given image. Thirdly, it involves speaking about different situations. (2.3) Communicative practice is a practice that focuses on communication and allows learners to create imaginative answers. This includes speaking sentences based on real-life situations, speaking according to a given situation, or describing a picture or situation and then illustrating it. 3) Distributed production consists of two stages: (3.1) Individual speaking practices create situations where learners can practice using language on their own and exchange information. The conversations that occur through these activities cannot be predicted. (3.2) Error correction, which helps to identify deficiencies in learners' communication and improves their skills, as shown in Figure 2.

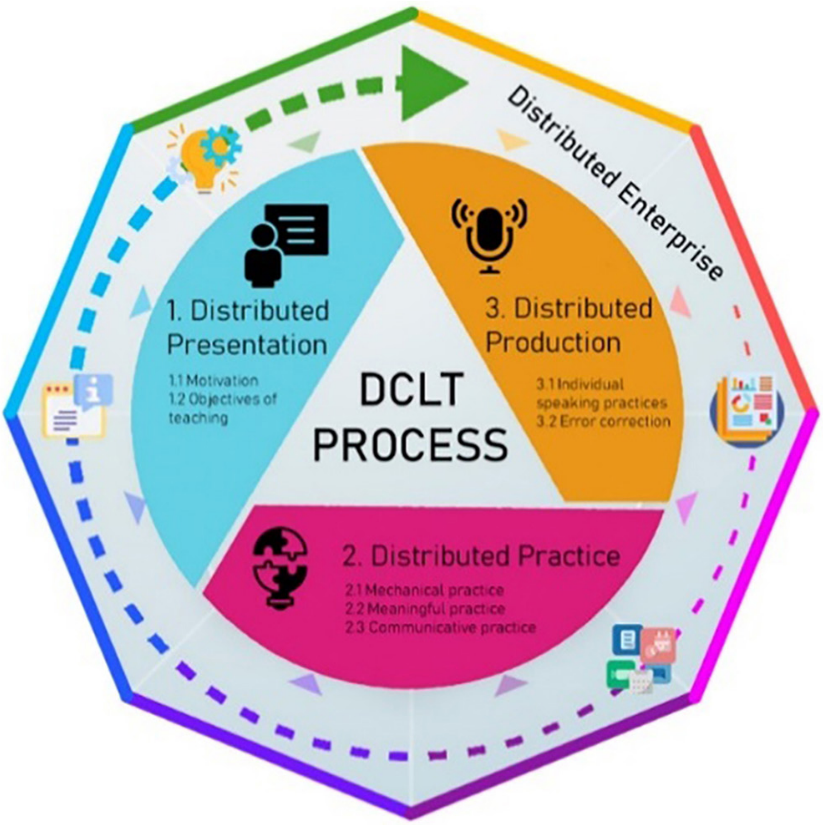

Fig. 2. The DCLT process

4.3 The system architecture of the DCLT using ASR technology for smart university

In this section, we present the system architecture design of a DCLT platform that utilizes ASR technology for smart universities, as shown in Figure 3.

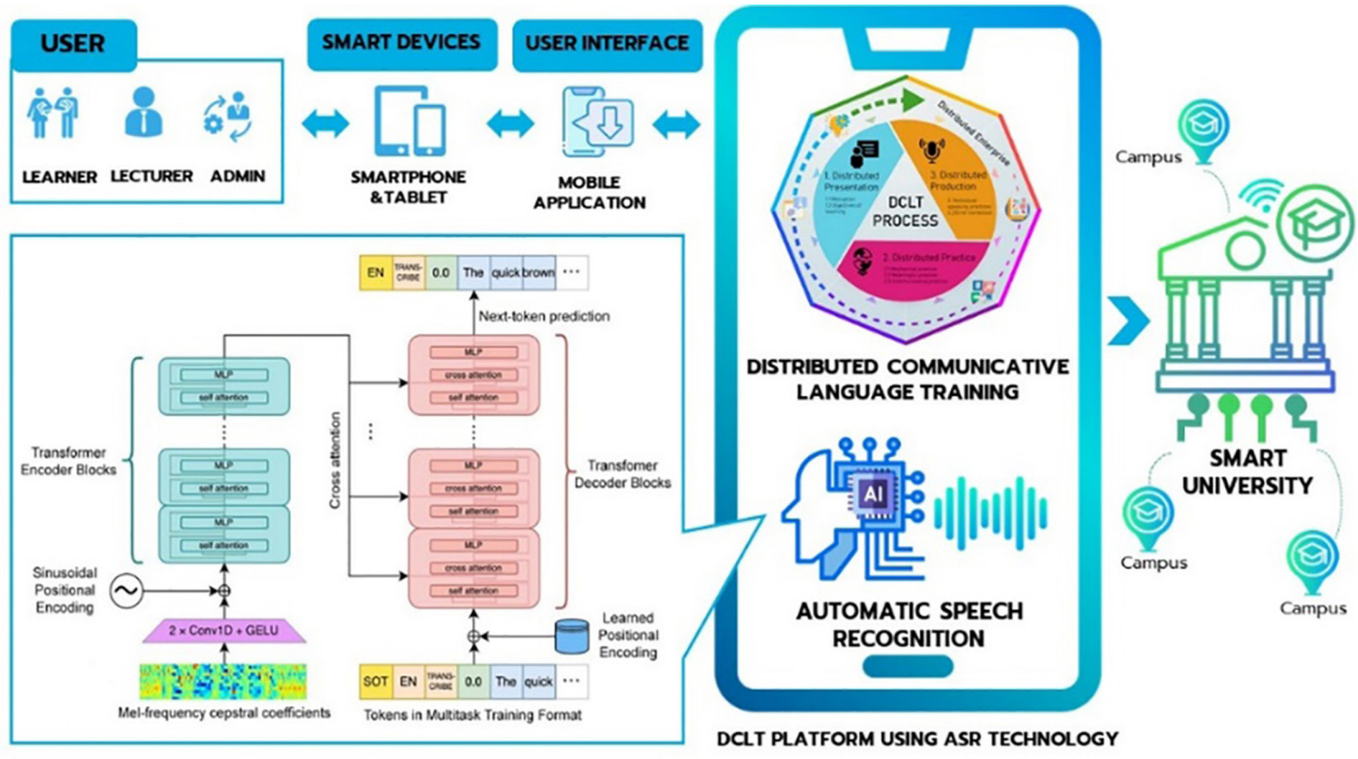

Fig. 3. The system architecture of the DCLT platform using ASR technology for smart university

Figure 3 represents the system architecture of the DCLT platform that utilizes ASR technology for smart university. The researchers designed and developed the concept, which comprised six main components. The details are as follows:

1. A user is a group of individuals who have been granted access rights to information within the system. Each group has different privileges based on the user's responsibilities and attributes. There are three distinct user groups: (1.1) learners who are individuals interested in improving their foreign language skills through learning; (1.2) lecturers, who determine the content for teaching foreign languages on the platform; and (1.3) administrators, who oversee the platform, coordinate with users, and strive to enhance its efficiency.
2. A smart device is a device connected to a platform, consisting of (2.1) a smartphone, that is used to access information and services through a user interface on an application. It is more convenient and faster than a computer because it is portable and can be used anywhere, anytime, via the Internet. (2.2) A tablet is a device that system users use to access information and services through an interface using an application. It has the same characteristics as a smartphone.
3. The user Interface connects platform users with the device to facilitate interaction with the program. The platform is developed as a mobile application for smart devices, including smartphones and tablets.

4. The DCLT process consists of three main processes: (1) A distributed presentation consists of two stages: (1.1) Motivation is the process by which learners are deliberately stimulated by stimuli to act or struggle to achieve concentrated learning objectives. (1.2) Objectives of teaching describe the attributes, learning, and abilities that the instructor expects the learner to experience after learning management. In a particular subject, learners can recognize and understand the material they need to learn; (2) Distributed practice consists of three stages: (2.1) Mechanical practice, which involves subject-based exercise such as multiple substitution drills, transformation drills, yes/no question-answer drills, sentence building, rub-out-and-remember, ordering dialogues, predicting dialogue, completing sentences, and split dictation. In this stage, learners speak according to a given situation or narrate a picture or situation and then paint a picture as it is described. (2.2) Meaningful practice, on the other hand, focuses more on the semantic aspects of subject-based practice. This practice has several characteristics. Firstly, it involves creating comparative sentences using images. Secondly, it involves forming sentences based on a given image. Lastly, it involves speaking about different situations. (2.3) Communicative practice focuses on communication and allows learners to come up with imaginative answers. For example, learners can speak sentences based on real-life situations, speak according to a given situation, or describe a picture or a situation, and then illustrate it. (3) Distributed production consists of two stages: (3.1) The first stage involves individual speaking practices where learners can practice using language on their own. Learners exchange information and engage in activities that cannot predict the conversations that will occur through activities. (3.2) The second stage involves error correction, which helps identify deficiencies in learners' communication and improves their communication skills.
5. Automatic speech recognition is a process that enables a system to learn by inputting audio signals into a neural network. This allows the system to make precise decisions and generate results based on various sound signals. The transformer model process is divided into two parts: the encoder and the decoder. The encoder receives an input sequence and analyzes it using the Mel-frequency cepstral coefficient (MFCC), which is a widely used feature in speech signal analysis. It then uses a convolutional neural network to identify audio signals. Because this section focuses solely on self-attention, it results in the loss of location information. The encoder utilizes a transformer architecture, wherein each block of the encoder comprises two main layers. The first layer incorporates self-attention, which captures the relationships between words in the text. The subsequent layer is a multi-layer perceptron (MLP) commonly employed to assist in determining priorities by working with educated guesses. On the right side is a decoder that receives an output sequence. Each block has three large layers. The lower layer and the upper layer are the same as on the encoder side, while the middle layer is cross-attention. The output from the last block of the encoder is sent to the middle layer of each block, while the output from the last block of the decoder is generated as the final output of the platform. In this training process, the output sequence is shifted to the correct position, which involves the teacher forcing the training process by combining the correct output (label) and the model's output (prediction) in a specific proportion.
6. Smart university is the implementation of educational activities in an intelligent environment, supported by smart technology, to create a better academic environment for teachers and students. Services are available on mobile applications

and web applications. There is a technological infrastructure in place to support and sustain the work. As part of their operations, smart universities will improve the lives of people on campus, including personnel, faculty, students, and stakeholders across all campuses.

4.4 The suitability of the DCLT platform using ASR technology for smart university

These are the assessment results of the DCLT platform that utilizes ASR technology for a smart university. The instruments included a suitable assessment form for evaluating the process of DCLT and the system architecture of the DCLT platform. All of these were carried out after being assessed by a team of nine experts. The results of the evaluations for each component can be summarized as follows:

1. The evaluation of the DCLT process is shown in Table 1.

Table 1. The suitability of the DCLT process

List of Evaluation	$\bar{x}$	S.D.	Interpretation
1. Distributed presentation	4.84	0.45	Highest
2. Distributed practice	4.82	0.55	Highest
3. Distributed production	4.85	0.38	Highest
Total	4.84	0.46	Highest

According to Table 1, the overall result of the evaluation of the DCLT process was highly suitable (mean = 4.84, S.D. = 0.46). Considering each item, most items were highly suitable.

2. The evaluation of the system architecture of the DCLT platform using ASR technology for smart universities is shown in Table 2.

Table 2. The systems architecture of the DCLT platform using ASR technology for smart university

List of Evaluation	$\bar{x}$	S.D.	Interpretation
1. User	4.73	0.60	Highest
2. Smart device	5.00	0.00	Highest
3. User Interface	5.00	0.00	Highest
4. DCLT Process	4.84	0.46	Highest
5. ASR	5.00	0.00	Highest
6. Smart university	4.60	0.57	Highest
Total	4.86	0.27	Highest

According to Table 2, the overall result of the evaluation is shown in Table 2. The system architecture of the DCLT platform, which utilizes ASR technology for smart universities, was highly suitable (mean = 4.86, S.D. = 0.27). Considering each item, most items were highly suitable.

5 CONCLUSION AND DISCUSSION

In conclusion, the evaluation of the DCLT process and the system architecture of the DCLT platform, enhanced by ASR technology for smart universities, yielded highly favorable results. The overall assessment of the DCLT process demonstrated a high level of appropriateness. Notably, upon closer examination of individual components, the majority of the items exhibited the highest level of suitability. Similarly, the evaluation of the system architecture of the DCLT platform demonstrated an exceptional level of suitability. A thorough analysis of individual components within the architecture confirmed that the majority of items reached the highest level of suitability. In summary, the research efforts focused on developing a DCLT platform, enhanced by ASR technology, for smart universities. These efforts resulted in the following key findings:

1. The DCLT process encompasses three principal phases: a) distributed presentation; b) distributed practice; and c) distributed production.
2. The system architecture of the DCLT platform comprises six primary components: a) user, b) smart device, c) user interface, d) DCLT process, e) ASR technology, and f) smart university.

The potential implications of adopting this platform for educational institutions or organizations are profound. It has the capacity to facilitate the establishment of intelligent universities that are closely aligned with the mission of leveraging technology for human progress. By fostering the development of individuals in both linguistic and technological domains, the platform holds the promise of elevating the nation's standing on the global stage. In essence, the research highlights the transformative potential of incorporating ASR technology into language training within the framework of a smart university. This symbiotic fusion of technology and education has far-reaching ramifications, not only for individual growth but also for the collective progress of the nation, ultimately leading to international recognition and acclaim.

6 ACKNOWLEDGMENT

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