**ARTICLE**

# A systematic review of technology-enhanced L2 listening development since 2000

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## Abstract

*Since 2000, technology-enhanced L2 listening development (TELD) has been increasingly investigated. However, systematic reviews concerning the technologies, learning tasks, and outcomes of TELD remain limited. To fill this gap, we conducted a systematic review of publications from 2000 to 2022 on TELD from the perspectives of technologies, learning tasks, and learning outcomes. Forty-six articles from Web of Science were screened by predefined criteria and analysed based on a step-by-step procedure using the PRISMA framework. The findings revealed 13 types of technology and 19 learning tasks useful for TELD. TELD was effective both in terms of building listening skills and enhancing learner emotions. The studies showed that TELD supported learner interactions, encouraged active engagement, and augmented various learning tasks. Based on the findings, we developed a TELD model consisting of two parts: "Within cognitive systems," in which learners deal with cognitive schemata, listening strategy application, and listening practice via solid attention; "outside of cognitive systems," in which TELD can construct and reconstruct cognitive schemata, support listening practices, encourage and guide listening strategy application, and improve learner emotions and attention by providing learning materials and activities based on listening-related knowledge, listening exercises with feedback, prompts and feedback on listening strategy application, and a sense of enjoyment and comfort.*

*Keywords: Foreign Language, Listening, Second Language, Technology-enhanced Language Learning*

***Language(s) Learned in This Study:*** *English*

## Introduction

The development of listening skills is a research topic frequently investigated in L2 education (Rost, 2013). Beyond understanding and acquiring auditory information from specific materials in specific settings, L2 learners seek to develop an understanding of general spoken L2 in general settings (Chen et al., 2012), which is essential for daily communication and the development of other L2 skills (Rost, 2005). However, developing L2 listening skills is widely perceived as very difficult, requiring rich input, construction and reconstruction of cognitive schemata, substantial attention control, and coordination of complex cognitive processes (Goh & Vandergrift, 2021; Vandergrift, 2011). The vital importance yet difficulty of acquiring listening fluency in a foreign language suggests there is a clear need to investigate effective tools and tasks to improve L2 listening.

To meet this need, researchers have been investigating technology-enhanced L2 listening development (hereinafter, TELD) since 2000 (Shadiev & Yang, 2020). Students have traditionally developed their L2 listening skills mainly by listening to their teachers, who are, in most cases, L2 speakers (Hsieh & Huang, 2020). However, using current digital technology, a vast amount of authentic listening materials in English

uttered by native speakers can be packaged into effective learning tasks allowing learners to perform these tasks at their own pace, leading to higher efficiency in L2 listening development than previous approaches that lacked digital affordances (Blake, 2016; Zhang & Shen, 2022).

Along with the growing empirical research on TELD, researchers have conducted reviews, syntheses, and meta-analyses in the area (e.g., Blake, 2016; Zhang & Shen, 2022); however, few, if any, of these studies have systematically focused specifically on technologies for TELD. Thus, a pointed review on TELD technologies has the potential to provide a comprehensive picture of the technologies useful for listening development, the results of which may help interested parties select appropriate technologies in their practices.

Additionally, studies have shown that certain tasks have different learning effects on L2 listening skill development (Rost, 2005, 2013), indicating that teachers must choose the appropriate task in TELD. Thus, again, a systematic review on TELD studies from the perspective of learning tasks may offer a comprehensive picture.

Further, few studies have systematically discussed the outcomes of TELD. Some researchers have promoted the overall positive results of TELD (e.g., Blake, 2016), while others have been less sanguine (e.g., Lim et al., 2022). Because such conflicting results may have resulted in researchers' and practitioners' confusion and hesitation in implementing this learning approach, a review of the empirical studies on TELD appears useful for illustrating the outcomes of previous TELD studies.

Accordingly, we systematically reviewed empirical studies on TELD from 2000 until 2022, focusing on digital technology, learning tasks, and learning outcomes. By undertaking this review, we aimed to: (a) identify the types of digital technologies and technology-enhanced learning tasks for L2 listening development; (b) analyse TELD outcomes; (c) develop a TELD model; and (d) provide implications for future research. Three questions guided this review:

- What digital technologies were used for L2 listening development?
- What learning tasks were applied in TELD?
- What were the outcomes of TELD?

## Literature Review

### L2 Listening

L2 listening encompasses complex cognitive processes, including: (a) word segmentation, which is breaking sound streams into meaningful units; (b) word recognition, which refers to retrieving and selecting lexical items from working memory based on speech signals; (c) syntactic parsing, which is the mapping of meaningful units onto a grammatical model to reconstruct spoken language; and (d) comprehension and inference, which refers to extracting explicit and inexplicit information from spoken language based on cognitive schemata and discourse analysis (Goh & Vandergrift, 2021). Researchers have proposed many theories and models to explain the cognitive systems involved in L2 listening. For example, Anderson (1985) divided the listening process into three phases. First, listeners hold L2 sound streams in their working memory. Second, listeners conduct word segmentation, word recognition, syntactic parsing, comprehension, and inference. Finally, listeners reconstruct cognitive schemata, predict the unuttered information, and make responses. Despite their differences, various models agree that the cognitive processes of L2 listening mainly occur simultaneously, intertwiningly, and collaboratively in a back-and-forth manner. Vandergrift (2007) proposed bottom-up and top-down listening processing. Bottom-up processing begins with word segmentation and recognition, followed by syntactic parsing, comprehension, and inference; top-down processing begins with comprehension and inference, followed by syntactic parsing, word segmentation, and recognition.

Acquiring good listening skills is essential for having a full range of L2 development, which includes internalising and applying knowledge and rules of the target language (Tsou et al., 2006). Researchers have

identified various learning tasks conducive to L2 listening development. For example, Rost (2005, 2013) described tasks focusing on different parts and processes in L2 listening. Some tasks focus on the construction and reconstruction of cognitive schemata related to group discussions, reflections on the listening process, pre-listening recalling of prior knowledge, and predictions of listening content. Others focus on developing the ability to recognise and segment words, such as transcript analysis (i.e., learners analyse the syntactic structures of transcripts). Yet others focus on enlarging listeners' working memory, such as shadowing (i.e., learners vocalise the spoken language they are currently listening to), non-reciprocal exercises (i.e., learners select information from the listening content and use it for specific goals), and note-taking (i.e., learners write down key information). Some researchers have noted the usefulness of listening strategies, arguing for developing L2 listening by receiving systematic instruction on listening strategies (Blake, 2016; Dalman & Plonsky, 2022). Instruction on language knowledge, especially vocabulary, is also essential in listening development since sufficient word knowledge is necessary to understand spoken language (Zhang & Shen, 2022).

Not all listening developmental tasks are effective, however, perhaps because of the lack of immediate feedback. Without immediate feedback, learners may have no idea when they made a mistake and are likely to repeat it in the future (Siegel, 2011). Moreover, learners tend to feel frustrated and anxious when performing listening developmental tasks (Vandergrift, 2011). Considering the influence of learners' affective states on learning efficiency (Dewaele, 2015), learners' negative emotions may reduce the effectiveness of L2 listening development. Blake (2016) also argued that TELD might be ineffective if the learning materials were too difficult for target learners.

## Previous Reviews, Syntheses, and Meta-analyses Related to TELD

Recent decades have witnessed an increase in empirical studies conducted on TELD (Zhang & Shen, 2022), with reviews, syntheses, and meta-analyses related to TELD growing at the same pace. Some of these have focused on the current and future research streams in TELD. For example, Zhang and Shen (2022) conducted a systematic review of 47 studies on L2 listening published in *System*, a well-recognised journal in the field of technology-enhanced language learning. They found that most of the covered articles used quantitative methods, and researchers from mainland China contributed the most articles. The main research streams concerned L2 listening performance are vocabulary knowledge, listening processing abilities, and assessment. The authors provided directions for future research on L2 listening concerning languages other than English, technological innovations to develop L2 listening skills, young learners' L2 listening development, positive psychologies in L2 listening, and the development of instructional strategies.

Researchers have reviewed TELD under the umbrella of technology-enhanced L2 education. For example, Levy (2009) conducted a synthesis study on the technology-enhanced development of different L2 skills, identifying annotating software and podcasting blogs as useful tools for developing listening. He argued that digital technology could prompt L2 listening development by providing language instruction, supporting listening strategy application, facilitating word segmentation, creating interactional context, and supporting information searches. Blake (2016), who also conducted a synthesis study on technology-enhanced development of L2 skills, argued that digital means could be effective for developing L2 listening by packaging authentic listening materials into highly-accessible learning tasks appropriate for target learners. Useful technologies for TELD were annotating software, electronic dictionaries, and mobile devices. Helpful tasks for TELD included pre-listening knowledge recall and systemic instruction on listening strategies. Macaro et al. (2012) systematically reviewed 47 studies on computer-assisted L2 learning, identifying various technologies for developing L2 listening, including laptops, electronic dictionaries, email, digital games, augmented reality, automated speech recognition, and e-books. They concluded that TELD teaching did not always enhance L2 listening. Golonka et al. (2014), who reviewed over 350 studies on technology-enhanced L2 education, found that personal digital assistants were effectively used for listening development. Shadiev and Yang (2020) in a review of 398 studies on technology-enhanced language learning identified the use and usefulness of games and e-books in L2 listening education. Most recently, Zhang and Zou (2022a) reviewed 57 studies on technology-enhanced

L2 education, identifying the application and overall usefulness of collaborative e-learning systems, augmented reality, mobile apps, computing platforms, and digital storytelling systems in developing L2 listening.

Some researchers have reviewed TELD focusing on the use and usefulness of specific technologies in L2 listening development. For example, Hwang and Fu (2019) reviewed 94 studies on mobile-assisted language learning, identifying inclusive results concerning the effectiveness of mobile technology in developing L2 listening. They concluded that mobile-assisted development of L2 listening might be ineffective when the experimental periods were short and listening practice was insufficient. Sung et al. (2015) conducted a meta-analysis of 44 studies on mobile-assisted learning of different L2 skills, noting the insufficient use of this learning approach in listening development. Moreover, they observed that empirical evidence for the effectiveness of mobile learning appeared especially lacking in listening development. Most recently, Lim et al. (2022) systematically reviewed 71 studies on the application of digital storytelling in language learning, finding that this technology was seldom used for enhancing listening proficiency; however, digital storytelling demonstrated great promise in this direction.

## Method

Our review was conducted based on the standard three-step method: identification, screening, and data analysis. We conducted our search of articles on August 10th 2022 in the Web of Science Core Collection, using "English" for the language and "article" for the document type. The time span was "from 2000-01-01 to the present" because digital affordances have been increasingly applied in L2 education since 2000 (Shadiev & Yang, 2020). Four groups of keywords adapted from Chen et al. (2021), Hwang and Fu (2019), and Zhang and Zou (2021a, 2021b) were used with AND operators between them (see Appendix). Following many previous reviews in the field of technology-enhanced language learning (e.g., Zhang & Zou, 2022c; Zhang et al., 2022), the search was conducted on articles indexed by the Social Sciences Citation Index (SSCI), Sciences Citation Index (SCI), and the Sciences Citation Index Expanded (SCI-E), as SSCI/SCI/SCI-E publications are usually rigorously peer-reviewed using stringent criteria with a high impact (Duman et al., 2015).

We identified 472 articles from the search, from which we selected articles based on seven screening criteria (see Table 1). We then screened the articles by title and abstract and immediately excluded 79 articles not relevant to L2 listening development plus three articles without full texts available online. The remaining 390 articles were then assessed by reading the main texts. As a first step, we excluded 281 articles that did not report empirical studies on TELD. Then further 55 articles that focused on the acquisition of auditory information from specific materials in specific settings were eliminated because our review is confined to general listening skills. Seven more articles that provided no explicit description of the implementation processes and outcomes of TELD were also screened out. Finally, we removed one more article that focused on learners with special needs because there were considerable differences between the education for this type of student and that of the general population of students (Scott & Windsor, 2000). Thus, the screening ended with 46 articles which included 48 individual studies (see References marked by asterisks). Figure 1 illustrates the process of article identification and screening, using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram (http://prisma-statement.org/prismastatement/flowdiagram.aspx).

Table 1

*Inclusion and Exclusion Criteria for Article Selection*

|  | **Inclusion criteria** | **Exclusion criteria** |
|---|---|---|
| Screening by titles and abstracts | • Related to L2 listening development | • Having no full text available online |
| Screening by main texts | • Reporting empirical study on TELD<br>• Providing explicit details of the implementation processes and outcomes of TELD | • Focusing on the acquisition of auditory information from specific materials in specific settings only<br>• Focusing on students with special needs |

We analysed the 46 articles reporting 48 studies deductively based on three codes corresponding to the RQs (see Table 2). First, "Technologies for L2 listening development" concerned e-learning tools and systems, digital devices, and digital tools for developing L2 listening. The sub-codes were developed from Golonka et al.'s (2014) and Shadiev and Yang's (2020) categorisation of modern technology for L2 learning, including games, robots, e-books, chats, etc. We coded this category mainly by reading two sections of the reviewed articles, the literature reviews and methods, focusing on the types, features, and affordances of digital technology for developing L2 listening. The second code was "Learning tasks for TELD," which concerned the learners' activities for developing L2 listening skills via digital means. The sub-codes were developed from Rost's (2005, 2013) list of tasks for L2 listening development, including shadowing, transcript analysis, note-taking, etc. This category was coded based on our reading of the literature reviews and methods sections of the 46 articles, focusing on the study plans and learner duties in TELD. The third code was *"*Outcomes of TELD," which concerned the effects of TELD on learners' academic performance and affective state. Following Zhang and Zou (2021a, 2021b), the sub-codes were classified into positive, neutral, negative, and mixed effects. We coded this category by reading the results and discussion sections, focusing on the outcomes of TELD and the reasons for the outcomes.

**Table 2**

*Coding Approach*

| **Codes** | **Sub-codes** | **Sections** |
|---|---|---|
| Technologies for L2 listening development | Games, robots, e-books, chats, etc. (Golonka et al., 2014; Shadiev & Yang, 2020) | Literature review; Method |
| Learning tasks for TELD | Shadowing, non-reciprocal exercises, transcript analysis, note-taking, etc. (Rost, 2005) | Literature review; Method |
| Outcomes of TELD | Positive, neutral, negative, and mixed effects (Zhang & Zou, 2021a, 2021b) | Results; Discussions |

We first analysed five studies together until we agreed on their understanding and coding methods of the papers. We then independently analysed the remaining articles. The coding results were compared and had satisfactory inter-rater reliability (Pearson's $r$ = 0.90), with the remaining differences resolved via discussion.

Figure 1

*Process and Methods of Article Identification and Screening*
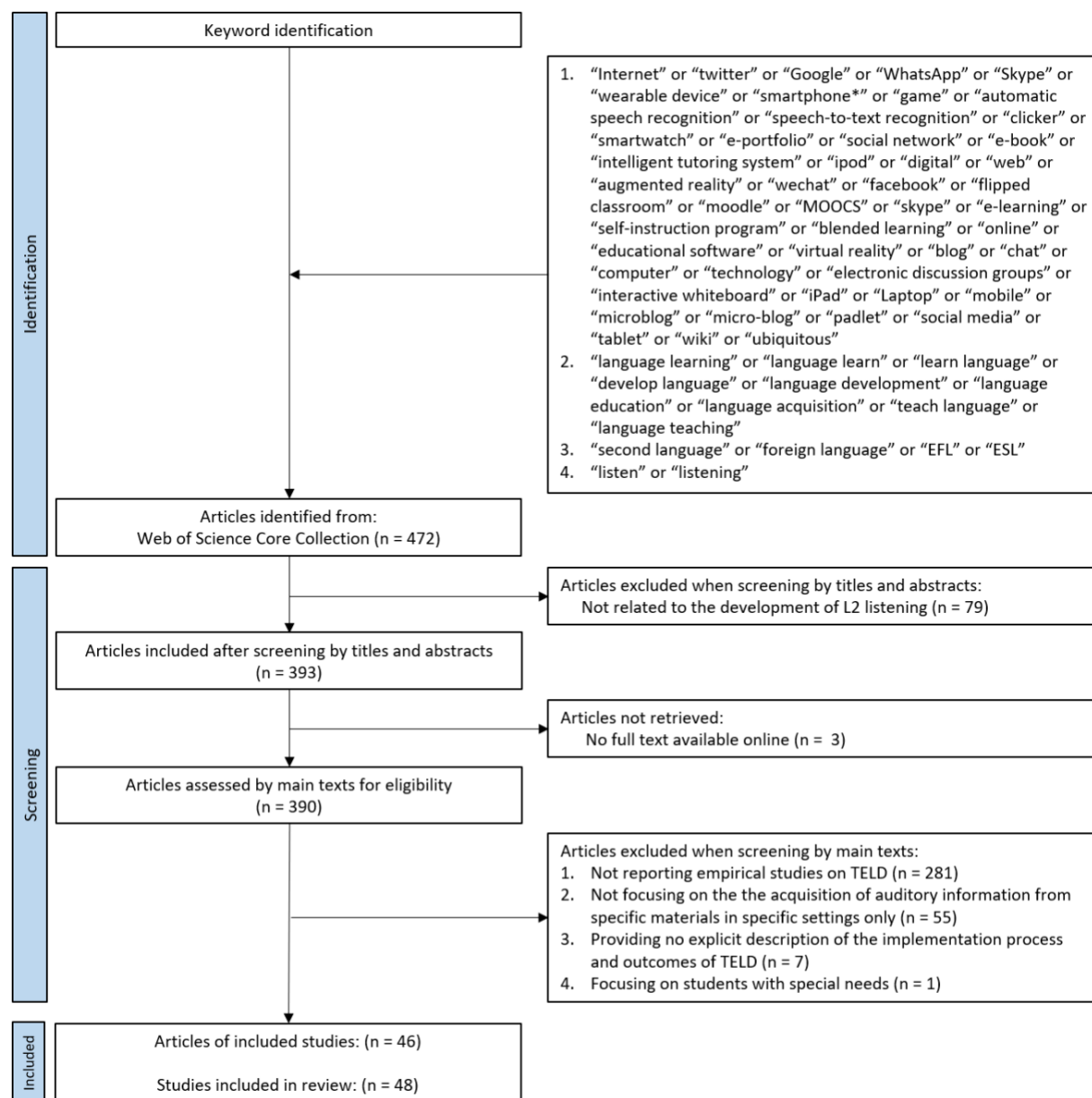


## Results

### Digital Technologies for L2 Listening Development

To answer RQ1, we identified diverse technologies used for listening development (see Figure 2). E-learning tools and systems were applied most frequently, consisting of course management systems (Li & Peng, 2022), intelligent tutoring systems (Chen et al., 2014), clickers (Pérez-Segura et al., 2022), Compact Discs (CDs) (Hamada, 2016), interactive boards (Pérez-Segura et al., 2022), and e-books (Hsieh & Huang, 2020). Educational technologies used for listening development included chats (Jia & Hew, 2022), websites and digital resources (Cross, 2009), games (Hsieh & Huang, 2020), and social networks (Read et al., 2021).

Digital devices used for listening development consisted of personal digital assistants (three studies), Nintendo DS Lite (Kondo et al., 2012), digital pens (Tan et al., 2020), and cell phones or smartphones (Cowie, 2018). The sum is larger than 48 because some studies applied more than one type of digital technology.

**Figure 2**

*Number of Studies Investigating Different Types of Digital Technology for L2 Listening Development*
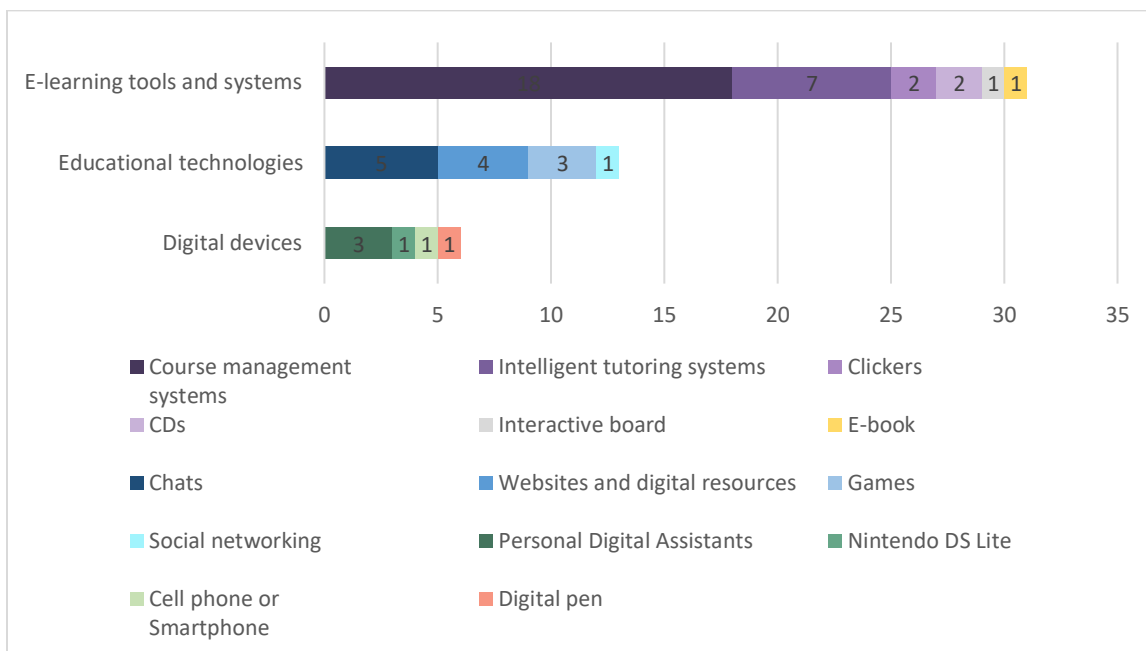


We identified five main affordances among the 13 types of tools and software for listening development. First, multimedia materials were delivered digitally, such as course management systems (Li & Peng, 2022), e-books (Hsieh & Huang, 2020), CDs (Hamada, 2016), intelligent tutoring systems (Chen et al., 2014), digital pen-based systems (Tan et al., 2020), Nintendo DS Lite (Kondo et al., 2012), and games (Hwang et al., 2017). The content was delivered via vlogs (Aldukhayel, 2021), stories (Cavus & Ibrahim, 2017), movies (Yenkimaleki et al., 2021), songs (Alvarez-Marinelli et al., 2016), news (Cross, 2009), reading materials (Bozorgian & Shamsi, 2022), pictures (Matthews & O'Toole, 2015), word lists (Matthews & O'Toole, 2015), flashcards (Hwang et al., 2017), and speech transcripts (Hwang et al., 2014). By delivering multimedia materials, digital affordances provided learners with listening-related knowledge to construct their cognitive schemata. For example, in Matthews et al. (2015), a course management program provided learners with word lists that helped them develop word knowledge to complete listening exercises efficiently based on newly learned words. Digital technology also facilitated the regulation and adaptation of multimedia materials to meet different needs in various learning tasks, which enhanced the task effectiveness in developing cognitive processes of L2 listening. For example, Tan et al. (2020) designed a digital-pen-based program that showed speech transcripts sentence by sentence. This affordance-supported transcript analysis enabled learners to carefully examine sentence structures and word boundaries of spoken language, thereby developing their word segmentation ability.

Second, exercises and feedback were provided through digital affordances, such as course management systems (Matthews & O'Toole, 2015), games (Hwang et al., 2017), personal digital assistants (Hwang et al., 2014), Nintendo DS Lite (Kondo et al., 2012), digital pen-based systems (Tan et al., 2020), and website and digital resources (Aldukhayel, 2021), while content included exercises, such as multiple-choice questions (Nah, 2011), matching (Hwang et al., 2014), and fill-in-the-blanks (Li & Peng, 2022). Students could speak out (Hwang et al., 2014) and select/write/type down (Kondo et al., 2012) their answers. Such

exercises helped learners develop language knowledge of and skills in managing cognitive processes of L2 listening. For example, Matthews and O'Toole (2015), who conducted dictation exercises using a course management system, found that the exercises helped learners develop vocabulary knowledge and top-down processing skills. Digital technology also facilitated feedback on learners' academic performance and strategy application in exercises, leading to students' strategy application and knowledge consolidation. For example, Tan et al.'s (2020) digital-pen-based program required students to complete listening exercises with scores provided automatically, which significantly enhanced learners' strategy application. In another study, Kondo et al. (2012) required students to do listening exercises using Nintendo DS Lites which revealed learners' accuracy on each question and presented total scores. Based on the feedback, learners learned from their mistakes and consolidated their knowledge.

Third, learner interactions were expedited using digital tools. We found this affordance in course management systems (Nah, 2011), clickers and interactive boards (Pérez-Segura et al., 2022), personal digital assistants (Lin & Chu, 2010), intelligent tutoring systems (Hong et al., 2016), cell phones or smartphone (Cowie, 2018), social networking (Read et al., 2021), and chats (Jia & Hew, 2022). As for in-class interactions, digital affordances helped expedite teacher-student interactions by quickly delivering teacher support and collecting student responses, which enhanced learner engagement in listening development. For example, in Pérez-Segura et al.'s (2022) study, the instructor presented listening exercises using an interactive board and required their students to complete exercises using clickers. Teachers provided feedback based on students' answers collected through the clickers, which increased the efficiency of teacher-student interactions and learner engagement in the listening class. As for out-of-class interactions, several types and modes were made possible using online platforms: synchronous (Jia & Hew, 2022) or asynchronous (Liu & Chu, 2010) and anonymous or non-anonymous (Agbatogun, 2014) group chat, private chat, and resource sharing among peers (Tai & Chen, 2022), teachers (Jia & Hew, 2022) and native speakers (Kato et al., 2016), all of which encouraged learners to acquire new knowledge and skills from others. For example, Jia and Hew (2022) required students to discuss their experiences of listening exercises with classmates using WeChat, a chat tool. They found that learners developed vocabulary and pronunciation knowledge from their peers in the discussions.

Fourth, interactions with learners as interlocutors were facilitated through online tools, such as intelligent tutoring systems. For example, Tai and Chen (2022) required their students to practice listening by interacting with Google Assistant using oral L2. This technology chatted and played games with learners, provided recommendations, and asked and answered questions. With this affordance, learners could practice their listening in real-time without social stress, improving their motivation (Dizon, 2020).

Fifth, gaming elements were integrated into listening instruction, such as storylines, incentives, and virtual scenes. For example, Hwang et al. (2017) designed a digital game in which the students obtained virtual treasures by learning new words and doing exercises via virtual battles. In another study, Levak and Son (2017) applied a multi-player 3D game *Second Life*, in which their students performed task-based interactions with classmates in virtual scenes, such as ordering drinks in a virtual café. By introducing gaming elements, learner enjoyment and cognitive and emotional engagement enhanced listening development (Hwang et al., 2017).

In sum, our review identified the application of 13 digital means for L2 listening development. Their main affordances were delivering multimedia materials, providing exercises and feedback, expediting learner interactions, interacting with learners as interlocutors, and adding game elements into listening development.

## Learning Tasks for TELD

To address RQ2, we identified 19 learning tasks used for TELD (Figure 3): comprehension exercises were applied most frequently (40 studies), followed by instruction on language knowledge (17 studies), group discussion (10 studies), instruction on listening strategies (10 studies), summary and reflection (eight studies), transcript analysis (eight studies), non-reciprocal exercises (eight studies), human-computer

interactions (seven studies), pre-listening guiding questions and prediction making (six studies), speech recording and sharing (four studies), role-playing (three studies), notetaking (three studies), shadowing (three studies), pre-listening retrieval of prior knowledge (three studies), Q&A (two studies), dictation/transcribing (two studies), instruction on background knowledge (two studies), self-evaluation (two studies), and interactions with native speakers (Kato et al., 2016). The sum exceeds 48 because many studies applied more than one task.

We identified four main purposes of the 19 types of learning tasks for listening development. The first purpose was to develop listening-related knowledge. Six tasks were applied for this purpose: (a) instruction on language knowledge, which presented language knowledge, such as phonology (Yenkimaleki et al., 2021), vocabulary (Hamada, 2016) and grammar (Hsieh & Huang, 2020); (b) instruction on listening strategies, which presented knowledge of listening strategies, such as self-evaluation and the identification of sentence boundary pauses (Cross, 2009); (c) instruction on background knowledge, which developed learners' familiarity to the content of the speech (Cross, 2009); (d) Q&A, in which students developed knowledge by asking questions to teachers and receiving explanations and recommended answers (Agbatogun, 2014); (e) group discussion, in which students developed knowledge from discussions with peers (Nah, 2011); and (f) transcript analysis, which required learners to acquire knowledge by examining transcripts (Cowie, 2018).

The second purpose was to support listening practice in exercises. Learners engaged in technology-enhanced exercises individually (Hsu et al., 2021) or collaboratively (Cowie, 2018). Five tasks were applied for this purpose: (a) comprehension exercises, which required students to complete exercises based on their understanding of the content (Chang et al., 2019); (b) non-reciprocal exercises, which required students to select and use listening content for specific purposes, such as filling in blanks (Bozorgian & Shamsi, 2022), matching pictures (Cowie, 2018), identifying differences between pictures and the spoken language (Li & Peng, 2022), etc.; (c) shadowing, which required learners to vocalise the spoken content as it was being played (Hamada, 2016); (d) dictation/transcribing, which required students to transcribe (Jia & Hew, 2022); and (e) Note-taking, which required students to write down the key information they heard (Aldukhaye, 2021).

The third purpose was to enable listening practice in spoken interactions. Four tasks were used for this purpose: (a) role-playing, in which students acted as characters and interacted with each other in L2 scenarios (Levak & Son, 2017); (b) interactions with native speakers, in which students had L2-spoken interactions with native speakers (Kato et al., 2016); (c) speech recording and sharing, in which students recorded their own voice, shared it with peers, and listened to their peers (Hwang et al., 2014); and (d) human-computer interactions, in which students had L2 spoken interactions with computer programmes (Dizon, 2020).

The fourth purpose was to guide and encourage listening strategy application. There were four tasks for this purpose: (a) pre-listening guiding questions and prediction making, which triggered students to guess the spoken content before listening (Aldukhayel, 2021); (b) pre-listening knowledge recall, which enabled students to retrieve listening-related knowledge before listening (Bozorgian & Shamsi, 2022); (c) summary and reflection, which required students to summarise and reflect on their listening process (Read et al., 2021); and (d) self-evaluation, which required students to evaluate their listening performance (Bozorgian & Shamsi, 2022).

In short, this review identified 19 types of learning tasks for TELD. They had four main purposes: developing listening-related knowledge; enabling listening practice in exercises; enabling listening practice in spoken interactions; guiding and encouraging listening strategy application.

Figure 3

*Number of Studies Reporting Different Tasks for TELD*
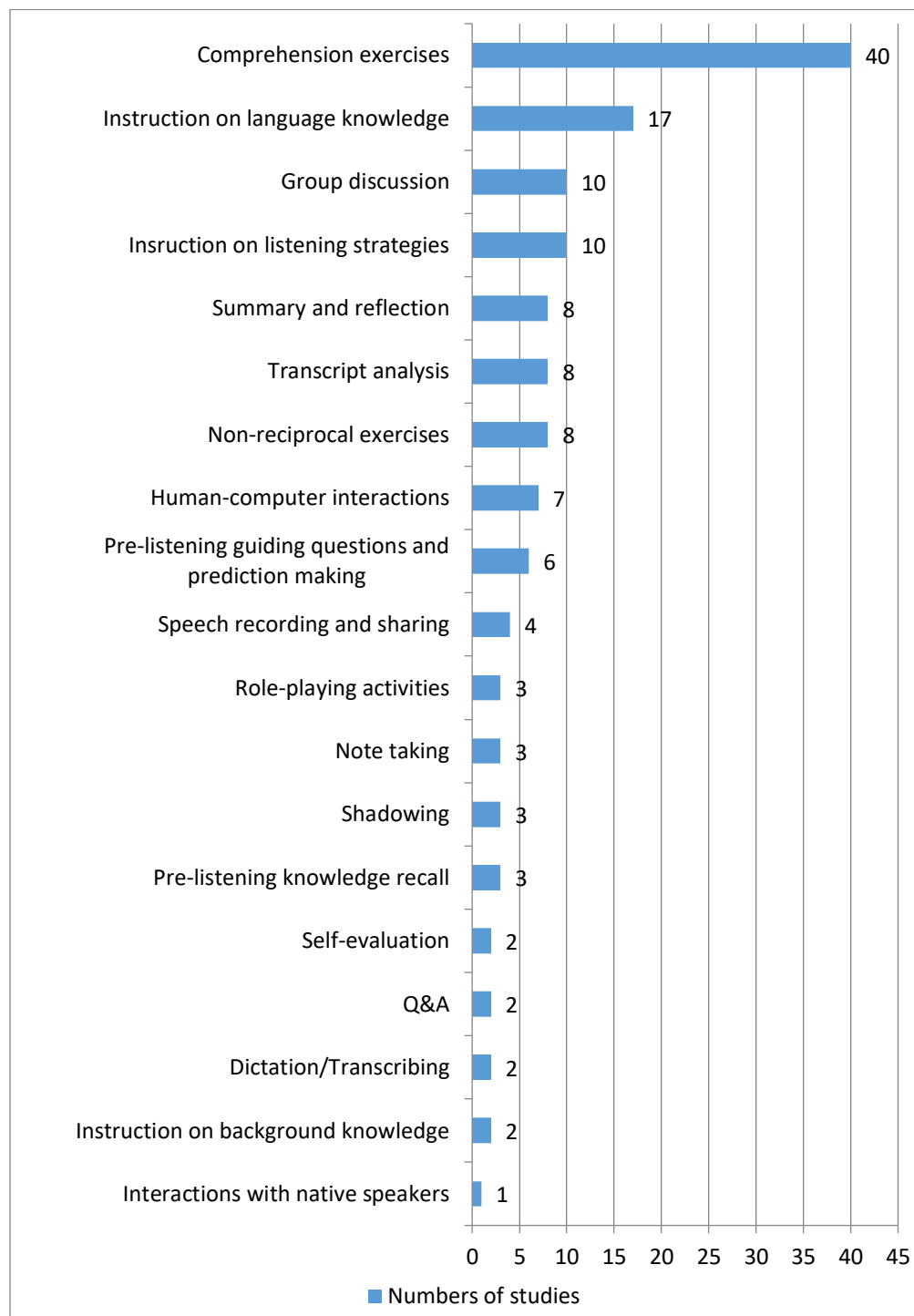
## Outcomes of TELD

To address RQ3, our review identified the overall positive outcomes of TELD (Figure 4). Among the 38 studies discussing academic outcomes, 28 studies reported significant positive results (74%), seven reported neutral results (18%), and three reported mixed results (8%). Among the 25 studies investigating the affective outcomes, 24 reported significant positive results (96%), and one reported a neutral result (4%).

**Figure 4**

*Number of Studies Reporting Different Outcomes of TELD*
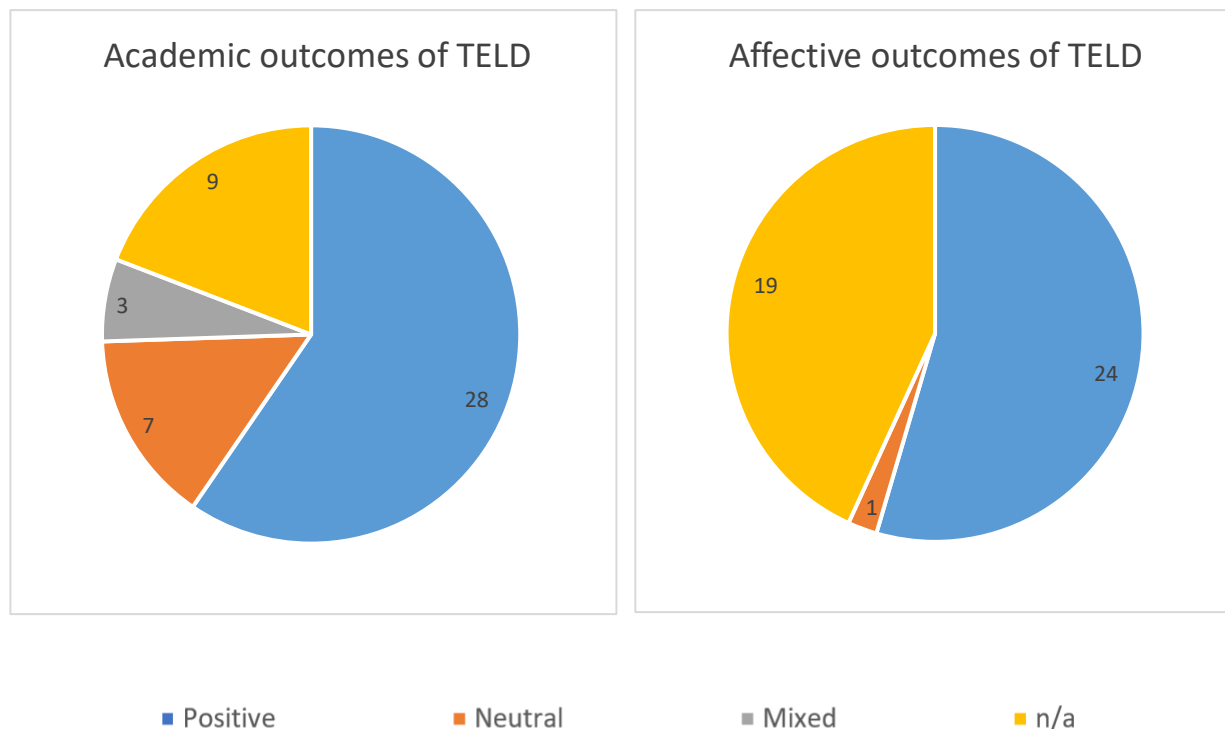


We identified the main reasons for and the main challenges regarding the effectiveness of TELD. The details are presented in the following two subsections.

### *Reasons for the Effectiveness of TELD*

We identified four main reasons for the effectiveness of TELD. First, it appeared to enhance learner emotions. TELD, in general, was enjoyable (Agbatogun, 2014) and comfortable (Chen et al., 2020) because it triggered a sense of novelty in students (Nah, 2011). Some digital affordances, such as games, were also inherently entertaining (Hwang et al., 2017). New tools reduced students' anxiety and embarrassment when listening (Tai & Chen, 2022) because they could remain anonymous (Agbatogun, 2014) and had human-computer interactions (Lee et al., 2011). Hence, students in TELD tended to feel relaxed (Hwang et al., 2014), confident (Bahari, 2019) and happy (Hong et al., 2016). These positive emotions motivated and engaged their listening development, leading to high learning efficiency (Pérez-Segura et al., 2022).

Second, TELD appeared to be effective in supporting learner interactions, by supporting diversified collaborative learning activities (Liu & Chu, 2010) and interactions with different partners (Jia & Hew, 2022). Regarding interactions, learners obtained new language input (Agbatogun, 2014), received feedback and suggestions on listening (Yenkimaleki et al., 2021), activated working memory and processed information in real-time (Tai & Chen, 2022), and practised listening strategies in meaningful situations (Kato et al., 2016). In these ways, interactions developed learners' cognitive schemata (Tai & Chen, 2022),

increased their ability to coordinate cognitive processes (Tai & Chen, 2022), and strengthened their cognitive connections between auditory forms and meanings (Hamada, 2016). The effectiveness of interactions may have been further increased through digital means, which can add a sense of authenticity and meaningfulness to the interactions by creating interactional contexts related to the spoken material that is close to learners' daily lives (Levak & Son, 2017). Technology-enhanced interactions also appeared to foster friendships among learners (Levak & Son, 2017), which increased learner self-efficacy (Zhao & Lee, 2022) and enhanced their motivation and engagement (Read et al., 2021).

Third, TELD effectively encouraged learners' active engagement. Digital affordances helped students' L2 listening development by allowing them to listen at their own paces (Kato et al., 2016) and select types and paces of learning tasks among various resources (Hsieh & Huang, 2020) based on individual preferences and proficiency levels (Aldukhayel, 2021). By providing prompts and feedback on strategy application, learners could devise study plans (Wu & Wang, 2021), reflect on listening processes (Wu & Wang, 2021), and assess their own difficulties in listening and address them using strategies (Tan et al., 2020). In this way, digital technology helped learners actively engage in their listening development with high levels of control (Kato et al., 2016), resulting in improved efficiency and positive emotions (Aldukhayel, 2021).

Fourth, TELD provided various approaches to listening practice. The review results showed that diversified approaches to listening practice in TELD were effective in developing various cognitive processes. For example, pre-listening predicting and reflection enhanced learners' comprehension and inferencing ability (Bozorgian & Shamsi, 2022); dictation/transcribing improved learners' word segmentation ability (Jia & Hew, 2022). Technology-enhanced tasks also helped learners switch between different L2 listening processes (Tan et al., 2020). Hence, TELD facilitated learners' development of cognitive systems and coordination of complex cognitive processes through various approaches to listening practice.

### *Challenges to the Effectiveness of TELD*

Our review identified three challenges to the effectiveness of TELD. The first concerned the unsatisfying quality and complex installation and operation of advanced technology. Students in the reviewed studies complained about the poor technical quality, such as the inaccuracy of the recognition system (Lee et al., 2011), the unnaturalness of machine-generated spoken language (Lee et al., 2011), and low processing speed (Levak & Son, 2017). These problems may have negatively influenced learner efficiency and affective states, impeding learning (Nah, 2011). In addition, new tools and platforms sometimes require complex installation and application, which can be difficult for students (Cross, 2009) and reduce learner engagement and even lead to students' refusal to use them (Read et al., 2021).

A second challenge concerned the learner' insufficient awareness and knowledge of listening strategies. Our review revealed that many students had no awareness of listening strategies (Dizon, 2020), let alone how to apply and modify them in interactional contexts (Chen et al., 2020). Some students were aware of the value of listening strategies but had no idea how to perform them (Cowie, 2018). The lack of awareness and knowledge of listening strategy application appeared to have resulted in learners' low efficiency in coordinating different cognitive processes in listening, leading to unsatisfying outcomes of TELD (Dizon, 2020).

The third challenge concerned the difficulty and complexity of learning tasks in TELD. Some exercises were far above the target learners' language proficiency levels: the exercises sometimes played too fast and did not allow speed regulation (Ramírez Verdugo & Alonso Belmonte, 2007); they sometimes included too many difficult words, collocations, and grammar (Aldukhayel, 2021). Some tasks had complex procedures and required deep thought, far beyond the target learners' working memory capacity (Cross, 2009). The difficulty and complexity of learning tasks might have caused cognitive overload (Cross, 2009) and attention splitting (Tai & Chen, 2022), negatively influencing learning outcomes.

In sum, TELD was effective overall because it enhanced learner emotions, facilitated learner interactions, encouraged active engagement, and supported various learning tasks. However, weaknesses included the unsatisfying quality and complex installation and operation of certain technologies, learners' insufficient

awareness and knowledge of listening strategies, and the difficulty and complexity of learning tasks.

## Discussion

Based on a bottom-up analysis of the review results, we developed a TELD model (see Figure 5) according to Winne and Hadwin's (1998) self-regulated learning model due to the shared foci between TELD and self-regulated learning. Our results show that in TELD, learners could select listening materials from rich resources based on their individual needs and preferences (e.g., in Hsieh & Huang, 2020). They could also actively engage in different learning tasks in TELD with high levels of control (e.g., Kato et al., 2016) and perform various self-regulated learning strategies (see Zhang & Zou, 2022b), such as reflecting on listening processes (e.g., Wu & Wang, 2021) and adjusting the content and pace of their listening practice (e.g., Bozorgian & Shamsi, 2022). We also identified several TELD programmes designed and implemented based on self-regulated learning theories and their overall effectiveness from affective and academic perspectives (e.g., Kondo et al., 2012; Read et al., 2021). Hence, developing TELD models based on a self-regulated learning model may be promising.

Figure 5

*A TELD Model*
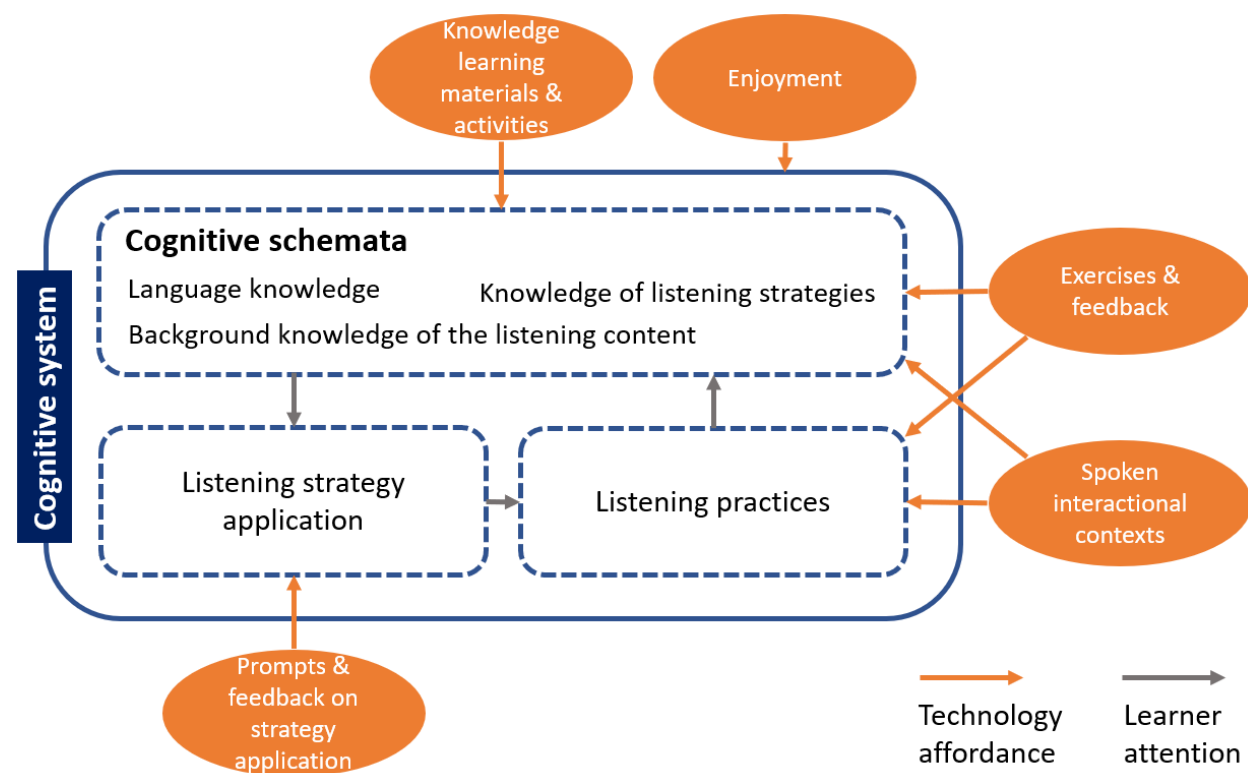


Our model consists of two parts: within and outside of learners' cognitive systems. The details are presented in the following two subsections.

### Within Cognitive Systems

Our study shows that in TELD, learners coordinate cognitive schemata, listening strategy application, and listening practice via attention within cognitive systems, which is basically aligned with Vandergrift's (2011) conceptualisation of L2 listening development. As for attention, we found that learners with positive emotions tended to pay more attention during TELD learning, and close attention led to high efficiency and

satisfactory outcomes (e.g., Hong et al., 2016; Pérez-Segura et al., 2022). This finding is in line with previous studies revealing the positive influence of learner emotions on engagement and efficiency in listening development (e.g., Zhang et al., 2021). Hence, it appears that TELD can be effective by improving learner emotions and attention.

As for cognitive schemata, our study showed that having knowledge of the language (Hamada, 2016), having some background of the listening content (Cross, 2009), and practicing listening strategies (Cross, 2009) helped to construct cognitive schemata for improving L2 listening. In TELD, learners practiced listening based on the knowledge retrieved from their schemata, so those with better-structured schemata were more likely to understand the spoken language well (Aldukhayel, 2021). This finding echoes previous studies that have highlighted the importance of knowledge in developing listening (e.g., Zhang & Shen, 2022). Hence, TELD may help students learn listening-related knowledge and develop their schemata.

As for listening strategy application, learners selected, used, and modified appropriate strategies for listening practices (e.g., Tai & Chen, 2022). Our results show that students frequently and skilfully applying listening strategies in TELD tended to have a clear idea of their limitations (e.g., Cowie, 2018) and efficiently cooperated cognitive processes of L2 listening (e.g., Tan et al., 2020), likely to obtain satisfactory learning outcomes. This finding is consistent with previous studies underscoring the importance of listening strategies (e.g., Blake, 2016; Dalman & Plonsky, 2022). Hence, TELD appears to effectively encourage and guide students to apply listening strategies frequently and skilfully.

As for listening practice, we found that learners developed various cognitive processes to listen using diverse technology-enhanced practices. For example, learners acquired new knowledge through interactions with native speakers, enhancing their cognitive schemata (e.g., Kato et al., 2016). They fostered awareness of phonetic modifications in natural spoken language through dictation/transcribing, thus developing word segmentation and recognition ability (e.g., Jia & Hew, 2022). This finding is in line with Rost's (2005, 2013) analyses of the effects of various listening tasks on different processes of L2 listening. Moreover, our study showed that learners could correct their mistakes and gain new knowledge from feedback, which reconstructed their cognitive schemata and helped them avoid mistake duplication (e.g., Matthews & O'Toole, 2015). This finding is consistent with Siegel's (2011) argument in favour of feedback during listening practice, which is a strength of TELD via its immediate and automated feedback.

## Outside of Cognitive Systems

Regarding outside of cognitive systems, TELD may influence learners' cognitive systems (i.e., attention, cognitive schemata, listening strategy application, and listening practice) in five ways. First, TELD may help learners construct cognitive schemata by providing knowledge-learning materials and activities. As shown in our review, digital means enhanced instructions and exercises on listening-related knowledge (e.g., Hwang et al., 2017) and transcript analysis (e.g., Cowie, 2018), and it expedited Q&A (e.g., in Agbatogun, 2014) and group discussion (e.g., Nah, 2011). In this way, TELD may develop and reinforce students' listening-related knowledge, construct their cognitive schemata, and improve their L2 listening (e.g., Tan et al., 2020).

Second, TELD may support listening practice and reconstruct cognitive schemata by providing feedback to exercises. The review findings showed that digital technology improved listening practice in diverse exercises, such as dictation/transcribing (e.g., Jia & Hew, 2022) and shadowing (e.g., Hamada, 2016). The diversified technology-enhanced exercises developed different cognitive processes of L2 listening, such as word segmentation and recognition (e.g., Jia & Hew, 2022) and comprehension and inference (e.g., Bozorgian & Shamsi, 2022). TELD also provided automatic feedback on learners' performance in listening exercises, such as scores in comprehension exercises (e.g., Kondo et al., 2012) and highlighted differences between transcripts and dictation/transcribing results (e.g., Matthews & O'Toole, 2015), which helped learners reconstruct their cognitive schemata and avoid duplicating errors (e.g., Matthews & O'Toole, 2015). However, technology-enhanced exercises were not always helpful. When they were very difficult or procedurally complex, the exercises could cause cognitive overload or a distraction, reducing their

effectiveness of TELD (e.g., Cross, 2009).

Third, TELD may support listening practice and reconstruct cognitive schemata by creating spoken interactional contexts. As shown in our review results, various digital tools supported collaborative learning tasks, such as story relay races (e.g., Liu & Chu, 2010), role-playing (e.g., Levak & Son, 2017), and interactions with different interlocutors, such as native speakers (e.g., Kato et al., 2016) and computers (e.g., Tai & Chen, 2022), thereby providing learners with rich spoken interactional contexts. This result is in line with connectivism, which emphasises the affordance of digital technology in prompting interaction and collaboration while connecting learning environments with learning opportunities (Greenwood & Wang, 2018). Digital affordances also appeared to enhance the meaningfulness and effectiveness of spoken interactional contexts by creating virtual scenes close to real life (e.g., Levak & Son, 2017). In doing so, digital technology may encourage learners to update their cognitive schemata with new information (e.g., Yenkimaleki et al., 2021) and coordinate listening processes (e.g., in Tai & Chen, 2022) as they immerse themselves in real-time, authentic situations. This is in line with sociocultural theory (Vygotsky et al., 1978), which states that learners may construct knowledge and skills from their personal experiences while interacting with their surroundings.

Fourth, TELD may encourage and guide listening strategy application by providing prompts and feedback. Our review identified two main ways that digital technology encouraged and guided learners' listening strategy application. One was via prompts, such as pre-listening guiding questions that triggered learners' predictions (e.g., Li & Peng, 2022); the other was feedback, such as scores and incentives depending on learners' listening strategies (e.g., Tan et al., 2020). This mechanism echoes Wong et al.'s (2019) contention that prompts and feedback are the two main ways to encourage and scaffold strategy application in technology-enhanced learning environments. Following this mechanism, TELD may expedite learners' frequent and skilful application of listening strategies, leading to enhanced learning outcomes (e.g., Tan et al., 2020).

Finally, TELD may improve learner emotions and attention by making activities enjoyable (e.g., Bahari, 2019). Digital affordances helped integrate learning tasks into gameplay (e.g., Hwang et al., 2017), which were exciting and entertaining for users (Zou et al., 2021). It also enhanced listening in virtual worlds (e.g., Levak & Son, 2017) which tended to be vivid and enjoyable (Golonka et al., 2014). Interactions with peers, including developing friendships, was also boosted through digital means (e.g., Levak & Son, 2017) as was the active engagement in listening development due to the easy accessibility of listening activities, which encouraged self-efficacy (e.g., Aldukhayel, 2021). Another affordance of modern technology was students' ability to remain anonymous in human interactions and engage in human-computer interactions, which can reduce learner anxiety (e.g., Agbatogun, 2014). However, Nah (2011) argued that the positive effects of TELD on learners' emotions and attention may be a result of learners' sense of novelty. Thus, according to novelty effect theories, such positive effects may gradually decline along with learners' increasing familiarity with TELD. Moreover, unsatisfying quality and complex installation and operation of advanced technology also triggered negative feelings and decreased attention in TELD contexts (Nah, 2011).

In sum, this model demonstrates four ways in which TELD is effective: (a) bringing enjoyment and comfort to learners to improve their emotions and attention; (b) providing knowledge-learning activities and feedback, plus spoken interactional contexts to construct and reconstruct learners' cognitive schemata; (c) providing exercises with feedback and spoken interactional contexts to support listening practice; and (d) delivering prompts and feedback to encourage and guide listening strategy application.

Despite the insights our review has uncovered, it is not without limitations. First, we included only SSCI/SCI/SCI-E journal articles. A more extensive database may be applied in future research to present a more complete picture of the field, including non-SSCI/SCI/SCI-E journal articles, book chapters, and conference papers. Secondly, we conducted no meta-analysis because we focused on the mechanisms and implementation of TELD, rather than statistical data. Future studies may calculate the effect size for each study and conduct meta-analyses, exploring TELD from a statistical perspective.

## Conclusion

Our review of TELD studies published from 2000 to 2022 indicates the field has great potential. Thirteen types of digital means were used in listening development, with course management systems used most frequently. Nineteen types of learning tasks were identified, with comprehension exercises implemented most frequently. TELD had overall positive outcomes from academic and affective aspects by enhancing learner emotions, supporting learner interactions, encouraging active engagement, and affording various learning tasks. Challenges to its effectiveness were found in the aspects of technology, the learner, and learning tasks. Based on the review results, we developed a TELD model consisting of two parts: within and outside of cognitive systems.

## Future directions

Directions for future studies on TELD emerged from this review. The first direction concerns modern technology and technology-enhanced tasks for listening development. When discussing technology-enhanced L2 listening development, most previous studies have focused on multimedia technology and extensive listening (Vandergrift, 2011). Our review, however, identified other digital tools (e.g., games) and technology-enhanced tasks (e.g., human-computer interactions) useful for listening development. We then developed a model for this learning approach. Researchers and practitioners are thus recommended to use more TELD applications and select digital means and learning tasks for L2 listening development referring to our review findings. For example, practitioners should attempt to develop learner skills that coordinate cognitive processes in real-time L2 listening. Our study recommends technology-enhanced listening practice in spoken interactions using course management systems, clickers, interactive boards, personal digital assistants, intelligent tutoring systems, smartphones, social networking, and chats. Our recommended tasks include role-playing, interactions with native speakers, speech recordings and sharing, and human-computer interactions.

We also found that many researchers implemented TELD based on limited or no involvement of theoretical frameworks. However, a tight connection between technology use and theoretical frameworks is essential for implementing and investigating technology-enhanced L2 learning. Without a rigid theoretical framework, digital technology might be used for its own sake, without resting on a solid foundation (Zhang & Zou, 2022a). Hence, we call for more scholarly attention to theoretical frameworks in the field. This review identified some potential theories for investigating and implementing TELD, such as connectivism (Greenwood & Wang, 2018) and sociocultural theory (Vygotsky et al., 1978).

In the end, L2 listening development is a bitter pill, difficult for most L2 students and teachers, but essential for communication and L2 acquisition. However, considering the increasing use of different types of digital affordances in L2 education, TELD may make this pill easier to swallow.

## Acknowledgements

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## <span style="color:blue">Appendix</span>. Search Terms

| Group 1: Educational technology (Chen et al., 2021; Hwang & Fu, 2019) | Group 2: L2 (Zhang & Zou, 2021) | Group 3: Language development (Zhang & Zou, 2021) | Group 4: Listening |
|---|---|---|---|
| "Internet" or "twitter" or "Google" or "WhatsApp" or "Skype" or "wearable device" or "smartphone*" or "game" or "automatic speech recognition" or "speech-to-text recognition" or "clicker" or "smartwatch" or "e-portfolio" or "social network" or "e-book" or "intelligent tutoring system" or "ipod" or "digital" or "web" or "augmented reality" or "wechat" or "facebook" or "flipped classroom" or "moodle" or "MOOCS" or "skype" or "e-learning" or "self-instruction program" or "blended learning" or "online" or "educational software" or "virtual reality" or "blog" or "chat" or "computer" or "technology" or "electronic discussion groups" or "interactive whiteboard" or "iPad" or "Laptop" or "mobile" or "microblog" or "micro-blog" or "padlet" or "social media" or "tablet" or "wiki" or "ubiquitous" | "language learning" or "language learn" or "learn language" or "develop language" or "language development" or "language education" or "language acquisition" or "teach language" or "language teaching" | "second language" or "foreign language" or "EFL" or "ESL" | "listen" or "listening" |

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