## Appendix A. Related review studies

|  |  |  |  |
| --- | --- | --- | --- |
| Author/s | Main focus | Main findings | Difference with our study |
| Ehsani & Knodt (1998) | – To analyze technological strengths and limitations of SRT;  – To suggest how to make good use of SRT. | – Disadvantages: SRT is always domain specific;  – Optimize SRT performance from four aspects (task definition, acoustic models, input modality, and input quality). | Focus on technological aspects of SRT only. |
| McKechnie et al. (2018) | – Current state of automatic speech analysis tools and purposes;  – Evaluate the quality and accuracy of the current SRT;  – Explain the feasibility of SRT use in clinical practice. | – 18 ASA tools were identified;  – ASA has been used effectively to analyze children’s foreign language pronunciation (phoneme, prosodic).  – The word recognition rate, percent agreement, correlation and measures used in signal detection of ASA compared with human judgment are relatively high. | Focus on specific group of learners (i.e., typically developing and speech sound disorders, children learning a foreign language) and on the accuracy of specific speech recognition analysis technology. |
| Radha & Vimala (2012) | – SRT development;  – Feature extraction techniques and speech recognition approaches;  – SRT performance evaluation measures. | – MFCC is used widely for feature extraction of speech;  – GHM and HMM are the best among all modeling techniques;  – Five SRT approaches;  – The most widely used measurement is accuracy and speed. | Focus on technological aspects of SRT only. |
| Shadiev et al. (2014) | – Applications of SRT for learning;  – Research evidence on how SRT can enhance learning. | – SRT enhances basic reading, spelling and writing, skills, understanding lectures content, and motivation;  – Design of learning activities and strategies to improve accuracy rate of SRT. | Focus on SRT applications to learning in general |

## Appendix B. Reviewed studies

Ahn, T. Y. & Lee, S.-M. (2016) User experience of a mobile speaking application with automatic speech recognition for EFL learning. *British Journal of Educational Technology*,47(4): 778–786. <https://doi.org/10.1111/bjet.12354>

Arcon, N., Klein, P. D. & Dombroski, J. D. (2017) Effects of dictation, speech to text, and handwriting on the written composition of elementary school English language learners. *Reading & Writing Quarterly*,33(6): 533–548. <https://doi.org/10.1080/10573569.2016.1253513>

Baker, E. A. (2017) Apps, iPads, and literacy: Examining the feasibility of speech recognition in a first-grade classroom. *Reading Research Quarterly*,52(3): 291–310. <https://doi.org/10.1002/rrq.170>

Bodnar, S., Cucchiarini, C., de Vries, B. P., Strik, H. & van Hout, R. (2017) Learner affect in computerised L2 oral grammar practice with corrective feedback. *Computer Assisted Language Learning*, 30(3–4): 223–246. <https://doi.org/10.1080/09588221.2017.1302964>

Cavus, N. & Ibrahim, D. (2017) Learning English using children’s stories in mobile devices. *British Journal of Educational Technology*,48(2): 625–641. <https://doi.org/10.1111/bjet.12427>

Dalim, C. S. C., Sunar, M. S., Dey, A. & Billinghurst, M. (2020) Using augmented reality with speech input for non-native children’s language learning. *International* *Journal of Human-Computer Studies*,134: 44–64. <https://doi.org/10.1016/j.ijhcs.2019.10.002>

de Vries, B. P., Cucchiarini, C., Bodnar, S., Strik, H. & van Hout, R. (2015) Spoken grammar practice and feedback in an ASR-based call system. *Computer Assisted Language Learning*,28(6): 550–576. <https://doi.org/10.1080/09588221.2014.889713>

Haug, K. N. & Klein, P. D. (2018) The effect of speech-to-text technology on learning a writing strategy. *Reading & Writing Quarterly*,34(1): 47–62. <https://doi.org/10.1080/10573569.2017.1326014>

Hsu, L. (2016) An empirical examination of EFL learners’ perceptual learning styles and acceptance of ASR-based computer-assisted pronunciation training. *Computer Assisted Language Learning*,29(5): 881–900. <https://doi.org/10.1080/09588221.2015.1069747>

Liakin, D., Cardoso, W. & Liakina, N. (2017) Mobilizing instruction in a second-language context: Learners’ perceptions of two speech technologies. Languages, 2(3): 1–21. <https://doi.org/10.3390/languages2030011>

Matthews, J. & O’Toole, J. M. (2015) Investigating an innovative computer application to improve L2 word recognition from speech. *Computer Assisted Language Learning*,28(4): 364–382. <https://doi.org/10.1080/09588221.2013.864315>

McCrocklin, S. M. (2016) Pronunciation learner autonomy: The potential of automatic speech recognition. *System*,57: 25–42. <https://doi.org/10.1016/j.system.2015.12.013>

Mirzaei, M. S., Meshgi, K., Akita, Y. & Kawahara, T. (2017) Partial and synchronized captioning: A new tool to assist learners in developing second language listening skill. *ReCALL*, 29(2): 178–199. <https://doi.org/10.1017/S0958344017000039>

Mroz, A. (2018) Seeing how people hear you: French learners experiencing intelligibility through automatic speech recognition. *Foreign Language Annals*,51(3): 617–637. <https://doi.org/10.1111/flan.12348>

Shadiev, R. & Huang, Y.-M. (2020) Investigating student attention, meditation, cognitive load, and satisfaction during lectures in a foreign language supported by speech-enabled language translation. *Computer Assisted Language Learning*,33(3): 301–326. <https://doi.org/10.1080/09588221.2018.1559863>

Shadiev, R., Huang, Y.-M. & Hwang, J.-P. (2017) Investigating the effectiveness of speech-to-text recognition applications on learning performance, attention, and meditation. *Educational Technology Research and Development*,65(5): 1239–1261. <https://doi.org/10.1007/s11423-017-9516-3>

Shadiev, R., Sun, A. & Huang, Y.-M. (2019) A study of the facilitation of cross-cultural understanding and intercultural sensitivity using speech-enabled language translation technology. *British Journal of Educational Technology*,50(3): 1415–1433. <https://doi.org/10.1111/bjet.12648>

Shadiev, R., Wu, T.-T., Sun, A. & Huang, Y.-M. (2018) Applications of speech-to-text recognition and computer-aided translation for facilitating cross-cultural learning through a learning activity: Issues and their solutions. *Educational Technology Research and Development*, 66(1): 191–214. <https://doi.org/10.1007/s11423-017-9556-8>

Tsai, P. (2019) Beyond self-directed computer-assisted pronunciation learning: A qualitative investigation of a collaborative approach. *Computer Assisted Language Learning*,32(7): 713–744. <https://doi.org/10.1080/09588221.2019.1614069>

Usai, F., O’Neil, K. G. & Newman, A. J. (2017) Design and empirical validation of effectiveness of LANGA, an online game-based platform for second language learning. *IEEE Transactions on Learning Technologies*, 11(1): 107–114.

van Doremalen, J., Boves, L., Colpaert, J., Cucchiarini, C. & Strik, H. (2016) Evaluating automatic speech recognition-based language learning systems: A case study. *Computer Assisted Language Learning*,29(4): 833–851. <https://doi.org/10.1080/09588221.2016.1167090>

Wang, Y.-H. & Young, S. S.-C. (2014) A study of the design and implementation of the ASR-based iCASL system with corrective feedback to facilitate English learning. *Journal of Educational Technology & Society*,17(2): 219–233.

Wang, Y.-H. & Young, S. S.-C. (2015) Effectiveness of feedback for enhancing English pronunciation in an ASR-based CALL system. *Journal of Computer Assisted Learning*,31(6): 493–504. <https://doi.org/10.1111/jcal.12079>

Yu, P., Pan, Y., Li, C., Zhang, Z., Shi, Q., Chu, W., Liu, M. & Zhu, Z. (2016) User-centred design for Chinese-oriented spoken English learning system. *Computer Assisted Language Learning*, 29(5): 984–1000. <https://doi.org/10.1080/09588221.2015.1121877>

Yueh, H.-P., Lin, W., Liu, Y.-L., Shoji, T. & Minoh, M. (2014) The development of an interaction support system for international distance education. *IEEE Transactions on Learning Technologies*,7(2): 191–196. <https://doi.org/10.1109/TLT.2014.2308952>

Zhang, Y. & Liu, L. (2018) Using computer speech recognition technology to evaluate spoken English. *Educational Sciences: Theory & Practice*, 18(5).

## Appendix C. Publications in journals (by numbers, in alphabetical order)

|  |  |
| --- | --- |
| Journals | Publications |
| *Computer Assisted Language Learning* | 8 |
| *British Journal of Educational Technology* | 3 |
| *Educational Technology Research and Development* | 2 |
| *IEEE Transactions on Learning Technologies* | 2 |
| *Reading & Writing Quarterly* | 2 |
| *Educational Sciences: Theory & Practice* | 1 |
| *Educational Technology & Society* | 1 |
| *Foreign Language Annals* | 1 |
| *International Journal of Human-Computer Studies* | 1 |
| *Journal of Computer Assisted Learning* | 1 |
| *Languages* | 1 |
| *Reading Research Quarterly* | 1 |
| *ReCALL* | 1 |
| *System* | 1 |

## Appendix D. Domain

|  |  |  |
| --- | --- | --- |
| Domain | *n* | Authors |
| *Language learning* | | |
| English | 17 | Ahn & Lee, 2016;  Arcon et al., 2017;  Baker, 2017;  Cavus & Ibrahim, 2017;  Dalim et al., 2020;  Haug & Klein, 2018;  Hsu, 2016;  Matthews & O’Toole, 2015;  McCrocklin, 2016;  Mirzaei et al., 2017;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Tsai, 2019;  Wang & Young, 2014;  Wang & Young, 2015;  Yu et al., 2016;  Zhang & Liu, 2018 |
| Dutch | 3 | Bodnar et al., 2017;  de Vries et al., 2015;  van Doremalen et al., 2016 |
| French | 2 | Mroz, 2018;  Liakin et al., 2017 |
| Spanish | 1 | Usai et al., 2017 |
| *Cross-cultural learning* | | |
| Cross-cultural understanding | 2 | Shadiev et al., 2018;  Shadiev et al., 2019 |
| *Distance learning* | | |
| Educational technology | 1 | Yueh et al., 2014 |

## Appendix E. Language skills

|  |  |  |
| --- | --- | --- |
| Skill | *n* | Author |
| Pronunciation | 15 | Ahn & Lee, 2016;  Cavus & Ibrahim, 2017;  Dalim et al., 2020;  Liakin et al., 2017;  Hsu, 2016;  Matthews & O’Toole, 2015;  McCrocklin, 2016;  Mroz, 2018;  Tsai, 2019;  Usai et al., 2017;  van Doremalen et al., 2016;  Wang & Young, 2015;  Wang & Young, 2014;  Yu et al., 2016;  Zhang & Liu, 2018 |
| Listening | 5 | Cavus & Ibrahim, 2017;  Matthews & O’Toole, 2015;  Mirzaei et al., 2017;  Shadiev et al., 2017;  Shadiev & Huang, 2020 |
| Writing | 3 | Arcon et al., 2017;  Baker, 2017;  Haug & Klein, 2018 |
| Communication | 3 | Shadiev et al., 2018;  Shadiev et al., 2019;  Yueh et al., 2014 |
| Grammar | 2 | Bodnar et al., 2017;  de Vries et al., 2015 |
| Word recognition | 1 | Matthews & O’Toole, 2015 |
| Vocabulary | 1 | Cavus & Ibrahim, 2017 |

## Appendix F. Speech recognition technology

|  |  |  |
| --- | --- | --- |
| Technology | *n* | Author |
| Dragon Naturally Speaking | 4 | Arcon et al., 2017;  Baker, 2017;  Haug & Klein, 2018;  Liakin et al., 2017 |
| Google speech recognition | 4 | Ahn & Lee, 2016;  Shadiev et al., 2018;  Shadiev et al., 2019;  Shadiev & Huang, 2020 |
| Windows Speech Recognition | 2 | McCrocklin, 2016;  Dalim et al., 2020 |
| ASR-based CALL system | 1 | Wang & Young, 2015 |
| Partial and synchronized captioning | 1 | Mirzaei et al., 2017 |
| Julius | 1 | Yueh et al., 2014 |
| Not specified | 13 | Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  de Vries et al., 2015;  Hsu, 2016;  Matthews & O’Toole, 2015;  Mroz, 2018;  Shadiev et al., 2017;  Tsai, 2019;  Usai et al., 2017;  van Doremalen et al., 2016;  Wang & Young, 2014;  Yu et al., 2016;  Zhang & Liu, 2018 |

## Appendix G. Application of recognition technology

|  |  |  |
| --- | --- | --- |
| Application | *n* | Author |
| *Providing feedback for learners to detect errors* | | |
| Guidance: technology provides feedback on voice input and language learner to improve mistakes | 13 | Bodnar et al., 2017;  de Vries et al., 2015;  Hsu, 2016;  Liakin et al., 2017;  Matthews et al., 2015;  McCrocklin, 2016;  Mroz, 2018;  Tsai, 2019;  Usai et al., 2017;  van Doremalen et al., 2016;  Wang & Young, 2015;  Wang & Young, 2014;  Yu et al., 2016 |
| Interaction: technology enables speaking interaction between computer and language learner | 5 | Ahn & Lee, 2016;  Cavus & Ibrahim, 2017;  Mroz, 2018;  Tsai, 2019;  Yu et al., 2016 |
| Evaluation: technology evaluates and scores voice input | 2 | van Doremalen et al., 2016;  Zhang & Liu, 2018 |
| *Showing texts generated by the technology* | | |
| Creating written content: students read texts; the system generates written texts from voice input that are used by students to find mistakes in created written content or pronunciation | 6 | Arcon et al., 2017;  Baker, 2017;  Haug & Klein, 2017;  Matthews et al., 2015;  Shadiev et al., 2018;  Shadiev et al., 2019 |
| Lectures in a foreign language: texts generated by the technology are shown to students on whiteboard or computer screens. | 3 | Mirzaei et al., 2017;  Shadiev & Huang, 2020;  Shadiev et al., 2017 |
| *Giving commands to the system* | | |
| Improving language skills: students give commands to the system so that students can interact with the system or create written content | 3 | Arcon et al., 2017;  Dalim et al., 2020;  Yueh et al., 2014 |

## Appendix H. Educational level of participants

|  |  |  |
| --- | --- | --- |
| Educational level | *n* | Author |
| College students | 20 | Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  de Vries et al., 2015;  Hsu, 2016;  Liakin et al., 2017;  Matthews et al., 2015;  McCrocklin, 2016;  Mirzaei et al., 2017;  Mroz, 2018;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Shadiev et al., 2018;  Shadiev et al., 2019;  Tsai, 2019;  van Doremalen et al., 2016;  Wang & Young, 2015;  Wang & Young, 2014;  Yu et al., 2016;  Yueh et al., 2014;  Zhang & Liu, 2018 |
| Elementary school students | 4 | Arcon et al., 2017;  Baker, 2017;  Bodnar et al., 2017;  Haug & Klein, 2018 |
| Junior high school students | 2 | Bodnar et al., 2017;  Wang & Young, 2015 |
| Preschool students | 1 | Dalim et al., 2020 |
| Not specified | 2 | Ahn & Lee, 2016;  Usai et al., 2017 |

## Appendix I. Number of participants

|  |  |  |
| --- | --- | --- |
| Number of participants | *n* | Author |
| Less than 30 | 12 | Arcon et al., 2017;  Baker, 2017;  de Vries et al., 2015;  Mroz, 2018;  Shadiev et al., 2018;  Shadiev et al., 2019;  Usai et al., 2017;  van Doremalen et al., 2016;  Wang & Young, 2015;  Yu et al., 2016;  Yueh et al., 2014;  Zhang & Liu, 2018 |
| Between 30 and 60 | 10 | Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  Haug & Klein, 2018;  Matthews et al., 2015;  McCrocklin, 2016;  Mirzaei et al., 2017;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Tsai, 2019;  Wang & Young, 2014 |
| More than 60 | 4 | Ahn & Lee, 2016;  Dalim et al., 2020;  Hsu, 2016;  Liakin et al., 2017 |

## Appendix J. Intervention duration

|  |  |  |
| --- | --- | --- |
| Duration | *n* | Author |
| Less than 1 hour | 5 | Arcon et al., 2017;  Dalim et al., 2020;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  van Doremalen et al., 2016 |
| Less than 1 day | 2 | Bodnar et al., 2017;  de Vries et al., 2015 |
| Less than 1 week | 1 | Haug & Klein, 2018 |
| Less than 1 month | 9 | Ahn & Lee, 2016;  Cavus & Ibrahim, 2017;  Liakin et al., 2017;  McCrocklin, 2016;  Mirzaei et al., 2017;  Mroz, 2018;  Shadiev et al., 2018;  Shadiev et al., 2019;  Usai et al., 2017 |
| More than 1 month | 6 | Baker, 2017;  Hsu, 2016;  Tsai, 2019;  Wang & Young, 2015;  Wang & Young, 2014;  Yueh et al., 2014 |
| Not specified | 3 | Matthews & O’Toole, 2015;  Yu et al., 2016;  Zhang & Liu, 2018 |

## Appendix K. Measures

|  |  |  |
| --- | --- | --- |
| Measure | *n* | Author |
| *Questionnaire (n = 24)* | | |
| Perceptions, attitudes and affection toward the application | 17 | Ahn & Lee, 2016;  Arcon et al., 2017;  Bodnar et al., 2017;  de Vries et al., 2015;  Liakin et al., 2017;  Matthews et al., 2015;  Mirzaei et al., 2017;  Mroz, 2018;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Shadiev et al., 2018;  Shadiev et al., 2019;  Tsai, 2019;  Wang & Young, 2015;  Wang & Young, 2014;  Yu et al., 2016;  Yueh et al., 2014 |
| Cognitive load | 3 | Arcon et al., 2017;  Haug & Klein, 2018;  Shadiev & Huang, 2020 |
| Beliefs of autonomy and autonomous learning behavior | 1 | McCrocklin, 2016 |
| Intrinsic motivation | 1 | Dalim et al., 2020 |
| Learning style and TAM | 1 | Hsu, 2016 |
| User test | 1 | van Doremalen et al., 2016 |
| *Pre-/posttest (n = 14)* | | |
| Language proficiency | 9 | Arcon et al., 2017;  Cavus & Ibrahim, 2017;  de Vries et al., 2015;  Liakin et al., 2017;  Mirzaei et al., 2017;  Mroz, 2018;  Usai et al., 2017;  Wang & Young, 2014;  Wang & Young, 2015 |
| Writing skill | 1 | Haug & Klein, 2018 |
| TOEIC, information recognition, lecture information recall and understanding of lecture | 1 | Shadiev et al., 2017 |
| Intercultural sensitivity | 1 | Shadiev et al., 2018 |
| Partial dictation, paused dictation and dictation tests | 1 | Matthews et al., 2015 |
| Colors, shapes, and spatial relationships | 1 | Dalim et al., 2020 |
| *Interview (n = 11)* | | |
| Learning experiences | 8 | Liakin et al., 2017;  McCrocklin, 2016;  Mroz, 2018;  Shadiev & Huang, 2020;  Shadiev et al., 2018;  Shadiev et al., 2019;  Wang & Young, 2015;  Yu et al., 2016 |
| Learning behavior | 1 | Shadiev et al., 2017 |
| Formal teacher interviews | 1 | Baker, 2017 |
| An expert review | 1 | van Doremalen et al., 2016 |
| *Computer practice behavior logs (n = 3)* | | |
| Practice times and repair times | 1 | de Vries et al., 2015 |
| Attempts for each question, first-try-corrects | 1 | Bodnar et al., 2017 |
| Login records, learners’ learning paths | 1 | Wang & Young, 2014 |
| *Content (n = 3)* | | |
| Reflective notes in learning logs, created texts and think-aloud protocols were analyzed | 3 | Arcon et al., 2017;  Tsai, 2019;  Yu et al., 2016 |
| EEG *recordings (n = 2)* | | |
| Getting ongoing recordings of brain electrical activity | 2 | Shadiev & Huang, 2020;  Usai et al., 2017 |
| *Fieldwork method (n = 1)* | | |
| Observation notes, field notes, theoretic notes, methodological notes, student artifacts and video recording | 1 | Baker, 2017 |
| *Eye tracking (n = 1)* | | |
| Visual attention | 1 | Yu et al., 2016 |
| *Task analysis (n = 1)* | | |
| Participants’ operations to carry out the tasks | 1 | Yu et al., 2016 |
| *Language learning logs (n = 1)* | | |
| Self-report of practicing time | 1 | McCrocklin, 2016 |
| *Usability review (n = 1)* | | |
| Testing the system against the relevant items | 1 | van Doremalen et al., 2016 |

## Appendix L. The results in reviewed studies

|  |  |  |
| --- | --- | --- |
| Results/domain | Content | Author |
| *Gains in proficiency* | | |
| Writing | – Strategy instruction with speech recognition application produced large gains on the three measures of argument writing in holistic text quality, word count, fluency, error rate, and variety of argument moves.  – Handwriting required significantly higher cognitive load than dictation-to-speech recognition. | Baker, 2017;  Haug & Klein, 2018 |
| Pronunciation | Students who used speech recognition significantly increased their autonomy and pointed to the feedback as enabling them to practice autonomously. | McCrocklin, 2016 |
|  | MyET was a mediating tool that provided feedback that could help raise awareness of linguistic features. | Tsai, 2019 |
|  | Significant measurable improvements in pronunciation (recognition, spatial relationship, color, speaking performance). | Cavus & Ibrahim, 2017;  Dalim et al., 2020;  Matthews et al., 2015;  Usai et al., 2017;  Wang & Young, 2015;  Wang & Young, 2014 |
| Grammar | – The system was useful in providing L2 speaking practice.  – The system was effective because the learners improved their grammatical accuracy as a result of practice with the system. | de Vries et al., 2015 |
| Cross-culture learning | Cross-cultural understanding was facilitated with the help of the system. | Shadiev & Huang, 2020 |
| Comprehension | Partial and synchronized captioning successfully adjusted its content to the learners’ proficiency levels and served as an effective medium for decreasing dependence on captions and preparing learners to listen without any assistance. | Mirzaei et al., 2017;  Shadiev & Huang, 2020 |
|  | The effect of the intervention was significant on attention and meditation. | Shadiev et al., 2017 |
| *Perceptions* | | |
|  | Helped the students practice speaking in private spaces, focus on accuracy in pronunciation, and the use of application increased the flexibility of learning. | Ahn & Lee, 2016;  Liakin et al., 2017;  Wang & Young, 2014 |
|  | Enabled the students to use their target language in authentic and situated contexts, assists their understanding of language appropriateness. | Ahn & Lee, 2016 |
|  | Made speaking activity more interactive. | Ahn & Lee, 2016;  Matthews et al., 2015;  Tsai, 2019 |
|  | Had a positive impact on their interest and motivation. | Ahn & Lee, 2016;  Bodnar et al., 2017;  Dalim et al., 2020;  de Vries et al., 2015;  Matthews et al., 2015;  Tsai, 2019 |
|  | Students became aware of their errors and modified their utterances. | Ahn & Lee, 2016;  Wang & Young, 2015 |
|  | Facilitated cross-cultural understanding and enhanced intercultural sensitivity. | Shadiev et al., 2019 |
|  | Easy to use | Shadiev et al., 2019 |
| *Questions, suggestions or approaches* | | |
|  | – Lack of accuracy, interactivity and explicit corrective feedback;  – Time-consuming;  – Teacher-supervised approach. | Liakin et al., 2017 |
|  | The system still had its limitations in areas such as the fluctuating scoring system and invariable visual and textual feedback. | Tsai, 2019 |
|  | The top three functions that should be included in the corrective feedback to assist learning are: (1) model pronunciation of the English sentences; (2) an audio file of the utterance that can be played immediately; (3) a list of the inaccurately pronounced words. | Wang & Young, 2014 |
| *System design* | | |
|  | – The prototype interface appeared good and learners could find the areas of their interests easily.  – The success rate of the interactive learning activities was satisfactory.  – Assistance and feedback strategies were the key design in the prototype and they were also accepted by the participants. | Yu et al., 2016 |
|  | – Accuracy rate of the system was the most essential indicator. | Zhang & Liu, 2018 |
|  | – Visual learning style had a positive significant effect on perceived ease of use of the system.  – Perceived usefulness had a significant effect on participants’ attitude toward using the system. | Hsu, 2016 |
|  | – The teachers generally thought that the system was easy to use, compatible with their current teaching methods and not frustrating to use.  – The students agreed with the positive statements about the system. | van Doremalen et al., 2016 |
| *Learning logs* | | |
|  | – The average number of times each learner accessed the system was approximately 2.5 times per week.  – The average login time was from 30 to 40 minutes. | Wang & Young, 2014 |
|  | – The control group made significantly more attempts and significantly more counts of successful corrections in both sessions. | Bodnar et al., 2017;  de Vries et al., 2015 |

## Appendix M. Advantages and disadvantages in reviewed papers

|  |  |  |
| --- | --- | --- |
| Advantages/disadvantages | *n* | Author |
| *Advantages* | | |
| Improving affective factors | 18 | Ahn & Lee, 2016;  Arcon et al., 2017;  Baker, 2017;  Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  Dalim et al., 2020;  Hsu, 2016;  Liakin et al., 2017;  Matthews et al., 2015;  Mirzaei et al., 2017;  Mroz, 2018;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Shadiev et al., 2018;  Tsai, 2019;  van Doremalen et al., 2016;  Wang & Young, 2014;  Wang & Young, 2015 |
| Enhancing language skills | 14 | Arcon et al., 2017;  Baker, 2017;  Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  de Vries et al., 2015;  Haug & Klein, 2018;  Matthews et al., 2015;  Tsai, 2019;  Usai et al., 2017;  Wang & Young, 2015;  Wang & Young, 2014;  Yu et al., 2016;  Yueh et al., 2014;  Zhang & Liu, 2018 |
| Promoting interaction | 5 | Ahn & Lee, 2016;  Baker, 2017;  Mroz, 2018;  Tsai, 2019;  Yueh et al., 2014 |
| Creating a self-paced learning environment and improving autonomy | 5 | Ahn & Lee, 2016;  Baker, 2017;  de Vries et al., 2015;  McCrocklin, 2016;  Wang & Young, 2014 |
| Increasing the learning  involvement | 3 | Dalim et al., 2020;  Liakin et al., 2017;  Yueh et al., 2014 |
| Self-monitoring of errors | 2 | McCrocklin, 2016;  Wang & Young, 2015 |
| Enhancing intercultural sensitivity | 2 | Shadiev et al., 2018;  Shadiev et al., 2019 |
| Supporting learner differences | 1 | de Vries et al., 2015; |
| Reducing task completion time | 1 | Dalim et al., 2020 |
| Developing awareness of intelligibility | 1 | Mroz, 2018 |
| *Disadvantages* | | |
| Accuracy rate | 9 | Arcon et al., 2017;  Dalim et al., 2020;  Liakin et al., 2017;  Mroz, 2018;  Shadiev & Huang, 2020;  Shadiev et al., 2017;  Shadiev et al., 2018;  Shadiev et al., 2019;  Yueh et al., 2014 |
| Insufficiency | 8 | Baker, 2017;  Liakin et al., 2017;  Tsai, 2019;  van Doremalen et al., 2016;  Usai et al., 2017;  Wang & Young, 2014;  Wang & Young, 2015;  Yu et al., 2016 |
| Places burden | 3 | Arcon et al., 2017;  McCrocklin, 2016;  Shadiev & Huang, 2020 |
| Time-consuming | 1 | Liakin et al., 2017 |
| Not specified | 9 | Ahn & Lee, 2016;  Bodnar et al., 2017;  Cavus & Ibrahim, 2017;  de Vries et al., 2015;  Hsu, 2016;  Haug & Klein, 2018;  Matthews & O’Toole, 2015;  Mirzaei et al., 2017;  Zhang & Liu, 2018 |