A SYSTEMATIC REVIEW OF THE INFLUENCE OF TEACHERS' KNOWLEDGE ON THE USE OF ASSISTIVE TECHNOLOGY

aChoo Bee Giek

aOpen University Malaysia, Malaysia

achoobee@oum.edu.my

ABSTRACT

Assistive technology is an essential tool that supports students in their learning participation and provide opportunities for their education, social interactions and social relationship. Teachers' knowledge in assistive technology has consistently shown to be required for them to come out with proper modification and differentiation using assistive technology for students with l special educational needs in inclusive education. There are numerous studies aimed at reviewing the impact of teachers' knowledge on the use of assistive technologies among elementary and secondary school teachers. This review intended to summarise the context of teachers' knowledge in the domain of general inclusive education and explore the instrument used, sample selection, validity and reliability as reported in the related studies. Electronic database includes Education Source, ERIC (Educational Resource Index and Abstracts), EBSCOhost by Elton B. Stephens Company and Scopus were systematically searched, reviewing published studies from January 2011 to January 2021 with the inclusion criteria selecting any study which focused on teachers' knowledge and their use of assistive technology with special educational need students in inclusive education. Of the 6 reviewed published studies, teachers' knowledge reported to have a positive impact on their use of assistive technology and have an influence on their level of confidence in integrating assistive technology in teaching. Recommendations for future studies include preparedness of pre-service teachers for assistive technology use in inclusive education to ensure they have sufficient knowledge for the use of assistive technology in teaching.

Keywords: Assistive Technology, Knowledge, Teacher, Inclusive Education

1. Introduction

In the 19th century, subject content knowledge was strongly being emphasised and it was known as an important element in teaching (Shulman, 1986; Thinzarkyaw, 2020). Towards the beginning of the 20th century, there was a switch in evaluating teachers' competencies, shifting its focus fundamentally to pedagogy (Shulman, 1986; Mishra & Koehler, 2006). Content and pedagogical knowledge cannot be mutually exclusive, there is an intersection point between these two elements, where good teachers need to confront these both issues concurrently to make the topics or content that they want to teach understandably to learners (Shulman, 1986). The blend of Pedagogical Content Knowledge (PCK), which goes beyond teachers' knowledge of the subject matter but the teachability of it, the knowledge of coming out with strategies to ease the learning process with their understanding of what makes the certain topic easy or difficult to be understood by learners (Shulman, 1986). Teachers need to be able to engage students in ways that align with the specific content being taught not just the content knowledge

in this context but also the way of delivering the content plays an important role (Redford, 2019). In the 1980s, technological knowledge was still not being emphasised as to how they are being foregrounded today due availability of technology, primarily digital technologies were not as commonly found nor used (Mishra & Koehler, 2006). However, textbooks, projectors, typewriters, highlighter, enlarged printed paper and many more, which were considered as low technologies, were being used by teachers in traditional classrooms. Often, low-tech technologies which can be conveniently found in today's classrooms were not even being considered as technologies (Mishra & Koehler, 2006).

In this contemporary era, the rapid development of technology has changed human work in many ways which include the world of education. These changes brought into the introduction of technology in education resulted in the trend towards more access to digital technologies given to students with educational needs and support their learning which symbolised the starting point of school ed-tech strategies. (Redford, 2019; Cranmer, 2020). The hardware, software, educational games and apps are one class of educational technology that has delivered on the promise to revolutionise teaching and learning (Redford, 2019). Mishra and Koehler (2006) introduced technological knowledge as the new domain and formed Technological Pedagogical and Content Knowledge (TPACK) model due to the immersed of role of the technologies, particularly in education. Research findings have shown, in order for teachers to make appropriate use of assistive technology, they need to acquire technological knowledge in order to use assistive technology to improve students' learning outcomes as it influences how teachers effectively integrate technologies in teaching (Hutchison, Beschorner, & Schmidt-Crawford, 2012; Edyburn, 2013).

1.1. Technological Knowledge in Assistive Technology

A functional understanding of technological knowledge justified its resistance to the changes in technology tools (Voogt, Fisser, Roblin, Tondeur & van Braak, 2013). Shulman did not specifically emphasised on technological knowledge but he explained how teachers can use different representatives in explaining specific topics/concepts when they teach in class as an extension of explanation for pedagogical knowledge. Furthermore, Mishra and Koehler (2006) stressed on how the low-tech tools are commonly found in the classroom and therefore being considered as "transparent" and sometimes not even being referred to as technologies. They argued and defined technological knowledge as the knowledge of how to use, install, operate and remove software or assistive devices, and most importantly adjusting these technologies into their classroom teaching (Mishra & Koehler, 2006; Cox & Graham, 2009).

Mishra & Koehler's TPACK framework being commonly used and researched, technological knowledge was being defined differently by different researchers. The definitions of technological knowledge are different in what are the technologies being included and the types of knowledge in this domain (Voogt, et al., 2013). Technological knowledge refers to the knowledge of technologies ranging from low to high tech, which includes books, pencil, lined papers to digital devices, the internet, interactive whiteboard (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). On another hand, Cox and Graham (2009) defined technological knowledge as knowledge on using emerging technologies; emerging technologies are defined as the new technologies that have not been treated as "transparent" in an educational setting and argued that digital technologies appeared to be the commonly found emerging technologies. While some defined technological knowledge as the knowledge of ICT technologies, for example how iPad, computers, cartoons, audiobooks, games, animations and

apps can be used to to support student learning and their social life (Bower, Hedberg & Kuswara, 2010; Lee & Tsai, 2010; Hutchison, et. al., 2012; Demirok & Baglama, 2018).

The diversity of assistive technologies in this modern age make wonders as they take the needs and interests of individuals into account and drew attention to how they can be used to support and serve students with special educational needs (Arouri, Attiyah, Dababneh & Hamaidi, 2020). For students with special educational needs teachers' technological knowledge in assistive technology makes a huge difference in opening the door of learning, participating, socialising, building the relationship and providing equal opportunities for learning in class with their able peers. The technological knowledge from low to high tech assistive technologies; from using to adjusting these technologies for their learning are essential in supporting their needs in many different areas. With the availability of assistive technologies in today's world, teachers will need to carefully plan and incorporate these technologies to empower students with special educational needs in class. Teachers' knowledge is essential because it helps in identifying the right tools to be used in teaching for the benefits of students with special educational needs. Successful use of assistive technology is associated with teachers' realisation of the benefits of these technologies in teaching students with needs and the key of it is teachers need to have the knowledge about the tools and how to use them in accommodating students' needs and supporting students' learning which allow them to be more competent and more involved in the application and implementation of the technologies (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur and Sendurur, 2012; DePountis, Pogrund, Griffin-Shirley, & Lan, 2015; Siyam, 2018; Arouri, et. al., 2020). This basic domain influence teachers' use of assistive technology but it influences the whole learning experiences, it offers powerful possibilities in improving students' learning and lives inside and also indirectly outside of the classroom. Therefore, teachers need to have sufficient knowledge about low-tech and high-tech assistive technology, knowing how to match it with students' needs or their learning environment (Jones & Hinesmon-Matthews, 2014).

1.2. Use of Assistive Technology

Assistive technology is being used in inclusive education to train, rehearse and enable learning (WHO, 2015; Ahmad, 2015). The use of assistive technology helps to bridge the gap between the able and disable kids in the same classroom, helping them to learn the similar topic/concept in a different way which they can understand by removing the barriers in learning and compensating for their lack in certain abilities, and work on their strengths. Assistive technology provides alternative ways for students to learn, show their learning and complete the works given by their teachers and increase the independence. Consistent with the findings in previous literature reviews, assistive technology found to have several benefits for students with special educational needs and should be taken note of by teachers.

First and foremost, use of assistive technology can increase students' engagement either in individual academic work or collaborative work with peers instead of waiting passively for teacher's support and this open up access and allow students to participate fully in an inclusive classroom (Pilgrim, Bledsoe, & Reily, 2012; Atanga, et. al., 2019). In addition, there is increasing evidence that these practical tools connect students' cognitive abilities with their learning opportunities and provide accessibility in classroom learning (Nkwoagba, 2011; Ahmad, 2015). Interestingly, Shapley, Sheehan, Maloney, & Caranikas-Walker (2011) found that teachers with the use of assistive technology managed their class differently, where special educational needs (SEN) students found to have better interaction which resulted in greater school attendance of students and they also reported to have less disciplinary actions. Different

areas of functions need different types of assistive technology in compensating the lack of abilities, for example, students with difficulties in decoding can use text to speech software to help them with reading; students with limitations in executive functioning can use a graphic organiser or work clock to serve as their organisation tools; word processor or speech to text as the assistive technologies for students who struggle with writing or spelling (Ahmad, 2015; Park, Takahashi, Roberts, & Delise, 2017). With the use of these tools, students with special educational needs will be able to accomplish tasks that are difficult or seem impossible for them, it encourages them to continue trying and learning. Ertmer and Ottenbreit-Leftwich (2013) also supported that the use of technology will help students learning in the classroom but instead of focusing on the technology integration, they focused on the pedagogical approach where technology can be used as a cognitive tool that helps students in authentic learning and called for a shift from technology integration to technology-enabled learning.

1.3. Teachers' Knowledge and The Use of Assistive Technology

Teachers must have sufficient knowledge in ensuring assistive technology has been used successfully for students with learning disabilities (Tony, 2019; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur and Sendurur, 2012; Arouri, et. al., 2020). The teacher who is equipped with technological knowledge effectively use assistive technology in their teaching instruction and supporting students' learning (Flanagan, Bouck & Richardson, 2013). The success of inclusion needs students with special educational needs to be included academically and socially with the help of assistive technology (Chmiliar, 2017; Erdem, 2017; Chambers, 2019). While the literature demonstrates that teachers' knowledge as an important factor in influencing their use of assistive technology, it also shows lacking of knowledge in teachers cause them to be incompetent, influence their confidence level and also influence the frequent use of assistive technology in class (Alkahtani, 2013; Yamamoto & Yamaguchi, 2017; Chukwuemeka & Samaila, 2020; Thurm & Barzel, 2020). Furthermore, studies found that lacking knowledge in teachers caused the assistive technology to be underused as teaching using technology is not a straight forward task, teachers will need the knowledge in understanding the digital tools techniques (Drijvers, 2019; Chukwuemeka & Samaila, 2020). With the technology has not been utilised and incorporate in the inclusive classroom, it will affect students' learning and widen the achievement gap between the able and disable kids in an inclusive classroom.

Comparatively, most of literatures demonstrate that assistive technology helps SEN students in learning, to engage and collaborate with peers from students' perspectives and this shows that there is a dearth of literature directly targeting teachers' perspectives of their knowledge and use of assistive technology, particularly in inclusive education. This means that there is a lack of systematic research on teacher knowledge and their use of assistive technology in relation to the inclusive education context. Teachers' experiences in using assistive technology which build or enhance this positive learning environment can enhance the essence of assistive technology immersion which allow the researcher to see the context from a different perspective. Thus, systematic review is needed to report the current understanding as well as fill the gap in current research on the influence of knowledge on teachers' use of assistive technology.

2.   Method

This study aims at analysing studies of the Influence of teachers' knowledge on the use of assistive technology primarily in the inclusive education through systematic review. Systematic review designed to be comprehensive, robust, inclusive, transparent, and reproducible when bringing together the evidence to answer a research question and it is a scientific tool that can be used to select the relevant studies in all design, then summarise, appraise and communicate the results of these unmanageable studies in answering a particular research question (Petticrew & Roberts, 2006; Bethel, Rogers & Abbott, 2021). Thus, a systematic review of the influence of teachers' knowledge on the use of assistive technology is important in identifying, evaluating and summarising all the relevant studies, provide an authoritative overview of current studies that are related to teachers' knowledge and the use of assistive technology and making the available evidence more accessible to teachers and decision makers in inclusive education.

The review is guided by the following review question: "What is the influence of teacher knowledge on the use of assistive technology?" The synthesis of this review went through seven stages as guided by Petticrew and Roberts' framework included defining review question, determining the types of studies needed to answer the review question, carrying out the literature search, screening the references and assessing the remaining studies against the inclusion/exclusion criteria, critical appraisal, synthesis of primary studies and considering the effects of publication bias and other internal and external biases (Petticrew & Roberts, 2006). A search by employing keywords such as technological knowledge, knowledge, assistive technology, adaptive technology and teacher in the electronic database included ERIC (Educational Resource Index and Abstracts), EBSCOhost by Elton B. Stephens Company and Scopus. Furthermore, several Boolean phrases were used, such as AND, OR, NOT, to reduce the duration of seeking for the relevant studies for the research aim. Qualitative and quantitative studies which collected data on teachers' perception about their knowledge and their use of assistive technologies have been included in this study to include broader range of evidence and reduce the risk of biased conclusions.

2.1. Inclusion and Exclusion Criteria

The inclusion criteria for this initial search to look for relevant studies were:
  i.   the study must be published in English
  ii.   the study must include the specific keywords mentioned above, published between January, 2011 and January, 2021
  iii. participants must be a teacher with no age limit, either from primary or secondary school
  iv.   all gender and any country
  v.   Teachers' knowledge and the use of assistive technology must the key measurements/assessments, with evidence.

In order to refine search result, four exclusion criteria were used considering the review question. Important to noted that, if a study that had been published in other types of publications (books, books chapter, conference paper and dissertations), did not include the use of assistive technology as a teaching tool, published in another language other than English and was not an empirical study were excluded. Following this process, 131 articles were extracted from ERIC, 324 articles were extracted from EBSCOhost, and 311 articles were extracted from the SCOPUS database. After reading the abstract, 45 articles were selected for screening process. Among the remaining 45 articles, 9 duplicate records were omitted for full texts articles assessed for eligibility. For eligibility and fulfilment of the requirements based on the inclusion

and exclusion criteria for this review, researcher successfully yielded 11 relevant studies which were selected to be included in this review. Next, an additional inclusion criterion which was the influence/relationship between teacher self-efficacy and use of assistive technology had to be measured. With this, 6 studies were left and included for in depth review.

3. Data Extraction

The 6 studies were systematically review and relevant information from the studies were extracted. The types of data extracted from the identified relevant studies were based on the review question. As this review aims at addressing the influence of teachers' knowledge on the use of assistive technology in the inclusive education context, data included the sample population, country where the research was conducted, year of publication, number of participants, research method, sampling method and finally research findings were the relevant information extracted from the articles and were tabulated in table 1 below.

Table 1 General Characteristics of the Studies

Authors	YOP	Country	Method	NOP	SM	SP	TK	Findings
Atanga, Jones, Krueger & Lu	2019	USA	Quantitative	62	Random	PST SST	limited	Knowledge +ve use of AT
Lamond & Cunningham	2019	Canada	Mixed Method	24	Non Random	PST SST	Adequate	Knowledge +ve use of AT
Flanagan, Bouck & Richardson	2013	USA	Mixed Method	51	Random	SST	Lack	Knowledge +ve use of AT
Alkahtani	2013	Saudi Arabia	Mixed Method	127	Random	-	Lack	Knowledge +ve use of AT
Fernández-Batanero & Lopez	2019	Spain	Quantitative	777	Non Random	PST	Sufficient	Knowledge +ve use of AT
Abed	2018	Saudi Arabia	Qualitative	20	Non Random	-	Lack	Knowledge +ve use of AT

Note. YOP= Year of Publication; SP= Sample Population; SM= Sampling Method; NOP= Number of Participants; PST= Primary School Teachers; SST= Secondary School Teachers; TK= Teachers' knowledge; AT= Assistive Technology; +ve= positively influenced; -ve= negatively influenced

Followed by data extraction, the quality of the studies was analysed using the EPPI-Centre Weight of Evidence (WoE) tool by Gough (2007). Initially, the quality of the study was being analysed from the three different perspectives which included the coherency and integrity of the study (WoE A), the appropriateness of the form of evidence (WoE B) and the relevance focus of the evidence in answering the review question (WoE C). In order to make a final decision deciding the quality of the study, an overall assessment was done (WoE D), compiling the three separate judgements.

As the analysis shown in Table 2, two of the studies were rated as high-quality research due to one of their primary focus of the studies looking at the impact of teachers' knowledge on the use of assistive technology, design of the study and the process of recruiting participants were clearly explained, limitations of the studies were cited and have the reliability of measurements indicating high coherency and integrity while evidence in the studies were found to be relevance and appropriate in answering the review question (Lamond & Cunningham, 2019; Flanagan, et. Al., 2013). On the other hand, the integrity and relevance focus of the evidence are not as convincing when the limitation of the study was not mentioned (Alkahtani, 2013), small sample size was used (Atanga, et. al., 2019) and the influence of teachers' knowledge on the use of assistive technology but was not the main focus of the study (Atanga, et. al., 2019; Fernández-Batanero & Lopez, 2019) which affected the quality of the studies. The overall WoE for the studies done by Abed (2018) was rated as medium quality research due to the lack of clarity in how the participants were recruited, limitation of the study did not mention and the interpretations of the result for his qualitative study without the use of verbatim quotations from the participants.

Table 2: Analysis of the Quality of the Studies using Weight of evidence (WoE) Framework

Study	WoE A	WoE B	WoE C	WoE D
Atanga, et. al. (2019)	High	Medium	Medium	Medium/High
Lamond & Cunningham (2019)	High	High	High	High
Flanagan, et. al. (2013)	High	High	High	High
Alkahtani (2013)	Medium	Medium/High	Medium/High	Medium/High
Fernández-Batanero & Lopez (2019)	High	Medium	Medium	Medium/High
Abed (2018)	Medium	Medium	Medium	Medium

4. Discussion

The overall review and synthesis of the studies have revealed that teachers' knowledge has a positive influence on the use of assistive technology among primary and secondary teachers. This finding is also consistent with the findings in previous studies where teachers' knowledge was found to be crucial in allowing them to be more involve and competent in using assistive technology (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur and Sendurur, 2012; DePountis, Pogrund, Griffin-Shirley, & Lan, 2015; Siyam, 2018; Arouri, et. al., 2020). Interestingly, even for teachers who are lacking of technological knowledge, they do agreed that with more knowledge, they will be more confident in using assistive technology (Atangan, et. al., 2019; Flanagan, et. al., 2013; Alkahtani, 2013; Abed, 2018). Relatedly, despite having lesser years of experience, younger teachers were reported to have higher level of technological knowledge due to the training and exposure on assistive technology that they have exposed to during their preservice teacher education program (Lamond & Cunningham, 2019; Fernández-Batanero & Lopez, 2019). Next, from the 6 articles that had been reviewed, most of the studies were carried out in the developed countries like USA (n=2), Canada (n=1) and Spain (n=1) (Atanga, et. al., 2019; Lamond & Cunningham; 2019; Flanagan, et. al., 2013; Fernández-Batanero & Lopez, 2019). This also shown that studies on the influence of teachers' knowledge and the use of assistive technologies were lacking in the Asia context, let alone Malaysia.

Besides, sample sizes of the studies varied widely from 20 participants to 777 participants. In relation to the methodologies employed by the studies reviewed, it was found that most of the researchers employed mixed-method study which indicated researchers began to value and aim to gain more insight around issues related to teachers' knowledge and their use of assistive technology from teachers' perspectives in the inclusive education context (Lamond & Cunningham, 2019; Flanagan, et. Al., 2013; Alkahtani, 2013). Survey and questionnaire were used as the major data collection tools in most of the studies (Atanga, et. Al., 2019; Lamond & Cunningham, 2019; Flanagan, et. Al., 2013; Alkahtani, 2013; Fernández-Batanero & Lopez, 2019). Besides using survey and questionnaire, the mixed-method studies and the solely qualitative study also used open-ended questions or interview to collect in-depth data, exploring teachers' technological knowledge and their use of assistive technology (Lamond & Cunningham, 2019; Flanagan, et. al., 2013; Alkahtani, 2013; Abed, 2018).

On the other hand, analysing the gender of participants who took part in the studies, five out of six studies had a female-dominated sample (Atanga, et. Al., 2019; Flanagan, et. Al., 2013; Fernández-Batanero & Lopez, 2019; Alkahtani, 2013; Lamond & Cunningham, 2019). Therefore, as for recommendation, more studies can be done which involve more male teachers where comparison of their level of knowledge and the use of assistive technology can be done between male and female teachers. As there is lacking of studies being done solely either in primary or secondary school, considering only the primary school or secondary school context could potentially yield an interesting finding. While the systematic review shows that most of the teachers were lacking of technological knowledge, perhaps for future recommendation, researchers can look into preparedness of pre-service teachers for assistive technology use in inclusive education to ensure they have sufficient knowledge for the use of assistive technology in teaching. It will be interesting to explore how knowledge of assistive technology of teachers change or develop from preservice to in-service teacher and looking at how or where is the area which can further be improved to help the implementation of assistive technology in teaching students with special educational needs in an inclusive classroom.

5. Conclusion

Assistive technology knowledge encourages teachers' use of assistive technology and increase their self-rated proficiency, in another word believe that they are more skillful in using assistive technology (Atanga, et. Al., 2019; Lamond & Cunningham, 2019; Flanagan, et. Al., 2013). Therefore, it is rational to suggest that teachers' knowledge, which defined as technological knowledge in the TPACK framework, have a positive influence on the use of assistive technology. With adequate knowledge in assistive technology, teachers will be more confident in ICT adoption and assistive technology implementation which allow learners to be supported with the learning aids. The present systematic review of 6 studies on teachers' knowledge and the use of assistive technology has revealed to us that there are areas around issues of teacher self-efficacy and use of assistive technology that need to be researched. Firstly, ways to increase teachers' knowledge as this is not only influencing their use of assistive technology but also their confidence level in assistive technology. Secondly, trainings in the area of assistive technology can be explored further as this was also being requested by teachers or suggested by researchers in a few studies (Lamond & Cunningham, 2019; Abed, 2018; Flanagan, et. Al., 2013; Fernández-Batanero & Lopez, 2019). There are a few limitations of this study which include the variability of the measures used for teachers' knowledge and their use of assistive technology. Searches of studies, screening of references and quality rating were done by one researcher which might result in reporting bias. In conclusion, this review has presented findings and recommendations to assist researchers in the overall understanding of the current literature on teachers' knowledge and the use of assistive technology and have suggested a few recommendations for future studies.

References

Abed, M. G. (2018). Teachers' Perspectives Surrounding ICT Use amongst SEN Students in the Mainstream Educational Setting. *World Journal of Education*, *8*(1), 6–16.

Ahmad, F.K. (2015). Use of assistive technology in inclusive education: making room for diverse learning needs. *Transcience*, 6(2), 62-77.

Alkahtani, K.D. (2013). Teachers' Knowledge and Use of Assistive Technology for Students with Special Educational Needs. *Journal of Studies in Education, 3*, 65-86.

Atanga, C., Jones, B. A., Krueger, L. E., & Lu, S. (2020). Teachers of Students with Learning Disabilities: Assistive Technology Knowledge, Perceptions, Interests, and Barriers. *Journal of Special Education Technology*, *35*(4), 236–248.

Arouri, Y. M., Attiyah, A. A., Dababneh, K., & Hamaidi, D. A. (2020). Kindergarten Teachers' Views of Assistive Technology Use in the Education of Children with Disabilities in Qatar. *European Journal of Contemporary Education*, *9*(2), 290–300.

Bethel, A. C., Rogers, M., & Abbott, R. (2021). Use of a search summary table to improve systematic review search methods, results, and efficiency. *Journal of the Medical Library Association*, *109*(1), 97–106. https://doi-org.newdc.oum.edu.my/10.5195/jmla.2021.809

Bower, M., Hedberg, J., & Kuswara, A. (2010). A framework for Web 2.0 learning design. *Educational Media International*, *47*(3), 177–198. https://doi-org.newdc.oum.edu.my/10.1080/09523987.2010.518811

Chambers, D. (2020). *Assistive technology to support inclusive education* (First ed., International perspectives on inclusive education, v. 14). Bingley, U.K.: Emerald Publishing Limited

Chmiliar, L. (2017). Improving learning outcomes: The iPad and preschool children with disabilities. *Frontiers in Psychology*, 8, 660. doi:10.3389/fpsyg.2017.00660

Chukwuemeka, E. J., & Samaila, D. (2020). Teachers' Perception and Factors Limiting the Use of High-Tech Assistive Technology in Special Education Schools in Northwest Nigeria. *Contemporary Educational Technology*, *11*(1), 99–109.

Cox S. & Graham C.R. (2009) Diagramming TPACK in practice: using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends* 53, 60–69.

Cranmer, S. (2020). Disabled children's evolving digital use practices to support formal learning. A missed opportunity for inclusion. *British Journal of Educational Technology*, *51*(2), 315–330. https://doi-org.newdc.oum.edu.my/10.1111/bjet.12827

Demirok, M. S., & Baglama, B. (2018). Examining Technological and Pedagogical Content Knowledge of Special Education Teachers Based on Various Variables. *TEM Journal*, *7*(3), 507–512. https://doi-org.newdc.oum.edu.my/10.18421/TEM73-06

DePountis, V. M., Pogrund, R. L., Griffin-Shirley, N., & Lan, W. Y. (2015). Technologies Used in the Study of Advanced Mathematics by Students Who Are Visually Impaired in Classrooms: Teachers' Perspectives. *Journal of Visual Impairment & Blindness*, *109*(4), 265–278.

Drijvers, P. (2019). *Head in the clouds, feet on the ground—A realistic view on using digital tools in mathematics education.* In A. Büchter, M. Glade, R. Herold-Blasius, M. Klinger, F. Schacht, & P. Scherer (Eds.), Vielfältige Zugänge zum Mathematikunterricht (pp. 163–176). Wiesbaden: Springer.

Edyburn, D. L. (2013). Critical issues in advancing the special education technology evidence base. *Exceptional Children*, 80, 7. doi: 10.1177/001440291308000107

Erdem, R. (2017). Students with Special Educational Needs and Assistive Technologies: A Literature Review. *Turkish Online Journal of Educational Technology - TOJET*, *16*(1), 128–146.

Ertmer, P. A., & Ottenbreit-Leftwich, A. (2013). Removing Obstacles to the Pedagogical Changes Required by Jonassen's Vision of Authentic Technology-Enabled Learning. *Computers & Education*, *64*, 175–182.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher Beliefs and Technology Integration Practices: A Critical Relationship. *Computers & Education*, *59*(2), 423–435.

Fernández, B. J. M., Cabero, J., & López, E. (2019). Knowledge and degree of training of primary education teachers in relation to ICT taught to students with disabilities. *British Journal of Educational Technology*, *50*(4), 1961–1978. https://doi-org.newdc.oum.edu.my/10.1111/bjet.12675

Flanagan, S., Bouck, E. C., & Richardson, J. (2013). Middle School Special Education Teachers' Perceptions and Use of Assistive Technology in Literacy Instruction. *Assistive Technology*, *25*(1), 24–30.

Gough, D. (2007). Weight of Evidence: A Framework for the Appraisal of the Quality and Relevance of Evidence. *Research Papers in Education*, *22*(2), 213–228.

Hutchison, A., Beschorner, B., & Schmidt-Crawford, D. (2012). Exploring the use of the iPad for literacy learning. *The Reading Teacher*, 66, 15–23. doi:10.1002/TRTR.01090

Jones, V. L. and Hinesmon-Matthews, L. J. (2014) Effective assistive technology consideration and implications for diverse students. *Computers In The Schools*, 31, 3, 220–232.

Lamond, B., & Cunningham, T. (2020). Understanding Teacher Perceptions of Assistive Technology. *Journal of Special Education Technology*, *35*(2), 97–108.

Lee, M.H., & Tsai, C.C. (2010). Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. Instructional Science: *An International Journal of the Learning Sciences*, 38(1),1–21.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, 108(6), 1017–1054.

Nkwoagba, O. S. (2011). Independent living for persons with special needs through assistive technology. *Child Care and Special Needs Education in Nigeria,* 3(1), 16 – 25.

Park, H. J., Takahashi, K., Roberts, K. D., & Delise, D. (2017). Effects of text-to-speech software use on the reading proficiency of high school struggling readers. *Assistive Technology*, *29*(3), 146–152

Petticrew, M. & Roberts, H. (2006). *Systematic reviews in the social sciences. A practical guide*. Oxford: Blackwell

Redford, K. (2019). ASSISTIVE TECHNOLOGY: Promises Fulfilled: From a teacher's perspective, assistive technology delivers on its potential to transform learning experiences for students with—and without—learning disabilities. *Educational Leadership*, *76*(5), 70–74.

Thinzarkyaw, W. (2020). The Practice of Technological Pedagogical Content Knowledge of Teacher Educators in Education Colleges in Myanmar. *Contemporary Educational Technology*, *11*(2), 159–176.

Thurm, D., & Barzel, B. (2020). Effects of a Professional Development Program for Teaching Mathematics with Technology on Teachers' Beliefs, Self-Efficacy and Practices. *ZDM: Mathematics Education*, *52*(7), 1411–1422.

Tony, M. P. (2019). *The effectiveness of Assistive Technology to support children with specific learning disabilities: Teacher Perspectives*. Jonkoping University. Available: https://www.diva-portal.org/smash/get/diva2:1321161/FULLTEXT01.pdf

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123-149.

Shapley, K., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2011). Effects of Technology Immersion on Middle School Students' Learning Opportunities and Achievement. *Journal of Educational Research*, *104*(5), 299–315. https://doi-org.newdc.oum.edu.my/10.1080/00220671003767615

Shulman, L. S. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher*, *15*, 4–14. https://doi-org.newdc.oum.edu.my/10.3102/0013189X015002004

Siyam, N. (2018). Special Education Teachers' Perceptions on Using Technology for Communication Practices. *Journal for Researching Education Practice and Theory,* 1(2), 6-18.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge - a review of the literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. https://doi-org.newdc.oum.edu.my/10.1111/j.1365-2729.2012.00487.x

World Health Organisation (WHO). (2015). *Assistive Technology for Children with Disabilities: Creating Opportunities for Education, Inclusion and Participation*. Retrieved from https://www.unicef.org/disabilities/files/Assistive-Tech-Web.pdf