A Rapid Evidence Assessment of the effectiveness of educational interventions to support children and young people with vision impairment

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A Rapid Evidence Assessment of the effectiveness of educational interventions to support children and young people with vision impairment

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Glossary

AAC	augmentative and alternative communication
ALN	additional learning needs
BAUK	braille authority of the United Kingdom, now: UKAAF (UK Association of Accessible Formats)
braille	the most commonly used tactile reading and writing system by people with vision impairment who cannot access print materials
CCTV	closed-circuit television (a type of LVD)
CP	communication partners
CTD	constant time delay
CVI	cortical vision impairment
ECC	expanded core curriculum
educational strategy	umbrella term used to describe an area of intervention (e.g. literacy, communication)
LMA	learning media assessment
LVD	low vision device (optical or electronic)
Moon	a tactile code used by some people with vision impairment as an alternative to print or braille
O&M	orientation and mobility
PECS	picture exchange communication system
QHA	qualified habilitation assistant
QHS	qualified habilitation specialist
QTVI	qualified teacher of children and young people with vision impairment
REA	rapid evidence assessment
SEN	special educational needs
TTT	talking tactile tablet
UEB	universal English braille
VI	vision Impairment
VISO	voice input/speech output

1. Introduction

1.1 The Welsh Government commissioned the University of Birmingham to undertake a rapid evidence assessment (REA) into the extent to which interventions to support learners affected by vision impairment are effective. The purpose of the review is to facilitate the planning and delivery of early, timely and effective interventions to support children and young people with vision impairment.

1.2 The Additional Learning Needs and Education Tribunal (Wales) Act (the Act) received royal assent in January 2018. The Act introduces a new additional learning system, which has three overarching objectives:

- a unified legislative framework to support all children and young people with additional learning needs (ALN) from birth up to the age of 25, where they remain in education
- an integrated, collaborative process of assessment, planning and monitoring which facilitates early, timely and effective interventions
- a fair and transparent system for providing information and advice, and for resolving concerns and appeals.

1.3 The Act provides for a single plan – the individual development plan (IDP) – which will replace the range of statutory and non-statutory plans for learners with special educational needs or learning difficulties and/or disabilities.

1.4 The Act forms part of a wider package of reforms, which aim to transform the expectations, experiences and outcomes for children and young people with ALN. One key area of the transformation programme focuses on awareness raising, to facilitate those involved in the ALN system to better understand the evidence of good practice, what can be expected from interventions, the interventions most likely to be effective, and the role of professionals. This is to help inform expectations and the effective deployment of resources.

1.5 This report has been prepared for the Welsh Government and provides a synthesis of the findings of the REA. These findings are intended to inform the development of a document regarding evidence based practice for practitioners and parents, to raise awareness amongst those engaging with

young learners with vision impairment in educational settings about various interventions and their effectiveness.

Population of children with vision impairment

Definition of Vision Impairment

1.6 There is no universally adopted definition of vision impairment in relation to children and young people, with the term describing a wide continuum of 'loss in visual function' (Douglas and McLinden, 2005). Depending on the context, a number of terms are used in the literature to describe the degree of vision loss in children including:

- *Severely sight impaired/blind* – a designation of vision impairment in the United Kingdom (UK) that involves a medical diagnosis by an ophthalmologist (i.e. to certify that the individual is eligible to be registered as 'severely sight impaired'/'blind'). Although the term means that a child is likely to function mainly through touch and hearing, it does not necessarily mean that the child has no *useful* vision at all.
- *Sight impaired/partially sighted* – a designation of vision impairment in the UK that involves a medical diagnosis by an ophthalmologist (i.e. to certify that the individual is eligible to be registered as 'sight impaired'/'partially sighted'). A child will have sufficient vision to manage some tasks but may require the help of specialist teaching methods and materials in school to account for his or her vision difficulties.
- *Low vision* – a commonly used term to describe a broad continuum of loss in visual function. Children described as having 'low vision' have restricted vision but can make use of this for learning with appropriate modification. They may be able to see work in close-up, with the aid of good lighting, careful positioning and low vision aids such as magnifiers.

1.7 A broad distinction is often made in the literature between vision conditions that are either 'ocular' or 'cortical' in nature. Ocular conditions affect parts of the eye itself and commonly include refractive errors such as astigmatism and severe myopia (or short-sightedness). The loss arising from a given

ocular vision condition can include a number of areas of function such as visual acuity (the ability to resolve detail), accommodation (the ability to focus), field of vision (the area which can be seen), colour vision, and adaptability to light. Cortical vision impairment (CVI) is also known as cerebral vision impairment/dysfunction and affects the child's *processing* of visual information. CVI is particularly prevalent in children who have more complex needs and may be diagnosed by itself, or "may coexist with ocular forms of visual impairment" (Roman-Lantzy, 2007, p3).

1.8 It is important to note that the majority of children with a vision impairment, including those classified as 'blind', do have some residual vision that can potentially be optimised and utilised in daily tasks and activities such as reading and mobility. For those children, it is widely acknowledged that medical descriptions of vision impairment (based on a clinical assessment of visual function) do not provide an accurate indication of how the child is able to use their vision for functional activities – or *functional vision*. For this reason, educational services for vision impaired children will usually make decisions about services they offer to children based upon *need* which draws upon *functional implications* of vision impairment as well as clinical assessments (Douglas et al., 2009).

1.9 It should be noted that the Welsh Government uses its own classification of vision impairment and gathers data on pupils with vision impairment as part of the PLASC data[1].

Numbers and Prevalence

1.10 In a review of prevalence studies in the UK, Tate et al. (2006) note that drawing upon "a broad and pragmatic definition of visual loss", (i.e. taken to mean a child is identified as being in need of special educational or social services), the data suggests a prevalence of vision impairment in the region of 1-2 children per 1,000. This compares with higher estimates based upon the number of children receiving *educational* support in relation to their vision impairment in the UK of 2.4 children per 1,000 (Keil, 2003). A useful way of

[1] Guidance for school information management systems

translating these figures to educational practice, and indeed to highlight the relative 'low incidence' nature of vision impairment, is to think about these figures as equating to approximately 1-2 children in a secondary school with a pupil roll of 1,000 children.

1.11 There is a wealth of evidence to show that a high proportion of children have disabilities in combination with a recognised vision impairment, although a range of terms are used in the literature to describe this combination of needs (e.g. McLinden and McCall, 2002). As examples, Ravenscroft et al. (2008) reported that 71% of children in Scotland with vision impairment have 'additional' disabilities, while a study by Flanagan et al. (2003) in Northern Ireland noted that 79% of their sample had "additional medical problems" (p. 493). The range of need within the 'sub-group' of children with 'additional' disabilities can be illustrated through reference to a 2015 key facts document about children and young people with vision impairment produced by Vision 2020, which reports that "Around 20 per cent of young people with vision impairment have additional special educational needs and/or disabilities (SEND) and further 30 per cent have complex needs." (Vision 2020, 2015).

1.12 Whilst a range of terms are drawn upon in the educational literature, the professional association of the vision impairment workforce in the UK (VIEW) and the RNIB currently make reference to the term 'complex needs' as a broad term to describe the combination of vision impairment and significant additional disabilities. For the purpose of this review, therefore, we will align our terminology with this practice unless making reference to a particular term that is used when describing a research study.

Conceptual framework and targeted educational outcomes

1.13 Vision impairment education in the United Kingdom has a long tradition of focussing upon two broad areas of targeted educational outcomes and associated interventions:

1. Ensuring young people have fair and optimised access to the school curriculum.
2. Ensuring young people have opportunities to develop their independence and social inclusion.

1.14 The first area is concerned with equal access to education. The second area is partly linked to maximising children and young people's ability to develop as independent learners within the school environment, but also part of a broader agenda about preparation for adult life, independent living and employment. The philosophy underpinning this broad distinction is based on a 'rights' agenda which demands fair and equal access to education for all children and young people, but also a concern that an individual child/young person should have agency, self-determination and independence.

1.15 Authors in the field of vision impairment education have articulated this distinction in a variety of ways reflecting particular perspectives about the nature and role of intervention for children and young people, e.g. desired educational outcomes, the conception of the curriculum, the provision of inclusive/specialist services and the training of professionals. More recently, this distinction has been captured through reference to a dual-model of access that draws on the terms 'access to learning' and 'learning to access' (e.g. McLinden and Douglas, 2014; McLinden at al., 2016; Hewett et al., 2017; Douglas et al., 2018). It is argued that this model provides a framework and vocabulary to address the broad concerns of the field, within which different interventions and targeted educational outcomes can be aligned:

- *Access to learning approaches*: inclusive practice and differentiation, ensuring that the child's environment is structured and modified to promote inclusion, learning and access to the core curriculum, the culture of the school and broader social inclusion.
- *Learning to access approaches*: teaching provision which supports the child to learn independence skills and develop agency in order to afford more independent learning and social inclusion.

1.16 The areas of intervention captured within the terms 'access to learning'/'learning to access' are most commonly discussed in relation to the school curriculum, with a particular emphasis on and the distinction between a 'core' curriculum and an 'additional' or 'expanded curriculum'. The latter is used as a term to include areas which would not typically be taught in

schools as part of a core curriculum, such as mobility, low vision and information access, and social skills (e.g. having friendship groups and self-advocacy skills). In the USA, the term ‘expanded core curriculum’ (ECC) is used to describe these areas and is defined, as having nine areas: compensatory or access skills, career education, independent living skills, orientation and mobility (O&M) skills and concepts, recreational and leisure skills, self-determination skills, social interaction skills, use of assistive technology, and sensory efficiency skills (e.g. Hatlen, 1996; Koenig & Holbrook, 2000; Sapp and Hatlen, 2010).

1.17 Sapp and Hatlen (2010) presented case studies of two 20-year-old men to illustrate how the ECC is linked with a broad notion of independence. The two men had similar academic achievements but very contrasting levels of independence. The authors argued that their contrasting outcomes could be explained by the fact that one young man had benefitted from sustained ECC intervention throughout his school career whilst the other young man’s teaching intervention solely focussed upon material preparation, support for academic teaching, and explaining his special needs to classroom teachers and other pupils.

1.18 Figure 1 summarises the links between the overarching conception of the field of vision impairment education and how this links with targeted interventions. The interventions (and the implicit associated educational outcomes) in relation to ‘learning to access’ are aligned to aspects of the ECC as described above. This includes the teaching of: mobility; the use of access technology; as well as independent living skills. The interventions in relation to ‘access to learning’ are more closely aligned with what might be commonly described as inclusive practice and accommodations/adjustments.

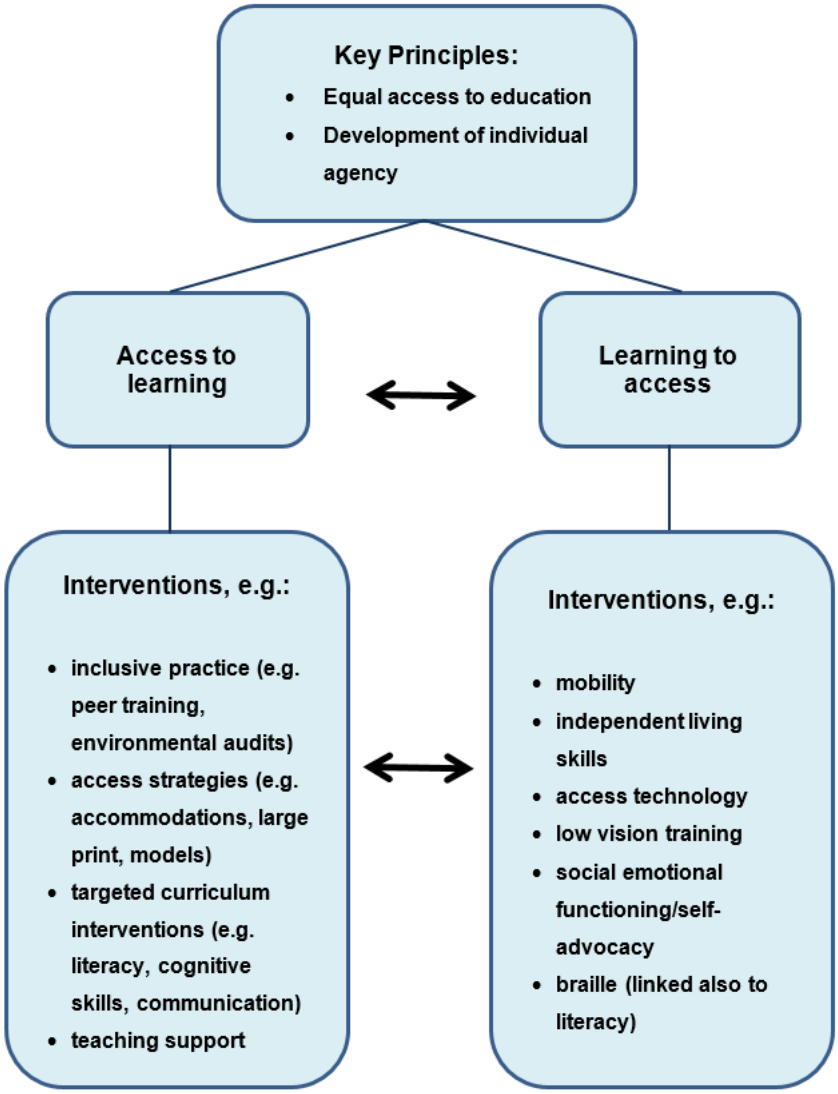

Figure 1: Relationship between overarching conception in the field of vision impairment education and how this links to targeted interventions

1.19 Whilst shown as separate pathways in Figure 1 in practice there will be overlap between these broad curriculum areas (as illustrated by the horizontal arrows). Indeed, Sapp and Hatlen (2010) argue that many ECC skills can be embedded in the 'core' curriculum noting that "Many general education curricula include skills that overlap the ECC, such as working in groups (social skills), learning about different jobs (career education), reading a map (O&M), and managing money (independent living skills)" (p. 344). This highlights the importance of the principles of a dual model of learning being facilitated in the classroom.

1.20 The focus of this REA is to assess the evidence of the *effectiveness* of the range of interventions in the field of vision impairment education. The discussion above provides a broad rationale for the types of interventions of concern. Even so, there are common ‘dilemmas and tensions’ in inclusive education (see, for example, Norwich, 2013) which are separate from the relative efficacy of given interventions. Rather these tensions are linked to different views of what the desired educational outcome should be. In vision impairment education this is linked to the different emphasis which is given to the two traditions outlined above: emphasis upon equal access versus development of individual agency; emphasis upon ‘access to learning’ versus ‘learning to access’. Examples of this include:

- text modification print enlargement versus development of technology skills
- sighted guide versus mobility teaching
- braille versus the use of computer technology
- anticipatory adjustments versus teaching of self-advocacy skills.

1.21 Clearly some of these decisions (and practical routes through the dilemmas) are not about the relative efficacy of interventions but what individual stakeholders and policies deem to be the ‘right thing to do’. Nevertheless, there are very practical and pragmatic challenges for parents, teachers and young people to navigate. A common challenge is responding to the ‘here and now’ needs of curriculum access, while at the same time attending to the longer term targets linked to developing and promoting independence (Douglas et al., 2011). Another undoubted challenge facing educators is knowing *how* to implement the ECC “given the time constraints of the school day” (Wolffe & Kelly, 2011, p. 341). Douglas et al., (2016) argue that educational systems which emphasise national assessments for the purposes of accountability (as is the case in the US and the UK) are in danger of narrowing the curriculum at the expense of disability-specific curriculum areas.

2. Methodology

2.1 The design of the REA agreed with the Welsh Government is split into five stages:

- Stage 1: Literature search and inclusion/exclusion criteria framework
- Stage 2: Refining the search
- Stage 3: Assessing the quality
- Stage 4: Data extraction
- Stage 5: Data synthesis/report production

Stage 1: Literature search and inclusion/exclusion criteria framework

2.2 The aim of stage 1 was to carry out searches using the databases and search terms specified below and to apply an inclusion/exclusion criteria framework. Following discussions with Welsh Government, it was noted that the specification for the REA was very broad in focus, seeking to look at interventions as a whole rather than focussing upon a specific type of intervention or targeted educational outcome (e.g. teaching reading). The REA was linked to all educational outcomes which the research team sought to simplify into thirteen broad educational strategies. This can be contrasted with other REAs undertaken in other disciplines which might seek evidence of the successful interventions in relation to much narrower target outcomes (for example in relation to ADHD, the focus may be linked to the reduction in particular defining behaviours).

2.3 Educational strategies were drawn from our initial conceptual work and captured broad educational areas and interventions associated with vision impairment education. These are listed in the table below:

Table 1: Vision impairment educational strategies – summary descriptions of 13 educational strategies

Educational Strategy	Description of the educational strategy
Communication	Supporting the development of communication skills, including focussing upon early communication and language development. Including alternative and augmentative communication systems.
Literacy	Supporting the development of reading and/or writing skills. This includes print, braille, and Moon (a tactile code based upon raised lines); as well as low vision access to print (e.g. CCTVs, technology).
Mathematics	Supporting the development of mathematical skills, including specialist braille codes, technology.
Access to examinations	Assessment accommodations/modifications.
Mobility and Independence	Supporting the development of mobility and orientation (including cane skills), independence and living skills.
Cognitive skills	Supporting the development of a range of cognitive skills (e.g. thinking skills, theory of mind, metacognitive strategies, working memory).
Social and emotional functioning	Supporting development of self-esteem, peer relationships, friendships and peer acceptance.
Use of technology	Supporting the development to use educational, enabling and access technology.
Low vision training	Supporting the development of functional vision (e.g. visual/low vision training, including use of optical and electronic magnification devices/low vision aids).
Teaching support	The use of various teaching support techniques (generally human support, e.g. learning support assistant, teaching assistant) to support children's learning.
Teaching Strategies	The use of teaching strategies to support learning, often the strategies involve the use of accessible/modified/alternative learning materials (often giving access to curriculum and experiences which would otherwise be difficult with 'traditional' approaches).
Minority Language	Approaches which are particularly concerned with teaching children with a vision impairment in a dual-language and/or multicultural context. This is linked to the importance of Welsh-medium education in Wales.
Inclusion	The use of environmental adjustments, inclusive practice, peer, teacher, and parental training to support and enable the learning environment.

2.4 Searching the literature in relation to the educational strategies described above was operationalised as thirteen separate searches of several

databases. Details of the search terms and procedure are presented in **Annex A: Database sources**, search terms. In summary:

- **Databases**. The search was carried out in four databases: (1) EBSCO Education Databases, (2) PsychInfo, (3) Proquest Social Sciences and (4) Web of Science. Some additional hand searches were also carried out.
- **Search structure**. Our broad search involved a series of searches with the following structure:
    - Age (various terms to include research relevant children and young people under the age of 25 years)
    - Vision impairment
    - Educational strategies (thirteen broad educational strategies – see above).

- **Filtering by types of materials and relevance.** Further inclusion and exclusion criteria, most notably: literature from 1980 onwards, published in English or Welsh, and based in OECD countries. The date of 1980 was chosen as an approximate time scale when education practice in relation to disability started to more clearly reflect current practice (e.g. in England and Wales through the 1981 Education Act), in particular the acceleration of the creation of services in the UK which supported the education of children with vision impairment in mainstream schools.

Number of sources identified (four databases)

2.5 The sources (references and abstracts) generated after applying the above were collated in EndNote (a bibliographic data software package) and duplicate citations were removed.

Table 2: Number of results from each database for each sensory field, plus totals after removing duplicates

Databases	Sensory field	Number of results
EBSCO	Vision impairment	3,247
PsychInfo	Vision impairment	954
Proquest Social Sciences	Vision impairment	2,356
Web of Science	Vision impairment	8,235
Totals (removing duplicates)	Vision impairment	14,786

Stage 2: Refining the search

2.6 The aim of the stage 2 was to narrow the material down from the initial search to ensure the most relevant material was selected.

2.7 A separate Endnote database for each subject area was created. The sources in each Endnote database were scrutinised based on the inclusion and exclusion criteria regarding the relevance of the study through reference to the title and abstract of each source. More details are presented in **Annex A: Database sources**, search terms.

2.8 In addition to the review needing to cover the huge breadth of ‘interventions’, there is a related challenge of defining the term 'intervention' itself. The working definition of an intervention study was ‘studies which sought to describe the effect of some kind of educational approach upon a targeted outcome. These studies might be qualitative designs, controlled trials, or single subject designs.’

2.9 In order to contextualise this definition further, the invitation to tender offers the following definition of the interventions of interest:

> “For the purposes of this research, an intervention is defined as SEP [special educational provision] as set out in the Education Act 1996 ‘education provision which is additional to or otherwise different from the education provision made generally for children of their age in maintained schools, other than special schools, in the area. For children aged under two SEP is considered to be education provision of any kind.” (p11)

2.10 Our proposal also unpicked special educational provision further and made a distinction between.

- Inclusive practice and differentiation: ensuring that the child's environment is structured to promote inclusion and learning throughout their education.
- Additional learning provision: supporting the child to learn distinctive skills in order to afford more independent learning.

2.11 Such a broad and inclusive definition of intervention is helpful in ensuring valuable evidence is included in this REA which is broad in scope. Nevertheless, such a definition is difficult to operationalise. The working solution agreed with the Welsh Government was to make a distinction between the following categories of sources: (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention'. All the sources in each Endnote database were categorised in this way. The table below outlines the criteria for this categorisation.

Table 3: Working definitions of categorisation of sources

Category	Definition	Example
1. Excluded/not relevant	The source is not linked to a relevant *educational* intervention or outcome (e.g. it is medical in focus), or the source does not provide an analysis of educational practice.	(1) Impact of cataract surgery upon functional vision. (2) A survey of teacher preparation or parent attitudes not linked to educational practice.
2. Good practice	The source is linked to *educational* practice. While it does not provide evidence of an effect of that practice upon target outcomes, it provides evidence and rationale for the differentiated education provision.	The development of standardised and accessible assessment approaches (e.g. a reading assessment for braille readers).
3. Intervention	The source presents evidence of the effect of some kind of educational approach upon a targeted educational outcome(s).	The trial of a reading intervention to measure the effect upon children's reading performance.

Outcomes following stage 1 and 2

2.12 The sources which were rated as ‘intervention’ or ‘good practice’ were grouped separately under each of the 13 educational strategies (plus 'other') (see Tables 4 and 5). The remaining sources were categorised as 'excluded/not relevant'.

Table 4: Vision impairment interventions – number of sources categorised as ‘intervention’ under each of the 13 educational strategies (plus other).

Strategies	Summary for categorisation under ‘intervention’ group	Numbers
Communication	Studies describing the effect of instruction/teaching/training to support the development of communication skills, including focussing upon early communication and language development.	6
Literacy	Studies describing the effect of instruction/teaching/training to support reading, and/or writing skills (print, braille, Moon).	25
Mathematics	Studies describing the effect of instruction/teaching/training to support mathematical skills.	6
Access to examinations	Studies describing the relative success of different assessment accommodations/modifications.	1
Mobility and Independence	Studies describing the effect of instruction/teaching/training to support mobility and orientation (including cane skills), independence and living skills.	10
Cognitive skills	Studies describing the effect of instruction/teaching/training to support a range of cognitive skills (e.g. thinking skills, theory of mind, metacognitive strategies, working memory).	3
Social and emotional functioning	Studies describing the effect of instruction/teaching/training to support self-esteem, peer relationships, friendships and peer acceptance.	4
Use of technology	Studies describing the effect of instruction/teaching/training using educational, enabling and access technology.	7

Low vision training	Studies describing the effect of visual/low vision training, including use of optical and electronic magnification devices/low vision aids.	19
Teaching support	No interventions were identified under this category.	0
Strategies	Studies describing the effect of particular teaching strategies upon learning, often the strategies involve the use of accessible/modified learning materials.	8
Minority Language	No interventions were identified under this category.	0
Inclusion	Studies describing the effect of environmental adjustments/inclusive practice/training on range of skills and outcomes (e.g. behaviour).	3
Other	A range of studies describing the effects of different educational experience upon a range of outcomes which do not fit neatly into other categories, e.g. educational experience and employment outcomes.	6
Total		98

Table 5: Vision impairment good practice – number of sources categorised as 'good practice' under each of the 13 educational strategies (plus other)

Strategies	Summary for categorisation under 'good practice' group	Numbers
Communication	Studies examining/exploring strategies used by teaching staff to support communication development but without formally/directly examining the effect of those strategies; assessment of communication.	17
Literacy	Studies examining/exploring strategies used by teaching staff to support reading/writing and or studies examining the factors which predict students' literacy skills (reading/writing) but without formally/directly examining the effect of those strategies; assessment of literacy and choice of literacy medium (e.g. print or braille; print size).	89
Mathematics	Studies examining/exploring strategies used by teaching staff to support training to support mathematical skills but without formally/directly examining the effect of those strategies; often the strategies involve the use of specialist equipment and techniques to aid access.	18

Access to examinations	Descriptions and critical analysis of different approaches to assessment accommodations/modifications but without formally/directly examining the effect of those approaches.	7
Mobility and Independence	Studies examining instruction/teaching/training to support mobility and orientation (including cane skills), independence and living skills but without formally/directly examining the effect of those strategies.	40
Cognitive skills	Studies examining/exploring strategies used by teaching staff to support the development of a range of cognitive skills (e.g. locus of control) but without formally/directly examining the effect of those strategies.	10
Social and emotional functioning	Studies examining/exploring the strategies used by teaching staff to support a range of socio- emotional skills (e.g. developing self-esteem, self-concept; overcoming social isolation or behaviour problems) but without formally/directly examining the effect of those strategies.	27
Use of technology	Studies examining/exploring strategies and technology used by teaching staff to support a variety of educational aims but without formally/directly examining the effect of those strategies; often the strategies involve the use of specialist equipment to aid access.	30
Low vision training	Studies describing the use of visual/low vision training, including use of optical and electronic magnification devices/low vision aids but without examining the effect of those strategies beyond an argument that young people can independently access information.	16
Teaching support	Studies examining and describing a range of different teaching support/service model, including critical analyses of their structure and philosophy.	21
Strategies	Studies describing the particular teaching strategies upon learning, often the strategies involve the use of accessible/modified learning materials; often offering examples of teaching approaches/activities which give access to curriculum and experiences which would otherwise be difficult (with 'traditional' approaches).	74
Minority Language	Studies examining/exploring the teaching of children with a vision impairment in a dual-language and/or multicultural context. None of these papers focussed upon Welsh or Wales; one Spanish/English, one Irish, one Maori/English, two paper were more general.	5

Inclusion	Studies describing environmental adjustments/inclusive practice/training, teacher and peer attitudes, and constructions of education and the curriculum (e.g. the Expanded Core Curriculum; Additional Curriculum).	34
Other	A range of studies describing different educational experience and targeted outcomes which do not fit neatly into other categories, e.g. employment outcomes.	10
Total		398

Inter-rater reliability – stage 2

2.13 To offer greater rigour, all sources identified as interventions were reviewed independently by another team member (LE). There was 91% agreement, and if disagreements were noted the sources were reviewed and if necessary re-categorised. A further 10% of the sources identified as 'good practice' were reviewed independently. There was 97% agreement, and if disagreements were found the sources were reviewed and re-categorised if necessary. No sources we re-categorised as an intervention. Total agreement across all independent reviews (N=163 sources) was 93%.

Stage 3 and 4: Assessing the quality and Data extraction

2.14 The aim of stage 3 was to assess the quality the identified research (and the protocol for checking the reliability of this assessment), while the aim of stage 4 was to extract the relevant information from the research articles/sources into a standard database. Clearly the two stages are intertwined.

2.15 In terms of quality assessment, the full text of articles which met the inclusion criteria for interventions (in stage 2 above) were viewed and assessed for relevance and robustness. They were subsequently excluded if they did not meet the inclusion criteria upon examination of the full text. The quality of the evidence was assessed (assigning a score of 1, 2 or 3) using the criteria described in Table 2 based on the following categories:

- Score of 1: where there was only **impressionistic** evidence of impact.
- Score of 2: where there is **modest** evidence of impact.
- Score of 3: where there is **strong** evidence of impact.

2.16 These criteria are drawn from a number of studies which have examined the evidence on ‘evidence based practice’ and assessment of REAs (e.g. Luckner, Bruce & Ferrell, 2016; Houghton-Carr, Boorman & Heuser, 2013; Collins, Coughlin, Miller & Kirk, 2015; Nelson, J. et al., 2011).

2.17 To ensure that the matrix was ‘fit for purpose’, four full text articles covering different methodologies were read and assessed using the matrix included in the inception report. Based on the rating of this sample of articles the matrix was further developed to the criteria presented in Table 6 (empirical studies) and Table 7 (literature reviews) below.

2.18 The combined score assigned to each article enabled the identification of the most relevant and most robust study, and as such were scored highest. This provided an indication of the confidence placed by the project team in the evidence in the selected articles.

Table 6: Matrix table to derive confidence in the robustness of EMPIRICAL STUDIES (Commonly experimental, trial and case study designs)

Components	Score 1: Impressionistic evidence of impact	Score 2: Moderate evidence of impact	Score 3: Strong evidence of impact
1) Objectives of study/hypothesis being tested	No clear objectives (e.g. the effect of intervention on student outcome is incidental/by-product of study).	General objective (e.g. investigation of school impact on intervention).	Clear specific objectives (e.g. investigation of effect of intervention on children's academic outcomes).
2) Approach – quality of outcome measures (valid and reliable)	Limited outcome measures – lack richness and depth (qualitative) or no evidence of valid/reliable measures.	Moderate quality outcome measures – offer some richness and depth (qualitative) or some evidence of valid/reliable measures (e.g. inter-rater reliability).	High quality outcome measures – offer high richness and depth including triangulation (qualitative) or clear evidence of valid/reliable measures including multiple variables.
3) Approach – quality of the research design (appropriate structure)	Design is limited, e.g. no baseline evidence.	Design is appropriate, but rigour is limited, e.g. no use of control or intervention group.	Design is high quality such as using a control and intervention group: either random assignment of participants to conditions or two groups equivalent before the intervention began. In qualitative designs, clear processes of extended periods of observation are recorded (e.g. in action research or case study work).
4) Quality of the intervention	The details of the intervention (independent variable) are not presented, or they are presented in very little detail. The intervention is not replicable.	Moderate quality - details of the intervention are presented, and it could be replicated. Nevertheless little or no rationale for the intervention is offered.	High quality - details of the intervention are presented, and it could be replicated. Rationale for the intervention is offered including theoretical and empirical underpinning.
5) Implication for practice (ecological validity)	Minimal implication on practice, e.g. the intervention in the study has no obvious/explicit link to educational practice, nor are these links made by the authors. Minimal or no discussion of the interpretation of the application of the study.	Moderate implication on practice, e.g. while the intervention was not carried out in a practice setting, there are clear similarities and possibilities for transfer; the authors explicitly make these links.	Strong implication on practice, e.g. the intervention was situated in practice (such as in the classroom, with classroom teachers); the authors explicitly make links to practical application of the intervention. No evidence of 'over-reach'.

6) Sample size	Small number of participants (e.g. n is less than 5 and reported as individual case studies).	Small sample sizes (e.g. studies based in only one or two educational settings), or the sampling/sample design does not account for bias/representativeness.	Large sample size allowing for calculation of effect sizes. The sampling/sample design accounts for bias/representativeness
7) Generalisability	Results only apply to the specific participant/s of the intervention.	Results are representative for a specific group of the population (e.g. results only apply to children with a specific degree of vision loss).	Results are an accurate representation of the majority population.
8) Evaluation – data reporting and analysis	Descriptive summary/review of results only. Minimal or no analysis and evaluation of study data.	Beyond descriptive, but not extensive, account of the results. Moderate analysis and evaluation of study data.	Extensive account of the results. Extensive analysis and evaluation of study data.
9) Evaluation – critical reflections on limitations of the study	Minimal or no reflection on the limitations of the study.	Moderate reflection on the limitations of the study.	Extensive and rigorous reflection on the limitations of the study.
10) Evaluation – Reporting of evaluation	Unpublished, subject to no peer review.	Reported on websites or in grey literature. Some peer/external review described.	Reported in peer reviewed literature.
Mean scores across all components (Max 30/10; Min 10/10)			

Table 7: Matrix table to derive confidence in the robustness of LITERATURE REVIEW articles

Components	Score 1: Impressionistic evidence of impact	Score 2: Moderate evidence of impact	Score 3: Strong evidence of impact
1) Objectives of the review	No clear objectives	General objective made clear	Clear and specific objectives given
2) Approach – search strategy rationale	No clear search strategy outlining key words and sources. Minimal database search; no clear databases defined	Moderate search strategy outlining key words and sources.	Strong search strategy outlining key words and sources. Typified by a systematic review.
3) Approach –rationale and breadth of search	No clear rationale for the inclusion of the selected studies.	Moderate rationale for the inclusion of the selected studies. Limited or no searching of grey literature.	Robust rationale for the inclusion of the selected studies. Extensive database search, including publication bias mitigation through identification of grey/unpublished literature. Typified by a systematic review.
4) Implication for practice (ecological validity)	Minimal implication on practice, e.g. the intervention in the study has no obvious/explicit link to educational practice, nor are these links made by the authors. Minimal or no discussion of the interpretation of the application of the study.	Moderate implication on practice, e.g. while the intervention was not carried out in a practice setting, there are clear similarities and possibilities for transfer; the authors explicitly make these links.	Strong implication on practice, e.g. the intervention was situated in practice (such as in the classroom, with classroom teachers); the authors explicitly make links to practical application of the intervention. No evidence of 'over-reach'.

5) Generalisability (of the conclusions of review)	Results only apply to a specific sub-group of the population.	Results are representative for a specific group of the population (e.g. results only apply to children with a specific degree of vision loss).	Results are an accurate representation of the majority population
6) Evaluation – data reporting and analysis	Descriptive summary review of results only. Minimal or no analysis and evaluation of study data.	Beyond descriptive, but not extensive, account of the results. Moderate analysis and evaluation of reviewed studies; limited synthesis.	Extensive account of the results. Extensive analysis and evaluation of study data; coherent synthesis.
7) Evaluation – critical reflections on limitations of the study	No or minimal reflection on the limitations of the review.	Moderate reflection on the limitations of the review.	Extensive and rigorous reflection on the limitations of the study.
8) Evaluation – Reporting of evaluation	Unpublished, subject to no peer review.	Reported on websites or in grey literature. Some peer/external review described.	Peer reviewed literature, including (a version of the review) presented in a peer reviewed academic journal.
Mean scores across all components (Max 24/8; Min 8/8)			

Inter-rater reliability – stage 3

2.19 A protocol for inter-rater reliability of scoring of the quality of studies is presented in Annex A: Database sources, search terms. Twenty-one of the studies were independently rated, and the agreement was 86%. There was disagreement in relation to three papers – which were removed (as not fulfilling criteria in relation the age of the participants or not an educational intervention).

Data extraction – stage 4

2.20 A predefined spreadsheet template was developed to facilitate recording of the most important details of each study on intervention to provide a comprehensive overview. This template (record) is summarised in Annex A: Database sources, search terms, and completed templates made available to the Welsh Government.

Further refinement of the selected intervention studies

2.21 Following careful reading of all of the identified sources and consideration of the literature as a whole, further refinement was made. First, several sources were removed from the analysis because they did not meet the inclusion criteria for various reasons. Some did not provide enough detail of methods, interventions or educational impact. Others, on closer inspection, were not intervention studies but correlation or longitudinal studies. This reduced the total number of intervention studies to 54, detailed analysis and summary of these sources is presented in the next section.

2.22 Second, the evidence was also described within a modified set of *eleven* broad educational strategy groups (rather than thirteen). Key changes made were:

1) ‘Mathematics’ was combined with ‘teaching strategies’, to form an overarching group of “teaching strategies (including mathematics)”. While mathematics is recognised as presenting particular teaching challenges in vision impairment education, it was judged that the associated interventions are illustrations of teaching strategies more generally.
2) ‘Cognitive development’ was incorporated into ‘communication’ and ‘mobility and independence’. The two sources identified fitted neatly with the literature in these two educational strategy groups. While the area of cognitive development does have a strong base in vision impairment education

literature, its breadth means it can be adequately captured by other educational strategy groups for the purpose of this REA.

3) Sources which were categorised as ‘other’ were either not included as they did not meet the inclusion criteria (see above), or were placed into other educational strategy groups.

3. Characteristics of the evidence

3.1 From the intervention studies we quality rated:

- 54 were 'interventions'
- 41 were rated moderate (2) to strong (3) quality
- 13 were rated impressionistic (1) to moderate (1.9)

Literacy is an area which has received most research attention in relation to intervention studies.

Table 8: Summary of quality rating ranges by strategy for the identified interventions (total of 54 sources; two sources appear in two strategy areas)

Strategy areas	Quality Rating: Impressionistic – moderate (score 1-1.9)	Quality Rating: Moderate to strong (score 2-3)	Total sources
1. Communication	0	7	7
2. Literacy	5	16	21
3. Low vision training	1	6	7
4. Teaching strategies (including maths)	2	5	7
5. Access to examinations	0	2	2
6. Mobility and independence	3	3	6
7. Social and emotional functioning	1	2	3
8. Use of technology	1	1	2
9. Teaching support	0	0	0
10. Inclusion	0	1	1
11. Minority Language	0	0	0
Total			**56**

Table 9: Summary of the study designs (54 studies)

Design type	Count
Systematic review/literature review/meta analysis	8
Quasi-experimental study or RCT	23
Multiple baseline designs (small N, including single case)	12
Case study (descriptive/qualitative)	9
Mixed methods	2

Table 10: Summary of national research settings (54 studies)

County	Count
USA	31
N/A (systematic review – various countries)	7
Canada or Canada/USA	4
UK/Wales	2
Various others (e.g. Turkey, Netherlands, Spain)	10

Table 11: Summary age range (54 studies, age groups not mutually exclusive)

Age group	Count
Pre-school focus	2
Primary years	14
Secondary years	4
16+	10
Combinations	23
Teacher intervention	1

Table 12: Summary of nature of disability (54 studies, disability groups not mutually exclusive)

Nature of disability	Count
Severely vision impaired (blind)	16
Vision impaired (low vision, partially sighted)	18
Vision impairment and complex needs	8
Combinations/other	12

3.2 The final list of 54 studies provides evidence within the nine broad educational strategy areas (no evidence was identified for 'minority language' and 'teaching support'). Nevertheless, within each of these educational strategy areas there were a range of different interventions (e.g. within literacy there are very different interventions linked to braille and low vision devices). The table below summarises the nature of the interventions within the different educational strategy areas.

Table 13: Summary of the interventions linked to each educational strategy area (total of 54 sources; two sources appear in two strategy areas)

Strategy area (number of studies)	Overview of the types of interventions
1. Communication (7)	A review article concluded that very little evidence exists regarding interventions and communication, although quite a lot of practice advice exists (Luckner et al., 2016). Nevertheless, three intervention categories were identified to have associated intervention studies which met the quality criteria: 1. Augmentative communication systems: (a) tangible symbols, (b) microswitches, and (c) dual communication boards. 2. Communication partner strategies: (a) wait time strategies, and (b) working with communication partners. 3. Listening skills training. 1a) Tangible symbols are three-dimensional cards embedded with whole or partial objects to represent a person, place, activity, object, idea, or action. The approach is used to support communication development for young and developmentally young people with vision impairment. The terms 'objects of reference' and 'object symbols' are often used in a similar way. Importantly, the design of the symbols is so they are accessible to children with no/reduced functional vision. Symbols are introduced by communication partners in particular ways, and

	for particular communication functions – e.g. making choices. (Ivy et al., 2014; Trief et al., 2013; Parker et al., 2008). 1b) Microswitch interventions are defined as supportive speech-output systems or devices that serve the purpose of building communication interactions or choice-making associations for the adults or children who use them (Parker et al., 2008). 1c) Dual communication boards consist of a printed board for the student to use for expressive communication (from the student to the communication partner) and an identical board for the partner to use for receptive communication (Parker et al., 2008). 2a) Working with communication partners are characterized by the intense training and support of partners (i.e. the adult teacher or carer) to respond to the communication behaviours (which are often idiosyncratic) of the student (Parker et al., 2008; Clark and McDonnell, 2008). 2b) Wait time focusses upon modifications to time the teacher/communication partner waits when communicating with young and developmentally young people with vision impairment. Increasing the wait time allows the learner to process what is being communicated (Johnson et al., 2013). 3) A study which stands out as different to the others was linked to listening skills and comprehension amongst older and academically able young people. In this case this was training listening skills (paragraph summarisation and listening summarisation) as an efficient alternative to reading (and is therefore linked to literacy) (Tuncer and Altunay, 2006).
2. Literacy (21)	Three intervention categories were identified linked to: braille, print and literacy interventions for children vision impairment and complex needs: Braille focussed interventions were concerned with: (1) Strategies for teaching and introducing braille code: a) when to introduce braille contractions in teaching (Barclay, et al., 2010; Emerson et al. 2009); b) phoneme instruction versus grapheme instruction (Crawford et al. 2006); c) Use of constant time delay to teach highly motivating words to beginning braille readers (Ivy et al., 2017) and late onset learners (Ivy and Hooper, 2015); d) Precise individualised approaches, early braille teaching based upon meaning-centred approaches (Schles, 2015); and e) Precise approaches, early braille teaching based upon character discrimination approaches (not meaning-centred) (Toussaint et al., 2017).

	(2) The use of technology to support braille learning: a) the use of refreshable braille technology and other technology (Bickford and Falco, 2012; Cooper and Nichols, 2007); b) increasing braille reading speed with refreshable braille (Cates and Sowell, 1990); c) computer-based tutorial for teaching mathematics braille code (Kapperman et al., 2012). Print focussed interventions were concerned with: (1) The use of optical and electronic magnification devices to support learning. Assessments of young people's functional vision and needs and the prescription of low vision devices (LVDs) to improve reading performance (Corn et al., 2002), compared to large print (Farmer and Morse 2007; Huurneman et al., 2013; Koenig et al., 1992; Lackey, 1982; Lusk, 2012; Lussenhop and Corn, 2002). (2) Similarly, the use of closed circuit televisions (CCTV) to improve reading performance (Lagrow, 1981). (3) Training in speed reading (Fridal, et al. 1981). A review of literacy interventions and children with vision impairment and complex needs (Parker and Pogrund, 2009: p461) noted that: (1) "Beyond the description of settings, researchers repeated the theme that literacy learning environments need to be highly responsive to students' initial literacy behaviors"; (2) "Another recurring description of successful learning contexts centred on individual tailoring of media for access and participation." (whether, e.g. AAC, braille, moon, print); and (3) "persistence and collaboration by the educational team, the individual, and the family to develop successful literacy outcomes."
3. Low vision training (7)	This educational strategy area overlaps with the area of print literacy (covered elsewhere). Several investigated interventions which explored the impact of low vision services, training and devices on visual efficiency and performance beyond reading (e.g. Binns et al., 2012; Liebrand-Schurink et al., 2016a; 2016b; Margrain, 2000; Uysal and Duger, 2012). Other interventions were concerned with visual training and visual stimulation programmes (e.g. tracking and visual discrimination exercises) to improve functional vision/visual

	perception (López-Justicia and Martos, 1999; Vervloed, et al., 2006).
4. Teaching strategies (including mathematics) (7)	This educational strategy area includes use of teaching strategies to support learning. The strategies involve the use of accessible/modified/alternative learning materials (often giving access to curriculum and experiences which would otherwise be difficult with 'traditional' approaches). Intervention approaches listed in the selected studies include: • individual adaptations to enable curriculum access (Boyd-Kimball 2012); • verbal mediation training to support problem solving skills (Cole and Chee Pheng 1998); • an intervention program to develop nutritional knowledge of children and adolescents with vision impairment (Celeste-Williams et al. 2010); and • use of audio description to teach scientific concepts (Cozendey and Costa 2016). This area includes teaching strategy interventions specifically linked to the development of mathematical skills, including specialist braille codes (Nemeth code and science notation) and technology. Of the identified intervention studies, four interventions utilised specialist technology to support the learning of maths, including the specialist maths code. Three of these intervention utilised auditory feedback/listening skills (Bouck et al., 2011; Bouck and Pei-Lin, 2014; Landau et al. 2003). The fourth intervention using technology was a follow-up study to evaluate the immediate and longer-term effectiveness of a software tutorial installed on a BrailleNote device and used by students who are blind to learn the Nemeth Code (Kapperman et al. 2012). A fifth intervention was designed for use with students making a transition from print to braille. The intervention used ‘constant time delay’ to teach braille and the Nemeth code for mathematics and science notation to students making the transition from a visual to a tactile code (Ivy and Hooper 2015).
5. Access to examinations (2)	These two connected interventions were concerned with the impact of using the talking tactile tablet (and associated training) as a test accommodation (in a mathematics exam) (Landau et al., 2003; Landau et al., 2006).
6. Mobility and independence (6)	This educational strategy area includes a wide range of intervention types: • In terms of young and developmentally young children, early intervention (pre-school children) involving regular visits by

	specialist staff, training of parents and environmental modifications and its impact upon mobility and orientation development (Beelmann and Brambring, 1998). The use of safe and stimulating rooms including auditory stimulation (as characterised by 'Nielsen's Little Room') to encourage movements in young, developmentally young children, including those with multiple disabilities (Dunnett, 1997). The use of structured teaching strategies to encourage the development of object permanence skills (Bruce and Vargas, 2013). • The use of models to teach environmental concepts, prior to travelling in the real world (Budd and LaGrow, 2000). The effect of targeted roadside instruction upon ability to cross roads safely (Wright and Wolery, 2014). • After school sport activities with adolescents as a method of increased physical engagement and fitness (Cervantes and Porretta, 2013).
7. Social and emotional functioning (3)	This educational strategy area includes studies examining approaches used develop social and emotional functioning: • A meta-analysis of the effect of teaching social interaction skills to young people while at school upon educational outcomes (Botsford, 2013). • Teaching social skills to a preschool child who is blind to improve play interaction (Celeste, 2007). • The teaching of visual perception training programmes to improve the social skills and activity performance of children with low vision (Uysal and Duger, 2012).
8. Use of technology (2)	This educational strategy area includes studies examining strategies and technology used by teaching staff to support a variety of educational aims. It has overlaps with a number of areas given it has a key focus on curriculum access through the use of technology (e.g. mathematics, braille literacy, low vision). A synthesis of research studies (1965-2009) investigated the impact of assistive technology on the educational performance of students with vision impairment noted the extent to which the field has researched this using rigorous, scientific-based methods is close to non-existent (Kelly and Smith, 2011). Several studies have focussed upon the use of technology to enable curriculum access, most are discussed in literacy and mathematics). Cole and Slavin (2013) explored the use of a video assistive device in a university science laboratory.

9. Teaching support (0)	N/A
10. Inclusion (1)	This one intervention was concerned with the impact of training of trainee teachers upon their attitude to having vision impaired children in their classroom (Ajuwon et al., 2015).
11. Minority Language (0)	N/A – no interventions in relation to vision impairment education and Welsh language were found, nor were any interventions in other comparable minority language contexts.

4. Intervention summaries

4.1 In this section, the findings for the different educational strategy areas are discussed in turn. For each, we present three sub-sections:

- Introduction
- Available evidence
- Implications.

Taking each in turn, the sub-sections have the following purposes:

4.2 The **Introduction** re-introduces the educational strategy area and how and why the given strategy has been defined in the broad field of vision impairment education. This is often linked to responses to identified need in the population of young people with vision impairment. We draw upon sources in the field of vision impairment education, including: recent literature reviews (e.g. Douglas et al., 2009), critical analyses (e.g. Douglas and McLinden, 2005; McLinden and Douglas, 2014), and overarching texts (e.g. Mason and McCall, 1995; Holbrook and Rosenblum, 2017). Importantly, this sub-section draws upon the conceptual framework outlined at the beginning of the report, most notably the distinction between *access to learning* and *learning to access*, and the related concept of the expanded core curriculum (ECC) and its relationship with the core curriculum. The introduction also describes why some original search areas have been combined and adjusted following the REA searches.

4.3 The **Available evidence** sub-section details each of the sources and articles identified through the REA. For each, this includes details of the intervention under investigation, what the researchers found, how they did this (methodology), and the quality of the evidence generated.

4.4 The **Implications** sub-section provides a reflection upon the overall available evidence in the context of the introduction, and offers a summary of possible implications for educational practice.

Communication

Introduction

4.5 This educational strategy area has a focus on interventions designed to support the development of communication skills. It includes early communication and language development and alternative and augmented communication systems. With respect to the expanded core curriculum (ECC), these approaches can be situated within a number of areas depending on how they are defined but are explicitly referred to in the first area: *Compensatory or functional academic skills and communication modes* (e.g. Holbrook and Rosenblum, 2017). This area of the ECC includes "communication modes for students with additional disabilities (such as tactile symbols, a calendar system, sign language, and recorded materials)" (Holbrook and Rosenblum, 2017, p206). It also includes microswitch interventions which can be described as supportive speech-output systems or devices that are designed to support the building of communication interactions or choice-making associations for the individuals who use them (Parker et al., 2008).

4.6 Compensatory and functional skills are considered to be required by children with vision impairment in order to access areas of the core curriculum. The development of compensatory skills means that the child has access to learning in a manner equal to that of sighted peers (e.g. Sapp and Hatlen, 2010). "Functional skills" refer to the skills that children with multiple disabilities learn that provide them with the opportunity to work, play, socialize, and take care of personal needs to the highest level possible (e.g. Holbrook and Rosenblum, 2017).

4.7 Commonly, the approaches identified in the literature with respect to this area utilised generic teaching approaches and adapted these to ensure they were accessible to children with vision impairment. This can be done by means of enhancing visual presentation (e.g. high-contrast line drawings), or alternative/non-visual presentation (touch and sound), as well as a combination of the two.

4.8 A review article concluded that whilst very little evidence exists regarding interventions and communication, there is a lot of practice that can be drawn upon (Luckner et al., 2016). Despite this dearth of evidence, three broad intervention categories were identified which met the quality criteria.

Available evidence – augmentative communication systems

Tangible symbols

4.9 Tangible symbols include three-dimensional cards embedded with whole or partial objects to represent a person, place, activity, object, idea, or action. The approach has been used to support communication development for young and developmentally young people with vision impairment (e.g. McLinden and McCall, 2002). The terms 'objects of reference' and 'object symbols' are often used in a similar way. Importantly, the design of the tangible symbols is such that they are accessible to children with no/reduced functional vision. Symbols are introduced by communication partners in particular ways, and for particular communication functions (e.g. making choices, daily timetable activities, expressive communication).

4.10 Ivy et al., (2014) worked with the Picture Exchange Communication System (PECS) combined with tangible symbols (i.e. three-dimensional cards (made of cardboard, plastic, etc.) embedded with whole or partial objects to represent a person, place, activity, object, idea, or action). This makes the symbols accessible to children with no/reduced functional vision. Using a multiple baseline design working with four young people aged between 5 to 11 years (and functioning below the age of 2 years), Ivy et al., (2014) first introduced tangible symbols and then sought to generalise their use with different communication partners (CPs). The study provided evidence of moderate quality that their highly structured approach and choice of symbols and activities facilitated and developed communication amongst these children and that they can generalise skills to new CPs and maintain learning for as long as 5 months.

4.11 In a larger-scale study, Trief et al., (2013) introduced a tangible symbol scheme across four schools, and recorded uptake over seven months. The sample included 43 young people with vision impairment and complex needs (age 3-11 = 68%; 12-21 = 32%) working with 60 communication partners based in 21 classes in four schools. In their field trial a pre- and post-test was carried out plus general data collected from practitioners. The study provided moderate to strong evidence that tangible symbols are a successful approach with children with the most severe impairments (including significantly, vision impairment) – the evidence from staff suggested a positive take-up of the symbols and increased success in the form of

children making 'correct responses'. Of interest was the finding that a greater number of correct responses were associated with participants who were independently ambulant. The symbols which had the greatest uptake involved choosing songs, juice, or sensory play, as well as expressing ‘more’ and ‘finished’. The evidence obtained by independent researchers was less positive (non-significant), but this may be linked to the children working with unfamiliar people.

4.12 Parker et al., (2008) carried out a literature review which identified 30 studies (including 66 participants overall) in relation to communication practices for children with vision impairment and complex needs. All the studies reported were single-subject designs. They identified a range of different approaches (and for this reason the article provides evidence in relation to a variety of interventions), including the use of use of object symbols. The nature of Parker et al.’s review was such that details of individual interventions was limited and relative efficacy of particular approaches was often non-specific. Despite these limitations, the review concluded that “the large majority of the participants in the combined 30 studies displayed purposeful choice making and the beginnings of self-advocacy by the conclusion of the interventions” (p548).

Microswitch interventions

4.13 The most common occurring intervention type by Parker et al., (2008) in their literature review of communication practices for children with vision impairment and complex needs was in relation to the use of microswitches (17 out of the 30 studies in total). Microswitch interventions are defined in the review as supportive speech-output systems or devices that serve the purpose of building communication interactions or choice-making associations for the adults or children who use them (p543). Switches are activated through a range of actions (e.g. eye movement, head movement, vocalisations), and targeted communication functions included making requests for objects, interactions, or preferred stimuli.

Dual communication boards

4.14 Again drawing upon the literature review undertaken by Parker et al., (2008), dual communication boards consist of a printed board for the student to use for expressive communication (from the student to the communication partner) and an identical board for the partner to use for receptive communication. Parker et al.,

(2008) identified four studies which reported using this approach successfully with young people with vision impairment and complex needs.

Available evidence – communication partner strategies

4.15 Communication partners (CPs) in the broad sense have a central role in all communication interventions. Nevertheless, some interventions particularly focus upon the training and support of CPs to respond to the communication behaviours of the young person. Parker et al.'s (2008) literature review of communication practices with children with complex needs identified six studies with this focus noting that, "all six studies documented the generalization of the behaviors across settings or communication partners" (p544). The review noted that interventions are characterised by the intense training and support of communication which responds and presents in ways which are sensitive to the sensory impairment of a given student, and often idiosyncratic (i.e. must be designed for the particular needs of a given student).

4.16 A separate study undertaken by Johnson et al. (2013) focusses upon varying 'wait time'. Wait time is described as the time the teacher/communication partner waits when communicating with young and developmentally young people with vision impairment. Increasing the wait time allows the learner to process what is being communicated. In a multiple baseline study involving three children, Johnson et al., (2013) adjusted the wait time. Although the optimum wait time which maximised engagement varied for each child, a recommendation of the study was that communication partners should vary the wait time and assess which is best for the individual. The evidence was judged to be of moderate quality.

4.17 Clark and McDonnell (2008) examined the effectiveness of an intervention package that included visual accommodations, daily preference assessments, and naturalistic instructional strategies on the accuracy of choice-making responses for three participants with complex needs. Using a multiple baseline design, the researchers followed a structured approach to increase opportunities for choice making. The results suggest that the intervention package was successful in increasing the accuracy of the participants' choices when the participants were presented with preferred and neutral items. Systematic instruction and appropriate visual accommodations also further increased the accuracy of choices made. Overall this paper provides moderate to strong quality of evidence.

Available evidence – listening skills training

4.18 The final intervention study identified in the review had a focus on listening skills and comprehension amongst older and academically able young people. Tuncer and Altunay (2006) undertook a multiple baseline design with four university-aged participants to assess the effectiveness of the training of listening skills ('paragraph summarisation' and 'listening summarisation') as a method of improving listening comprehension (and as an efficient alternative to reading). The experimental phases included listening comprehension, listening comprehension instruction, generalisation, and maintenance. Training was reported as improving performance in listening comprehension tasks, and this was generalised to other tasks and maintained 30 days later. The evidence was judged to be of moderate quality.

Implications

4.19 Communication is a broad concept encompassing a wide range of approaches. Most of the identified studies focus upon developing and facilitating the communication of young and developmentally young children, in particular those with complex communication needs. Philosophically important to these approaches is the principle that communication skills develop through the process of communicating, and some children with vision impairment (in particular those with complex needs) may find it difficult to access opportunities to meaningfully communicate. A relatively well evidenced area is the use of augmentative communication systems to provide these opportunities:

- There is a moderately strong evidence base that tangible symbols (or objects of reference), which are specifically designed to maximise access by children with vision impairment, can have a positive impact on the development of communication. As well the importance of selecting and designing appropriate symbols, the evidence suggests that their structured and consistent use is an important ingredient for success. Symbols appear most effective when associated with communicating relevant and motivating topics (and therefore *accessible* topics) – e.g. linked to singing, sensory play, and juice.
- Although evidence is not as strong, the general principles of creating accessible, relevant and structured opportunities for communication are likely

to also apply to the use of other augmentative communication systems. This includes using microswitches, dual communication boards, and various other approaches described in the good practice literature.

- The use of various augmentative communication systems with children who have vision impairment in combination with complex needs relies upon adult communication partners who are able to implement the systems appropriately. This requires a structured and consistent approach as noted, but also requires that the approaches are personalised to the individual child (both in terms of their interests and accessibility needs and preferences). Such an individualised approach requires communication partners to communicate with one another to ensure consistency of approach, and requires appropriate training. There is evidence that training of communication partners is an important and necessary part of the interventions.
- Although limited evidence exists, an area of identified importance is the 'wait time' (the time the teacher/communication partner waits when communicating with the young person). It is recognised that optimum wait time will vary from individual to individual (and possibly from one time to another). Again the communication partner must be able to appropriately adjust wait time, and this is likely to require training.

4.20 In a separate area of communication development of older learners and those without complex needs, some evidence exists that the teaching of listening strategies as an efficient and faster alternative to braille or print reading can improve comprehension. While evidence is limited, the links with the important areas of literacy and technology (speech technology) are relevant.

4.21 The REA did not identify other evidence which met the inclusion criteria, although there are links with other intervention areas: literacy and technology as already noted, but also communication associated with self-advocacy which is discussed within mobility and independence.

Literacy

Introduction

4.22 In a review of pedagogy and vision impairment education, Douglas and McLinden (2005) argue that a main research emphasis has been on the concept of access; the reasons for this seem to be a view that the principal barrier facing vision impaired people is access to visual information. Further, Douglas et al. (2009) argue that "The 'craft' of teaching vision impaired children tends to draw on two broad pedagogical strategies that involve using 'alternative' or 'enhanced' modalities of presentation and communication" (p.92). In the context of literacy education, this is clearly illustrated by the contrast between braille and print, which are the two main routes to literacy for children with vision impairment. Braille offers an alternative (non-visual) modality, while print commonly requires enhancement to ensure access for the reader with low vision.

Literacy through print

4.23 Douglas et al. (2002) and Hill et al. (2005) observed delays in speed, accuracy and comprehension of print reading among British children with low vision compared with their sighted peers in their work on reading test development. They made an important distinction between 'developmental delays in reading' and 'difficulties in text access'. Arguably, long-term difficulty in text access leads to developmental delays, which means that some children with vision impairment have particular reading profiles and may make particular reading errors (Douglas et al., 2004; Cornelissen, 1991). Also of relevance here is the 'access to learning' approach taken to optimise the print presentation for a given learner. The use of enlarged print is a common approach, but optimal print size and style will vary for a given individual. Even so, a common strategy adopted in many educational settings has been to offer a limited range of large print sizes for all children with low vision (e.g. Arial 24 point) (e.g. Cobb, 2008; Buultjens et al., 1999).

4.24 An alternative (or complementary) position is to provide young people with vision impairment with tools and training so that they can 'learn to access' standard print independently. The most common focus of research in this regard is the use of low vision devices (LVDs) (e.g. Corn et al., 2003), but also the use of computer screen (including closed circuit televisions (CCTVs)), speech technology (including audio recording and screen reader technology), and more recently the use of mainstream

electronic equipment which can be used in a similar way to a LVD (e.g. smart phones and tablets).

Literacy through braille

4.25 Greaney, Hill and Tobin (1998) tested the reading of 317 braille readers using a braille version of the NARA (Neale Analysis of Reading Ability) – then a popular reading test developed for sighted children that assesses reading speed, accuracy and comprehension. As with print readers with low vision, the data showed that the average reading ages for accuracy, comprehension and speed for the braille-reading sample generally fell below their chronological age, and lagged behind both fully sighted and low-vision readers. The size of the lag increased with age. In the case of braille, however, the area of greatest lag was found in reading speed.

4.26 The case for the differences in performance in braille reading is relatively well established. One crucial difference when comparing the reading performance of sighted with tactile readers is that while "the eye can easily take in a whole word at a glance, the finger can only take in one character at a time" (McCall 1999, p.38). This letter-by-letter approach to braille reading has resulted in the development of reading schemes that have tended to be reliant on phonic approaches rather than on whole-word recognition or "look and say" methods in the early stages of reading (see McCall, McLinden and Douglas, 2011). Differences in reading print and braille have given rise to the identification of "braille-specific errors" (Greaney et al., 1998, p.24). In part, evidence for these differences is an obvious consequence of using a different code and, more importantly, a different sense (i.e. touch rather than sight). Even so, careful observation by researchers and practitioners has generated a sophisticated knowledge base of braille reading, including types of error that are particular to the braille code (such as reversal, rotation and alignment errors), efficient hand movements and correct posture (e.g. Greaney et al., 1998; Millar 1997; Olson and Mangold 1981).

4.27 McCall et al., (2011) argue that a current debate in braille literacy instruction revolves around whether reading and writing in braille is best introduced through uncontracted braille or contracted braille. Uncontracted braille, or 'alphabetic' braille, uses no contractions and maintains a letter-for-letter correspondence with print. Contracted braille involves the use of the traditional alphabet, along with different signs and contractions that represent groups of letters or whole words. Contractions

in braille include many common letter clusters (e.g. in unified English braille (UEB) ‘sh’, ‘ou’, ‘ing’) and common words as short forms (e.g. in UEB ‘and’, ‘with’, ‘this’). However, different countries (and languages) and versions of braille will have different approaches to contractions. See section on Welsh Language below.

Decisions about literacy media – braille or print?

4.28 A key decision in a vision impaired child’s education is the choice of route to literacy – most commonly print, braille or both. This decision is inherently difficult and is affected by a number of considerations, for example the degree of vision loss, prognosis, efficiency of vision use and parental preference (Corn and Koenig 2002). The Learning Media Assessment (LMA) procedure was first developed by Koenig and Holbrook (1995) to help teachers assess whether children should receive literacy instruction through braille, print or through a combination of braille and print (dual media). Importantly, the LMA only provides a framework for decision making: there will always be individual nuances to such a decision, but it must also account for the cultural and economic context of the teaching. The availability of literacy resources has a profound impact upon the choices that can be made. At a basic level, the availability of braille and print books and writing devices is important. Also important is the availability of equipment to enhance print (large print books, computers and printers, lighting, low vision optical devices, electronic optical devices), equipment to produce braille (e.g. computers and embossers, teams of transcribers) and to work electronically (e.g. computers with screen enlargement or speech software).

Other routes to literacy

4.29 As indicated in the previous section, summing up braille and print as the two routes to literacy for children with vision impairment is a simplification. First, the emergence of speech technology in recent years has meant that many young people with severe vision impairment commonly access reading and writing with no direct interaction with braille or print. In the main this literacy strategy is in combination with more traditional routes – most young people who are screen reader users will also read braille or print. Nevertheless, there are examples in the literature of young people who *only* access reading and writing through speech technology (e.g. Douglas et al., 2011); and these are often people who started using print before moving to speech technology as their vision deteriorated (but not exclusively).

Clearly this has a significant impact upon the approaches to literacy teaching adopted in schools.

4.30 Second, a very important consideration of routes to literacy is linked to young people with vision impairment and complex needs. In part this is linked to a more profound discussion about the distinction between literacy and communication more generally. As discussed by Watson et al. (2004, p.84) in relation to sensory impairment, literacy might be narrowly defined as involving “decoding print [or braille] and writing of recognisable words”; or alternatively it might be more broadly defined to include the use of symbols, or even pre-intentional or early intentional communicative behaviour (Watson et al., 2004). This broader definition is taken up by, for example, McLinden and McCall (2002) and Parker and Pogrund (2009) who identify a variety of routes to literacy for these young people including alternative tactile codes (such as Moon, e.g. McLinden and McCall, 2002) and symbols (such as objects of reference and tangible symbols). Douglas et al. (2009) note,

> “There has been some research into the possibilities afforded by alternative tactile codes, such as Moon, for children who are blind and who have additional disabilities that suggests that children with [vision impairment and complex needs] have the potential for engagement in functional literacy activities and need access to opportunities to engage in literacy-related activities that have clear functional applications”. (p.116)

Available evidence – braille

4.31 Braille as a route to literacy for children with severe vision impairment is well established. Children successfully learn to read and write using the braille code, which in turn gives access to broader curriculum areas and independent access to information.

Braille: contractions

4.32 Research into braille-focussed interventions has been concerned with strategies for teaching the braille code. One debate is when to introduce braille contractions in teaching – should teachers introduce them from the beginning, or first teach the uncontracted/alphabetic braille and then introduce the contractions when children are older? Drawing upon a longitudinal design (the 'ABC' study), Emerson et al. (2009) tracked the progress of 42 braille readers. The study formed a 'natural experiment' based on tracking children's reading progress and then categorising them into intervention groups based upon 'contractivity' of braille teaching (i.e. how much their teachers had taught them contractions, and at what stage of their reading career). The quality of study is rated moderate to strong; much of the strength being linked to impressive data collection and relatively large sample size given the small population. Nevertheless, the uncontrolled allocation of participants to intervention groups means that the level of 'contractivity' of braille teaching could not be meaningfully associated with improved literacy outcomes. A linked analysis (taken from the ABC study) was carried out by Barclay, et al., (2010). They offer a holistic analysis of two contrasting case studies of children learning braille over three years (one child was introduced to braille contractions early, one later). Both interventions were successful/effective in that reading progressed, but it was impossible to conclude which intervention was the best. The study offers high ecological validity, but the two cases mean that it has limited generalisability and is of moderate quality. A key ingredient to progress in braille literacy appears to be high levels of input in a variety of ways, commonly including one-to-one activities every day, preparation by the teacher involved, and communication with others to instil practice and consistency. Success was possible whether contractions were introduced early or late.

Braille: phoneme instruction vs grapheme instruction

4.33 Crawford et al. (2006) present findings from a series of experiments which compared instruction using phoneme and grapheme instruction strategies. Specifically, phoneme instruction included the use of sound patterns, onset-rime, rhymes, rhythm, pitch and song in the acquisition of reading; grapheme instruction included letter shape and whole-word instruction. The results showed a statistically significant advantage for the phoneme instruction compared to the grapheme

instruction. The quality of the evidence was judged as moderate: the strength of the research design is impressive, with the exception that the participants were sighted children (blindfolded). This is a key challenge as the sighted children differ in (1) prior knowledge (e.g. were these children learning to read, or learning a code?); and (2) modality of teaching (learning by sight or by touch). For this reason the key challenge is the transferability of these findings to blind children.

Braille: use of constant time delay

4.34 Constant time delay (CTD) is a highly structured technique for teaching particular skills. By repeating prompts, but systematically increasing the time delay between prompts and required responses the skills are acquired. Ivy et al., (2017) applied this technique to teaching highly motivating words to beginning braille readers with developmental delay. Ivy and Hooper (2015) also applied the technique to teaching braille to young people who had later onset vision impairment (and were already print readers). Both studies provide moderate evidence that the approach worked in that target words were learnt and learning appeared to be maintained. Nevertheless, the approach is time consuming and the evidence that the approach will work beyond teaching highly motivating words to early braille readers is limited.

Braille: meaning and non-meaning centred approaches

4.35 Schles (2015) describes a precise individualised approach to early braille teaching based upon meaning-centred approaches. The intervention involves constructing teaching material content which is particularly meaningful to the child. The study provides evidence of the progress made by the single case study, but impressionistic evidence of the general applicability of the approach. Nevertheless, it is convincingly argued that such a meaning-centred approach may be crucial for particular complex situations were young people would benefit from bespoke attention to content (as in the case study example of the child who was a recent immigrant, and had limited cultural or language reference points).

4.36 In contrast to a meaning-centred approach, Toussaint et al. (2017) sought to improve braille reading character discrimination by teaching beginning readers by successively introducing braille characters in pairs of increased similarity: stage 1 (very different; 4+ dots difference) to stage 5 (very similar; 0 dot difference). To this extent the approach makes no reference to intrinsic meaning for the child, but rather focussed upon tactual skill development in isolation. The key thrust of the

intervention was to increase the stage and minimise errors. The multiple-baseline study with just three children provides moderate quality of evidence.

Braille: refreshable braille technology

4.37 In recent years, specialist refreshable braille technology has entered the market. Bickford and Falco (2012) compared the children's reading development when taught following the same teaching approach but either using traditional mechanical writing technology (the Perkin's brailler) or a specialist braille notepad with a 20 character refreshable braille display. There was no advantage of either method, but other non-measured advantages and disadvantages of the refreshable braille were noted – positive: portability, paper not needed; negative: one line and no spatial understanding developed. Additionally, the findings suggest that following some instruction with the traditional technology, students can quickly learn to use an electronic braille device and they are motivated to use these devices. The multiple-baseline study with just three children provides moderate to high quality of evidence.

4.38 Cooper and Nichols (2007) carried out a similar study with 20 young braille readers using a different technology: Mountbatten Pro Brailler (an electronic braille writing device with speech output and a built in embosser) and peripheral equipment (a 'Mimic' which provided a small screen interface for print access by peers and teachers). The research was essentially an uncontrolled evaluation of the use of this braille technology by experienced staff in real educational settings and offered only qualitative accounts of the benefits gained. The study provides evidence of only impressionistic quality, but the description of the work and teaching undertaken, and the portfolios of work produced by the young people, provides convincing evidence of the utility of such technology.

4.39 In an investigation using a very early version of refreshable braille, Cates and Sowell (1990) investigated its potential for the teaching of increased braille reading speed. The small scale multiple baseline study offers only evidence of impressionistic quality, and no reading speed improvement was observed. The paper is old and used what was then new braille display equipment. While attempts to increase braille reading speed may be valuable, it is likely that very fast access would now be more focussed upon other technologies such as screen reading/speech output technology.

4.40 The use of technology as a method of enabling older learners to undertake self-study in the area of literacy was explored by Kapperman et al. (2012). The study followed a cohort of students (N=41) using specialist braille notepads with refreshable braille which incorporates some self-study materials for teaching the Nemeth braille maths code. The improvement in reading and writing mathematical symbols between pre- and post-tests offers evidence of moderate quality. While the Nemeth code is not used in the UK, the study provided evidence of the principle that specialist technology/software can be used by students to learn higher-level literacy/maths skills independently.

Available evidence – print reading

Print: optical and electronic magnification devices to support learning

4.41 Corn et al., (2002) described an evaluation of a low vision service involving the assessments of young people's functional vision and the prescription of low vision devices (LVDs) to improve reading performance. Findings indicated the provision of optical devices offer a benefit for independently accessing/deciphering text and improved reading speed. Nevertheless there was no evidence of improved mechanics of reading (i.e. improved reading strategies). Although the study had no control group, it had a large sample (N=185) and gives moderate to strong evidence that LVDs successfully improve independent access to print for young people.

4.42 A series of other studies made a more direct and controlled comparison between using LVDs and large print. An early study by Koenig et al. (1992) provides a series of case studies (N=6) of alternative approaches to accessing print using LVDs and large print. It offers impressionistic to moderate quality of evidence that the use of LVDs matched the use of large print in terms of reading performance, although the analysis was dominated by a broader argument about the relative independence the LVDs afford. An even earlier study by Lagrow (1981) compared closed circuit televisions (CCTV) to accessing normally-sized print. Given that now large print is easily available (and CCTV technology has improved), the paper is no longer relevant; nevertheless it does highlight how this educational intervention is closely related to technological development (a point returned to below).

4.43 Lackey's (1982) early study examined whether students read more when reading large print (control) compared to using the Visolett low vision device (intervention). Fifty-five elementary and junior high students were recruited and were randomly

assigned to two groups. They alternatively used large print and the LVD for eight weeks each with the view of comparing the amount that the participants read when reading large print (control) compared to using a LVD (intervention). In every case students using the LVD read more than those using large print. In three cases the differences were significant at or above the 0.5 level. The fourth and fifth graders read significantly more total books and school books using the LVD than they did when using large print: the seventh, eighth and ninth graders read significantly more total pages than they did when using the large print. In no case did students read more with the large print texts than they did with the LVD. Consequently, the LVD is seen to offer educators an extremely cost-effective means of providing a richer and more varied reading curriculum to many low-vision students. This study was judged to provide moderate to strong quality of evidence, scoring ‘strong’ in the majority of categories.

4.44 Lussenhop and Corn (2002) carried out a literature review also exploring comparison between using LVDs and large print which was judged as providing evidence of moderate quality. They identify eight studies (including Corn et al., 2002 and Koenig et al., 1992), concluding "that reading standard print with optical devices is as effective a literacy medium as large print – and perhaps a more effective one" (p.67), and while LVDs are not always the appropriate solution for all children, teachers and students should re-examine “traditional reliance on large print” (p.68).

4.45 More recently, Farmer and Morse (2007) compared two groups of students over a year. The first group (N=9) received a prescribed LVD, training in its use, and support offered to their teachers. The second group (N=7) just received large print materials. Both groups appeared to make equal reading progress, while the majority of the LVD group were able to access reduced print size. The evidence is of moderate quality.

4.46 Also rated as moderate quality, Lusk (2012) carried out a multiple baseline study in which students (N=5) were exposed to different types of LVD configuration (as well as their standard print/large print condition). Performance with LVDs broadly matched that of the large print condition, but the focus of the conclusion was around the individual differences of young people with vision impairment and the likely need for a range of strategies (and associated assessment and training) that will change with time and situation.

4.47 Huurneman et al. (2013) compared the influence of two different types of magnification method reading task (magnifier versus large print on crowded near vision task performance). Fifty-eight vision impaired children aged 4-8 years participated. They were divided into two groups, and matched on age and near visual acuity. Group 1: the magnifier group and Group 2: the large print group. The type of magnifier chosen was a 90mm diameter dome magnifier in order to avoid measuring the confounding effect of navigational skills. The results suggest that a magnifier is equally effective as large print in improving the performance of young children with a range of visual acuities on a crowded near vision task. Vision impaired children with stronger crowding effects showed larger improvements when working with magnification. The authors particularly note that the use of magnifiers is feasible with young (primary age) children. The children in this study had no experience working with a magnifier. Overall this study provides moderate to strong quality of evidence, scoring 'strong' in the majority of the categories.

4.48 Of critical relevance here is whether students with low vision, who use individually prescribed LVDs for reading, will perform as well as (or better than) students with low vision, who use large-print reading materials. The collective evidence appears to be strong that the use of LVDs at least matches the use of large-print. It is also worth noting that the studies have also tended to focus upon older optical technology, and these finding are likely to be transferable to electronic screen technology such as tablets and smart phones.

Print: training in speed reading

4.49 While speed of print reading is identified as an area of concern for young people with low vision, there appears to be few studies which have explored interventions to address this issue beyond the use of LVDs. Fridal, et al. (1981) carried out a multiple baseline study with six university students who were selected because they were very slow readers. They were given a range of training: speed reading exercises (speed cards); coaching/explanation of reading processes (eye movement regressions, fixation); speed reading with a purpose (searching for specific information); removal of sub-vocalisation. Reading speeds improved considerably for all six participants (and this improvement was largely maintained for the two participants who were followed-up).The evidence was judged to be of moderate quality.

Available evidence – literacy and children with complex needs

4.50 A review of literacy interventions and children with vision impairment and complex needs was undertaken by Parker and Pogrund (2009), and provides evidence judged to be of moderate quality. A key feature of this population is that the young people have an extremely wide range of needs and circumstances which led Parker and Pogrund to note "Beyond the description of settings, researchers repeated the theme that literacy learning environments need to be highly responsive to students' initial literacy behaviors" (p.461). It is probably for this reason that a range of descriptions of potential routes to literacy presented in the literature rarely reached our threshold for an intervention research study. This range of approaches is also reflected in Parker and Pogrund's key finding that "Another recurring description of successful learning contexts centred on individual tailoring of media for access and participation" (p.461). Therefore, there are many accounts in the literature (in broadly the case study tradition) of researchers and practitioners describing the use of augmentative and alternative communication (AAC), braille, Moon, and print as a route to literacy for young people with vision impairment and complex needs. Such approaches rely upon "persistence and collaboration by the educational team, the individual, and the family to develop successful literacy outcomes" (p.461). It should also be recognised that this area of intervention overlaps with 'Communication' (see previous section).

Implications

4.51 Literacy is one of the most researched areas in the field of vision impairment education. Most of the research focusses upon reading rather than writing, and this is largely split between braille and print reading.

Implications – Braille

4.52 Firstly, it is important to recognise that if we consider teaching braille as an educational intervention in itself, there is clear evidence that it offers a legitimate and successful route to literacy for many young people with severe vision impairment. Nevertheless, precise details of *how* braille literacy should be taught is more complex. The research evidence offers the following steer:

- There is no conclusive evidence of the relative advantages associated with different timings of introducing braille contractions in teaching, i.e. there appear

to be advantages of introducing contractions from the beginning, or first teaching the uncontracted/alphabetic braille and then introduce the contractions when children are older.

- A key ingredient to progress in braille literacy appears to be high levels of input in a variety of ways, commonly including one-to-one activities on a frequent and regular basis, preparation by the teacher involved, and communication with others to instil practice and consistency. Success appears not to be linked to whether contractions were introduced early or late.
- This suggests that other factors may usefully be drawn upon when making decisions about selecting approaches to teaching braille contractions including pupil and family preferences. It may also mean that linking braille teaching to print reading schemes used by other sighted peers may be more easily achieved, and justified on grounds of inclusion and engagement while not compromising likely literacy outcomes.
- Although the quality of evidence is moderate, teaching approaches which focus upon associating braille letters and letter clusters with phonemes prove successful.
- There are a range of strategies which have associated moderate and impressionistic quality of evidence – arguably such strategies will be used in a varied approach to teaching (not least in motivating the learner). These include: using teaching materials and activities based upon highly motivating words and content, with attention to relevant and intrinsic meaning for the child; using teaching materials and activities which involve tracking and discrimination-type activities with little intrinsic meaning.
- The use of refreshable braille technology has not been investigated in any great detail in terms of intervention studies. Although the evidence is not very developed, it seems clear that the technology has no negative impact upon literacy learning, while it has the pedagogical and practical advantages associated with portability as a writing device and quick access to large volumes of braille reading materials. For older learners there may also be the potential of using the technology to enable self-study of higher-level braille literacy/maths skills independently.

Implications – Print literacy

4.53 As with braille literacy, it is important to recognise that print offers a successful route to literacy for many young people with vision impairment. What is complicated in relation to print literacy, is that the adjustments which need to be made in order to visually optimise access to print for a young person will vary from one individual to another, and how this visual optimisation is achieved can also be accomplished in different ways, e.g. adjustment of the printed materials, or the use of optical or digital magnification. It is this comparison which dominates the evidence identified in the REA:

- Collectively, there is strong evidence that students with low vision who use individually prescribed LVDs for reading and have associated training and support will perform as well as students with low vision who use large-print reading materials. Performance here is in relation to different aspects of reading: speed, accuracy and comprehension.
- While most of the evidence is in relation to older optical technology, these finding are likely to be transferable to electronic screen technology such as tablets and smart phones. However, more research in this regard is required.

Further relevant evidence is also identified within low vision training (next section).

4.54 Only one other intervention related to print literacy education was identified in the REA which met the inclusion criteria, and this was linked to training to improve reading speed amongst older academically able young people. There is moderate evidence that coaching in various aspects of speed reading can improve reading speed amongst this group.

4.55 It is interesting that the REA did not identify other interventions linked to print literacy education which met the inclusion criteria, e.g. linked to developing reading comprehension and accuracy, linked to access to writing. Nevertheless, there are links with other intervention areas, most notably technology.

Implications – literacy and children with complex needs

4.56 The REA identified very few interventions linked to literacy and children with vision impairment and complex needs which met the inclusion criteria. Even so, a literature review by Parker and Pogrund (2009) offers a helpful overview of the range of different approaches which researchers and practitioners have taken in this

regard. As with approaches to developing communication amongst children with complex needs a key focus of these approaches is around individually tailoring the approach taken. The evidence-base is very undeveloped, but does provide accounts of augmentative and alternative communication (AAC), braille, Moon, and print as a successful route to literacy for young people with complex needs.

Low vision training

Introduction

4.57 Influential work by Barraga (e.g. Barraga 1964; Barraga and Collins 1977; Barraga 1990) concluded that visual development amongst children with vision impairment benefited from children using their residual vision. Previously, there had been concern that the vision of children with a vision impairment could not be developed and that educators should not encourage its use. This shift in view had far reaching implications, including (1) encouraging the use of vision (including structured visual training or visual stimulation) would improve functional vision, and, (2) teaching should include the use of appropriate visual devices which are offered through low vision services.

4.58 The visual training literature is particularly concerned with the assessment of functional vision and associated teaching/training activities (in particular linked to young and developmentally young children). For example, the assessment tool "Look and Think" (e.g. Chapman et al. 1989) identified eighteen different visual skills that a teacher could assess through the use of test materials and a check-list. Douglas et al. (2009) note there are a range of publications which describe how children with vision impairment can benefit from training in a range of visual functions – from basic visual functions, such as visual attention, to complex functions, such as tracking and matching. The literature is wide ranging and includes work with children with vision impairment and complex needs and the use of computer-based tasks (exploiting the visual control offered by software packages).

4.59 Literature concerned with low vision services, training and devices often (though not always) focusses upon access issues rather than development. This is partly because these services are generally in place for adults (most of whom will have late onset vision impairment) as well as children. Literacy (often reading) is a common strand of this work because access to text is a common challenge for

people with vision impairment. The impact of these services upon the development of literacy is discussed in previous sections (0 Literacy, Available evidence – print reading). Nevertheless, research is focussed upon how services seek to assess, prescribe and train in the use of low vision strategies generally – e.g. lighting, LVD use. This research is commonly not directly educational research, but associated. For example, Ruddock et al. (2004) investigated the running of low vision services and children's access to these services. In their sample, they identified 29 out of 57 children and young people who were not using LVDs who could benefit from doing so, i.e. the focus of the research was upon the efficacy of the service in improving up-take of LVDs, rather than the educational impact of using LVDs *per se*.

Available evidence

Visual training and visual stimulation programmes

4.60 Interventions were concerned with visual training and visual stimulation programmes (e.g. tracking and visual discrimination exercises) to improve functional vision/visual perception (López-Justicia and Martos, 1999; Vervloed, et al., 2006).

4.61 The effectiveness of two programmes to develop visual perception in Spanish schoolchildren with low vision was explored by López-Justicia and Martos (1999). In this randomised controlled trial, the 20 participants (aged 4-6 years old) were divided into four different groups – two interventions, one placebo control (training, but "different from and unrelated to" the interventions), one untreated control (no training). The interventions were designed to investigate whether it was possible to increase visual efficiency and acuity through teacher-led activities in a normal classroom setting. Existing interventions were used – one of which is used to help people with low vision who do not use their residual vision appropriately (designed for those with a development age of 3 years) and one to help develop perceptual skills (designed for children aged 4 to 7 with delayed reading, learning, hearing or intellectual deficits). The results of the study do not provide a basis to conclude that either of the two programmes is the more effective, since all the children improved regardless of the type of treatment received (including the non-intervention groups). The authors conducted additional qualitative analyses and identified that in standard teaching practice the teachers were giving the children activities that paralleled those in the interventions, suggesting that the gains in visual efficiency were the result of the children's normal maturation and tasks integrated into standard

teaching practice. Thus, they concluded there is no evidence to show that these specific interventions supported development of visual perception in schoolchildren with low vision. Overall, the study provides moderate to strong quality of evidence, scoring ‘strong’ in the majority of categories. However, the sample size was relatively small and whilst the intervention was conducted in the classroom there is limited information with regards to how it was practically implemented which would make it challenging to replicate.

4.62 A systematic review relating to the visual rehabilitation of children with vision impairment was undertaken by Vervloed et al. (2006). The authors suggest that there is an urgent need for good randomised controlled trials with dependent variables that are relevant to everyday life. They conclude that visual stimulation or training programs are not effective if they take place in artificial surroundings and are non-contingent on the child’s behaviour (i.e. if the child has a passive role). These findings should encourage teachers, trainers and clinicians to refrain from non-contingent visual simulation programmes; rather training of visual functions seems fruitful when skills are ecologically valid and adapted to the individual needs and task demands of the child being trained. Even so, the empirical evidence is still too sparse to draw convincing conclusions. The evidence was judged to be of impressionistic to moderate quality.

4.63 The teaching of visual perception training programmes was examined by Uysal and Duger (2012). Working with a total of 40 children with low vision aged 7-14 years, one group of 20 children used a pen and paper intervention and the other group of 20 children used a computer. The training programmes were performed in a single specialist school for three months (two days a week and 45 mins each day). It was observed that neither the visual perception training in a computerised environment or using paper and pen improved performance against measures of visual perception (although improvement in social skills measures was observed – see section 0 Social and emotional functioning). Overall the paper demonstrates moderate to strong quality of evidence, only scoring in the impressionistic category in evaluating critically the limitations of the study, and moderate in relation to implication for practice, sample size and generalisability.

Impact of, and access to, low vision services

4.64 This educational strategy area overlaps with the area of print literacy. Several identified studies investigated interventions which explored the impact of low vision services, training and devices on reading performance and development (Huurneman et al., 2013; Koenig et al., 1992; Lagrow, 1981; Lusk, 2012), and/or reading habits (Lackey, 1982). These are discussed and evaluated within (print) Literacy above.

4.65 Four other studies explored the impact of low vision services, training and devices upon visual efficiency more generally (rather than reading specifically) (Binns et al., 2012; Liebrand-Schurink et al., 2016a; 2016b; Margrain, 2000).

4.66 Liebrand-Schurink et al. (2016a) analysed the effectiveness and efficiency of magnifier use in children with vision impairment who had not previously used LVDs. The participants consisted of twenty nine 4-8 year old children with vision impairment and 47 age-matched children with normal vision. After first seeing an introductory symbol, children were instructed to (1) move the stand magnifier as quickly as possible toward a small target symbol (that could only be seen by using the magnifier), (2) compare the two symbols and (3) move the magnifier to one of the two response areas to indicate whether the two symbols were identically matched. Performance time was measured in terms of accuracy, response time, identification time and movement time. The results showed that both children with VI (mean success rate: 80%) and children with normal sight (mean success rate: 84%) could adequately identify the symbols with the stand magnifier. Vision impaired children's performance in terms of success rate, mean reaction time and mean movement time of first and second movement parts, did not differ from normally sighted children. The comparison between the sighted and VI children offers some insight into how they may adopt different strategies of use. Of greater educational relevance is that the study demonstrated that the stand magnifier is a suitable tool for young VI children from the age of four years to carry out these ecologically valid visual tasks. Overall, this study provides moderate to strong quality of evidence.

4.67 In a second study, Liebrand-Schurink et al. (2016b) investigated the use of two kinds of LVDs (dome and stand magnifiers) to carry out standardised visual tasks. The participants were young children with vision impairment (n=56) compared to a

group of children with normal sight (n=66). The children were 4-8 years old. The results confirmed that children with vision impairment differed from peers with normal sight in motor performance – and they could best preserve accuracy by slowing down their movements. As with their previous study, of greater educational relevance is that the study gave insight into how young VI children could undertake these visual tasks using LVDs, and also there was evidence that the dome magnifier was used more successfully than the stand magnifier for this age group for these search tasks (appearing to be easier to control). The study was judged to provide mainly strong quality of evidence within the moderate to strong rating category.

4.68 Margrain (2000) sought to quantify the effectiveness of standard low vision services in Wales – i.e. providing a low vision assessment and associated prescription of LVDs and how this would be of benefit to individual people with VI. The study involved 168 participants recruited over a six month period as they attended low vision clinics for a low vision assessment. They were from a wide age range of 10-100 years (and 99% were aged 20 and above). The participant's visual performance without LVDs was assessed with standard procedures at the low vision clinic. Participants were tested to see if they could read N8 size print or better without a LVD. Following the introduction of a LVD the participants were then tested again to see if they could now read N8 (or better). The findings show that the prescribed LVD significantly improved reading ability (or print access), clearly indicating that LVDs are an effective means of improving reading access in people with impaired vision. Overall this study provides moderate to strong quality of evidence. However, the study is not educationally focussed and does not focus upon changes in reading habits. There is a difference between being able to physically read a text size and it being a viable method for a sustained period of reading. While the paper provides clear demonstration of improved access to text, it is less clear how it might be relevant to children who are developing reading skills. Even so, the research is situated in Wales and relevant to the review. The evidence is judged to be of moderate to strong quality.

4.69 Binns et al. (2012) conducted a systematic review to assess the effectiveness of low vision service provision. Initially 478 potentially relevant articles were identified which were narrowed down to 58 studies which met their 'liberal inclusion criteria',

of which only seven of these were RCTs. The study was looking at low vision service provision in general and, therefore, the majority of the studies relate to the rehabilitation of adults. They note there is limited evidence for children and young people. They identified only two good quality studies looking at young people – Corn et al. (2002) (discussed in the literacy section) and Ruddock et al. (2004) which, as noted above, focused upon the efficacy of the service in improving up-take of LVDs, rather than the educational impact of the actual intervention. The systematic review was comprehensive with clear entry criteria. The main issues were to do with the data available – the authors noted a lack of well-designed studies which meant that conducting the literature review was challenging. In particular, they noted that there is not much consistency with the outcomes that are used to assess the interventions made by low vision services. Overall, this literature review was judged to provide moderate to strong quality of evidence.

Implications

4.70 The evidence of the positive impact of structured visual training and visual stimulation programmes upon the development of functional vision is limited. It seems most likely that contingent and naturally-situated visual activities are most likely to have benefit. Evidence is absent for the impact of using computer-based activities (in which visual stimulation can be carefully controlled and maximised) to develop functional vision. Nevertheless, adjusting and optimising visual presentations seems a powerful and necessary way to engage young and developmentally young children. This is likely to have greatest value in developing function vision if the presentation strategies are embedded in broader activities which encourage communication so that the visual tasks have meaning, although evidence is not established.

4.71 In terms of access to low vision services and training, clearly the availability of services and equipment which can be utilised in education is crucial. Research demonstrates that LVDs (and general modification to the visual environment) clearly gives access to visual information for people with vision impairment. Whether the benefit of this can be practically utilised within education is a different question. Some evidence of low uptake of (optical) LVDs amongst teenagers with vision impairment suggests that this is not straightforward (e.g. Mason, 1999), but evidence in relation to literacy demonstrates it can be done.

4.72 There is evidence that young children (at the age of 4 years) have the control and ability to use LVDs. This suggests that starting interventions with *young* children is a good strategy (and may have benefits of normalising LVDs and approaches to independence). In terms of specific technology, 'dome' LVDs may be easier to use than 'stand' LVDs for young children. The REA did not identify formal investigations into the use of mainstream electronic technology as LVDs (e.g. mobile phone screens, tablet screens), but it seems likely that this has many possible opportunities and should be the focus of future research.

Teaching strategies (including mathematics)

Introduction

4.73 This strategy area has a focus on studies examining the use of teaching strategies/approaches to support learning of children with vision impairment, i.e. pedagogy. Early work by Lowenfield (1973) has been particularly influential in delineating three main limitations that can be associated with vision impairment: restriction in the range and variety of *experiences*; restriction in the child's *mobility*; restriction in the child's interaction with the *environment*. To reduce the effect of these, Lowenfield (1973) proposed three "principles of special methods" for teaching students with vision impairment:

- The need for concrete experiences;
- The need for learning by doing;
- The need for unifying experiences.

4.74 Considering whether these principles constituted unique (disability specific) strategies/approaches to teaching, Douglas and McLinden (2005) argue that at a 'micro-strategy' level of teaching there is evidence that particular approaches are necessary when teaching children with a vision impairment "which has its basis in 'access' to the curriculum" (p.36). In drawing out the implications for practice they conclude that:

1) The teaching strategies are necessarily sensitive to the modality of the interaction because of the children's impaired vision (i.e. its accessibility);
2) This can be done by either 'enhancing' the visual mode (e.g. enlarged print) or using 'alternative' presentations (e.g. through speech or a tactile code);

3) The use of micro-strategies may take longer than (or have different qualities to) traditional teaching strategies (most obviously, they may be slower).

4.75 In translating these points to practical implications for how the learning can be managed in the classroom environment, Douglas and McLinden (2005) note:

- Without these strategies access to the curriculum by vision impaired children would be compromised or even denied.
- These adapted methods of teaching may require more time than conventional teaching strategies (partly because children with vision impairment generally require more time to process information and to complete tasks).
- Some aspects of the curriculum may require significant modifications to enable access by children who are vision impaired (e.g. braille literacy).

4.76 However, arguably particular teaching strategies may be relevant for particular curriculum areas. Smith (2017) reports that the impact of vision impairment is widely recognised to be particularly significant for mathematics learning given that much of "the language of mathematics relies on visual references (direction, quantity, shape, logical attributes, and so on) and requires significantly more cognitive processing for students with visual impairments" (p480). He notes that concepts in geometry and measurement are challenging because of their visual nature, and the same can be true for relatively 'simpler' concepts such as multiplying or dividing large numbers involving spatial manipulations. Smith (2017, p508) argues that:

> "because of the overall visual nature of mathematics, its use of unique tools, and its general difficulty, the challenges for students with visual impairments in being successful are typically greater than those for their sighted peers. However, these challenges can be overcome with the use of innovative and well-conceived instructional strategies rooted in basic mathematical pedagogy."

4.77 Therefore, this area also includes interventions designed to support the development of mathematical skills, including specialist braille codes (Nemeth code and science notation) and technology.

Available evidence – strategies generally

4.78 Boyd-Kimball (2012) presents a description of the adaptations (mainly the development of tactile materials) made in a university setting to facilitate curriculum access for an individual blind student. The research offers a formal case study describing the development of teaching materials (tactile materials in particular) in response to teaching which was typically taught with a lot of visual/pictorial content (in this case degree level chemistry). The student was able to access content successfully, whereas before this had not been possible. Although providing strong evidence of impact in relation to implication for practice and reporting of the evaluation, and moderate evidence in relation to the objectives of the study and the quality of the intervention, in all the other categories it only provided impressionistic evidence. Consequently, the overall score for this source of evidence was impressionistic to moderate.

4.79 Moderate to strong quality of evidence was provided by Celeste-Williams et al. (2010) in their intervention programme to develop nutritional knowledge of children and adolescents with vision impairment. The intervention took place over seven days during a week-long children's camp, where the children had two mini-lessons a day where they learnt about food groups, portion sizes, and the nutrients in the meals they were consuming. Tactile and braille resources were made available. The participant's learning was reinforced through daily questioning and on the last day there was a group competition with prizes. The results of the study indicated the intervention was successful in increasing the nutritional knowledge of the participants with vision impairment at all ages from 8 to 17, and at all levels of vision impairment.

4.80 Impressionistic to moderate quality of evidence was provided by Cozendey and Costa (2016) in relation to the use of audio description to teach concepts in physics. Video with and without audio description was presented to students, and it was shown that audio description was useful for both VI and non-VI students in developing understanding of concepts, images and representations. Although the quality of the study was judged as impressionistic (evidence of success was only gathered through interview), the fact that students could access material when before they could not was clear. Of interest, is that the study also included those with normal vision, who also benefitted from the intervention. This is relevant

because it highlights that some pedagogical adaptions designed to include children with vision impairment may have more general benefit.

4.81 Also including normally sighted children in their research design, Cole and Chee Pheng (1998) explored the use of verbal and visual mediation training to support concrete problem solving skills. Participants were required to complete the Tower of Hanoi disc puzzle. Participants in the 'verbal mediation training group' were asked to talk out loud about the moves they were making. Participants in the 'visual mediation training group' were asked to visualise their moves in their mind. The effect of verbal mediation training had greater positive impact than that of visual mediation training for both children with vision impairment and children with normal vision. The study indicates that if children with vision impairment are given time to familiarise themselves with the demands of the task, they should eventually do as well as participants without VI on concrete problem-solving activities. Overall, this paper provides moderate to strong quality of evidence.

Available evidence – mathematics

4.82 Of the identified intervention studies, all three utilised specialist technology to support the learning of maths, including the specialist maths code (Nemeth). Two of these interventions utilised auditory feedback/listening skills (Bouck et al., 2011; Bouck and Weng, 2014). The third intervention using technology was a follow-up study to evaluate the immediate and longer-term effectiveness of a software tutorial installed on a BrailleNote device and used by students who are blind to learn the Nemeth Code independently (Kapperman et al. 2012).

4.83 The efficacy and efficiency of a newly developed 'voice input/speech output' (VISO) calculator as a tool for solving maths calculation problems by students with vision impairment was explored by Bouck et al., (2011). The trial was based upon participants using the calculator in a way of their choosing; there was no formal instruction. The results showed that although using the VISO calculator took longer and required more attempts than the participants usual method of calculation, it gave students with vision impairment an opportunity to be independent; they do not need to rely on another individual to enter mathematical problems or to retrieve the answers. Although providing strong quality of evidence in relation to the objectives of the study and the reporting of the evaluation, it provided impressionistic evidence

in relation to sample size, consequently overall the paper provides moderate to strong quality of evidence.

4.84 Similarly, Bouck and Weng's (2014) comparison of accessing algebra via a digital textbook rather than a traditional textbook (either braille or print) also provided moderate to strong quality of evidence. Again, the trial was based upon participants using the digital textbook in a way of their choosing; there was no formal instruction. This was compared with their use of a traditional text book (in braille for one participant, and print for the other two – one of whom used a CCTV). The results suggested that students tended to solve the algebra equations better when they were presented through their traditional textbook; task completion took longer for all three participants when using the digital textbook; and two of the three students preferred their traditional textbook and one preferred the digital textbook. This suggests digital texts must be used with caution and it should not be assumed they will improve access/learning. Perhaps of greatest significance, is that students need teaching and preparation in the efficient and effective use of digital textbooks.

4.85 The immediate and longer-term effectiveness of a software tutorial installed on a BrailleNote device and used by students who are blind to learn the Nemeth Code was examined by Kapperman et al. (2012). Results show that the tutorial was a very effective tool that can be used by teachers to provide instruction in reading and writing the braille maths code, with significant long-term effectiveness. While it must be noted that the Nemeth Code is not used in the UK, there is no reason why the findings would not be transferable to supporting the teaching of other specialist braille codes. Overall, the study provides moderate to strong quality of evidence, scoring 'moderate' in most categories but 'strong' in relation to the quality of the research design and reporting of the evaluation.

Implications

4.86 A common research design is to offer formal accounts of specific teaching practice, i.e. researchers and researcher-practitioners describe the preparation work and modifications they make to their teaching strategies for given curriculum areas. The literature contains many other accounts of similar practice, although it generally does not meet the inclusion criteria of the REA.

4.87 There is a well-established philosophical position that adjusting the presentation of educational material will improve access for students with vision impairment. It is rather an obvious requirement, and perhaps that is why there is relatively little formal research identified in the REA which has gathered empirical evidence in this regard. An analysis by Douglas and McLinden (2005) summarises these presentational adjustments to teaching strategies as either 'enhancing' the visual mode, 'alternative' presentations (e.g. through speech or a tactile code), or combinations of the two. The research and good practice literature offers many examples of both:

- enhancing the visual mode: e.g. enlarged materials, simplified and enhanced diagrams, increased contrast and colour adjustments, adjusted lighting, the use of LVDs, electronic materials (with associated enhanced visual output).
- alternative presentations: e.g. tactile diagrams in science and mathematics, braille materials (including use of particular braille notation for science, music and maths), explicit verbal questioning and verbal mediation, audio description of videos, electronic materials (with associated speech and/or electronic braille output).

4.88 Nevertheless, the findings of the review also suggest the following:

- There is evidence that some changes to teaching/presentation strategy can benefit all learners, not just those with vision impairment, e.g. audio descriptions of videos and diagrams, and verbal mediation in problem solving.
- Nevertheless, some strategies are very specific to the child with vision impairment, e.g. the use of braille code.
- There is implicit evidence in the literature that some adjusted materials need educators with particular/specialist knowledge and/or training to prepare and create the materials, e.g. adjusted visual diagrams, tactile diagrams, braille code.
- There is implicit evidence in the literature that some adjustments may take time for the young person to learn and master. This links to the concept of 'learning to access' in which the young person with vision impairment may need instruction and practice time to be able to benefit from the adjustments

and the improved access they afford, e.g. learning to use software, electronic books and tactile diagrams.

- Some curriculum areas may need particular attention in terms of requiring particular teaching strategies to maximise access. The REA identified research evidence in relation to maths and science, but other curriculum areas have well documented strategies (e.g. music, physical education).

Access to examinations

Introduction

4.89 This strategy area has a focus on studies describing the relative success of different assessment accommodations/modifications. As reported by Douglas et al. (2009), while the formal assessment of children through public examinations is a central feature of most education systems, standard examination formats and procedures may present barriers to children with vision impairment. This could mean that they are not able to demonstrate their abilities under standard examination conditions.

4.90 Whilst there is limited empirical evidence describing the success of different assessment accommodations generally, there have been international analyses of practice. For example, QCA (2007) provides a typology of assessment accommodations: presentation, response, setting, and scheduling accommodations. Douglas, McCall, Pavey and Nisbet (2009) provide evidence of international practice in relation to vision impairment, and Cobb (2008) offers an overview of the system for children with vision impairment in England and Wales that includes a history of its development. The central mechanism of this system relates to 'access arrangements', whereby examination 'modification' or 'enlargement' is requested from examination boards for individual students before their examination. A limited choice of arrangements is available, including enlarged text, enlarged 'modified' text, and braille modified. Zebehazy, Kamei-Hannan, and Barclay (2017) also make a similar distinction between testing accommodations or modifications:

- *accommodations* which are adaptations to the test or instructions that do not have an impact on the skill that is being tested
- adaptations to the test that result in a change to the skill or skills being tested are referred to as *modifications* or *nonstandard accommodations*.

4.91 Douglas et al. (2009) report there is evidence that teachers do not understand the mechanisms for examination arrangements, the modifications made by examination boards are inconsistent, and the choices of examination format (in effect large type, of 18 or 24 point, or braille) are inadequate for meeting the needs of the pupils. Building upon this argument, Douglas, McLinden and Weston (2010) highlighted that a key challenge was the misalignment between normal classroom practice and examination conditions. On one hand, students are not prepared for examination conditions, and on the other hand the available access arrangements do not have the flexibility to allow students to use the full range of independence skills they have developed (most notably there is ambiguity around the use of computer technology in examinations).

Available evidence

4.92 Only two articles were identified in the literature that met the criteria in this strategy area (both by the same authors, and both rated as being of moderate quality). Landau et al. (2003) and Landau et al., (2006) explored the impact of using a talking tactile tablet (TTT) with associated training, as a test accommodation in a mathematics exam for middle school students in the USA. The 2003 study formed a pilot study of eight young people, the latter 2006 study was bigger involving 20 participants. Although the results from both studies suggest the use of the TTT had no effect on student performance (as arguably should be the case), the findings indicated four advantages to its use:

- The TTT allows students to complete tests more quickly without diminishing performance.
- It provides students with more independence when performing a test that involves graphic elements.
- It eliminates the opportunity for a test administrator to assist students inadvertently during testing.
- It increases the standardisation of test delivery by presenting items in the same format.

Implications

4.93 Given the importance of formal assessment and examinations in young people's lives, it is surprising that there is so little empirical research exploring the relative efficacy of different access arrangements for those with vision impairment. Nevertheless, descriptions of the available approaches to access arrangements are more established. The literature describes approaches which seek to make accommodations and modifications to assessments to enable greater inclusion/access (e.g. QCA, 2007). The debate also includes the principle of 'inclusive' or 'universal' design which requires assessments developers to maximise the accessibility of the assessment at the design stage in order to minimise the requirement for later accommodation and modifications. This suggests the following implications:

- Access arrangements for examinations should be clearly defined and offer the flexibility to enable young people with vision impairment to use their available independence skills and preferred way of working.
- Classroom practice and access arrangements should align with one another as much as is possible, and when there are differences young people should be prepared for this at time of examination.
- Technology (e.g. word processors with specialist software) has potential value for young people with vision impairment in many examinations. It provides a means to efficiently access assessment material and express assessment responses. This assumes that these approaches are taught and become embedded in young people's standard classroom and studying experiences.

Mobility and independence

Introduction

4.94 Most overviews of vision impairment education include significant discussion in relation to what is broadly labelled mobility and independence. With respect to the expanded core curriculum (ECC), many of the areas identified are underpinned by a concern for developing what could be broadly described as 'independence'. Even so, the areas of orientation and mobility, independent living skills, and self determination most directly link to the broad intervention strategy of 'mobility and independence'.

4.95 The far reaching nature of mobility and independence is reflected in work in the UK by Pavey et al. (2002). They argued that services must attend to a mobility and independence curriculum which includes:

- Early and foundation mobility and independence
  - Body and spatial awareness – e.g. early sensory-motor development, spatial language, mobility and orientation in different settings.
  - Social and emotional development – asking for assistance, social conventions, manners, confidence and motivation.
- Advanced mobility and independence
  - Travel skills – e.g. routes and technical aspects of travel, mobility and orientation, road safety, cane techniques.
  - Independent living skills (ILS) – e.g. kitchen skills, eating, hygiene, money handling, dressing.

4.96 Miller, Wall and Garner (2011) describe the roles of the 'qualified habilitation specialist' (QHS) and 'qualified habilitation assistant' (QHA), as well as associated practice/training standards. While the roles are not mandatory in any of the UK education systems, the roles are widely recognised as important in relation to developing broad mobility and independence skills in children with VI, and 'habilitation' is referred to in the SEND Code of Practice for England, and the draft Additional Learning Needs Code of Practice for Wales.

4.97 Good mobility and independence skills amongst people with vision impairment are commonly associated with positive outcomes, including employment outcomes. For example, the factors associated with post-school employment for young adults with vision impairment were investigated by Cmar (2015). Secondary data from the US National Longitudinal Transition Study was analysed to investigate employment outcomes for young people with vision impairment based on orientation and mobility skills. The results suggest that independently travelling to places outside the home, using public transportation, and arranging airplane or train trips predict post-school employment for youths with vision impairment. Positive self-beliefs about work for pay, financial self-support, and independent living were also associated with employment.

Available evidence – young and developmentally young children

4.98 Working with pre-school children, Beelmann and Brambring (1998) described a holistic intervention involving fortnightly home visits by professionals for two years which included:

1. Giving parents guidance on interaction and environmental design.
2. Blindness specific aspects (activities linked to developing tactile and auditory object perception, spatial orientation and mobility, and daily living skills).
3. Following assessment, a bespoke set of play materials were given to the family, such as noise-making objects, touch books, and three-dimensional models (e.g., of the family home or garden).
4. The parents were offered 'problem-oriented counselling' from a family-oriented perspective (e.g., consideration of the needs of parents, siblings and specific family constellations, as well as the child with vision impairment).

4.99 Beelmann and Brambring (1998) evaluated the effectiveness of this approach comparing the progress of the intervention group (10 children with severe vision impairment and their families) with that of a comparison group (40 children) who received various services from local centres. This comparison intervention was not standardised or clearly described. The evidence is judged to be of moderate quality, and the results themselves do not show an unambiguous benefit of the intervention. Nevertheless, it appears that for blind children born at full-term, the intervention was effective (particularly in relation to the development of mobility and orientation). The effect was less clear for pre-term infants.

4.100 The use of safe and stimulating environments or rooms (as characterised by 'Nielsen's Little Room') to encourage movements in young and developmentally young children (including those with multiple disabilities) has been recommended by many commentators. Dunnett (1997) presents evidence of impressionistic quality in the form of a case study of child being placed in such a room on a resonance board for extended periods. Comparison was made with the child behaviours outside the room, and it was argued the child gradually started to explore objects when placed in the room.

4.101 Object permanence is the concept of knowing that objects continue to exist when they cannot be directly experienced (typically if the object cannot be seen, but it might also be if it cannot be touched or heard). It is recognised as an important

early developmental milestone and an important precursor to mobility. Bruce and Vargas (2013) explored teaching object permanence to a young child with vision impairment and complex needs (with some functional vision) through an action research multiple baseline design. Lessons for teaching object permanence were highly structured and based upon familiar and motivating objects, which also could produce noise. The structured routine involved establishing shared visual attention of the object, and then concealing it beneath different covers (with and without sound cues). The structured approached proved successful in that the child had increased motivation to seek objects and successfully find them, and some evidence of transference of the learning to other contexts (such as seeking dropped toys). The results demonstrated that consistent team approach to direct instruction of object permanence was of benefit to this one vision impaired participant with multiple disabilities. Overall this paper provides impressionistic to moderate quality of evidence.

Available evidence – Travel and mobility

4.102 Working with children of primary age, Budd and LaGrow (2000) used models to teach environmental concepts prior to travelling in the real world (an interactive wooden model that consists of pieces to represent roads, borders, crossings, and also enhanced with toy cars and figures). Children were introduced to 48 environmental concepts through the use of the interactive model. The children were put into pairs and taught in a number of 30 minute sessions. Three distinct sets of concepts were taught, only moving from one set of concepts to the next once the first had been understood. Employing a case study design with four primary aged children, the researchers found that children did demonstrate learning of spatial concepts but the study included no assessment of whether this learning was maintained or transferred to travelling. The evidence was judged to be of impressionistic quality.

4.103 Wright and Wolery (2014) explored the effect of targeted roadside instruction upon ability to cross roads safely. Specifically, the study was implemented using roadside instruction to determine whether graduated guidance paired with verbal rehearsal was effective. This involved the teacher breaking down the task, describing it to the participant with vision impairment in graduated statements (and physical modelling if required), and encouraging verbal rehearsal before implementing the road

crossing. Employing a multiple baseline design with four participants (13 to 20 years of age with light perception or less), the evidence was judged to be of medium to high quality. The findings indicated the approach was successful. Follow-up work provided evidence that the learning was maintained for the road crossings taught, and the learning was generalised to other road crossings. Wright and Wolery also identified other supporting research that roadside instruction is more effective than classroom-based instruction for teaching road safety. While this research included participants with and without disabilities, “no [previous] studies were found evaluating methods for teaching street crossing to individuals with visual impairments” (p.47)

Available evidence – fitness

4.104 Cervantes and Porretta (2013) explored the use of after school sport activities with adolescents with vision impairment as a method of increased physical engagement and fitness. Four adolescents (three male, one female) at a residential school for VI pupils were recruited. Two were totally blind and two had low vision. The young people took part in a nine session programme delivered over five weeks based on social cognitive theory adapted from a programme for non-disabled participants. Physical activity increased during the intervention period, but dropped to baseline levels immediately the programme ceased, so did not provide evidence of sustained benefits. This paper was judged to provide evidence of moderate to strong quality.

Implications

4.105 Given the centrality of mobility and independence within the ECC and the field of vision impairment education, it is surprising that there is little evidence of evaluations of educational interventions which met the REA criteria. Perhaps this is because education draws upon approaches which were developed in the adult rehabilitation field (e.g. the use of the long cane) – the approaches have been applied to the education of children through practice and described in practice-based guidance. Arguably, the development of mobile and independent children was seen as evidence enough of the validity of the educational approaches used. In terms of the evidence identified, positive impact is associated with:

- Early pre-school holistic intervention with parents and families which highlights a broad range of activities and interaction strategies should be

undertaken with young children with vision impairment to encourage mobility and independence.

- Combining interventions with attention to general adjustments to the environment, as well as specific adjustments to specific activities to ensure they are accessible.
- The use of specialist rooms/multi-sensory environments, which may provide particularly accessible and stimulating opportunities for young and developmentally young children, in particular those with additional disabilities.
- Mobility instruction for older children who are learning to move around the outside environment (e.g. learning to cross roads), should take place in those authentic environments. More specifically, there is evidence that precise situated instruction involving verbal rehearsal before actions and practice appears to lead to successful learning.

4.106 Beyond these areas, the REA identified little evidence of successful interventions, or evidence of details of general principles of mobility and independence education: e.g. exactly what activity, how long an intervention should last, and when interventions should take place. It is likely that starting interventions as early as possible is beneficial (e.g. to develop independent mobility, dressing, food preparation), with no obvious disadvantages. This is underpinned by the need for all those involved (professionals and family) to recognise that mobility and independence is both possible and desirable, and opportunities are maximised which encourage this development in children and young people with vision impairment. In the context of UK education system, maximising mobility and independence before children enter secondary school seems particularly crucial because those environments make greater demands upon these skills and present fewer opportunities for these skills to be taught.

Social and emotional functioning

Introduction

4.107 This strategy area includes studies examining approaches used to develop social and emotional functioning. This is a broad area with a range of terminology used in the literature. As an example, within the US-defined ECC there is close alignment with the areas of 'social interaction skills' (which includes awareness of body language, gestures, facial expressions, and personal space) as well as 'self-determination' (which includes choice-making, decision-making, problem solving, personal advocacy, assertiveness, and goal setting).

4.108 Vision impairment is associated with access barriers for children in developing their social competences and skills. Reduced visual input can limit a child's social interaction with others resulting in the child becoming socially isolated at school and creating challenges in forming friendships (e.g. Douglas et al. 2009). Douglas et al. (2009) note that particularly vulnerable times for children include times of worsening vision, transition between schools, and later teenage years when vision impairment might limit some activities they are able to engage with (e.g. driving).

4.109 Sacks and Page (2017, p800) note that children and young people with vision impairment "either are unable to learn or have difficulty acquiring social skills through observation and imitation as sighted students do." Similarly, Douglas et al., (2009) found that there is a broad consensus in the literature that while vision may not be an essential requirement for successful social interaction in early childhood, it does contribute to the spontaneity, ease and frequency with which these early social exchanges take place. There is therefore a general acceptance that young children with vision impairment need specific active teaching from adults to develop social skills, including functional play skills.

4.110 Brown, Odom, and Conroy (2001) provide a categorisation of intervention types in relation to approaches to encourage social interaction and including children with special educational needs. This can be broadly linked with the conceptual framework outlined above (section 0):

- 'Access to learning' strategies include less intrusive classroom-wide interventions, designed to influence peers' attitudes.

- ‘Learning to access’ strategies incorporates social integration activities and the explicit teaching of social skills, including individualised interventions with the child with vision impairment that are taught to address specific areas of need.

4.111 Instructional strategies outlined by Sacks and Page (2017) for teaching/developing social skills include:

- Structured social skills training.
- Peer mediated/peer support social skills training.
- Role playing and problem solving scenarios.
- Audio-visual approaches to provide feedback on social interactions.
- Use of role models and mentors.
- Social thinking skills intervention.

There is, however, a paucity of research to demonstrate the efficacy of such instructional strategies in the literature.

Available evidence

4.112 Botsford (2013) provides a meta-analysis of the effect of teaching social interaction skills to young people while at school upon educational outcomes. As it is a meta-analysis limited information is presented about the actual interventions that were undertaken with the children. The combined studies suggest that students with vision impairment benefit from developing effective social skills. However, a direct link between social competence and employment was not measured. Taken as a whole, the research included in this meta-analysis indicates that students benefit from developing social interaction skills before reaching the age of 16 years. This paper provides moderate to strong quality of evidence. Given the challenges of conducting research using small samples in the field of vision impairment, meta-analysis offers opportunities to test the overall effect of interventions by combining the findings of multiple smaller studies. However, the specificity of the intervention is reduced.

4.113 Celeste (2007) explored teaching social skills over the course of a school year to a single blind pre-school child to improve interaction with peers. Importantly, the child's educational setting, childcare provider and parents were involved in following the child's specific intervention plan, resulting in increased group play and an increased frequency of social interactions, and the recognition that there is a need for ongoing support and teaching as the child grows and develops. The intervention plan was based on a hierarchy for promoting peer interactions: (1) less intrusive classroom wide interventions, designed to influence children's attitudes; (2) the use of naturalistic interventions, such as the incidental teaching of social behaviour; (3) social integration activities and the explicit teaching of social skills, including individualised interventions that are taught to address specific areas of need. After the plan was implemented, the child demonstrated an increased frequency and range of play behaviours and social interactions. Although providing strong quality of evidence in relation to the reporting of the evaluation, the intervention was a single case study with only one participant, so scored low in terms of sample size and generalisability. Consequently, this paper provides impressionistic to moderate quality of evidence.

4.114 The teaching of visual perception training programmes, to improve the social skills and activity performance of children with low vision was examined by Uysal and Duger (2012). Working with a total of 40 children with low vision aged 7-14 years, one group of 20 children used a pen and paper intervention and the other group of 20 children used a computer. The training programmes were performed in a single specialist school for three months (two days a week and 45 mins each day). It was observed that visual perception training in a computerised environment was not more effective than visual perception training using paper and pen (and this is also discussed in section 0 Low vision training). However, of relevance here, both interventions provided evidence of increased performance in social skills measures. The authors argue the play activity nature of the visual perception training programmes was the reason for this development, although in the absence of a control there may be a researcher-effect being observed. Overall, the paper demonstrates moderate to strong quality of evidence.

Implications

4.115 The REA identified only three studies which investigated the quality of interventions to support the social and emotional development of children and young people with vision impairment, and all focussed upon social skill development. Interventions can be usefully split into two categories: (1) socially-focussed ('access to learning') strategies which seek to make adjustments to the social environment (e.g. awareness training of sighted peers), (2) individually-focussed ('learning to access') strategies which seek to explicitly teach social skills to children and young people with vision impairment. The identified evidence suggests:

- Individually-focussed interventions appear to have a positive impact when viewed collectively in a meta-analysis, but specific details of what works is not clear from the literature.
- It is likely that individually-focussed strategies are usefully combined with a broader socially-focussed strategy which increases awareness of those around the child, and also addresses and encourages socially appropriate interactions in day-to-day/naturalistic activities (rather than targeted teaching).
- General activities which incorporate elements of play, turn taking and social interaction (including activities which do not have the primary purpose of developing social skills), will provide opportunities for social development.

4.116 Given this general steer, broader 'good practice' literature provides a range of example strategies which are believed to be associated with improved social and emotional development of children and young people with vision impairment:

- Improving general independence of young people (e.g. mobility) leads to increased opportunities for social interaction (Shapiro et al. 2010).
- Facilitating opportunities for social interaction during lunchtime (Peavey and Leff, 2002).
- Using a portfolio approach to develop self-advocacy skills to help students learn how to assess themselves (Krebs, 2002).
- Using assertiveness training to enhance the social/assertiveness skills of vision impaired adolescents (Kim, 2003).

- Using music therapy to address the issues of social isolation including specific musical activities through which children can practice socializing and interacting with one another (Gourgey, 1998).

Use of technology

Introduction

4.117 Most overviews of vision impairment education include significant discussion in relation to the importance of technology. With respect to the ECC, a key area is identified as “assistive technology” and this is underpinned by a concern for developing young people’s independence.

4.118 Building upon previous work, Douglas et al. (2009) made a distinction between “educational technology” and “access technology” (often called “enabling” or “assistive” technology) when applied to the area of vision impairment education. The former is described as having an explicit educational aim, while the latter is used in conjunction with mainstream software in order to provide access to the underlying functions. In practice the two increasingly overlap, not least because more inclusive design of some operating systems and technology generally means that user preferences can be commonly controlled: control of the presentation (e.g. speech output, colours, size) and input devices (e.g. keyboard, touch screen, mouse, speech input). While recent developments continue to improve technology, for many years the literature has emphasised that the presentation and control opportunities that technology affords make it particularly valuable in the education and inclusion of people with vision impairment. For example, computers can enhance visual presentations (for example backlit screen displays of large text in a range of colour combinations) or provide alternative presentations (e.g. speech output of screen-based text).

Available evidence

4.119 A synthesis of research studies (1965-2009) investigated the impact of assistive technology on the educational performance of students with vision impairment was undertaken by Kelly and Smith (2011). They identified and reviewed 256 articles for evidence-based research on assistive technology. However, there were only two articles which provided promising evidence-based practices leading the authors to suggest that the extent to which the field has researched this topic using rigorous,

scientific-based methods is close to non-existent. Overall, this paper provides moderate to strong quality of evidence.

4.120 In a more specific study, Cole and Slavin (2013) explored the use of a video assistive device in a university science laboratory through a single case study with a university student with low vision. The paper is a descriptive case study account of the selection and use of the video assistive device which enabled the student to participate almost fully and independently in a regular, experimental physics program that had previously been inaccessible because of its visual complexity. Not only did it enable the student to set up the laboratory apparatus himself, he could read fine measurement devices, the chalkboard and projection screen, as well as record data or notes on a computer while viewing the camera output on the same screen. Due to the narrative and descriptive style of the paper, the small sample size and lack of generalisability, and poor approach and evaluation the study falls in the category of impressionistic to moderate quality of evidence, falling towards the impressionistic end of the range.

4.121 The use of technology is commonly applied in specific areas of the curriculum. Four papers described the use of refreshable-braille technology in the teaching of braille literacy (Bickford and Falco, 2012; Cooper and Nichols, 2007; Cates and Sowell, 1990, Kapperman et al., 2012; see section: “Literacy”). Similarly, two papers described the use of technology in teaching of mathematics (Bouck et al., 2011; Kapperman et al., 2012; see section: “Teaching strategies (including mathematics)”), and one paper described the use of technology in the assessment process (Landau et al., 2003; see section: “Access to examinations”).

Implications

4.122 Given the significance of assistive technology within the ECC and the field of vision impairment education, it is surprising there is little evidence of evaluations of educational interventions which met the REA criteria (and this is reinforced by the analysis of Kelly and Smith, 2011). Arguably, the existence of assistive technology, and the successful use of this technology offers strong evidence of the importance technology as a mechanism to support access to learning, while at the same time requiring teaching so that children can use this technology independently in their own learning (i.e. learning to access).

4.123 While evidence is limited, a key implication that children require focussed teaching in relation to developing their assistive technology skills remains persuasive. This will vary for different children, but this will often include training in touch-typing, and training in the use of particular access technology/software. Some authors have developed significant resources to support this work. For example, Presley and D'Andrea (2008) provide a detailed syllabus of assistive technology skills young people need.

4.124 Beyond general access, technology offers the potential for supporting the teaching in particular curriculum areas (for example visual training, braille and communication). Other sections describe interventions which incorporate the use of technology.

Teaching support

Introduction

4.125 The 'teaching support' intervention area is concerned with the use of various teaching support techniques and configurations to support children's learning. This commonly involves support offered by non-teaching staff, e.g. learning support assistant or teaching assistants. Douglas et al. (2009) noted that while the use of teaching assistants in the education of children with vision impairment appears to be common practice in Western countries, there are few empirical studies evaluating the role. The nature of the work undertaken by teaching assistants varies considerably. For example, an early US-based description of a teaching assistant in the field of vision impairment education offered by Topor, Holbrook and Koenig (2000):

> "an individual who works under the direction of the teacher of students who have visual impairments …[and whose] activities may include preparing materials such as braille, tactile graphics and enlarged print … [and who] may perform general school duties, reinforce children's orientation and mobility skills during travel, perform self-care routines for students who need assistance, provide feedback about visual activities and reinforce the use of optical devices." (p. 8)

4.126 This suggests then that teaching assistants can take on the broad roles of supporting ‘access to learning’ (e.g. the preparation of materials in advance, or within classroom activities), or reinforcing ‘learning to access’ approaches (e.g. reinforce children’s mobility skills during travel, or the use of other independence skills). Authors have suggested that both roles require teaching assistants who have received specialist training in relation to vision impairment (and some training programmes exist) – e.g. Morris and Smith (2007). Related to this, some authors have expressed concerns about finding the correct balance of roles. If not used appropriately, teaching assistants can serve as a barrier to the child developing independence and being social included by their peers (Davis and Hopwood 2002; Gray et al. 2007).

Available evidence

4.127 No evidence was identified through the REA.

Implications

4.128 No educational interventions specifically in relation to teaching support have been identified in the REA. This is surprising given the common use of teaching assistants in the support and education of children with vision impairment. Indeed, many of the interventions described throughout this report are commonly supported and implemented by teaching assistants.

4.129 Blatchford, Russell and Webster (2012) carried out research exploring the effectiveness of using teaching assistants to support children with special educational needs more generally, and have raised concerns about how this practice can inadvertently mean that these pupils get less contact with the teacher and reduction in quality of instruction. Specific concerns have also been raised about over-supporting of pupils with vision impairment (BBC, 2016). While empirical evidence has not been identified which details the effectiveness of particular approaches in the use of teaching support, it seems very likely that teaching assistants can provide a valuable role in relation to:

- ‘access to learning’ (e.g. the preparation of accessible materials for pupils with vision impairment, providing access support within classroom activities).
- ‘learning to access’ (e.g. reinforce children’s mobility skills during travel, or the use of other independence skills).

4.130 The challenge in the management of this valuable role is in relation to:

- providing the right balance of this support, and if done incorrectly may prevent the development of independence skills and agency.
- preventing the development of relationships between the pupils with vision impairment and their peers.

Inclusion

Introduction

4.131 The 'inclusion' intervention area has a focus on studies describing the effect of environmental adjustments, inclusive practice, and peer, teacher, and parental training to support and enable the learning environment. The approach comes from the broad position that appropriate adjustments of the physical and social environment will enable young people with vision impairment to experience greater inclusion and improved learning opportunities. This might be contrasted with the idea of specialist learning environments which are specific and exclusive to the young person with vision impairment.

4.132 A focus on 'inclusive' approaches has particular resonance given the majority of children in the UK with vision impairment and no additional disability are educated in mainstream schools within their local authority area, with support provided by a specialist vision impairment team, which may be part of a larger SEN/ALN support service (e.g. Douglas et al. 2009).

4.133 Broad overlapping areas of intervention which are commonly described in the literature can be summarised as:

- **Environmental audits**. These are approaches which involve a systematic analysis of the learning environment to ensure that it is adjusted to maximise access (and minimise barriers). Common physical adjustments include: management of lighting (such as task lighting, avoiding glare from windows and shiny surfaces, use of blinds); use of colours and rails (e.g. addition of contrasting coloured bannisters on stairs, contrasting colour of door frames); use of tactile signage (e.g. braille labels on doors); avoidance of dangerous obstacles and overhangs. Common social adjustments include: general procedures and approaches to behaviours to avoid potential physical hazards (e.g. always tidying, never leaving chairs in corridors/on routes); consistent use

of accessible file formats which are available to all; policies which highlight tolerance of difference).

- **Training of peers, staff and parents.** In examining effective practice, Holbrook, Kamei-Hannan and McCarthy (2017, p25) report that a challenge is the need to "constantly inform others about the nature of this unique low-incidence disability" given that many educators, administrators and peers may have little knowledge about vision impairment. This approach might include ideas of 'visual awareness training' in which sighted people are exposed to activities and tasks to help them appreciate some of the barriers and enablers to access for those with vision impairment. The aim of such training is to promote inclusive behaviours and positive attitudes.

4.134 In considering how to educate groups about the needs of children with vision impairment, Holbrook and Ellen Croft (2017) highlight the significance of the specialist teacher of children with vision impairment. They report for example, presentations by the specialist teacher can help general educators and carers "fulfil their role as primary instructors in standard content areas and encourage parents to participate more fully in their children's education" (p318). Further, it is argued that a well-prepared demonstration of adaptive materials "can increase sighted classmates' understanding of classmates with visual impairments and may lead to more effective inclusion" (p318).

Available evidence

4.135 Only one article was identified that met the criteria in this strategy area. Ajuwon et al. (2015) explored the impact of an introductory special education course with students in initial teacher training upon their attitude to having vision impaired children in their classroom. Participants were from three different training institutions and involved 91 trainee teachers. The results found that the training did not significantly change participant hostility or receptivity towards teaching students with vision impairment. The paper was judged to provide moderate to strong quality of evidence.

Implications

4.136 Only one source was identified by the REA, and this study provided no evidence of positive impact of an inclusion-focused intervention (in this case the training of initial teacher trainees to improve their attitude towards teaching pupils with vision impairment in their classroom).

4.137 The low incidence nature of vision impairment means it is common that specialist teachers of these children will seek to be 'agents of change' (McLinden et al., 2017) by influencing others around the child with vision impairment, e.g. the child's peers, and those who are involved in their direct teaching and care. This is commonly done through environmental audits and training of educators, parents and peers. There in an absence of evidence of the effectiveness of these strategies in teaching pupils with vision impairment. This suggests that more research is needed and that specialist educators should gather their own evidence to assess the efficacy of their practice.

Welsh language

Introduction

4.138 Based upon Welsh Government figures, in 2017-18 approximately 16% of pupils in Wales are taught through the medium of Welsh, and significant numbers of additional pupils have some of their lessons taught through the medium of Welsh (StatsWales, 2018a). Based upon Welsh Government figures, in 2017-18 there were approximately 260 pupils with vision impairment in Wales taught through the medium of Welsh (in terms of SEN provision: 65 with a statement of SEN, 150 with school action plus, 45 with school action – see StatsWales, 2018b). It is, therefore, important to consider whether this has any specific implications for their educational provision. Vision impairment is a low incidence disability and this has associated challenges in terms of educational provision (e.g. specialist training of staff, availability and distribution of accessible resources). These challenges are likely to be multiplied in the Welsh-medium context which does not benefit from the greater availability of English-medium resources and English-speaking specialist trained staff.

4.139 Appropriate Welsh-medium resources in *print* for young people with low vision is unlikely to have any particular challenges for this group as this would be based upon available resources for most others who are taught through the Welsh-medium. Nevertheless, more challenging may be the availability of specialist vision impairment-specific materials in Welsh, e.g. braille, speech-based technology (and associated applications), and tactile diagrams (with braille labels).

4.140 As described in the literacy section, contracted braille involves the use of the traditional alphabet, along with different signs and contractions that represent groups of letters or whole words. Contractions in braille include many common letter clusters (e.g. in unified English braille (UEB) 'sh', 'ou', 'ing') and common words as short forms (e.g. in UEB 'and', 'with', 'this'). However, different language versions of braille will have different approaches to contractions. As noted by BAUK (2006):

> "Welsh braille uses the same general rules with regard to composition signs, punctuation signs, etc., as those stated in British Braille. However, the alphabet, and the system of contractions used for grade 2 are specific to Welsh [...]. In addition, there are special signs for accents, and the line sign." (p1)

4.141 Another area of likely concern is the availability of Welsh language screen reader technology. While this appears to have improved significantly in recent years, the integration of the technology with mainstream technology may be limited (e.g. in touch typing training software).

Available evidence

4.142 No interventions in relation to vision impairment education and Welsh language were found through the REA, nor were any interventions in other comparable minority language contexts.

Implications

4.143 No educational interventions in relation to vision impairment education in the Welsh language were identified through the REA. The broad principles and interventions identified in the REA are not language specific. However, many interventions do require specialist staff who speak the appropriate language and require availability of resources. In the USA, Correa-Torres and Durando (2011) carried out a survey to assess the perceived training needs of teachers of students with vision impairments

who work with students from culturally and linguistically diverse backgrounds (in the context of this study this was non-English speaking, and often Spanish-speaking). They noted the need for providing training for the teachers, including concerns about lack of appropriate teaching resources, how to work with families, how to work with interpreters, and practicum opportunities during training. Furthermore, the findings "highlight the need to recruit individuals from culturally and linguistically diverse backgrounds into the field of visual impairment" (p531). A similar survey across Wales may prove useful in identifying specific training and resource needs in relation to children with vision impairment taught through the medium of Welsh.

4.144 With this in mind, we informally explored the issue with specialist vision impairment teachers (including Welsh-speaking teachers) in two services in Wales. Issues raised included:

- No availability of a Welsh braille version of the braille primer;
- Limited versions of Welsh braille text books and past examination papers;
- There is a need for a Braille Welsh medium reading scheme and reading assessment;
- Touch Type software is only available in English;
- There is concern about Welsh medium versions of specialist print assessment tools (e.g. Maclure Reading Test Type for Children);
- There is concern about availability of Welsh medium text to speech software (screen reader software);
- There is a concern at the lack of mobility specialists who work through the medium of Welsh in some Local Authorities.

5. Conclusions

5.1 We presented a conceptual framework in section 0 to illustrate how vision impairment education in the United Kingdom has a long tradition of focussing upon two broad areas of intervention approaches and targeted educational outcomes, namely:

- Ensuring young people have fair and optimised access to the school curriculum.
- Ensuring young people have opportunities to develop their independence and social inclusion.

5.2 At the heart of this conceptual framework is a distinction between two overlapping imperatives: (1) facilitating equitable access to education and (2) promoting the development of individual agency. The educational response to this – and the associated *educational interventions* – can also be considered as two broad overlapping approaches:

- *Access to learning approaches*: inclusive practice and differentiation ensuring that the child's environment is structured and modified to promote inclusion, learning and access to the core curriculum, the culture of the school and broader social inclusion.
- *Learning to access approaches*: teaching provision which supports the child to learn independence skills and develop agency in order to afford more independent learning and social inclusion.

5.3 The REA was undertaken with reference to these broad approaches, and the literature was searched for, and presented within, different educational strategy areas which can be linked back to each. In section 4, 'Intervention summaries' we presented detailed descriptions of the evidence, and also drew out the implications of this for practice. In this section we offer overarching themes, reflect upon the nature of the evidence available, and consider the implications for educational practice in Wales.

Overview of the evidence

5.4 The eleven educational strategy areas included for investigation (communication; literacy; low vision training; teaching strategies; access to examinations; mobility and independence; social and emotional functioning; use of technology; teaching

support; inclusion; minority/Welsh language) broadly capture the areas of discussion and debate in the field of vision impairment education[2]. Whilst there is broad consensus in the vision impairment education literature about the importance of each of these areas (e.g. Mason and McCall, 1999), there is a difference in the amount and quality of evidence identified by the REA within each. Perhaps unsurprisingly, literacy had the most associated evidence although the focus is mainly on reading rather than writing. In part this reflects the high importance attached to literacy within education, but also reflects that literacy is commonly identified as an area which children with vision impairment can find difficult. Associated with literacy are 'specialist' approaches (braille, low vision devices, technology) that have received relatively large amounts of research attention. We return to literacy in section 0 below 'Navigating the balance between educational strategies' because it provides a useful illustration of the relationship between 'learning to access' and 'access to learning' approaches, and the importance of ensuring there is appropriate input from educational specialists to promote these.

5.5 In contrast to literacy, relatively little evidence of the effectiveness of different educational interventions was identified in relation to other educational strategy areas. This seems surprising given the importance attached to some of these areas, and the educational resource which is required. For example, areas typically associated with vision impairment education are the use of the technology, low vision training, and mobility and independence (all of which form part of the ECC, e.g. Hatlen, 1996). In spite of this, the REA identified very little evidence of the effectiveness of the associated interventions. As we discuss in more detail below, this may be because educational practice demonstrates that some of these interventions broadly work: e.g. children with vision impairment can use technology including low vision devices successfully, and can make effective use of long canes for mobility. However, the lack of research evidence means that the precision with which the interventions should be implemented is unclear from the literature: including when, with whom, and exactly how these interventions should be used.

[2] Minority / Welsh language perhaps stands out as slightly different to the other areas. It was introduced because of the importance of considering Welsh-medium education in the context of the Wales-focused REA.

5.6 Little research evidence was identified in relation to the general area of 'teaching strategy'. Adjustment and modification of teaching strategy to include children with vision impairment is commonly described in the literature, but rarely systematically evaluated through formal research. Such presentational adjustments to teaching strategies include either 'enhancing' the visual mode, 'alternative' presentations (e.g. through speech or a tactile code), or combinations of the two (e.g. Douglas and McLinden, 2005). Case study work commonly describes how practitioners have made such adjustments successfully, enabling children with vision impairment to engage in learning. Some approaches (e.g. multi-modal presentation such as verbal descriptions of visuals) are likely to benefit *all* learners, not just those with vision impairment. These approaches overlap with what we broadly describe as 'inclusive' practice. However, there is also evidence that some modifications require explicit teaching for children with vision impairment to learn *how* to access information efficiently (and might involve specialist professional knowledge in the design and implementation of the modifications – see below). Examples of these modifications include tactile diagrams and braille literacy.

5.7 This close attention to the *accessibility* of teaching strategies is a commonly reoccurring theme in much of the identified literature, and this is clearly illustrated in the area of communication. Work to develop the communication of children with vision impairment and complex needs commonly uses tangible symbols (or objects of reference) – three-dimensional cards embedded with objects to represent a person, place, activity, object, idea, or action. A key aspect of the approach is the importance of selecting and designing accessible and appropriate symbols for the children and young people which are sensitive to their vision impairment. Evidence also suggests that their structured and consistent use is an important ingredient for success, as is their use to communicate relevant and motivating topics.

5.8 Approaches to ensure assessment and examinations are accessible also draw upon these teaching strategies. While policies are in place which require the preparation of modified examinations in many countries (including Wales), virtually no evidence which met the REA inclusion criteria was identified which has evaluated the efficacy of these strategies. Nevertheless, Douglas et al., (2010) note that a key challenge is the inconsistency between classroom practice and options which are available for students with vision impairment in assessments. For

example, if students with vision impairment are encouraged to develop skills using technology such as touch typing and using word processors, it seems unfair and unreasonable for these skills not to be utilised within formal assessment settings. “Students without visual impairment do not experience such a difference between their way of working in the classroom and their experience of assessment. Solutions must seek possible ways of encouraging greater harmony of practice” (Douglas et al., 2010, p92).

5.9 Similarly, we identified very limited evidence of the effectiveness of two educational strategy areas: teaching support and inclusion. The former is concerned with use of various teaching support techniques and configurations to support children’s learning, and this commonly involves support offered by non-teaching staff. The latter is concerned with environmental adjustments, inclusive practice, and peer, teacher, and parental training to support and enable the learning environment. These broad approaches are commonly implemented in UK schools, so it is surprising that no formal evaluations were identified through the REA (only one study was identified which assessed the impact of training upon the attitudes of pre-service teachers towards teaching pupils with vision impairment in their classroom, and this was not found to be effective).

Reflections upon the type of available evidence

5.10 This REA broadly focusses upon vision impairment education generally rather than upon a specific intervention area. Even so, only 54 sources were identified which met the inclusion criteria. This suggests little evidence exists which is concerned with the relative efficacy of educational interventions in this field. This is in keeping with other relatively recent reviews and assessments of evidence undertaken in the field of vision impairment education (e.g. braille: McCall et al., 2011; pedagogy: Douglas and McLinden, 2005; literacy and communication: Luckner et al., 2016; education more generally: Douglas et al., 2009).

5.11 It is also interesting to consider the design and quality of the studies identified in the REA. Based upon the criteria employed in the REA, 41 of the 54 sources (76%) were judged to be of moderate to strong quality and 13 of the sources (24%) were judged to be of impressionistic to moderate quality. Of the evidence gathered, high proportions were case studies or small sample multiple baseline studies (21/54, 39%); studies rarely incorporated control groups. In part this reflects the nature of

the vision impairment population, which is not homogenous and is relatively small in number. Reflecting upon a previous review of vision impairment education, Douglas et al. (2009) speculated that the lack of evidence was linked to historic concerns with educational *access* which means that comparator groups are often not used in research design:

> "[Research] in the field generally does not have a comparative design. Researchers and practitioners describe educational approaches they adopt in order to provide visually impaired students with improved access to information. An implicit comparator is that, without the approach, 'access' would not be possible (or would be severely compromised)." (p.23)

5.12 This is reflected in the points raised above in relation to some areas of the ECC. Educational practice demonstrates that some specialist interventions *work*; for example, children with vision impairment:

- use assistive technology successfully;
- learn to touch type;
- make use of long canes for mobility;
- learn to read and write braille;
- use low vision devices to access print.

5.13 A traditional research position might be to speculate whether this learning would take place without educational intervention, i.e. without teaching. Nevertheless, this seems very unlikely to imagine, and ethically dubious to research. However, there is a challenge of designing services based upon imprecise and ungeneralisable evidence, which is particularly challenging given the heterogeneous nature of the population. For example, at what age should long canes be introduced, what are the teaching approaches which should be used, and for which children is this useful (and for which is it not)?

5.14 As a result, many of the implications drawn from the evidence presented in section '4 Intervention summaries' have a rather speculative quality. Continuing with the example of mobility education, it is clear that teaching long cane skills to children with severe vision impairment is a useful and successful intervention. Practitioner guides and traditional professional training offer strong arguments that such training

should start with children when they are as young as possible and that particular teaching strategies should be adopted. While the evidence for the relative success of these approaches is more speculative (e.g. compared to starting at a later age), it seems the best conjecture is to follow this practice.

Definitions of interventions, the role of assessment and educational specialists

5.15 The nature of the evidence, and the requirement to individualise the precise interpretation of the intervention according the needs of a given child or young person, has significant implications for how educational interventions should be implemented. It suggests that the educator (and often the *specialist* teacher) has an important role in designing interventions and monitoring learning progress.

5.16 Given the evidence that a particular intervention in unlikely to work for *every* child with vision impairment, a different kind of approach is required. On one hand, tools which can sensitively assess the individual needs and progress of children and young people with vision impairment are required. On the other hand, there is need for educators who can interpret evidence gathered through observation and these assessment tools and make judgements about how interventions should be modified, adjusted and implemented.

5.17 Firstly, considering assessment tools. The REA searched for evidence of the effectiveness of *interventions*. This did not identify assessment procedures (which did not meet the inclusion criteria of the REA). However, assessments of various relevant aspects of children's development form an important part of vision impairment education. As examples:

- Early years general progress (e.g. Developmental Journal for babies and young children with Vision Impairment (DJVI), Dale and Salt, 2007[3]).
- Braille reading assessment (e.g. The Neale Analysis of Reading Ability, Braille version; Greaney, Hill and Tobin, 1998).
- Print reading assessment (e.g. The Neale Analysis of Reading Ability, Low vision version; Hill et al., 2005).

[3] The OPTIMUM Vision Impairment project is carrying out an evaluation of the DJVI with publication of results imminent. That will provide evidence of the efficacy of this intervention. Douglas et al., (2009) described the previous version of DJVI as "the most contemporary and most empirically based tool of its kind" (p.84).

- Assessments of preferred routes to literacy (e.g. Learning Media Assessment (LMA); Koenig and Holbrook, 1995).
- Visual development (e.g. Look and Think – Chapman et al. 1989; Vision for Doing – Aitken and Buultjens 1992).
- Checklist of assistive technology progress (e.g. Presley and D'Andrea, 2008).
- Curriculum for orientation and mobility (e.g. Pogrund et al., 2012).

5.18 As well as a range of assessments of a child's developmental progress, there are also assessments of how a student is included which focus upon the broader learning environment (e.g. environmental audit checklists).

5.19 Secondly, considering the role of the educator. The 'educator' (using the term in a general sense to refer to an appropriate adult) must make use of information from assessments and then make decisions about interventions that may be beneficial to the given child's learning and development. Drawing upon the educational strategies identified in the REA, these interventions may focus upon environmental and resource adjustments, pedagogy or curriculum (or most commonly combinations of all these things). The challenge for the educators involved is deciding upon the appropriate combination of interventions and having the appropriate skills to implement them. The complexity of navigating this range of interventions was discussed by Douglas et al. (2009), who noted the literature has "consistent agreement that multi-agency working is an essential feature of effective support" (p67). More specifically, the range of professionals involved will include classroom teachers (in mainstream and specialist schools), teaching assistants, specialist teaching assistants, habilitation workers, mobility specialists, low vision specialists, and specialist qualified teachers of children and young people with vision impairment (QTVIs). In addition to professionals are parents and the young people themselves.

5.20 The REA has not focussed upon different professional roles in undertaking different interventions, nor has it directly focussed upon the different skills, experience and training those professionals may require. However, a recurring theme has been that *specialist* staff are commonly needed to undertake and/or advise on 'additional learning provision' (as defined as special educational provision as set out in the Education Act 1996) *and* inclusive practice and differentiation. While the availability and organisation of professionals varies in different countries, in Wales the

traditional coordination of this complex arrangement of educational support is generally undertaken by QTVIs. McLinden et al. (2016) and McLinden et al. (2017) analyse the role of QTVIs in detail. Not only do they note the role the QTVI in relation to additional learning provision and inclusive practice and differentiation, but also their role navigating the balance between these strategies.

Navigating the balance between educational strategies

5.21 In section 0, 'Conceptual framework and targeted educational outcomes' we highlighted that there are likely tensions between types of interventions which focus upon different educational outcomes. In vision impairment education, this is linked to the different emphasis which is given to the two traditions outlined in the conceptual framework: emphasis upon equal access versus development of individual agency; and emphasis upon 'access to learning' versus 'learning to access'.

5.22 Through the REA, the access to learning/learning to access distinction helps to reveal some of these dilemmas and provide the basis to make informed decisions about the type of interventions which are most appropriate at a given time. In the table below we provide some examples of alternative approaches and interventions, as well as suggestions for choosing between them. Presented in this way, interventions can be thought of as complementary rather than oppositional. Decisions can be navigated in a child-centred way rather than lead to intractable dilemmas. A key part of this decision making process is linked to the age/development age of the child with vision impairment, and accounting for the preferences of child and parents. To some extent, the evidence identified in the REA offers some steer about which approach works and at which point in the young person's development. Nevertheless, the REA also reveals the evidence is often absent or impressionistic, or is only based upon practice and professional judgement.

5.23 As described in the previous section, the design and implementation of the interventions often requires professionals with specialist training – e.g. in relation to braille, low vision, mobility, technology. It also requires professionals who can take a researcher-practitioner role, i.e.: (1) able to assess individual children and modify interventions appropriately based upon evidence of progress; and (2) emphasise

that interventions should increasingly seek to promote young people's independence and agency over time.

5.24 Table 14 draws upon the implications presented in section 4 'Intervention summaries', and gives a framework for the content of the guidance which accompanies this report.

Table 14. Complementary interventions - 'Access to learning', 'Learning to access' and a balanced approach (evidence is categorised as strong, moderate and practice)

'Access to learning'	'Learning to access'	Balance (evidence)
Access to print: • Preparation of bespoke print materials	**Access to print:** • Training in the use of optical and electronic LVDs • Use of computers/access technology	**Access to print:** • Preparation of bespoke materials will commonly be a helpful strategy, particularly for young children (strong) • With training, the use of LVDs and standard print can be as effective as bespoke materials (strong) • Children can successfully use LVDs and technology from an early (primary) age (moderate) • Teaching of braille as a route to literacy, as well as the use of speech technology, will be the best solution for many who require very large print (strong) • Maximise independent access to print/literacy before secondary school age (practice)
Access to writing: • Use of adult scribe • Additional time allowances	**Access to writing:** • Teach touch typing • Teach the use of computers/access technology • (For those with very poor vision) braille as a route to literacy	**Access to writing:** • Use of scribes and additional time will commonly be a helpful strategy, e.g. within formal assessment (strong) • Touch typing and use of computers with access technology can increase speed of access (strong) • Braille can provide a successful route to literacy (strong) • Access/computer technology can be successfully introduced from an early age (moderate)

'Access to learning'	'Learning to access'	Balance (evidence)
Movement around school: • Training staff and peers to offer guided support • Environmental audit, adjustments to school environment	**Movement around school:** • Teaching of mobility to vision impaired student, including self-advocacy to help express when help is needed and when it is not • Teaching of targeted routes around the school • Recruit school staff and parents to encourage practice and reinforce mobility actions	**Movement around school:** • Guided support by staff and peers in school can be a successful and safe way of supporting children to move through the school (practice) • Training or staff and peers in sighted guide technique is helpful (practice) • Environmental audits leading to modified school environments will make the school more accessible/inclusive (practice) • Teaching children with vision impairment mobility using a variety of techniques and with a variety of tools (e.g. long cane, symbol cane) improves independent mobility (strong) • Teaching mobility from an early age is advisable (practice) • Professionals working with parents and staff so they can reinforce and encourage practice of independent mobility is effective (practice)
Communication/social interaction: • Peer and staff vision awareness training • Whole class communication activities • Reduced use of adult support to aid peer-to-peer communication	**Communication/social interaction:** • Focussed teaching of the child with vision impairment in self-advocacy, and about child's own disability	**Communication/social interaction:** • Training of staff and peers in aspects of disability awareness will improve opportunities for and effectiveness of social interaction (practice) • Whole class activities can be used to successfully model accessible/inclusive ways of communication (practice) • Use of teaching assistants working closely with children can reduce opportunities for peer-to-peer interaction – seek opportunities to reduce this (practice)

‘Access to learning’	‘Learning to access’	Balance (evidence)
• Train adults in techniques to facilitate peer-to-peer communication		• Specific targeted training of children with vision impairment in how to optimise communication and offer explanation of their needs/entitlement (moderate)

Note: the evidence categories (moderate, strong, practice) broadly cross reference to the intervention summary evidence presented earlier in the report.

Implications for Wales

5.25 The Additional Learning Needs and Education Tribunal (Wales) Bill was passed by the National Assembly for Wales on 12 December 2017 and became an Act on 24 January 2018 after receiving Royal Assent. This will create the legislative framework which aims to improve the planning and delivery of additional learning provision, through a person-centred approach to identifying needs early, putting in place effective support and monitoring, and adapting interventions to ensure they deliver desired outcomes (Welsh Government, 2018).

5.26 The transformed system seeks to:

- ensure that all learners with ALN are supported to overcome barriers to learning and achieve their full potential;
- improve the planning and delivery of support for learners from 0 to 25 with ALN, placing learners' needs, views, wishes and feelings at the heart of the process;
- focus on the importance of identifying needs early and putting in place timely and effective interventions which are monitored and adapted to ensure they deliver the desired outcomes.

5.27 The Act requires that learners with ALN will have a single plan – the individual development plan (IDP). This will replace the current range of statutory and non-statutory plans for learners with special educational needs or learning difficulties and/or disabilities.

5.28 The new emphasis of the legislation aims to bring about many changes, but fundamental will be the attention to the support of learners with ALN up to the age of 25 years, and a focus upon targeting services to deliver *outcomes*. Drafts of the ALN Code of Practice place great emphasis upon targeted outcomes, including reference to developing young people's *independence* as part of accessing a broad and balanced curriculum.

5.29 The conceptual framework for vision impairment education presented in this report aligns with this policy transformation – the emphasis upon equal access to education ('access to learning') balanced with development of individual agency ('learning to access'). The framework presented, and the associated eleven educational strategy areas, offers a vocabulary for identifying the needs of, and educational interventions for, children and young people with vision impairment. The

analysis of available evidence through the REA identifies relatively little evidence of the effectiveness of many of these interventions. Nevertheless, it is argued that educational practice demonstrates the general value of many of the interventions. However, it is commonly the case that such evidence does not provide precision of what works, when, and with whom. In some cases, there is a complete absence of evidence. Two implications of this are: (1) more research evidence is needed, and (2) practitioners must design broad interventions based upon the evidence and practice available, and then modify and adjust that intervention based upon assessment of progress.

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7. Annex A: Database sources, search terms and data extraction

Stage 1: Literature search and inclusion/exclusion criteria framework

The aim of stage 1 was to carry out searches using the databases and search terms specified below and to apply an inclusion/exclusion criteria framework.

Databases

In the inception report it was stated that seven databases would be searched to identify the literature. Following advice from the subject-specialist librarian at the University of Birmingham and discussion with the funder, it was decided to complete searches within four of those databases. The reasons for inclusion or exclusion of each database are provided in the table below:

Table 15: REA stage 1 databases

Included?	Database	Rationale for inclusion/exclusion
Searched	**EBSCO Education Databases**	Provides a platform on which a search can be undertaken across five important databases in the field of education – British Education Index (BEI; Child Development and Adolescent Studies; Education Administration Abstracts; Education Abstracts and ERIC (an American education database).
Searched	**PsychInfo**	Provides abstracts and citations to the scholarly literature in the psychological, social, behavioural and health sciences.
Searched	**Proquest Social Sciences**	A social sciences database platform which includes databases also contained within EBSCO Education Databases, but also some additional relevant databases.
Searched	**Web of science**	Added following Inception Meeting.
Not searched	**Education Research Abstracts not searched**	This database does not allow sophisticated searches (combination of searches). The subject specialist librarian advised that the sources included in this database would have already been retrieved by the searches within the other comprehensive databases (particularly EBSCO).
Not searched	**Medline (including CINAHL plus) Medline- not searched**	This database is included in the Web of Science database.
Not searched	**Science Direct:- not searched**	The subject specialist librarian advised us that the sources included in this database would have already been retrieved by the searches within the Web of Science database.

A number of other generic databases and known websites were identified in the Inception Report. These hand searches have not yet been performed as a high volume of sources were identified by the searches described above.

Search structure

Our broad search involved a series of searches with the following structure (the detailed search terms follows in the next section):

[Age] AND [Sensory Impairment X 3]

AND

[Educational strategy]

Search terms

An asterisk was used for truncation in some of the databases for quicker searching: for example, "visual* impair*" would find instances of "visual impairment" as well as "visually impaired", and "child*" would find articles with "child" and "children" as well as other possible variations of the word.

Age (using Boolean operator OR)
Child* OR student* OR pupil* OR pre-school OR "post school" OR transition OR kindergarten OR youth OR "young people" OR teenagers OR adolescent* OR "early years"

Sensory impairment: Vision Impairment (using Boolean operator OR)
("Visual impair*" OR "visually impaired" OR "vision impair*" OR "partial* sight*" OR "low vision" OR blind*) NOT (“blinden” OR “double blind*” OR “double-blind*” OR “blind rat*”)

Educational strategy

The thirteen strategies listed below were to be searched for individually (each using Boolean operator OR), and repeated with some adjustment for each sensory impairment group.

1) Communication

Auditory OR Oral OR Sign OR "Sign bilingual" OR "Cued Speech" OR "Visual phonics" OR "Manually coded sign systems" OR "Objects of reference" OR "Calendar systems" OR "Voice output" OR "Haptics" OR "social haptics" OR "Adapted signing" OR "Smell cues" OR "On body signs"

2) Literacy

*Reading OR Writing OR "Metacognition and reading Comprehension" OR "Emergent literacy" OR Phonology OR "Phonological awareness" OR "Phonemic skills" OR "Visual phonics" OR Vocabulary OR "Syntactic Knowledge" OR Braille OR "*Large* print" OR "Modified print" OR Print*

3) Mathematics

Numeracy OR "Math problems" OR "Math* concepts", "visual spatial abilities" OR quantity*

4) Access to examinations

Exam OR Examination OR "Assessment accommodation" OR "Access arrangements"

5) Mobility and Independence

Habilitation OR mobility OR independence OR ILS OR "independent living skills" OR "daily living" OR "activities of daily living" OR orientation OR O&M OR M&I

6) Cognitive skills

Cognition OR Play OR "Theory of Mind" OR "Visual attention" OR Perception

7) Social and emotional functioning

Social OR Emotional OR Assertiveness OR Resilience OR "Self concept" OR "Self-worth" OR "Deaf identity" OR Friendship OR Behaviour OR Interpersonal OR "Well being" OR "Peer training" OR "Peer awareness" Buddy OR "Circle of friends" OR "Self advocacy"

8) Use of technology

"Cochlear implant" OR "Hearing aids" OR "FM systems" OR "Acoustics ICT" OR Computer OR "Mobile technology" OR "Assistive technology" OR "Enabling technology" OR "Access technology"

9) Low vision training

"Low vision therapy" OR "Low vision device" OR LVD OR "Low vision aid" OR LVA OR "Visual skills"

10) Teaching support

"Learning Support assistant" OR LSA OR "Teaching Assistant" OR TA OR "Communication Support worker" OR Intervenor

11) Strategies

"Co-active movement" OR "Preparation of teaching materials" OR "Audio description" OR "Subtitle" OR "Enlarged print" OR "Simplified language"

12) Minority language

Catalonia OR Catalan OR Basque OR Brittany OR Breton OR Frisian OR Welsh OR Gaelic OR Irish OR "Minority ethnic" OR "Minority language" OR bilingual OR "dual language"*

13) Inclusion

Acceptance OR Rejection OR Modification OR Learning styles OR Pre-teaching OR "post teaching" OR "School environments" OR "Person centred learning"

Filtering by types of materials and relevance criteria

In each of the four databases the filter setting was used to enable us to select only the types of materials under the inclusion criteria.

Table 16: Types of materials – inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Peer reviewed academic journals	Websites not hosted by a recognised organisation as determined by the reviewers. Decision making will be documented.
Professional journals	Personal blogs
Expert opinion*	Personal opinions of interventions (presented online)
Students' work, PhD and Masters dissertations	Newspapers

Note * expert opinion must be written and published by a professional body or reputable publisher, and the author has considerable experience in the field. This will be determined by the reviewers and decision making will be documented.

An additional filter was used to enable us to select the materials under the relevance inclusion criteria.

Table 17: Relevance – inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Date	1980 onwards*	Older than 1980
Language	English or Welsh	Any other language
Geographical location**	International	No exclusion
Population age	0-25	25 onwards

** date 1980* – this date was chosen as an approximate time scale when education practice in relation to disability started to more clearly reflect current practice (e.g. in England and Wales through the 1981 Education Act), in particular the acceleration of the creation of services in the UK which supported the education of children with vision impairment in mainstream schools. The time period also reduces the search results while still including evidence from approximately the last 40 years.

** Location – the focus of the search was agreed to be research undertaken in OECD countries but this was not an available search criteria in. This criteria was therefore applied in stage 2.

Stage 2: Refining the search

The aim of the second stage was to narrow the material down from the initial search by offering a detailed consideration of each source to ensure the most relevant material is selected.

A separate Endnote database for each subject area was created. The sources in each Endnote database were scrutinised based on the inclusion and exclusion criteria regarding the relevance of the study. Although the 'location' filter in each database (stage 1) assisted in selecting sources only from OECD countries, the sources were further scrutinised (reading the abstracts) for geographical location

In terms of relevance to the aim of the study, this is defined as the extent to which educational interventions are effective (or not) for vision impairment with the purpose of improving targeted outcomes. Where research is related to technology, this technology should be current and has not been superseded by new technology/approaches which means the intervention is no long relevant. For example, this strategy would exclude the applications of technology called the Optacon (OPtical to TActile CONverter) – though briefly used in education, Opticon is no longer manufactured and has been superseded by optical character recognition (OCR). Also, to be relevant the intervention should not be *solely* about a medical intervention (e.g. cataract surgery), nor solely about the provision of a technical aid (e.g. low vision aid), but should be about the educational intervention around this. Furthermore, while interventions should have an education focus they should be additional to or different from those provided as part of, for example, a school's usual differentiated curriculum and strategies.

It was also noted that many articles generated in stage 1 were not relevant – particularly in vision impairment were studies incorporating alternative meanings of key terms were initially identified (e.g. "blind marking").

Initial sorting of materials for each sensory field

Following discussions with the funder, it was noted that the commissioned sensory REAs were very broad in focus, rather than focussing upon a specific type of intervention or targeted educational outcome. All three REAs were linked to all educational outcomes, which the team sought to simplify into thirteen areas (see search terms in section **Stage 1: Literature search and inclusion/exclusion criteria framework**). This can be contrasted with other REAs undertaken in other disciplines which might seek evidence of the

successful interventions in relation to much narrower target outcomes (for example in relation to ADHD, the focus may be linked to the reduction in particular defining behaviours).

In addition to the point about breadth of the review, there is a related challenge of defining the term 'intervention'. Our working definition of an intervention study was outlined in the proposal as studies which sought to describe the effect of some kind of educational approach upon a targeted outcome. These studies might be qualitative designs, controlled trials, or single subject designs.

In order to contextualise this definition further, the invitation to tender offers the following definition of the interventions of interest:

> “For the purposes of this research, an intervention is defined as SEP [special educational provision] as set out in the Education Act 1996 ‘education provision which is additional to or otherwise different from the education provision made generally for children of their age in maintained schools, other than special schools, in the area. For children aged under two SEP is considered to be education provision of any kind.” (p11)

Our proposal also unpicked special educational provision further and made a distinction between.

(1) **Inclusive practice and differentiation**: ensuring that the child’s environment is structured to promote inclusion and learning throughout their education.
(2) **Additional learning provision:** supporting the child to learn distinctive skills in order to afford more independent learning.

Such a broad and inclusive definition of intervention is helpful in ensuring valuable evidence is included in these REAs which are broad in scope. Nevertheless, such a definition is difficult to operationalise. The working solution was to make a distinction between the following categories of sources: (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention'. The table below outlines the criteria for this categorisation.

Table 18: Working definitions of categorisation of sources – (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention'.

Category	Definition	Example
1. Excluded/not relevant	The source is not linked to a relevant *educational* intervention or outcome (e.g. it is medical in focus), or the source does not provide an analysis of educational practice.	(1) Impact of surgery upon functional vision. (2) A survey of teacher preparation or parent attitudes not linked to educational practice.
2. Good practice	The source is linked to *educational* practice. While it does not provide evidence of an effect of that practice upon target outcomes, it provides evidence and rationale for the differentiated education provision.	The development of standardised and accessible assessment approaches (e.g. a reading assessment for braille readers).
3. Intervention	The source presents evidence of the effect of some kind of educational approach upon a targeted educational outcome(s).	The trial of a reading intervention to measure the effect upon children's reading performance.

Based upon these working definitions all the sources in each Endnote database were categorised into (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention', and this is reported upon in the sections which follow.

Stage 3: Protocol for inter-rater reliability of robustness scoring

An inter-rater reliability check was performed based on the following protocol:

1. Quality rater 1 (QR1) to identify 25% of articles from each category (13 categories). If necessary round up the number of papers e.g. 25% = 2.75, rate 3 papers. The selection of the articles to be given to Quality Rater 2 (QR2) is based on the following criteria:
   - Only one article by author in each category.
   - A variety of methods when possible. If the category includes interventions with a range of methodology, select a sample different designs of interventions (e.g. trials, case study etc.).

- A range of scores. If possible the selected articles should reflect the range of scores given (i.e. 1, 2, 3).

2. Quality Rater 2 (QR2) to rate each selected article blindly.

3. The total mean scores from each rater are entered in two columns in excel (QR1, QR2).

4. Calculation of inter-rater agreement (percentage).

- The scores from the two raters will be entered into columns in excel (QR1 and QR2).
- Agreement will be calculated based on the two scoring categories (1- 1.9: impressionistic to moderate evidence, 2-3 moderate to strong evidence).
- The agreement of the two raters will be entered in a third column. When the scores of the two raters agree on these two scoring categories (i.e. score is anywhere between 1-1.9 or between 2-3) then a score of 1 will be given. If the scores of the two raters are in a different scoring category (e.g the first rater scores 1.6 and the second 2.5) then a score of 0 will be given in the third column.
- The number of agreement (i.e the number of 1s) will be added and divided by the number of the articles that were rated by both raters and multiplied by 100.

Example is given below:

A	B	C
QR1	**QR2**	**Agreement (1-1.9 and 2-3)**
1.9	2.3	0
2.1	2.6	1
2.3	2.1	1
2	1.8	0
2.3	2.3	1
1.3	1.4	1
2.4	2.5	1
2.8	2.6	1
	Average (sum divided by the number of articles rated)	**0.75**
	Percentage of agreement 75%	**75%**

1. In the above example 8 articles were rated, for 6/8 articles there was agreement on the scores (in the same category of 1-1.9 or 2-3). The agreement was 75%.

2. Discussion between the two raters where there is no agreement in their scores (a score of 0 was given in the agreement column). In this case, the raters need to discuss and reach a conclusion on the score that will be assigned to each article. This will be discussed by looking at the individual components' score.

3. After rating QR2 to read the 'extracting info' section and to add or amend text as necessary.

Table 19: Inter-rater analysis for the quality scoring (N=21 studies)

Category	QR1	QR2	Agree?	Action
Communication	2.8	2.7	1	
Literacy	2.6	2.4	1	
	2.3	2.3	1	
	1.8	1.9	1	
	2.75	2.75	1	
	2.3	2.4	1	
Mathematics	2.1	2	1	
Examinations	2	2.4	1	
Mobility	2.2	2.4	1	
	1.9	1.9	1	
Cognitive	1.7	1.9	1	
Soc + Emotional	2.75	2.75	1	
Technology	2.6	2.4	1	
	2.5	2.6	1	
Low Vision	2.7	2.5	1	
	2.6	N/A	0	Article: Rubin et al. Outside age range; Move to good practice
	1.86	1.75	1	
Strategies	2	N/A	0	Article: Abramowicz et al. Not educational intervention; Removed from analysis
	1.6	1.5	1	
Inclusion	2.1	N/A	0	Article: Desrochers et al. Participants have MSI: Move to MSI Removed from analysis, but used in MSI REA

Other	2.6	2.6	1	
Total (N)			**18/21**	
Total (%)			**86%**	

Stage 4: Data extraction

A predefined spreadsheet template was developed to facilitate recording of the most important details of each study on intervention to provide a comprehensive overview. This template (record) includes the following details (fields) for each article:

- Title and authors with full reference or web address
- Funder of the research study
- Authors' affiliations
- Welsh specific data
- Theme of the intervention linked to the educational outcomes (13 categories)
- Methodology – including aims, objectives, sample size etc.
- Participants including the following details:
    - Sample size
    - Age group covered
    - Gender
    - Ethnicity
    - Socioeconomic data
    - Details related to the characteristics of the participants with specific sensory impairment (e.g. degree of sensory loss)
- Design of the research and intervention details:
    - The nature of the intervention/independent variable under investigation.
    - Case study; Action Research; Longitudinal study; Trial; Control trial; Single subject design
- Pre and post measures
- Data Issues – Quality and Limitation
- Key findings summarising the effectiveness of the intervention
- Author's conclusions and recommendations covering the key messages from the article
- Confidence scoring of robustness of the articles (see below).

- OTHER comments – any other reviewer comments which may support the writing upon the report as a whole and/or synthesising the findings (e.g. noting opinions about the applicability – or otherwise – of the findings in the opinion of the reviewer, which were not reported by the original authors)