Visual Light Hypersensitivity, Classroom Digital Media and Inclusive Pedagogy: Untangling the Maze

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Bachelor of Science
Diploma of Education
Masters of Education (Research)

This thesis is presented for the degree of
Doctor of Philosophy
of
Murdoch University

October 2019
Declaration

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

Janene Leesa Sproul
October 2019
Abstract

Visual light hyper-sensitivity (VLH) is a sensory state in which light causes an abnormal reaction leading to intermittent or consistent discomfort, nausea, migraine and even seizure. Technological development has encouraged digital media-rich classrooms, altering the way in which visual information is accessed by students from traditional light reflective tools to light emitting devices. The possibility exists that this increase in light exposure within our classrooms is an invisible dis-abling mechanism for many students, decreasing cognitive ability and increasing discomfort. Using the perspective of Vygotsky’s theory of defectology, a model is presented that describes a unique group of students with VLH and the role of accommodations to support their active participation in learning.

A transformative paradigm incorporating a mixed method approach is utilised to examine policy and practices related to the frequency of digital classroom usage and the accommodations made for students with VLH within schools. A systematic review of academic literature, Australian education documents, manufacture and broadcast guidelines regarding digital media use for students with VLH identified a gap in policy and lack of awareness in practice but also highlighted six common parameters as reasonable adjustments for the classroom. The quantitative component used data from online surveys of 95 current students and 47 parents to calculate the total digital media used for educational purposes (minutes/day), digital devices used, and subject area usage of digital media. The qualitative component triangulated data from interviews with three groups of invested participants: six past students, five parents and five teachers to explore trends in digital media use and commonly used accommodations for students with VLH.

The study found that many students spend at least half of their class time using light emitting digital media devices. The technological advances and changes in the material culture of our classrooms is having a direct impact on students with VLH. This is further complicated by the incorporation of online assessment within our schools. The researcher calls for transformative change in digital classrooms by adopting design guidelines for usage and accommodation practices that enable, rather than dis-able, active participation of students with VLH.
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Glossary of Terms and Acronyms

AAP
American Academy of Pediatrics
An American not-for-profit corporation based in Illinois. Since 1931 the AAP has focused on pediatric medicine and the changes over time of health systems. Research articles have been published since 1932 in the Journal of Pediatrics.
https://www.aap.org/en-us/about-the-aap/Pages/About-the-AAP.aspx

ABS
Australian Bureau of Statistics
The Australian government’s national statistics agency. Facilitates census data collection, analysis and access to population statistics for demographic groupings in Australia.
http://www.abs.gov.au

ACARA
Australian Curriculum, Assessment and Reporting Authority
An independent statutory authority responsible for shaping the Australian School Curriculum, administering NAPLAN and reporting on key indicators for individual schools through the My School websites.
https://www.acara.edu.au/about-us

acute illness
Illness with sudden onset, sharp rise, short course (Merriam-Webster, 2013).

accommodations
An alteration of environment, curriculum format, or equipment that allows an individual with a disability to gain access to content and/or complete assigned tasks (University of Washington, 2019)

ADHD
attention deficit hyperactivity disorder
A neurobiological developmental disorder that starts in childhood but continues throughout a person’s life. “Key features are inattention, distractibility, hyperactivity and impulsivity, and it may also be linked to other mental health conditions”.

adjustments
A measure or action taken to assist a student with a disability to participate in education and training on the same basis as other students (Department of Education, Employment and Workplace Relations, 2012)
AISWA
Association of Independent Schools of Western Australia
A non-profit organisation representing and promoting the interests of over 150 independent non-government schools in Western Australia. Operates in parallel with CEWA.
“represent[s] the interests of Independent Schools in Western Australia. AISWA is a member of the Independent Schools Council of Australia which represents the interests of all Independent Schools in Australia”.
Retrieved from:
https://www.ais.wa.edu.au/independent-schools

AITSL
Australian Institute for Teaching and School Leadership
National body established in 2010. Provider of teaching standards in Australia (AITSL standards), including pre-service teachers for government and non-government schools.
“Quality teaching starts with high quality teacher preparation. We provide support, resources and tools to ensure every pre-service teacher is classroom-ready upon graduation”.
Retrieved from:
https://www.aitsl.edu.au/about-aitsl

CEWA
Catholic Education Western Australia
System of non-government schools in Western Australia. Operates in parallel with AISWA with additional Catholic focus.
“...mission to facilitate the delivery of an authentic and empowering Catholic Education aimed at improving learning outcomes and life opportunities for the maximum possible number of children, families and communities across WA”.
Retrieved from:
Administrative arm known as Catholic Education Office (CEO).

Certificate subjects
Vocational Education and Training (VET) courses reduce the number of WACE courses required to graduate high school. Applies to Year 11 and 12 students in Western Australia.
https://senior-secondary.scsa.wa.edu.au/vet/all-about-vet

chronic illness
An illness that is prolonged in duration, does not often resolve spontaneously, and is rarely cured completely.

clinical symptoms (photo-paroxysmal)
Visible, observable symptoms in addition to registering on EEG.
<table>
<thead>
<tr>
<th>term</th>
<th>definition</th>
</tr>
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<tbody>
<tr>
<td>concussion</td>
<td>A traumatic brain injury that affects brain function. Usually temporary, symptoms (including VLH) can be immediate or delayed. <a href="https://www.mayoclinic.org/diseases-conditions/concussion/symptoms-causes/syc-20355594">https://www.mayoclinic.org/diseases-conditions/concussion/symptoms-causes/syc-20355594</a></td>
</tr>
<tr>
<td>contrast</td>
<td>Ratio of screen luminance of lightest colour (white) to darkest (black).</td>
</tr>
<tr>
<td>cortex (cerebral)</td>
<td>Outer layer of brain, from which electrical measurement is possible with externally placed electrodes during EEG.</td>
</tr>
<tr>
<td>DALY</td>
<td>Disability Adjusted Life Years (DALY) is the summary measure used to give an indication of overall burden of disease. One DALY represents the loss of the equivalent of one year of full health. <a href="https://www.who.int/gho/mortality_burden_disease/daly_rates/text/en/">https://www.who.int/gho/mortality_burden_disease/daly_rates/text/en/</a></td>
</tr>
<tr>
<td>digital media</td>
<td>Screen based technologies e.g., computers, iPads, IAW.</td>
</tr>
<tr>
<td>disability</td>
<td>“an umbrella term for impairments, activity limitations and participation restrictions” (WHO, 2001, p. 3)</td>
</tr>
<tr>
<td>DoE</td>
<td>System of government schools in Western Australia. “Our purpose is clear: a system of public schools in which every school is a good school, every teacher is effective and every student is successful”. Retrieved from: <a href="https://www.education.wa.edu.au/our-strategic-directions">https://www.education.wa.edu.au/our-strategic-directions</a></td>
</tr>
<tr>
<td>EEG</td>
<td>An apparatus for detecting and recording brain waves. (Merriam-Webster, 2013).</td>
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<tr>
<td>epilepsy</td>
<td>A disorder of the brain characterised by an enduring predisposition to generate epileptic seizures and by neurobiologic, cognitive, psychological, and social consequences of this condition (p. 471) (Fisher, Boas et al., 2005).</td>
</tr>
<tr>
<td>ERIC</td>
<td>United States Department of Education database collating educational research material and published documents. <a href="https://eric.ed.gov">https://eric.ed.gov</a></td>
</tr>
<tr>
<td>GBD</td>
<td>A study conducted in 1990 by the WHO, World Bank and Harvard School of Public Health as the beginning of a longitudinal research project. The project has continued until the present by Global Health Metrics.</td>
</tr>
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</table>
Most recent publications of the 2017 data are found in the journal The Lancet https://www.thelancet.com/gbd

| **headache** | Pain located above the eyeline. (Kasteleijn-Nolst Trenité et al., 2010). |
| **health** | “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. (Official Records of WHO, 1946, No 2, p. 100) |
| **IAW** | A large touch-sensitive board connected to a computer and a digital projector, used for teaching in the classroom. Also called Smartboard (Collins Dictionary, 2013). |
| **ICF** | A system developed by WHO, approved in 2001 by World Health Assembly. |
| **ICILS** | Global computer-based standardised test in computer and information literacy for Year 8 students. Demographics include student, school and system contexts. Questionnaires for students, teachers and school. Reporting on 2018 data collection to be released in 2019. https://icils.acer.org |
| **ictal** | In this document, ‘ictal’ refers to the episode of clinically observable symptoms. Some sources only use ictal to describe epileptic seizure occurrences, others for ‘migraine’ and epilepsy. In this document the term is used to denote time period during an episode of migraine or seizure. “Ictal phase is dominated by headache in migraine with and without aura” (Gupta, Gupta, & Borad, 2016). |
| **IEP** | A program created for an individual student to incorporate specific learning/environmental needs. These programs may be tailored to run in tandem with a mainstream program. |
| **impairment** | “biological aberration causing individual inability to move one’s muscles, hear sounds etc” Bøttcher and Dammeyer (2016, p.4) or decrease in cognitive ability (Binnie, 1993) |
interictal

The period between episodes of clinically observable symptoms.

IPS

intermittent photic stimulation

A form of visual stimulation using an external light source flashing at predetermined frequencies. Routinely used during EEG monitoring to investigate stimulus frequencies for diagnosis of photosensitivity by production of a particular brain wave pattern (PPR).

luminance

A measure (in candelas per square metre) of the brightness of a point on a surface that is radiating or reflecting light (Collins Dictionary, 2013).

MEDLINE®

“MEDLINE is the U.S. National Library of Medicine® (NLM) premier bibliographic database that contains more than 25 million references to journal articles in life sciences with a concentration on biomedicine.”

migraine

“Migraine has two major types:
1.1 Migraine without aura is a clinical syndrome characterised by headache with specific features and associated symptoms.
1.2 Migraine with aura is primarily characterised by the transient focal neurological symptoms that usually precede or sometimes accompany the headache. Some patients also experience a prodromal phase, occurring hours or days before the headache, and/or a postdromal phase following headache resolution” (The International Classification of Headache Disorders 3rd edition).
https://www.ichd-3.org/1-migraine/

Recurrent headache disorder. In children, attacks can last from 1-72 hours (Headache Classification Subcommittee of the International Headache Society, 2004).

MUHREC

Murdoch University Human Research Ethics Committee

An eight membered committee convening to ensure all research conducted under auspice of Murdoch University complies with NSECHR and protects well-being of all human participants. Responsible for advising researchers of approval/not-approved decision for research projects and allocating project number.
http://our.murdoch.edu.au/Research-Ethics-and-Integrity/Human-research-ethics/Committee/
**NAPLAN**  
*National Assessment Program Literacy and Numeracy*  
Standardised annual assessment for all students in Australia currently in Years 3, 5, 7 and 9. There are three separate tests in reading, writing (language conventions) and numeracy. Students scoring Band 8 or higher in all three strands from NAPLAN Reading, Writing or Numeracy achieve competency in these areas for high school graduation. An alternative pathway to high school graduation is provided with OLNA for students who do not achieve Band 8 by Year 9. The NAPLAN test instrument operates under the national authority of ACARA  
https://www.nap.edu.au/about

**NCCD**  
*Nationally Consistent Collection of Data on School Students with Disability*  
An Australian Government initiative to standardise accommodations and support for students with disabilities. It draws on legislation provided by the Disability Discrimination Act (1992) and Disability Standards for Education (2005) with the aim to maximise participation and student support whilst minimising marginalisation due to disability.  
https://www.nccd.edu.au/

**neurological**  
To do with the structure, function and diseases of the nervous system (Merriam-Webster, 2013).

**NSECHR**  
*National Statement on Ethical Conduct in Human Research*  
The current study refers to the 2007 statement which contains guidelines in line with the National Health and Medical Research Council Act 1992. The current study did not need to alter methodology to align to the updated 2018 statement.  

**occupital**  
Involved with vision.

**OLNA**  
*Online Literacy and Numeracy assessment*  
Online assessment with equivalent competencies in Literacy and Numeracy as Band 8 NAPLAN. Alternative prerequisite for Western Australian Certificate of Education accreditation to demonstrate achievement of the minimum standard of literacy and numeracy. This test instrument operates under the state authority of SCSA.  
physiology
A branch of biology that deals with the functions and activities of life or of living matter (as organs, tissues, or cells) and of the physical and chemical phenomena involved; the organic processes and phenomena of an organism or any of its parts or of a particular bodily process (Merriam-Webster, 2013).

PubMed®
“PubMed is a free resource supporting the search and retrieval of peer-reviewed biomedical and life sciences literature with the aim of improving health—both globally and personally.”

photosensitive
Visually sensitive, displays an epileptic reaction to visual light stimuli (Kasteleijn-Nolst Trenité et al., 2010).

PL
professional learning
Industry based education required by TRBWA to maintain registration as a teacher.

PPR
photo-paroxysmal response
Specific spike and wave pattern on EEG graph during IPS, used in diagnosis of photosensitivity (Kasteleijn-Nolst Trenité et al., 2010; Waltz, Christen & Doose, 1992).

SCSA
School Curriculum and Standards Authority
An independent statutory authority in Western Australia which reports to the state Minister for Education. SCSA sets standards for student achievement in tandem with ACARA national curriculum, as well as accrediting courses for schools and validating high school graduation through WACE.

subclinical
Relating to or denoting a disease which is not severe enough to present definite or readily observable symptoms.
https://en.oxforddictionaries.com/definition/subclinical
“In exceptional cases, which occur almost exclusively in childhood, the sub-clinical focus might consist of an epileptic focus that activates the TVS, thereby inducing migraine without any other known cortical epileptic signs or symptoms” (Kasteleijn-Nolst Trenité et al., 2010).

TCI
transitory cognitive impairment
A self-limiting momentary decrease in cognitive ability (Binnie, 1993).

TK
Technological Knowledge
A subset of the TPACK model created by Mishra and Koehler (2006).
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<tr>
<th><strong>TPACK</strong></th>
<th><strong>TRBWA</strong></th>
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<tr>
<td><strong>Technological Pedagogical Content Knowledge</strong></td>
<td><strong>Teacher Registration Board of Western Australia</strong></td>
</tr>
<tr>
<td>A model created by Mishra and Koehler (2006) to depict the interaction of different types of knowledge used by an educator in a technology rich educational environment.</td>
<td>A seven member board appointed by the state Minister of Education and responsible for registration of all teachers in Western Australia. TRBWA also accredits new and international teachers transferring into Western Australia, provides PL entry logs for currently registered teachers and maintains database of teacher details. <a href="http://www.trb.wa.gov.au/Pages/default.aspx">http://www.trb.wa.gov.au/Pages/default.aspx</a></td>
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<tr>
<th><strong>VLH</strong></th>
<th><strong>W3C</strong></th>
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<tr>
<td><strong>visual light hypersensitivity</strong></td>
<td><strong>World wide web consortium</strong></td>
</tr>
<tr>
<td>Inclusive of photosensitivity, photophobia and light sensitivity. Individuals with VLH demonstrate abnormal sensitivity to light stimuli (Verotti, Tocco, Salladini, di Corcia &amp; Chiarelli, 2005; Sproul, MacCallum &amp; Ledger, 2017).</td>
<td>Led by Tim Berners-Lee (co-founder of the web) the consortium has 4 global hubs working to standardise web technologies and improve access to web data for all people (see WCAG). <a href="https://www.w3.org/Consortium/facts#history">https://www.w3.org/Consortium/facts#history</a></td>
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<tr>
<th><strong>WCAG</strong></th>
<th><strong>WHO</strong></th>
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<tr>
<td><strong>Web Content Accessibility Guidelines</strong></td>
<td><strong>World Health Organisation</strong></td>
</tr>
<tr>
<td>A range of recommendations synthesised by W3C to improve accessibility to web data for individuals with a range of disabilities, sensory and/or mechanical. WCAG2.1 (June, 2018) supersedes previous versions. <a href="https://www.w3.org/TR/WCAG21/">https://www.w3.org/TR/WCAG21/</a></td>
<td>A specialised agency with representatives in 150 countries responsible for health matters within the charter of the United Nations. Constitution of WHO first adopted in 1946 at the International Health Conference. <a href="https://www.who.int/about/who-we-are">https://www.who.int/about/who-we-are</a></td>
</tr>
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List of Publications

Paper 1

Contribution of work within this paper:

- Janene Sproul: original concept, literature review, synthesis of article, editing
- Judith MacCallum: revision of concept, revision of drafts
- Susan Ledger: revision of audience and process, revision of drafts

Paper 2

Contribution of work within this paper:

- Janene Sproul: original concept, literature review, synthesis of article, editing
- Susan Ledger: framework of methodology, revision of drafts
- Judith MacCallum: theoretical process, revision of drafts

Paper 3
Sproul, J. *The Escher-like steps of post graduate research in visual light hypersensitivity when you identify as visually light hypersensitive*. Manuscript submitted for publication.

Contribution of work within this paper:

- Janene Sproul: complete paper
Acknowledgements

To those who have shared their stories, may you see how your voice added to the transformative nature of this document.

To those in positions of authority who said “you can” when I was unable to see a way forward, my thanks for your strength. To my students who daily provided the reminder of why I was doing this, and often unknowingly supported or eliminated elements of pedagogy, may you acknowledge your own roles in the shaping of culture and practice.

To the multi-disciplinary cheer squad who encouraged every step of the way, even when Ethics was getting challenging. This includes Mr Michael Done, a talented formatter who saved me many headaches, my thanks and may I provide the same encouragement to those who follow me.

To my current supervisors Associate Professor Judith MacCallum and Dr Susan Ledger who may have suffered nightmares of my thesis being submitted in dot point... thank you for the notes on hard copy, meetings in rooms with natural light and copious quantities of coffee. Also to Associate Professor Greg Thompson for his insights at the beginning of the journey.

This research was supported by an Australian Government Research Training Program (RTP) Scholarship. To those who decided this project was worthy of support, may you see this resultant thesis as justification for your decision.

To my extended family, ever patient and supportive, my thanks. The tradition of providing a forum for those without a voice continues in this thesis. Whilst we catch up with a few more family gatherings, I look forward to hearing about camping out, Lego and concerts.

Finally, to my own little family, thank you for understanding why this project was important, for listening patiently to abstract ideas along the way and for sharing the excitement at its conclusion. Ian, I am looking forward to accompanying you on a long fishing trip. Jemma and Bella, may you find your own transformative projects to influence the amazing world we live in, I look forward to watching you investigate the possibilities.
Chapter 1   Introduction

Digital media is now prominent in the lives of children and adolescents both at home and at school. The World Health Organisation (WHO) recently published a set of guidelines in recognition of the potentially detrimental effect of extended duration of digital media use (WHO, 2019). The guidelines focus on children under the age of 5 and are age-dependent, advocating no screen time in the youngest and up to 1 hour per day for the oldest. Similar recommendations are evident in the most recent set of guidelines from the American Academy of Pediatrics (AAP) for the 2 to 5 year old age group (AAP, 2016a). For school-aged children living in a more complex social sphere incorporating a wider choice of activities using digital media, the guidelines are less straight forward. The most recent recommendation from the American Academy of Pediatrics (AAP) for school aged children and adolescents (AAP, 2016b) focus on the content viewed and consistency of limits, rather than maximum duration. The AAP acknowledge the need for time spent away from digital media, as well as acknowledging that each child is individual therefore requiring a personalised digital media plan.

Digital media in schools has increased substantially over recent years. From limited computer access in the 1980s and 1990s, the use of digital media increased from an estimated 20 – 40 minutes per day in the early 2000s (CSIRO, 2008) to over 2 hours per day in the 2010s (Houghten et al., 2015).

Additionally, in 2016 Australia endorsed online standardised testing for students in Years 3, 5, 7 and 9 for literacy and numeracy (NAPLAN), therefore increasing all students’ use of digital media for both learning activities and assessments. In 2018, the authority that provides the South Australia Certificate of Education (SACE) introduced the first online examination for graduating high school students, and in 2019 there will be three subjects examined this way.

My interest in the research area of visual light hypersensitivity (VLH) and digital media was motivated by observations in various high school Science classrooms over 15 years, Primary specialist science classrooms and one specific incident. I also draw from my experience as a tutor in the tertiary sector and my own sensitivity to visual light.

For many years I thought my situation with VLH and discomfort from extensive computer work was unique until a critical incident (Tripp, 2011) during a relief lesson1.

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1 I was acting as a relief teacher/substitute teacher within the school for the entire day as the regular classroom teacher was absent.
During this particular relief lesson, one student earned time on the large class computer (no BYO laptop in those days) as a reward for completion of a modified program with the Education Assistant. I was told this was a regular occurrence. The pair moved to the computer in the back corner of the classroom and soon afterwards I observed the student behaving oddly, but continuing to play the online game. I asked the Education Assistant whether everything was alright as it seemed that this behaviour was new, sudden onset and seemed similar to petit mal seizures. The verbal response from the Education Assistant was that it happened most times that the student used the computer and I confirmed later that the parents were aware of the situation. The incident stayed with me, and I was keen to investigate further to see if this was an isolated event or a common occurrence. I also wondered whether there were any links to my own migraine patterns, which often occurred following long durations of computer and Interactive Whiteboard use.

Research I conducted as part of a Masters degree in Education revealed that the phenomenon of VLH as a symptom connected to a host of syndromes from long term (e.g., epilepsy) to short term (e.g., concussion). It highlighted societal acknowledgment of VLH following the Pokémon (Pokémon Company, Tokyo, Japan) incident in 1997. It also documented that there was little awareness, understanding or self-efficacy professed by teachers regarding inclusive pedagogies or access to professional learning about this phenomenon, and how to minimise the inherent adverse effects for a student with VLH.

The current research aims to build on my previous investigation and examine the extent of digital media being used by students in high school, especially those with VLH and students’ access to accommodations. For the purpose of the current research, students who have adverse responses to light stimuli are referred to as students with visual light hypersensitivity (VLH).

There are three elements to this term, visual light hypersensitivity. Visual sensitivity as used by Verotti et al. (2005) applies to all individuals who are sensitive to visual light, whether intermittently or permanently. Individuals with migraine are clinically sensitive to light during an episode and show sub-clinical observable reactions (using brain imaging) to light in between episodes (Martin et al., 2011; Schwedt et al., 2013). Approximately 45% of individuals with chronic migraine also report clinical sensitivity to light in between episodes (Schwedt et al., 2013). The specific physical properties of light causing adverse reactions are unique for each individual with light sensitivity, although there are certain commonalities. Light was added to acknowledge the focus on physical parameters, rather than image content. The third word was expanded to include the prefix hyper as this term is used as a reference point by WHO (2001), differentiates between the
assumed and unexpected levels of sensitivity to visual light and was incorporated following feedback from Gubbay2 (personal communication, July 17, 2019).

In the current research, impairment is considered a description of “the physical attribute” (Ellis & Kent, 2011, p.3), and defined as “the biological aberration causing individual inability to move one’s muscles, hear sound, etc” (Böttcher & Dammeyer, 2016, p. 4), it would include non-normative visual experiences. The term disability is “socially created” (Ellis & Kent, 2011, p. 3) and refers to consequences experienced by a student due to impairment, as in Böttcher and Dammeyer (2016). This differentiation of cause and effect supports individualization of learning facilitation as students with a similar impairment may be dis-abled in different ways. This differentiation of effect extends to use and design of digital media (Goggin, 2017).

The current research also addresses one of the research gaps acknowledged by WHO (2019), the need to “consider the particular needs of children with disabilities and how guidelines can be adapted to meet their needs” (p. 13). Research investigating use of digital media revealed that integration of academic, socio-economic, social relationship and multitasking reveal a “complex and reciprocal relationship [that] defies simple linear description” (Gerwin, Kaliebe, & Daigle, 2018). Analysis of this relationship within the educational environment challenges linear measurement of duration of digital media use. The current research focuses on digital media use in a small sample of high schools in Western Australia, investigating the current guidelines for digital media use, specific support available for students with VLH and addresses the possibility of multitasking with digital devices in the classroom. This responds to the gap in research highlighted by Dobransky & Hargittai (2016) into everyday use of digital media by individuals with a disability. Unlike previous calculations of digital media use, the current research includes interactive whiteboards in addition to the usual types of digital media. The current research also compares groups of students; upper and lower high school, students with VLH and students without VLH.

The findings will support the development of broadscale inclusive pedagogies for students with VLH. These will enable students with VLH to actively participate in classroom activities, decreasing the probability of developing along a different developmental pathway.

2 Dr Sasson Gubbay is an eminent neurologist and Emeritus Professor at the University of Western Australia in the Faculty of Health and Medical Sciences.
Organisation of the dissertation

The evolution of the phenomenon of VLH in parallel with increasing digital education is developed in Chapter Two. It comprises a published paper which highlights the modification of visual stimulus within the classroom from light reflecting media (books) to light emitting media (computers). Absenteeism is identified as a potential consequence of visual overstimulation for students with VLH.

A literature review was necessary to inform the experimental phase of the research. As shown in Figure 1.1, Chapter Three provides a systematic review of guidelines and safety parameters for digital media use. It is a modified paper accepted for publication. Medical, broadcast and school guidelines are reviewed for safety parameters identified for students with VLH, manufacturer guidelines are reviewed for safety of users in general as well as specific guidelines for individuals with VLH. The converging six parameters are proposed as a scaffold for incorporation into future school digital media guidelines.

Figure 1.1 Diagrammatic representation of literature review informing experimental phase of research

What we currently know about digital media use in classrooms and who may be affected by VLH is examined in Chapter Four. Following on from the previous chapter, Chapter Four continues to cross traditional disciplinary barriers to identify potential elements of universal design and inclusive pedagogy in the increasingly digital forum of high school education.

Taking a theoretical perspective, Chapter Five examines the evolution of digital learning and its impact on students with VLH through the lens of Vygotsky’s theory of defectology. It proposes a model for understanding the potential exclusion of students with VLH as classroom use of digital media increases. It also proposes use of evidence-based inclusive pedagogies to increase active participation of students with VLH in digital learning activities.

Chapter Six explains the methodological approach. It begins with a review of current knowledge and gaps in understanding on the current use of digital media use by
students with VLH and accommodations used as inclusive practice. The research questions are then presented. The mixed method design adopted to investigate student digital media use, and to access and analyse teacher and parent observations is explained. A short summary of the issues related to the ethics requirements for this research is also presented.

The major findings are presented in Chapter Seven. These include the duration of digital media use by subject and device, analysis between students with and without VLH, as well as any accommodations used. Perspectives of past-students, parents and teachers provide further elaboration regarding digital media use, access to accommodations and their effectiveness.

Chapter Eight is a discussion of the findings with reference to past research and recommendations. It highlights the lack of awareness in educational institutions of challenges faced by students with VLH and encourages incorporation of universal design to support these students within the educational community. Examples of application of these findings within a high school setting and using teacher professional learning are presented. Strengths and limitations of the current research are acknowledged.

Chapter Nine concludes the study by reiterating key issues revealed by the current research and recommendations to increase access to accommodations for students with VLH. It outlines areas for future research for inclusive digital media use in high school. More importantly it highlights the need to recognise VLH as a disability requiring accommodations in all phases of formal learning from Early Childhood Education (ECE) to Tertiary, specifically through the agency of NCCD funding.

Chapter Ten is a postscript to the research. It emerged as a consequence and as such provides insight of VLH from a Tertiary student’s perspective. It presents the lived experience of the author as a postgraduate student with VLH working in a digital environment. This chapter is currently under review in modified format.
Chapter 2  Screens and Teens with Migraines: Visually Sensitive Learners in Contemporary Digital Classrooms

This chapter introduces the concept of VLH as a phenomenon of influence and concern in educational settings. Due to the physiological symptoms exhibited by students with VLH, it has previously been treated as a medical condition (Kasteleijn-Nolst Trenité et al., 2012; Yamashita, 1998) or disability linked with a diagnosis (PedMIDAS; Heyer, Perkins, Rose, Aylward & Lee, 2014). The focus on diagnosis of migraine drove the initial stages of this research, fueled by concerns voiced through social media (daily migraine, golden graine). The concerns included work absences, marginalisation and minimal awareness of barriers to full participation in work spaces.

The chapter is based on a published paper which juxtaposed findings from medical research with the physical requirements for contemporary high school students. It examines a digital revolution, the changes in digital tools used in classrooms from light reflecting to light emitting, a digital revolution. It outlines the inclusive access to digital media images for industry, the requirements outlined by the Independent Television Commission (ITC) guidelines and Web Content Access Guidelines (WCAG 2.0). The paper refers to the lack of guidelines for schools and emphasises the disparity in promotion of inclusive access across different areas of society.

The lack of practical guidelines relating to accommodations for digital media use for students with VLH suggests a need for further research and highlights the need for recommended guidelines. The paper provides justification for the current research and the necessity for incorporation of current societal guidelines and determination of current digital media use by the cohort of students with VLH.
2.1 Introduction

Technology rich school classrooms incorporate digital media in the form of computers and interactive whiteboards into the visual learning environment. Whilst evidence-based research shows use of technology improves academic outcomes for high school students in general, there are limited data available on the consequences of digital media use for high school students with migraine. This article highlights the historical issues with light emitting media, the physical parameters that are changed by adoption of this digital media into the classroom and some of the adverse effects caused by visual light stimulation. The article concludes with calling for further social research to better understand adjustments needed by students with migraine in the digital media classroom, and the policies needed to support image parameter guidelines for schools.

In this article the term visual light hypersensitivity refers to any student’s abnormal sensitivity to optically sighted light leading to negative responses, including that of migraine.

2.2 Reactions to light emitting digital media

In 1997 a broadcast episode of Pokémon Pocket Monsters (fantasy, children’s cartoon) was attributed as the cause behind 685 children being hospitalised for neurological reactions to specific visual images. The reactions ranged from dizziness to seizure. Many of these children had no previous diagnosis of neurological disorders. It follows that with increasing use of digital media in schools, there is the potential for similar adverse reactions to classroom visual images. Yamashita et al. (1998) estimated that 6.25 percent of the young people watching the cartoon would have been affected neurologically. Although isolated incidences of screen-induced seizures were reported prior to 1997 (Harding & Harding, 1999), the Pokémon incident prompted widespread investigation of the visual properties of the cartoon and the effects they have on developing and developed brains. The parameters investigated include alterations of
wave length and luminance (Parra, Kalitzin, & Lopes da Silva, 2005), frequency (Ricci, Vigevano, Manfredi, & Kasteleijn-Nolst Trenité, 1998), amount of visual area stimulated (Wilkins, Emmett, & Harding, 2005) and concentration during a program (Furusho et al., 2002). In 2002, Binnie et al. demonstrated individualised reactions to broadcast flicker patterns. This could explain why the Pokémon cartoon did not elicit a negative response in its creators, but stimulated a range of reactions in the audience of children.

2.3 Digital media and school

Technology rich classrooms have altered the way in which information is accessed by students. Visual communication has changed from light reflective to light emitting, so students perceive the information in a different way. *Light reflective* visual communication includes the blackboard, non-interactive whiteboard, books and pen/paper. *Light emitting* visual communication includes interactive whiteboards, tablets, computers and laptops. In general, light emitting visual communication devices are categorised as digital media. There is evidence that use of an interactive whiteboard (IAW) in a classroom increases student engagement (Preston & Mowbray, 2008). For students with light sensitivity, however, this increase in engagement could be tempered by the negative reaction to the physical attributes of the images (Binnie et al., 2002; Wilkins et al., 2005).

There have been many technological advances regarding digital media used in classrooms. These changes may increase or reduce the risk of an adverse reaction for students with visual light hypersensitivity, but all represent change in a student’s learning environment. For example, the change in viewing screens from cathode ray tubes (CRTs) to liquid crystal displays (LCDs) has reduced the risk of an adverse reaction due to increased refresh rate or flash frequency. However, the increase in screen size from smaller TV screens to larger interactive whiteboards (IAWs) and the use of laptops used closer to the user has greatly increased the percentage retinal area stimulated by the image, increasing the risk. Increased screen luminance from CRTs to IAWs has also increased the risk of an adverse reaction. In addition, more than half the school day can be spent with digital devices “on” in the classroom (Sproul, 2014, December), using a screen saver, even though they are not the immediate focus of the current learning experience. This peripheral stimulus for hours during the day can have an adverse effect on students with migraine due to lack of habituation (Boulloche et al., 2010).

Overall, the evolution of digital media in education has gradually increased student exposure to light emitting digital media. The documented increase in number of visual
light sources, intensities and duration could create impairment for students who are light sensitive, including those students with migraine. To date the use of digital media in the classroom has not been recognised as a limiting factor for students with light sensitivity. Freund (2001) introduces the idea of technology as “material culture” (p. 690). He discusses the importance of spatio-temporal arrangements of material culture as part of the material environment, able to be adjusted. Classroom IAWs demonstrate the effect of these arrangements. A visual light sensitive student sitting at the front of a classroom would increase the risk of adverse reaction. However, the same student would decrease this risk by sitting further back. By acknowledging that specific cultural tools could create limiting factors for some students, individual accommodations could be created to enable these students to access the digital media with decreased risk.

2.4 Migraines and school

Students with migraine are already disadvantaged at school. Lipton et al. (2007) reported that 28 percent of people with migraine felt that their productivity at work or school was reduced by at least half. Since migraine impacts productivity, a student may be present in class but not be able to work at full capacity. For affected students this may have implications for curriculum knowledge, understanding, process development and assessments. Added to this is the high rate of school absence due to migraine. In the same research, Lipton et al. (2007) found that 25 percent of people with migraine reported an absence rate of greater than one day per week from work or school. In a population study in Iceland, more than 20 percent of children aged 10-12 reported headaches within the past seven days (N = 10 726) (Taehtinen, Sigfusdottir, Helgason, & Kristjansson, 2014) commenting that “present findings demonstrate the significance of total daily minutes of screen-based activities among both genders” (p. 133). In a study of 4927 tertiary students, Montagni et al. (2016) concluded that “Increasing levels of screen time exposure are associated with increased reporting of migraine amongst post-secondary students” (p. 1026). The Global burden of disease study (GBD) recently reported that negative effect of migraine in the general population in 2017 was statistically significantly increased compared to 2007 (Global Health Metrics, 2018). This increase in population percentage of people with the neurological disorder of migraine (and students with migraine) suggests a future requirement of support in schools to enable access to all educational activities for these students.

Educators have an important role in understanding and creating a supportive environment (Smagorinsky, 2012). Teachers provide particular support for students with
diagnosed medical conditions, but not all conditions attract the same level of assistance to access learning activities. For example, frequency and levels of adjustments allowed for students with migraine and ADHD are different despite the similar prevalence in adolescents. Both follow international guidelines that include neurological symptoms. ADHD may not be fully understood, but it is well recognised in the compulsory educational community therefore reasonable adjustments can be made for the students both during and between episodes. However, migraine in children and adolescents is neither understood nor well known. It attracts few adjustments in the classroom to support student participation, other than in the pain stage. Most individuals with migraine are noticeably sensitive to visual stimuli during an episode, it can trigger an episode (Shepherd, 2010) but they are also sensitive in between episodes (Martin et al., 2011). This is also known as interictal (Prescot et al., 2009). Prescott et al. (2009) reported increased levels of excitatory neurotransmitter precursors in patients during interictal period, concentrated in two regions of the brain. Individuals diagnosed with migraine with photosensitivity reporting moderate to severe discomfort during interictal investigations with graduated intensity of visual stimuli (Chu, Im, Chung & Oh, 2011). Building on previous research by DaSilva et al. (2007) who reported the thickening of the somatosensory cortex in individuals with migraine compared with individuals without migraine, Maleki et al. (2012) demonstrated the correlation between frequency of migraine and amount of thickening. Schwedt, Berisha and Chong (2015) continued the identification of structural changes beyond the scope of the present study, however, they highlight that structural changes are present and will not change quickly whether the current status of the student is ictal or interictal. Therefore interictal responses to stimuli are different for students with migraine, and would not always be observable in the classroom as can be termed discomfort rather than pain.

As with many neurological disorders, reactions to stimuli (like light) are unique to each individual. There are specific physical properties of light and certain combinations that trigger adverse reactions in significant groups of the population. Some individuals are sensitive to changes in frequency (colour) whilst others are sensitive to changes in luminance. Using data collected from different demographic groups, theories were generated regarding the parameters causing the adverse reactions. These led to the revision of guidelines in use by developed countries. They include the Independent Television Commission (ITC) guidelines which are designed to increase equity of safe access to broadcast television. The World Wide Web Consortium (WC3) developed the Web Content Access Guidelines (WCAG) incorporating equitable access for light sensitive individuals. This was followed in 2008 by WCAG 2.0 to incorporate additional technological developments (https://www.w3.org/TR/WCAG20/).
Classroom application of safer viewing parameters as outlined in these policies would enable equity of access to information using digital media for visually light hypersensitive individuals including those with migraine. However, at this time, compulsory educational institutions are not required to adhere to these policies. This means that students with migraine are less protected from digital images in the classroom.

2.5 Future research

Given the altered parameters of screen type and use in the classroom, and the age of the students using them, it is imperative that classroom digital media guidelines be re-interpreted with a focus on neurological safety. The increase in digitalised classrooms also highlights the need for further social research regarding equity of access to learning activities including spatio-temporal arrangements. This would involve using contemporary classroom equipment, current digital media pedagogies and the inclusion of digital media in required schoolwork completed outside the classroom, especially for upper school students.

“Digital participatory pedagogy” (Dooley, Ellison, Welch, Allen, & Bauer, 2016) requires teachers to facilitate more than access to digital technologies, but connecting these tools to tasks requiring student interaction. One of the examples used by Dooley and colleagues (2016) was the student-designed and student-constructed video (in place of written text) to demonstrate understanding of mathematical concepts. Digital participatory pedagogy (Dooley et al., 2016) and literacy are key elements in contemporary classroom learning activities, each with associated environmental factors. The need for conscious control of environmental parameters in digital media such as luminance and external lighting are alluded to in Lang (2000), which proposed a limited capacity model of media information processing. This model relies on two assumptions; firstly, that people are information processors and secondly that the ability to process information is limited. These processes can be either automatic or by conscious choice. The three sub-processes involved in information processing are Encoding, Storage and Retrieval, however, encoding capabilities are inversely proportional to the cognitive load (Lang, Potter & Bolls, 1999).

Using Lang’s (2000) model, with simultaneous acknowledgment that during a migraine episode, cognitive function is compromised (Chiang, Starling, Dodick & VanderPluym, 2018), visual information presented on digital media can erect a barrier to learning for a student with migraine. Erecting barriers to cognitive processing seems
counterintuitive for educational institutions assuming they are aware of the potential impact of digital media for people with VLH.
Chapter 3  A Review of Digital Media Guidelines for Students with Visual Light Sensitivity

This chapter acknowledges the place of high school education within society and investigates discrepancies between societal access, health guidelines and school policies. The complexity of the health guidelines required a systematic review of the literature in the context of visual light sensitivity (VLS). During the seminar to share the findings and conclude the current research, the terminology changed from *visual light sensitivity* to *visual light hypersensitivity* under advisement from an eminent neurologist (S.S. Gubbay, personal communication, July 17, 2019). The alteration in terminology occurred 14 months after the manuscript *A Review of Digital Media Guidelines for Students with Visual Light Sensitivity* was accepted for publication. Therefore, in this chapter, the original term has been maintained.

To explore whether current digital media accommodations originate from evidence-based investigations or industry policy, four societal sources were examined: academic databases, broadcast television guidelines, Australian Education policy documents and User Guides issued by digital media manufacturers. These sources exact influence on educational institutions from a range of perspectives such as acknowledgement of the burden of disease (Vos et al., 2013) in society and education (Davis, 2005), necessity for educators to be knowledgeable in their use of technology (Mishra & Koehler, 2006) and the use of individual technological devices (Apple Inc., 2010; Smartboard ®, 2012). The findings from the review inform instrument construction for the current research.

The chapter concludes with six recurring parameters found in both evidence-based investigations and industry policy constructed as accommodations for classroom use. These parameters and the review findings are incorporated into the instrument design. They are also are highlighted as key accommodations for students with VLS within the final recommendations.

This chapter has been accepted for publication by the International Journal of Disability, Development and Education (IJDDE). It has been included in this thesis in modified form allowing inclusion of additional explanations and examples.
3.1 Abstract

Technological developments allow visual information to be accessed by individuals using digital devices as small as phones or as large as whiteboards. Education technology research and policy, however, has focused more on viewing content and less on optimal viewing parameters for the student users. Students with light sensitivity potentially face a barrier with e-learning activities in the classroom. This review aimed to identify points of convergence and inconsistency across various literature sources containing guidelines for digital media use by students. Inconsistencies were found between academic and both manufacturer and school guidelines. Six parameters were identified for modification on behalf of students with light sensitivity: image colour, image flash frequency, duration of viewing, luminance and environmental lighting, both natural and artificial. The findings highlight the need for revision of school policies regarding digital learning environments to support inclusive access and use by students with light sensitivity.

3.2 Introduction

As advances in technology continue, the use of digital media in developed countries continues to increase. From computers to phones, digital media are capable of facilitating access to information for both work and leisure, and these digital devices are well entrenched (Martin, Shaw, & Daughenbaugh, 2014). Yet this global societal trend may be creating inequities due to the types and combinations of visual light produced by digital media devices. In some instances the visual light parameters could impair an individual and prevent them from completing or participating in an activity (Furusho et al., 2002).

In classrooms, the digital learning environment has altered the visual tools used for learning activities. Much of the information is still presented to students in visual form, without compensating for digital presentation. Visual tools that once were light reflective – whiteboards and paper, are now light emitting - interactive whiteboard and laptops (Sproul, MacCallum, & Ledger, 2017). This alteration to the classroom environment has
been propelled by the perceived requirement for its adoption in all facets of education activities (Fraillon et al., 2014), its endorsement by many educational technology researchers (Martin et al., 2014), and students (Biddix, Chung, & Park, 2015).

Inclusive pedagogy within the mainstream classroom aims to provide access to effective learning opportunities for all students. The key principles informing inclusive pedagogy (Florian, & Black-Hawkins, 2011) include: each student is valued equally; teaching requires support of all students (not most students); and facilitation of participation in learning activities avoids marginalisation. An effective learning environment without marginalisation may require differential pedagogy nested within an inclusive learning environment. While students who are extending beyond the current learning task may need encouragement to explore further, students with a physical disability may benefit from a differential pedagogy to access the learning hardware, and those with an intellectual disability may require additional support to access the abstract concepts embedded in the activity.

In the current research, the term impairment is used to identify the cause, the term disability to identify the effect of impairment, in the manner of Bøttcher and Dammeyer, (2016). The WHO (2001) also outline additional interaction of environmental contexts, and suggest;

To infer a limitation in capacity from one or more impairments, or a restriction of performance from one or more limitations, may often seem reasonable. It is important, however, to collect data on these constructs independently and thereafter explore associations and causal links between them (p. 19)

Whilst the WHO (2001) outlines distinctions between cause and effect, many of the policy documents referred to in the literature review have not. In some cases, the author has added the term impairment to give context to the reader, the judgements based on the content of the whole document.

The Disability Standards for Education (Australian Government, 2005) outline the parameters for use of the term “disability” (and/or impairment) within an educational setting; disability, in relation to a person, means:

(a) total or partial loss of the person’s bodily or mental functions; or
(b) total or partial loss of a part of the body; or
(c) the presence in the body of organisms causing disease or illness; or
(d) the presence in the body of organisms capable of causing disease or illness; or
(e) the malfunction, malformation or disfigurement of a part of the person’s body; or
(f) a disorder or malfunction that results in the person learning differently from a person without the disorder or malfunction; or
(g) a disorder, illness or disease that affects a person’s thought processes, perception of reality, emotions or judgment or that results in disturbed behaviour;

and includes a disability that:

(h) presently exists; or
(i) previously existed but no longer exists; or
(j) may exist in the future; or
(k) is imputed to a person. (Australian Government, 2001, Section 1.4. Para 11)

These parameters include injuries such as broken bones (impairment)(University of Canberra, 2014). Imagine a basketball player returns to school with a broken arm from Friday night’s game and his physical education studies class is completing their basketball rotation. Teacher awareness of differential pedagogy alters the participation of the student, and thus the academic and social effect (disability) of the impairment. Rather than sitting out of the class (exclusive pedagogy) or changing the sport to soccer (possible inclusive pedagogy but maybe detrimental to other students regarding assessed curriculum), the injured student could act as referee (differential pedagogy). With extra scaffolding and alteration of assessment parameters the student is still included in the learning activities, all students are supported in learning the game, and no one is excluded, thus demonstrating differential pedagogy nested within an inclusive learning environment. Provision of these nested pedagogies requires teacher awareness of relevant disabilities and strategies. Just as students with hypermobility (Pacey et al., 2015) may use an iPad for writing, students with the disability of light sensitivity could be afforded similar support when using digital media by changes in seating plans and alteration of visual display parameters.

Inclusive pedagogy maintains equitable access to digital learning experiences, whilst a differential pedagogy acknowledges and incorporates the material culture (Freund, 2001) parameters preferred by students. Both differential and inclusive pedagogies can promote digital media access and increase active participation in classroom activities without causing discomfort or adverse reaction. The Nationally Consistent Collection of Data (NCCD) Guidelines “[align] to the definitions of disability in the Disability Discrimination Act 1992” (Commonwealth of Australia, 2019, p. 7).

3.3 Light sensitivity an “invisible” disability

An “invisible” disability (Davis, 2005) is one that is not immediately apparent to observers, therefore may be overlooked in students. While a digital participatory
pedagogy (Dooley et al., 2016) attempts to develop inclusive classroom practice with digital media, it may not account for environmental elements such as light emitted from digital media. To date, the majority of research for inclusive pedagogy using digital media has focused on content and process (Gillett-Swan, & Sargeant, 2018; Orr, & Hammig, 2009). The potential need for a differential pedagogy to allow all students to participate is driven by the physical parameters of the digital images. Davis (2005) describes the concept of an “invisible disability”, where both the impairment and consequence are unseen. The invisible disability experienced in the classroom caused by visual light hypersensitivity (impairment) has not yet been explored in depth by educational literature. Educators and educational researchers may not be aware of the evidence accumulated in other research fields regarding potential barriers and support strategies for visual perception in young children and adolescents. This evidence could provide scaffolding for both inclusive and differential pedagogies for digital learning environments in all levels of education.

Image perception amongst students is explored by many researchers in the medical field (Maniyar et al., 2014; Mickleborough et al., 2013) with a focus on individuals with light sensitivity as part of their impairment, some caused by neurological diseases such as migraine. In the International Classification of Functioning, Disability and Health (ICF, World Health Organisation, 2001) the term disability serves as “an umbrella term for impairments, activity limitations or participation restrictions” (p. 3). It continues by listing light sensitivity as impairment, specifically citing the example of “photophobia (hypersensitivity to light)” [italics in original text] (p. 63). Although a student may have “perfect” (20/20) vision they may still be sensitive to light through migraine or concussion, both of these conditions being classified as disabilities. The systemic analysis contained within the Global Burden of Disease Study (Vos et al., 2013) rated migraine as the third highest disease by prevalence (p. 2168). Cultural effects of this impairment include estimates of disability using parameters such as years lived with disability (YLD) and disability adjusted life years (DALYs). Consequently migraine was the 6th highest rating disability worldwide in 2013, compared to 2000 when it was ranked nineteenth (Steiner, Stovner and Vos, 2016). The World Health Organisation characterises migraine as “recurrent, often life-long, and characterised by recurring attacks”1. Concussions (traumatic brain injury) rate highly against other athletic injuries in high school (8.9%) and college (5.8%) (Gessel, Fields, Collins, Dick, & Comstock, 2007) demonstrating the prevalence of this episodic, acute (short term) impairment leading to disability. Other conditions that may encompass the symptom of light sensitivity include ADHD (Kooij, & Bijlenga, 2013), depression (Seggie, Canny, Mai, McCrank, & Waring, 1989) and anxiety

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Cumulatively, students with light sensitivity account for a significant portion of the student population at any secondary or tertiary institution. Davis (2005) expands on the social and educational implications inherent in the definition of these often invisible impairments and disabilities; that the invisibility of a impairment does not decrease its impact. On the contrary, lack of visibility can increase the difficulty in accessing the accommodations necessary for effective functioning. Koehler and Mishra (2009) encourage enhanced technological pedagogical knowledge by educators when incorporating technology into the learning environment. Manipulation or “reconfiguring them [digital technologies] for customised pedagogical purposes” (p. 66) would promote differential pedagogy, accommodating more students with light sensitive impairments causing disability. Teacher education and school guidelines regarding practical pedagogies (both inclusive and differential) would be appropriate to prevent any inequity generated by digital media use.

The functional impact of light sensitivity has been directly linked to presented visual stimuli (Takahashi, & Tsukahara, 1998; Trenité et al., 2010) and become evident by general population reactions to Pokémon (Episode 38) and the 2012 Olympic Logo launch. Both contained visual images capable of triggering an adverse reaction ranging from headache to seizure. The Pokémon incident in 1997 caused 685 children to be taken to hospital with a range of neurological symptoms including nausea and seizure (Furusho et al., 2002). These symptoms were attributed to a series of colour and pattern changes in the visual display (Takahashi, & Tsukahara, 1998). Following this incident, guidelines were applied to broadcast television in the UK and Japan. In 2007 the animation to launch the London 2012 Olympic Logo was televised on BBC news without analysis for adherence to these safe image guidelines. Immediately after the broadcast, the BBC and Epilepsy Action (UK) were contacted by members of the public reporting epileptic seizures triggered by the visual images in the footage. The animation was removed from air and a revised broadcast-guideline-compliant animation was released soon after. Similar instances could occur in classrooms, yet there are no guidelines for educational institutions.

3.4 Digital learning environments

Classroom materials and practices are “adapted to children with normal psychophysical constitutions” (Bøttcher and Dammeyer, 2016), similarly the use of digital media is rooted in the social world. Whilst digital integration is still increasing, it is moderated by factors such as geographic location (Mikail, 2015; Pathak-Shelat, &

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2 https://www.epilepsy.org.uk/news/2012-logo-far-too-flashy
DeShano, 2014), socioeconomic status (Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017; Ritzhaupt, Liu, Dawson, & Barron, 2013), and device type (McCarthy, 2010; Sproul, 2014a). The superimposition of mobile or electronic learning (e-learning) onto this learning environment extends the complexity of the digital media model. The capabilities of e-learning, of increasing or decreasing access and opportunity for students, are still being investigated. Teacher knowledge and classroom use of digital media capabilities, interpretation and manipulation affects the adoption of digital participatory pedagogies (Dooley et al., 2016). Prensky’s digital natives (2001) may be comfortable as a population with use of digital media; however adverse neurophysiological consequences from digital images may be experienced by individual students whose data may be subsumed by generalized overviews (Harris & Sanborn, 2014). Similar instances of detrimental stimulation may not be expected, may be slight and transitory (Furusho et al., 2002) when interacting with the digital aspect of material culture, or reporting of occurrences may be linked only with comorbid conditions (Mansur et al., 2018).

In digital learning environments, digital media is used to emit visual light and audible sound to communicate information. Information regarding potential risks associated with use of new technologies is understandably absent from manufacturer advertisements, but can still be found in early operation manuals:

**Seizures, Blackouts, and Eyestrain:** A small percentage of people may be susceptible to blackouts or seizures (even if they have never had one before) when exposed to flashing lights or light patterns such as when playing games or watching video.

If you have experienced seizures or blackouts or have a family history of such occurrences, you should consult a physician before playing games or watching videos on your iPad. Discontinue use of iPad and consult a physician if you experience headaches, blackouts, seizures, convulsion, eye or muscle twitching, loss of awareness, involuntary movement, or disorientation. To reduce risk of headaches, blackouts, seizures, and eyestrain, avoid prolonged use, hold iPad some distance from your eyes, use iPad in a well-lit room, and take frequent breaks (Apple Inc., 2010, p. 2)

These warnings are not included in the 2012 or later safety manuals for Apple Inc. iPads.

An adverse reaction to visual light is referred to in the medical literature by various terms: visual sensitivity, light sensitivity, photosensitivity or photophobia (Trenité, 2010; Verrotti et al., 2005; Wilkins, Patel, Adjamian, & Evans, 2002). The stimuli for the adverse neurological reaction to the Pokémon cartoon were attributed to the physical parameters of the images, such as particular screen colours (Tobimatsu, Zhang, Tomoda,
Mitsudome, & Kato, 1999) or flash frequencies (Takahashi, & Tsukahara, 1998) which have been shown to affect different children in different ways. Flash frequencies greater than 4Hz of an image can trigger a clinical seizure for a student with or without photosensitive epilepsy (Harding and Harding, 1999), whereas cognitive processing is affected for students with migraine simply by using digital media (Mickleborough et al., 2013). These parameters are reflected in industry digital media guidelines but again, like image guidelines these currently are not evident in the digital learning environment literature.

3.5 Methods

This review examines the current recommendations and guidelines that address differentiation or inclusion of students with light sensitivity using digital media and its implications for classroom practice. It investigates the interplay of neurological processing and educational pedagogy, superimposed over societal and educational visual tool use. The following questions guided the review to inform the explanatory section.

1 What are the recommendations in various literatures (academic, broadcast television, manufacture, Australian education) for digital media use by students with reference to visual light?

2 What are the implications for inclusive or differentiated pedagogies for digital media use by students with light sensitivity?

3.5.1 Source of academic guidelines

Academic databases ERIC and Web of Science were accessed for general educational, pedagogical, medical, ergonomic and ophthalmological research (including Pediatrics and Cephalagia). Article inclusion parameters were English language, full text availability and published before February 2017. The initial search used the terms:

(photosensitiv* OR photophob* OR ‘visual light sensitivity’)  
AND (child* OR student* OR adolescen*)  
AND (guidelin* OR recommendation*).  

ERIC returned 1 result, Web of Science returned 47 results, with no articles being in common. The 48 search results were filtered by reading titles and abstracts for adherence to the following criterion (1) visible light reference and (2) recommendations for individuals who were visually light sensitive. Articles were excluded if referring to
conditions of dermatology, pregnancy and pharmaceutical intervention. A second search focused on the guidelines specifically for use in schools. The second search used the terms:

('digital media' OR computer* OR television* OR iPad* OR tablet* OR 'interactive whiteboard' OR 'smartboard')
AND (school* OR university* OR student* OR classroom*)
AND (guideline* OR recommendation*)
AND (light* OR brightness OR contrast* OR time* OR vis*)

ERIC returned 237 results, Web of Science returned 973 results which were filtered by reading titles and abstracts for adherence to the following criterion (1) includes visible light reference (2) applies to use of digital media use by students (3) includes school environment reference (4) published after 1997. The exclusion criteria were duplicate papers and e-portfolio design. This process left 82 unique articles, which were read in full, only ten of which suggested guidance relating to visual light and digital media use.

3.5.2 Sources of broadcast television and digital media user guides

Broadcast television guidelines and digital media user guides were included in analysis as they denote societal requirements of safe digital media use and can form part of an educator’s Technological Knowledge (TPACK, Koehler & Mishra, 2009). Search terms for broadcast television guidelines initially included:

‘telecommunication guidelines’, ‘photosensitive’
AND either ‘Australia’, ‘United Kingdom’ or ‘United States’.

Although the word photosensitive introduces a bias in document selection (Bowen, 2009) this review is focusing on a particular group of individuals; therefore, documents gained by this selection criterion are valid inclusions. At the same time, documents excluded by this method are unlikely to contain information salient to the argument. The first 100 results from the secondary search for each geographical domain were accepted as the documents with strongest correlation to search terms. These documents were filtered for adherence to the following criterion (1) issued by contemporary telecommunications network or government agency (2) accurate for geographical entry (3) inclusive of light sensitive visual image parameters. Exclusions consisted of previous versions of current guidelines, updates, and unapproved recommendations. Further documents were included if referenced in guidelines and were necessary for contextual understanding. Eventually 11 Australian, 14 United Kingdom and 18 United States documents satisfied the inclusion and exclusion criteria for guidelines for broadcast television (telecommunications) in regard to general population and those with visual light sensitivity.
In addition to journal articles User Guidelines published by manufacturers to accompany all digital media devices were analysed. Three digital media devices of differing dates and from different companies were chosen to incorporate two types of screen sizes; medium (iPad) and large (Interactive Whiteboard, IAW). The devices were chosen as examples of different screen types used in education. The Apple Inc. iPad is used for mobile and individual learning in mainstream classrooms, whilst the SMART Board® interactive whiteboard (IAW) is used for whole-class participation. IAW use ranges across activity and class groups from login by kindergarten students to demonstration of microscope procedures for Year 12 students (Martin et al., 2014; Sproul, 2014a).

3.5.3 Source of Australian education policy documents

Government or school policies or guidelines released to Australian educational institutions pertinent to classroom digital media use by students with light sensitivity were also searched using the terms:


Millions of results were returned, so the first 100 results were filtered for adherence to the following criterion (1) issued by a school or compulsory education institution (2) accurate for geographical inclusion in ‘Australian Education Policy Documents’ (3) inclusive of light sensitive visual image parameters. Exclusions consisted of previous versions of current guidelines, software guidelines, and unapproved recommendations. Further documents were included if referenced in guidelines and were necessary for contextual understanding of documents.

Qualitative document analysis consisted of “skimming (superficial examination)” and “reading (thorough examination)” (Bowen, 2009, p. 32). Literature based references to guidelines for individuals generated qualitative themes (as described by Bowen, 2009). Terminology was analysed for congruent definitions of terms describing physiological events and physical parameters. Given the cross discipline nature of the review, synonyms used for terminology and classification were included (Trenité et al., 2010) so expression of recommendations included in articles and documents refer to light sensitivity as inclusive of students with photosensitivity, migraine, concussion and photophobia.

The process developed by Mathison (1988) was used to triangulate secondary and tertiary data, and identify convergent, inconsistent and contradictory guidelines. The triangulation process began with collation of various literatures for students with light
sensitivity synthesised by researchers and publicised by broadcast television companies, manufacturers and education departments. The assimilated guidelines were listed, high frequency recommendations were presented in detail.

Collating the light sensitive guidelines recommended by various literature (academic, broadcast television, manufacture, Australian education) included synthesis of themes. Each search is reported in two sections, an overview of the guidelines followed by within-source details. Between-source convergence, inconsistencies and contradictions guide the analysis and discussion in the later section, which also includes potential application of these guidelines through inclusive and differential pedagogies.

3.6 Findings to inform current research

The systematic meta-analysis highlights the following findings related to guidelines for: students; digital media use in school, broadcasting and manufacture; digital media guidelines issued by schools in Australia. A summary of the findings for each set of guidelines is provided and discussion follows that includes concerns and recommendations.

3.6.1 Academic database guidelines for students with light sensitivity

All analysed articles contained guidelines recommending that people with light sensitivity needed to accommodate their adverse reactions by avoiding stimulative visual light or modifying their exposure (Table 3.1). Cumulatively the articles outlined six specific light parameters to avoid; flashes/flickers, saturated colour, high contrast, high luminance/glare, long duration, moving patterns and individual synchronous eye stimulation (in three-dimensional imagery). Suggested modifications to viewing environment included; increasing viewing distance, addition of external light sources and single eye stimulation.

<table>
<thead>
<tr>
<th>Article</th>
<th>Article Type</th>
<th>Suggested Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bureau et al. (2004)</td>
<td>Review</td>
<td>Avoid flicker (Use 100 Hz screens)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid saturated colour and high contrast ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase viewing distance</td>
</tr>
<tr>
<td>Fallah and RamachandranNair (2009)</td>
<td>Empirical</td>
<td>Avoid striped patterns, glare, and bright flashes</td>
</tr>
<tr>
<td>Article</td>
<td>Article Type</td>
<td>Suggested Parameters</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Fisher, Harding et al. (2005)</td>
<td>Review</td>
<td>Avoid oscillating patterns, high luminance, bright flashes, saturated red colour. Incorporate break time, increased viewing distance, use of external light source, covering one eye when necessary.</td>
</tr>
<tr>
<td>Kasteleijn-Nolst Trenité et al. (2012)</td>
<td>Methodological</td>
<td>Avoid the following: flashing lights, increased screen size, individual eye stimulation (3D), high contrast, saturated red lights, red/blue combinations.</td>
</tr>
</tbody>
</table>

The guidelines occurring with highest frequency related to image colour, flicker and brightness/luminance.

- **Colour.** The colour saturated red (long wavelength red) was isolated as a screen-based colour to avoid in five articles. Ishida et al. (1998) discussed the recorded non-seizure and seizure adverse reactions to the 1997 Pokémon cartoon’s red colour combinations including headache, nausea and dizziness. Ishida et al. (1998) concluded that regulations were necessary for technical characteristics, especially for colour. Harding and Takahashi (2004) summarised the UK broadcast guidelines subsequently adopted by Disney and American ABC. These included avoidance of long-wavelength red colour. Continuing the trend of linking medical research to societal guidelines, Bureau, Hirsch and Vigevano (2004) refer to manufacturer introduced colour and contrast regulations for video games, remarking on the decrease in games which contravene the recommendations.

- **Flicker.** Flicker is the inherent refreshing of the screen as part of its functioning. Flash frequencies are designed flashes within a visual image sequence, chosen and able to be changed by the broadcaster (as in strobe lighting). Bureau et al., (2004) suggest decreasing flicker from screen by increasing screen frequency from 50Hz to 100Hz. Kasteleijn-Nolst Trenité et al. (2012) wrote that flashing lights in diagnostic test protocols can cause seizures or headaches, the most stimulative visual frequencies for flashing images being between 4 and 50 Hz, hence these should be avoided.

- **Brightness/Luminance.** The significance related to avoidance of brightness, were referenced in the review by Fisher, Harding et al. (2005) and included in references to flashes (Fallah, & RamachandranNair, 2009)
### 3.6.2 Guidelines for digital media use in schools: visual light

All analyzed articles included recommendations parallel to avoidance of stimulative visual light or suggested some ways to modify the exposure (Table 3.2). This group of articles had a higher emphasis on the role of environmental lighting.

<table>
<thead>
<tr>
<th>Article</th>
<th>Article Type</th>
<th>Suggested Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kondo et al. (2012)</td>
<td>Empirical</td>
<td>Avoid extended duration</td>
</tr>
<tr>
<td>Narayanasamy et al. (2016)</td>
<td>Empirical</td>
<td>Avoidance of some colours, Contrast investigated due to lighting conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorporation of break times, large print and extension time for some tasks</td>
</tr>
<tr>
<td>Sandnes and Zhao (2015)</td>
<td>Empirical</td>
<td>Specific colour and contrast parameters tool</td>
</tr>
<tr>
<td>Schoor et al. (2012)</td>
<td>Empirical</td>
<td>Instructional design e.g., not red for digital background</td>
</tr>
<tr>
<td>Sotoyama et al. (2002)</td>
<td>Empirical</td>
<td>Inclusion of natural and artificial lighting to support visual tasks</td>
</tr>
<tr>
<td>Stobaüs et al. (2014)</td>
<td>Commentary</td>
<td>Inclusion of lighting requirements, large fonts for support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extended time for tasks</td>
</tr>
<tr>
<td>Thompson et al. (2002)</td>
<td>Empirical</td>
<td>Avoidance of certain colours, high contrast, flashes, repetitive patterns, glare</td>
</tr>
<tr>
<td>Winterbottom and Wilkins (2009)</td>
<td>Empirical</td>
<td>Avoidance of glare, high luminance and high contrast from IWB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilt all whiteboards to reduce glare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use overlays/filters to decrease contrast</td>
</tr>
<tr>
<td>Wu et al. (2007)</td>
<td>Empirical</td>
<td>Avoidance of flicker, extended duration, low luminance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorporate increased viewer distance from screen, breaks from screen</td>
</tr>
</tbody>
</table>

The guidelines occurring with highest frequency related to image colour, environmental lighting and luminance/glare from screen.

- **Colour.** Four articles advised avoidance of red and/or saturated colours. Thompson, Thurlow, Quenemoen and Lehr (2002) referenced many government policies regarding both optical and neurological disability access. Most notable is the inclusion of the draft Web Content Access Guidelines (WCAG) addressing the issue of flash/flicker (blinking) and colour. Constructed by the World Wide Web Consortium (W3C, [https://www.w3c.org/](https://www.w3c.org/)) the updated WCAG 2.0 formed the focus of Sandnes and Zhao’s (2015) product development, a colour choosing tool which ensures compliance with light sensitive guidelines.

- **Environmental lighting.** Environmental lighting is included as a factor in six of the ten articles. Narayanasamy, Vincent, Sampson and Wood (2016) investigated the lighting in Australian primary school classrooms and determined that the use of
natural lighting and adjustment of artificial lighting was underutilized. Winterbottom and Wilkins (2009) concluded that excessive fluorescent lighting and glare reflection from whiteboards using data projector impairs visual performance. Zandvliet and Straker (2001) encourage the manipulation of “physical factors (such as lighting and workspace)” (p. 850) reporting a high correlation between the visual environment (including lighting) in digital media classrooms and student cohesion, autonomy and task orientation. Visual fatigue was mentioned by Sotoyama, Bergqvist, Jonai and Satio (2002) who reported computer use “not exceed[ing] two hours per week” (p. 40). At these daily levels, they encouraged “consideration of natural and artificial lighting” (p. 41) as it impacts student's fatigue.

- **Luminance/Glare.** Opposing guidelines exist within this theme; ophthalmological and ergonomic disciplines (Narayanasamy et al., 2016; Thompson et al., 2002; Wu, Lee, & Lin, 2007) require increased luminance and contrast ratio to assist with lowered visual acuity, whereas neurological compliance (Sandnes, & Zhao, 2015) require decreased luminance to lower neurological stimulation. Stobaüs et al. (2014) focused on lifelong learners, specifically the elderly and their use of computers. As visual acuity decreases with this age group, the focus was on providing sufficient luminance to support each individual.

### 3.6.3 Guidelines for broadcast television (telecommunications)

Australia, the United Kingdom and the United States displayed convergence in their referrals to globally recognised documents such as Web Content Accessibility Guidelines (WCAG) and International Telecommunications Union (ITU) rules. Inconsistency was shown by reference to country specific disability legislation. Table 3.3 shows a summary of the agencies responsible for release of each reference document.

<table>
<thead>
<tr>
<th>Country</th>
<th>Reference Documents</th>
<th>Released by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WCAG 2.0</td>
<td>United States Access Board (2000)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>ITU – RS BT 1702</td>
<td>Ofcom (2013)</td>
</tr>
<tr>
<td></td>
<td>WCAG 2.0</td>
<td>Ofcom (2013)</td>
</tr>
<tr>
<td></td>
<td>The BCAP Code The UK Code of Broadcast Advertising v1.2.10 Rule 4.6</td>
<td>Broadcast Committee of Advertising</td>
</tr>
<tr>
<td>Australia</td>
<td>International Telecommunication Union (ITU) – Radiocommunication Sector (RS) BT 1702</td>
<td>ITU (2005)</td>
</tr>
</tbody>
</table>
The guidelines occurring with highest frequency related to image flash/flicker and contrasting patterns:

All analyzed documents identified flicker/flash as a parameter to avoid. This was accomplished by referencing one of the documents in Table 3.3 or restating the limits of physical light parameters. International Telecommunications Union (ITU) guidelines (Rule 2.13 of the Ofcom code) prohibit any television station from broadcasting a program which includes greater than 3 per second flashing images. It continues by suggesting the avoidance of patterns, luminance and contrast changes. The ITU guidelines reiterate that the precautions reduce rather than eliminate the risk of adverse neurological reactions for light sensitive individuals. In January 2017 the United States Access Board issued a “final rule”. This rule referred requirements of information and communication technology parameters to “harmonise” with the European Commission standards and globally recognized WCAG guidelines, compliance to be completed by January 2018.

### 3.6.4 Digital media user guides issued by manufacturers

Over time the dimensions of these devices have altered, as have the published user guides. Device statistics and guidelines pertinent to visual light included in the safety manuals are summarised in Table 3.4. Both types of digital light emitting devices operate at different sizes and proximity to the user and unlike the smaller device, the guidelines included in the SMART Board® 480i5 Interactive Whiteboard System’s Configuration and User’s Guide (2012), are applicable to 3D material only. The 3D warnings include cautions for viewers with a family history of light sensitive seizures, as well as advising against viewing 3D material when sleep deprived or unwell.

<table>
<thead>
<tr>
<th>Device</th>
<th>Screen Size</th>
<th>Suggested Safety Guidelines</th>
</tr>
</thead>
</table>
| Apple Inc. iPad 1 (2010) | 19.7 cm × 14.8 cm | Increase distance from screen  
Use external lighting  
Take frequent breaks  
Limit time engaged with iPad |
| Apple Inc. iPad (2016)   | 19.7 cm × 14.8 cm | Medical conditions: “If you have any medical condition that you believe could be affected by iPad (for example, seizures, blackouts, eyestrain, or headaches), consult with your physician prior to using iPad.” |
Specific light sensitive guidelines occurring with highest frequency were found in the older version of the Apple Inc. iPad (all visual material) as well as the SMART Board® (3D material) user guidelines:

- Extend the distance of viewer from the screen
- Take frequent breaks.

### 3.6.5 Digital media guidelines issued by schools – Australia

Australia’s educational policies are governed by its constituent states and territories, of which there are eight. In addition to the one hundred sites/documents previewed, all reference literature was viewed which lead in total to over five hundred separate documents. In December 2016, using the parameters stated earlier in this review, only three documents from three different states contained information relevant to use of digital media by students with light sensitivity, as summarised in Table 3.5. The guidelines that occurred with highest frequency incorporate flash/flicker in various forms were:

- Avoid certain flash frequencies in screened material/workplace
- Take a break every 20 – 30 minutes

<table>
<thead>
<tr>
<th>Device</th>
<th>Screen Size</th>
<th>Suggested Safety Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMART Board® 480i5 Interactive Whiteboard (2012)</td>
<td>156.5 cm × 117.3 cm</td>
<td>3D material: Children and adolescents may be more at risk than adults, Minimum distance of 2 metres from board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Take a break for 15 minutes every hour</td>
</tr>
</tbody>
</table>
Table 3.5  Summary of safety guidelines from Australian school policy

<table>
<thead>
<tr>
<th>Document</th>
<th>Suggested Safety Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop Safety for Staff</td>
<td>Minimise glare</td>
</tr>
<tr>
<td>NSW (now disconnected)</td>
<td>Take a break every 20 – 30 minutes</td>
</tr>
<tr>
<td>Film, Television and New Media (2005)</td>
<td>Flicker avoidance</td>
</tr>
<tr>
<td>Queensland Studies Authority</td>
<td></td>
</tr>
<tr>
<td>Distance Education Centre, Victoria</td>
<td>Avoid computer flicker, use 70+ Hz monitor</td>
</tr>
<tr>
<td></td>
<td>Brightness and contrast to be comfortable</td>
</tr>
<tr>
<td></td>
<td>Distance from screen</td>
</tr>
<tr>
<td></td>
<td>Take a break every 20-30 minutes</td>
</tr>
</tbody>
</table>

The reference to “20-30 minutes” before having a break originated from Worksafe Victoria’s website (2006), specifically health and safety in the office. The NSW Department of Education included suggestions for limiting screen time in their advice to parents in their online “a to z of schooling practical help for parents”3.

3.7  Discussion

A wealth of research has developed practical and applicable guidelines for safer use of digital media by all students, including students with VLS. A degree of convergence was found between two of the accessed sources regarding digital media guidelines. Although there were few contradictions, inconsistencies were extensive when searching for guidelines issued by Australian schools. Convergence was identified throughout the analysis of recommendations for students with light sensitivity to avoid stimulative light or modify visual parameters. Within these parameters, many inconsistencies were identified, some due to the narrow focus of the empirical research. Cumulatively, the highest frequency parameters were avoidance of stimulative flash/flicker, saturated colour and long duration as well as modification of environmental lighting.

3.7.1  Use image flash frequency <3 Hz

This guideline was found across the societal boundaries throughout the academic research, broadcast regulations and the school policies with the exception of digital media user guides. W3C is an international group whose protocols including Web Content Accessibility Guidelines (WCAG) 2.0 created by Web inventor Tim Berners-Lee. WCAG 2.0 describes parameters to increase web accessibility for people with a range of disabilities – including VLS. Similarly, Professor Graham Harding developed

the Harding Pattern Flash Analyser (HPFA), a computer program used by Ofcom to determine compliance to Rule 2.13 (http://www.hardingfpa.com/).

3.7.2 Avoidance of stimulative colour

There were many recommendations to avoid red/saturated red/red-blue flashes throughout the analysed articles. WCAG 2.0 guidelines include, “Web pages … flash is below the general flash and red flash thresholds. (Level A)” (http://www.w3.org/TR/WCAG20/). Within the section WCAG 2.0 - 2.3.1, “… a special test is provided for saturated red flashing. These guidelines are based on guidelines for the broadcasting industry as adapted for computer screens, where content is viewed from a closer distance”, also avoiding low contrast (WCAG 2.0 - 1.4.3) allows access for those with low visual acuity. Harding and Takahashi (2004) mentioned the need for internet guidance which has been addressed by industry and government bodies embracing the WCAG guidelines.

3.7.3 Take breaks during digital media work

Although the origins of the “take a break every hour during computer work” were not traced, they were inherent in many aspects of this review. This point is particularly pertinent for school-based online assessments when a break is not included in the allocated assessment time.

3.7.4 Brightness/luminance/glare

Contradictions were identified in the recommendations for brightness/luminance/glare. This parameter involves a combination of the material culture (glare from reflections, student choice of luminance level) as well as software application. Different tasks require differing levels of luminance to support eye physiology (Summers, 1989). For example, reading four paragraphs of text requires an increase in luminance compared to watching a teacher demonstrate transect calculations on the whiteboard. In addition, age of the individual is an indirect moderator of luminance requirements. As age increases, visual acuity decreases thus requiring increased luminance for successful task completion. In general, schools are operating with younger aged students, so the luminance requirement should not need to be increased to moderate for visual acuity problems associated with advanced age. Young students may, however, benefit from neurological support for individuals with light sensitivity using decreased luminance (Fisher, Harding et al., 2005). Whilst classroom architecture is not easily manipulated (Winterbottom and Wilkins, 2009) the material culture
within the classroom can be adjusted to be more inclusive. Individual students may be seated in key positions when viewing interactive whiteboard, thus decreasing screen size from individual perspective. Digital participatory pedagogy (Dooley et al., 2016) can also influence software or website choice for the teacher, dependent on target students.

3.7.5 Incorporate environmental lighting

Manipulation of environmental lighting was the most common inclusion parameter with support from medical and allied health research. Freund (2001) highlights the importance of the arrangement of material culture, which is inclusive of seating arrangements, lighting and screen types. For a high school science lesson using the IAW for observation of microscopic organisms, a student with VLS could be seated near the back of the classroom close to a window which would decrease the visual contrast of the digital images (Kasteleijn-Nolst Trenité et al., 2012), increase the distance from the screen (Bureau et al., 2004) as well as provide external light whilst viewing (Zandvliet & Straker, 2001). Current teacher knowledge of the potentially stimulative properties of digital media images is low (Sproul, 2014a). This is reflected in Hudson et al. (2016) who underlined the need for networked knowledge of evidence-based guidelines and practical differential pedagogy for students with special educational needs.

Awareness of globally accepted guidelines would allow teachers and teacher educators to sculpt more digital participatory lessons through choice of optimal digital material, timing and use of differential pedagogy through classroom material culture. It would also avoid the filing of future law suits, a practice becoming more common in America (Alper & Goggin, 2017) due to violation of federal policy to support people with disabilities. Choice of optimal digital images for inclusive pedagogy requires depth of teacher knowledge regarding physical parameters of digital media images; which to avoid as well as the recognition of adverse reactions from students. Although Pokémon (Episode 38) is banned from broadcast television, a teacher can stream it from the internet into the classroom to demonstrate the anime technique of paka paka. Substitution for images with less saturated red colour would be less stimulative (Hodgetts, 2014) whilst still allowing demonstration of the visual technique. Practical differential pedagogy allows individual students to follow safer viewing guidelines and participate in digital media learning activities without negative impact on the rest of the class.
3.8 Limitations

There are several limitations inherent in this initial review of literature. First, the range of nomenclature used in different research fields and in society is extensive. Whilst many synonyms were incorporated into searches, others could be used and still fall within the scope of VLS or digital media. This challenge of nomenclature was raised by Bøttcher and Dammeyer (2016) regarding the focus of empirical research on differences between impairments, rather than the similarities, thus individualising rather than grouping supportive processes.

Second, this review was limited by the inability to include all digital media devices used in classrooms however the sample does include the most prevalent technological advances and uses. Conversely, some of the technology used to test participants is now obsolete. The third limitation was the absence of knowledge regarding individual student consumption of digital media and how this may change in the future. Although some data exists regarding digital media use outside of school hours, there is currently little data specifying device and duration within school hours, this requires further research. Fourth, individual educational institutions in Australia may have additional digital media guidelines available through internal access. These guidelines were not accessible for the current review and require further research.

3.9 Conclusion

Convergence was found in the need for students with light sensitivity to avoid or moderate exposure to visual light (including digital media). Disability in the form of light sensitivity requires modification to previously acceptable parameters as shown by the recent final rule of the United States Access Board. There was very little contradictory data within the sources collected, although large inconsistencies exist in recent safety guidelines issued by digital media manufacturers and the departments of education in Australia. The latter is possibly due to inaccessibility of intranet resources within schools. In view of the apparent lack of transparency between educational institutions, current knowledge and application of these guidelines requires further investigation. Kasteleijn-Nolst Trenité et al. (2012) highlighted the increased risk for adolescents, therefore placing high school recognition of guidelines as most important. Considering the number of students who potentially have a degree of light sensitivity, the relative ease of classroom adjustments to provide inclusive learning experiences for these students and the increasing use of digital media in our classrooms, there is a large discrepancy between guidelines from academic research and inclusive educational
guidelines. Fortunately, foresight by leaders within the digital media industry laid foundations for equitable access through policy such as WCAG and ITU BT 1702, including the option of gradual implementation.

Given the limitations of this review and the understanding that classroom requirements may alter, the following six parameters are presented as the most common recommendations for inclusive digital media use in schools and classroom. Dooley et al. (2016) coined the phrase “digital participatory pedagogies” (p. 53) to describe the teacher-instigated alterations to digital integration in the classroom. They provide a potential framework for digital participatory pedagogies that support students with VLH and teachers:

- **Image flash frequency** – no more than three flashes per second (Harding and Takahashi, 2004; ITU, 2005; W3C, 2008)
- **Luminance/glare** – decrease glare or luminance of projections (Fisher, Harding et al., 2005; Winterbottom and Wilkins, 2009)
- **Colour** – avoid saturated red flashes (W3C, 2008), increase contrast between the colours when using them for text (Sandnes and Zhao, 2015)
- **Manipulate environmental lighting** – use daylight where possible, avoid high contrast with the computer screen in a dark room (Stobaüs et al., 2014; Winterbottom and Wilkins, 2009)
- **Duration in front of screens** – take frequent breaks (Apple Inc., 2010; Fisher, Harding et al., 2005)
- **Distance from screens** – increase distance (Apple Inc., 2010; Bureau et al., 2004).

Application of these digital media guidelines to our classrooms could enhance the learning experience of students with light sensitivity at little cost to the educator. These digital participatory pedagogies may accommodate more of the visual needs of our students with invisible impairments and disabilities thus facilitating more inclusive digital learning environments.
Chapter 4  Digital Media Use in Education

Previous chapters have introduced evidence of students with VLH in modern classrooms. This chapter presents a review of the changing face of education and lack of guidelines experienced in digital media use in high schools in Australia. It begins by describing the material culture of classrooms and alterations to these physical environments for students with disabilities. It outlines the continuing changes to digital media use in high school and the impact this has on students with VLH. The move to online examinations as an assessment tool and the possibility of an unique impact on students with VLH is raised. Finally, suggested limits to screentime are introduced and the chapter concludes by outlining Professional Learning required by teachers to provide reasonable adjustments for students with VLH.

4.1  The classroom

The current project is based in Western Australia within the high school education system. Students attend school for between six and a half and seven hours per day, for up to two hundred days per year. The major model is didactic classroom based instruction, with up to 32 students per class with one teacher in Years 7 – 10, as agreed to in The School Education Act Employees’ (Teachers and Administrator) General Agreement 2017 (Western Australian Industrial Relations Commission, 2018). Variations on this model occur with increased complexity of curricula, learning challenges and school initiated instructional design.

Visual light is an almost inescapable element of digital media access, and it is so obvious it seems to have been overlooked in the majority of school health and safety policies. As the digital media used in schools is light emitting, it alters the visual stimulus received by the brain, therefore altering the material culture of the learning environment (Freund, 2001) for every student. However, widespread use of light emitting tools in a visual based learning environment is contingent on the assumption that all students have similar visual image perception and interpretation to adult teachers. It also assumes that the visual perception and interpretation of students will not cause adverse effects either physiologically or psychologically. Developmental and medical research has demonstrated these assumptions are not true for all students. Bøttcher and Dammeyer (2016) highlight the importance of matching learning activities to the individual student. For any student who is sensitive to light due to a medical condition such as migraine, concussion or depression (Gil-Gouveia et al., 2016; Truong, Ciuffreda,
& Suchoff, 2014) an altered classroom landscape creates challenges for full immersion into educational experiences. Chrisman et al. (2013) reported VLH was “strongly associated with concussive symptoms [greater than or equal to] 1 week” (p. 6). In 2018, Mansur and colleagues published evidence supporting use of non-LCD computers for individuals with concussion, as it decreased the negative effects of light sensitivity. They state that most patients who have experienced a concussion reported “difficulty with computer screens, for which we have coined the term computer screen intolerance, a unique post-concussion symptom involving discomfort with screens that refresh at high frequency, including cell phones and computers” (p. 1886). Twenge, Martin and Campbell (2018) published statistically significant empirical evidence that increased screen time [digital media use] decreased psychological well-being. These findings were generated from an annual national representative survey of thousands of students in Years 8, 10 and 12 in America, now in its 27th year. This marked difference led to Twenge and colleagues suggesting, “The abrupt changes in adolescents’ time use and well-being suggest a possible generational shift appearing among those born after about 1995” (p. 778). In Australia, individuals born after this generational shift would now be entering the teaching workforce as new graduates if teaching is their first career.

Currently there are no national standards or policies determining light parameters for digital media use in schools (Sproul, Ledger, MacCallum, in press), which suggests students may be using or exposed to digital media for the entire the school day, using default luminances and contrasts. The current research focuses on students with VLH, who are directly affected by these alterations in classroom material culture. Students with VLH (inclusive of students with migraine), can be dis-abled when using digital media (Bruhn, Kronisch, Waltz & Stephani, 2007; Chu, Im, Chung & Oh, 2011; Shigihara, Tanaka & Watanabe, 2010; Sotoyama et al., 2002;)

4.1.1 Material culture in contemporary Australian classrooms

Freund (2001) incorporated technology into the elements of material culture as discussed earlier (chapters 2.3, 3.2, 3.7.5). The material culture evolves as societal influences and technological advances introduce novel items or uses, such as skylights in classroom architecture or using an inkless pen on an iPad. Alterations in medium sized items of material culture include the modification of bench seats facing a blackboard evolving into modular seating with mobile whiteboards and projectors.

With the influx of school- and personally-owned computers, the extent of proposed-use, perceived-use and actual-use is still being investigated. Merga (2016) suggested that
the increased adoption of BYOD in high schools would increase the use of computers in the classroom from the 5-10% of classtime (20 – 40 minutes) reported by Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2008). Peterson and Horn’s (2016) poll of American public, teachers and parents regarding amount of instructional time students should be spending on a computer ranged from 0% through to 100%. The mean percentages, however, told a different story; general public (30%), parents (30%), 48 blended learning experts (40%) and teachers (20%). The article ended with, “And, of course, we must issue our own caveat. The right amount of time is going to vary with the individual student” (p. 95). Peterson and Horn’s (2016) percentages equate to approximately 1.2 through to 2.4 hours. They do not, however, include time spent using digital media at home on educational activities required to support academic classes.

Use of educational digital media by Australian high school students is steadily increasing. From the 20 – 40 minutes per day (CSIRO, 2008), data collected 2011 – 2013 by Houghton et al. (2015) reported that the majority of students used more than 2 hours of screen time per day. This increased again during 2013 – 2015, as Houghton et al. (2018) reported total screen use between 3.0 hours and 5.2 hours per day. It is unknown how much educational digital media is used by Australian high school students with VLH. In comparison, use of digital media by adults is estimated at 5.9 hours per day (Meeker & Wu, 2018) including all phone, computer and other digital devices. Given these variances in perspectives on digital media use, the perceived expectations and requirements of educational digital media use are similarly varied.

The concept of adjusting material culture within the classroom to benefit students (Freund, 2001) included reasonable adjustments for students with invisible impairments and disabilities. In the late 2000s, research was still referring to desktop computers (material culture) being configured into general classroom pedagogy (Berner, Moeller & Ball, 2009). Meanwhile, the goal of 1:1 computers (laptops) for all Australian students in Years 9 – 12 (Digital Education Revolution Program, National Secondary Schools Computer Fund) purchased nearly 1 million laptops before funding ceased in 2014. High school pedagogy has reacted by expanding and became more student participatory to include flipped classrooms, peer tutoring and group investigative research using both off-line and online resources (Lo, Hew & Chen, 2017).

The impact of challenges faced by students with disabilities is more complex than for other students of a matched age (Alper & Goggin, 2017). In view of this, adjustments for students with VLH (and other impairments and disabilities) are endorsed by the Australian government in all learning institutions. Identification of an individual with a
disability is partly cultural, partly political and partly constrained by policy (Goggin, Steele & Cadwaller, 2017). For students in Australia the policy, The Disability Standards for Education 2005, requires educational institutions to facilitate equal access to all learning activities using reasonable adjustments, including activities using digital media. In response to student and parent expectations, rights and requirements, many students with disabilities in high school have Individual Education Plans (IEPs) requiring alterations to educational experiences (Van der Bij, Geijsel, Garst & Ten Dam, 2016). These alterations designed for individual students to sculpt their learning environments have met with mixed results in practice (Andreasson, Asp-Onsjö & Isaksson, 2013; Martin, Marshall & Sale, 2004). This may be due to the lack of awareness or understanding of individual requirements for students with disabilities, as advocacy and specialist research groups are “under-resourced” (Alper & Goggin, 2017, p. 735).

Using a medical model of disability, parents have argued that using IEPs to support these students encourages a viewpoint of deficit or remediation in regards to the student (Zeitlin & Curcic, 2014). Altman (2001) used a social model to explain disability as the “gap” between social demands and student capabilities. Thompson, Wehmeyer and Hughes (2010) developed this model within the classroom stating:

A person-environment fit model focuses on the gap between a student’s capacities and the environment, and the implication for educators is to concentrate efforts on closing the gap between capacity and environmental context so students can meaningfully participate in school settings and activities (i.e., function successfully). (p. 170)

Ellis and Kent (2011) use the example of the “Captcha” validation screen as an example of a barrier erected between the user and the accessible internet content. The “blurred and disfigured image” (p.48) designed to exclude computer programmes can also exclude those with non-normative visual perception, a social marginalisation.

Following this, Ellis and Goggin (2015) used a “critical disability approach” (p. 78) in their account of participation in digital media for people with disabilities highlighting the role of blogs and current news media focus on extra-ordinary projects. In their conclusion, Ellis and Goggin remarked on the unresearched areas of “everyday engagement” (p. 85) which would include education in schools. Although teachers do not need to know the specific diagnosis of a student, knowledge of the individual student’s learning differences are critical (Sharma, 2019). The concept of “environmental context” (Thompson et al., 2010) is equivalent to that of Freund’s “material culture” (2001), situating the “gap” (Thompson et al., 2010) or “individual
student’s learning difficulty” (Sharma, 2019) squarely within the pedagogical domain of the classroom teacher. Both context and culture affecting student learning can be used to describe the alteration in classroom-based visual stimuli for students with VLH.

In education, one of the limitations for using the medical model for children with a disability is lack of acknowledgement for contextual impact (Norwich, 2002). This is recognised by Bøttcher and Dammeyer (2016) in their cultural-historical approach by incorporating the material culture of the educational setting; “the development of the child is not formed by the impairment in itself, but can only be understood when looking at the child and his/her social situation of development together” (p. 77). By following a social model of disability, Alper and Goggin (2017) focussed on the need for equitable access for all children, addressing disability across the “intertwined digital and physical domains” (p. 727). The developing material culture of the classroom increases access for some students whilst simultaneously decreasing access for others (Mansur et al., 2018). The social model of disability develops further when it incorporates “public policy at the interfaces of disability, technology innovation and social development” (p. 35) Goggin, Yu, Fisher & Li, 2019). On entering a classroom it adds teacher-based decisions regarding pedagogy when using digital media for learning activities.

Digital participatory pedagogies (Dooley et al., 2016) incorporate a range of digital devices (IAWs, laptops and iPads) as well as supportive environmental lighting options (natural only, fluorescent) bridging discrepancies between physical ability and digital access. These alternatives encompass a myriad of combinations, which when given time, can be tailored to specific tasks to support students with special needs. Use of these devices without explicit attention being given to visual parameters is not considered inclusive pedagogy as it can exclude students with VLH. Default settings on digital devices are moderate to high contrast teamed with high luminance which increases the visual load for students. Use of high contrast for long duration can exclude students from active participation due to VLH. These digital devices include the IAW found in many of the classrooms, iPads and phones which facilitate App use and photographic inclusions for learning activities. All of these activities and choices can increase the disparity between active participation for a student with VLH and active participation for a student without VLH in digital classroom activities.

4.1.2 Online Examinations

Online examinations now affect the graduation eligibility students in Western Australia (SCSA, 2017). With the rise of digital media use in schools and its
effectiveness as a tool, there has been an inordinate increase in the use of technology to assess students (McFarlane, 2019; Petterson, 2018). To prevent marginalisation of students with VLH by mandatory use of online assessment protocols two options are immediately available; participation through the medium of pen and paper, alternatively altering the parameters of the digital device and duration of assessment. The accessibility of these options is discussed below.

National Assessment Program Literacy and Numeracy (NAPLAN)

In Australia the National Assessment Program Literacy and Numeracy (NAPLAN) is an annual standardised assessment for all students in Years 3, 5, 7 and 9. The online format was originally rolled out as optional in 2015 and will soon be required by all schools with sufficient internet capabilities. In 2019 there is an option for these tests to be conducted off-line (using paper) rather than online, however the movement is towards full population online participation. The duration of the tests themselves ranges from 45 to 65 minutes over 4 categories; writing, reading, conventions of language and numeracy. However, it can take 20 minutes to log in an entire class of students (personal experience, 2016) which extends the duration of digital media use for a student.

NAPLAN Online categorises disability using the Disability Standards for Education (Australian Government, 2005). The document National protocols for test administration — NAPLAN online (ACARA, 2019a) specifies;

6.2.1 Where disability impacts on access to the tests, reasonable adjustments may be granted to facilitate access to all or some of the tests

6.2.2 … Adjustments should reflect the kind of support and assistance normally required for assessment in the classroom in order for students to demonstrate what they know and can do, noting that adjustments that are appropriate in a learning environment may not be appropriate in an assessment environment. (p. 15)

Using adjustments “to enable access to the tests on an equivalent basis to students without disability” (p. 14) would require extra resources on behalf of the school to apply for the Disability Access Codes (ACARA, 2019b) to continue the tests online, or access to paper tests via application to the Test Administration Authority (TAA).

Whilst the NAPLAN was designed to provide schools and parents with a view of how an individual student is progressing, student results are now being used to validate minimum literacy and numeracy requirements. The minimum requirement for high school graduation with a Western Australian Certificate of Education (WACE) is achievement of Band 8 in NAPLAN. If this is not achieved by Year 9, subsequent
Online Literacy and Numeracy Assessments (OLNA) are offered in 24 or 25 day windows, twice a year. If a student does not achieve their literacy and numeracy requirements within these windows before the end of Year 12, they do not achieve high school graduation with a WACE.

OLNA testing protocols also categorise disability using the Disability Standards for Education (Australian Government, 2005). However, specific requirements to allow adjustments for students use a medical model, rather than educator knowledge.

Adjustments may be considered only for students who have a current diagnosis from a relevant specialised medical professional that effectively states that the student’s disability diminishes test accessibility and that the provision of a specific adjustment would restore test accessibility for that student, so long as that adjustment is permissible for the OLNA component in question. (SCSA, 2017, p. 20)

It is currently not possible to take the OLNA assessment “offline”. The accommodations that can be used require teacher teachers to have knowledge about students’ technological needs (Koehler & Mishra, 2009) and additional resources (teacher time and storage for documentation for four years) to enable equitable access for a student with VLH. Each student must have all adjustments approved by SCSA (2017) prior to sitting the test. There is no guarantee that requests for these will be granted. Without these adjustments, students with VLH can be prevented from fully participating in the assessments, which may prevent them from graduating high school.

High School Graduation Examinations in South Australia

On November 7, 2018 the first electronic examination for high school graduation was conducted in Australia in the subject of English Literary Studies. Over 2,000 students from South Australia and the Northern Territory accessed the online examination. The SACE board published Vision statements citing authenticity, application to real work and creativity of assessment in novel scenarios as influencing the change in format.¹

In 2019 the provision of practise exams for English Literary Studies, Psychology and Modern History allow students to spend more time online familiarising themselves with the format and application of tools applicable to the examination.

The Special Provisions in Curriculum and Assessment Policy (SACE Board of South Australia, 2017) is currently active and includes allocation of “reasonable adjustments” such as completion of examination in paper format. The determination of

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permission regarding application of this adjustment is determined on a case-by-case basis following application to the SACE board. Students with VLH could apply for the adjustment to paper examination format if enrolled in a subject slated for electronic examinations on both medical and neurological grounds of disability. According to a posting by John Gardner (Member for Morialta, South Australia) in the 2018 English Literary Studies examination, two students were eligible for special provisions and completed the examination on paper from the start of the examination time and five more students transferred from digital to paper format during the examination period. As the examiner’s report was not published at the time of writing, any further comments or findings regarding the cause of changing medium were unknown.

4.1.3 Adjustments and Accommodations in the classroom

As stated in the previous section, students with disabilities can benefit from pedagogical choices and application to the governing authority for adjustments during online assessments (Commonwealth of Australia, 2019). Students with VLH benefit from particular environmental and media access options. Different countries and educational systems set different parameters to determine recognition of a disability, the associated adjustments or accommodations and the allocation of any federal funding (United States Department of Education, 2018).

In Australia, a diagnosis of a disability by a medical professional which is communicated to the school expedites incorporation of support across the whole school. The process is outlined by the Disability Standards for Education (Australian Government, 2005). The Guidelines for this document include the following definition of an “adjustment”;

> a measure or action taken to assist a student with a disability to participate in education and training on the same basis as other students. An adjustment is reasonable if it achieves this purpose while taking into account the student’s learning needs and balancing the interests of all parties affected, including those of the student with the disability, the education provider, staff and other students. (Department of Education, Employment and Workplace Relations (DEEWR), 2012, p. 3)

Within the inclusive education field and in United States Education System the term “accommodation” is often used instead of adjustment (Kent, Ellis & Giles, 2018; United States Access Board, 2000). The Disabilities, Opportunities, Internetworking, and Technology (DOIT) Center at the University of Washington describe an accommodation as;

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an alteration of environment, curriculum format, or equipment that allows an individual with a disability to gain access to content and/or complete assigned tasks. They allow students with disabilities to pursue a regular course of study. Since accommodations do not alter what is being taught, instructors should be able to implement the same grading scale for students with disabilities as they do for students without disabilities. (University of Washington, 2019, para.1)

For the purposes of the current research, these terms, adjustments and accommodations, are interchangeable.

Whilst the material culture (Freund, 2001) of the classroom has evolved to include the digital realm, the infrastructure of supporting policy for health and safety of students with VLH has not kept pace in educational institutions. Digital participatory pedagogy (Dooley et al., 2016) connects with Recommendations 3 and 8 from the review of the Disability Standards for Education 2005 (Thomas & Wise, 2015). Recommendation 3 includes “develop a range of exemplars of good practice which illustrate effective adjustments” (p. viii). Good practice in using digital media requires the teacher to have high Technological Knowledge (TK) (Koehler & Mishra, 2009) to modify visual parameters for students. Teachers need to be capable of recognising when technology is beneficial for the learning task, and when it is counterproductive (Koehler & Mishra, 2009). Recommendation 8 (Thomas & Wise, 2015) incorporates “guidance on the use and content of individual learning plans and the need for periodical review” (p. ix), this periodical review is pivotal to monitor changes in student access to digital media. For example, students with VLH from concussion would be expected to alter their ability to access digital media within a short time frame (Halstead, Walter, & Moffatt, 2013). A challenge faced by the Australian Government’s Department of Education in response to Thomas and Wise (2015) was to produce exemplars in a wide enough range to incorporate foreseeable scenarios within the classroom (Australian Government, 2019) which were supported by an evolving policy document.

Standardised online assessments, both formative and summative, were not endorsed at the time of Thomas and Wise’s 2015 review, however recent movements within South Australian and Western Australian systems have done just that (AISWA, February 2018; SACE Board, 2018). Support for students with disabilities is required by law through reasonable adjustments, however the application of inclusive pedagogies during digital media use is dependent on teacher TK (Koehler & Mishra, 2009) and awareness of the disability. The lack of teacher awareness and access to information for environmental effect for students was highlighted by Buckley (2014) and Sproul (2014a). Sproul commented that 51% of teachers in her study “professed no knowledge of
photosensitivity” (p. 67). Further investigation revealed that the first avenue of teacher instigated investigation was Google, which returned a majority of information on dermatological rather than visual photosensitivity. Ten of the 43 teachers who participated in the study reported that they would use their Interactive Whiteboard for more than three hours per day (p. 66). Buckley (2014) led an investigation funded by the charity trust fund connected with Megaman (company producing energy efficient lighting) to determine how lighting in secondary school classrooms could be improved. The project ran in partnership with the Royal College of Art (The Helen Hamlyn Centre for design), during which Buckley visited many classrooms using digital projectors or Smartboards. The modelled digital pedagogies did not demonstrate awareness of environmental lighting impact; “[i]n a lot of the classrooms..., we found the same scenario — the electric lights are on and the blinds are drawn, blocking out natural light.” (2014, p. 6). The teacher determined environmental choice increased the visual load for students. Whilst using digital media, Buckley suggested incorporation of natural light as much as possible (p. 6) as well as altering the settings on light emitting objects (p. 7). In regards to access and active participation in learning activities, Buckley’s report describes observations of situations which would create disparity between students with VLH and students without VLH through the use of socio-culturally acceptable tools of digital media and fluorescent lighting.

Controversially, as recent digital media requirements within educational institutions increase (NAPLAN, OLNA, online graduation examinations) there is a simultaneous increase in societal guidelines to decrease duration of digital media use by children (AAP, 2016a; WHO, 2019). For students with VLH, digital media based learning activities may decrease their ability to fully participate in learning activities, until awareness by teachers of the phenomenon and accommodations to support it increases.

Educational research has demonstrated the positive academic and potentially inclusive influence of digital media in learning environments (Nolan & McBride, 2014; Preston & Mowbray, 2008) and Apps have been instrumental in increased students engagement and understanding of literacy, maths and science (Castek & Beach, 2013; Schneps et al., 2014; Zhang, Trussell, Tillman & An, 2015). However, general classrooms have not adopted inclusive pedagogy to support adversely affected students (Sproul, 2014a; Sproul, Ledger & MacCallum, in press). Students with VLH perceive and interpret digital media differently to those who are not (Huang et al., 2011). Researchers in the fields of technology, medicine and education have investigated and promoted different elements compatible with classroom pedagogy and IEPs for students with VLH. Education research has revealed how technology use has increased the visual
load. This has resulted from altering the tools used for learning activities from light reflective (paper based) to light emitting (digital media) (Sproul, MacCallum & Ledger, 2017) thus increasing the visual load. Technological and medical research has determined reasonable adjustments by decreasing light emission in computers to support students with VLH caused by concussion (Mansur et al., 2018). The Technology and Communications Industry promote differentiations in luminance and contrast ratio when using digital media (World Wide Web Consortium, 2008). Medical research has demonstrated light-stimulated neurophysiological differences between control and students with light sensitivity (Harding, 1999; Martin et al., 2011) as well as decreased cognitive function (Gil-Gouveia, Oliveira & Martins, 2016). Neurologists quantified safer parameters for students with VLH (Trenité et al., 2010) although some evidence-based research incorporated now-obsolete technology such as cathode ray tube televisions (Keehn et al., 2009).

Within the maelstrom of changing technological tool use and environmental contexts, teachers facilitate the learning of curriculum knowledge and practice process. As incorporation of digital technologies is expected in all schools, there are policies regarding content and facilitation of lessons using digital media, including cyber bullying and texting and other dangers (Alper & Goggin, 2017), yet few outlining safe use of visual light parameters of digital media. In response to Thomas and Wise’s (2015) recommendations 3 (exemplars) and 8 (revision of context of IEPs) there is a need for digital participatory case studies for students with VLH.

4.2 The Student population

There are different trends in school policy, student populations and digital media use in Australian high schools. This section focuses on student demographics and outlines the visual load elements that impact attention and cognition for students with VLH.

4.2.1 Australian students with disabilities; population and chronic health conditions

With the introduction of digital media, the material culture of the classroom has changed (Freund, 2001; Sproul, MacCallum & Ledger, 2017) to include interactive whiteboards, projectors, computers, phones and VR headsets. Cunningham and Turnbull (2014) refer to “the formation of a highly volatile and greatly altered media landscape” (p. 7), partly influenced by the introduction of software such as apps.
However, over exposure to light emitting digital devices impacts students with VLH in a range of ways including headache, nausea and seizure. As previously mentioned, VLH is considered an invisible impairment with the potential to dis-able a student. A disability or chronic health condition may be contextually dependent, identification with disability may also alter at different stages in a person’s life (Goggin, 2017). Due to the changing culture of the classroom, re-examination of abilities necessary to fully participate in learning activities is required. This is critical as the number of students in Australia reporting chronic health conditions is substantial whilst supporting evidence is limited. White (2015) calculated 437, 462 Australian students identify with the category of chronic health conditions, with relative scarcity of research supporting them (White & Rosauer, 2015) a parallel view to Ellis and Goggin (2015). Using the 2016 Australian census data summarised in *School, Australia, 2017* (Australian Bureau of Statistics, ABS, 2018) and 12% student population with chronic health conditions (Sawyer et al., 2007), the previous stated statistics have increased to 461,907 enrolled students. White (2015) highlighted the “unseen” element of a chronic health condition (impairment), and the effect on concentration and cognitive ability when sitting in the classroom (disability) and includes arguments that the legislation seems written to provide educational institutions an option “out” clause (p. 1299) if the required accommodations (reasonable adjustments) were deemed too difficult to grant. In 2015, the Report on the National Database Project (White & Rosauer, p. 14) stated the following;

… as figures about students with health conditions are not available in Australia, this project provides an important starting point for longer-term research that identifies numbers of students in each state and territory with health conditions, existing educational needs and provision as well as gaps and requirements in system and school level educational support.

The potential impact for students is recognised in the meta review by Lum et al. (2017) on *Understanding the school experiences of children and adolescents with serious chronic health conditions*. Fundamental requirements for strong academic and social outcomes, “highlighted that school support is strongly associated with better school experiences and outcomes among students with chronic health conditions” (p. 655). Moreover, satisfaction at school is fundamental for the judgments that students make of their own general well-being (Cummins & Tomyn, 2011).

School support is underpinned by policy and implemented by parents, teachers, education assistants and executive teams within individual schools. Böttcher and Dammeyer (2012) describe the incongruence of individualised student needs with a static school structure. This observation is continued by Thomas and Wise (2015) in the review
of the Disability Standards for Education 2005, who reported that while the flexibility of the standards permitted individual tailoring of adjustments, alternate perspectives existed regarding what is needed and required between two groups; educators and the family of the student with the disability. They continued by reiterating that the standards are the minimum expectations, and that there is support for raising the bar and linking their function to broader objectives of social inclusion (p. ii). This would decrease the disparity between student needs and provision of traditional support within the school education environment. Also, the funding required to realise this support would be extensive and may perpetuate the social pathological model of disability (Burns and Haller, 2015) where students with disabilities are seen as disadvantaged and in need of financial support. The “digital divide” referenced by Goggin (2017) is part of this identification for support, but focuses on students already identified as having a disability.

Inclusive school digital media use needs to address social elements as proposed by Alper and Goggin (2017). The appropriate additions of social elements to school digital media policy could incorporate the recommendations by Lum et al. (2017). They challenged researchers designing future studies to examine multiple school experiences and outcomes alongside medical, school, psychosocial and socio demographic covariates...Teachers may play a critical role in protecting students with chronic health conditions from disengaging academically and socially at school. (p. 657)

Students with disabilities have legitimate rights that require support. To encourage the civil rights over the medical model (Goggin, 2017) students can be encouraged to voice self-views of their disability (Bøttcher, 2018) and choose elements of support required to actively participate in cultural practices, including those of digital media use.

Students with a disability often travel a non-normative pathway. For students with a permanent, non-environmentally stimulated, visible impairment (e.g., short stature), the knowledge about adjustments required to enable success on their pathway is often brought to the classroom with them. For students with an episodic, environmentally stimulated, invisible impairment (e.g., VLH) the knowledge about adjustments required for success in learning and development may not accompany them to the classroom, potentially dis-abling the student from some successes. Some adolescents with a newly identified impairment may still be in the process of determining triggers and advantageous supports. These supports can include alterations to pharmacological
interventions which can take many months\(^3\), all happening whilst the student is attempting to maintain acceptable school attendance and compliance with assessment requirements.

Classrooms containing large amounts of digital media dictate VLH students take a non-normative path. This “different” path is a result of facing excessive luminance and visual stimulation in lessons, which can lead to avoidance as well as decreased cognitive levels (Gil-Gouveia, Oliveira & Martins, 2015; Petrusic & Zidverc-Trajkovic, 2014). Decreased cognitive levels and avoidance can present as voluntary lack of active participation in the class. Observation of the students in a modified environment can demonstrate the difference in traits and patterns of attendance caused by external environment (Kinnealey et al., 2012). The external stimuli forcing the students onto alternative pathways is usually not intentional; pedagogical choices “might inadvertently create barriers to access and participation” (Graham, Tancredi, Willis & McGraw, 2018) which requires increased awareness of both stimuli and inclusive practices to reduce incidences.

To access school support requires teacher knowledge of a student’s learning differences and differential teaching within the classroom or requisite application for funding for extra-normative support (alongside appropriate documentation). In Australia, this is processed through the Nationally Consistent Collection of Data on School Students with Disability (NCCD). The overview of the NCCD is:

In practice, such students will be receiving reasonable adjustments from the school so that they are able to participate in education on the same basis as other students, as required by the Disability Standards for Education. (Commonwealth of Australia, 2019, p. 8)

From 2018, extra funding was allocated to schools to support students with disabilities dependant on the data submitted to the NCCD. This necessitates teachers to be cognizant of contributory medical diagnoses to student learning differences in the classroom, capable of incorporating evidence-based accommodations within the classroom and collecting evidence supporting these personalised learning programs.

Currently, many students with VLH may be overlooked as identifying with a disability as many teachers in high schools are unaware of the cognitive implications of VLH within a digital media rich classroom. Consequently, no applications for available funding would be made to support reasonable adjustments for these students. The current

research aims to inform the Education Council and Joint Working Group to Provide Advice on Reform for Students with Disability (JWG). An area of specific influence would be the criteria for the NCCD Guidelines which are referred to by schools and practising teachers around Australia. The aim is to identify the level of support required for students with VLH as Differentiated or Supplementary, include examples of reasonable adjustments within the classroom and alternate access to learning materials and online assessments.

4.2.2 Visual load, working memory and attention

Visual Light Hypersensitivity (VLH) has both neurophysiological and psychological elements. Neurophysiological research focuses on the chemical, electrical and mechanical processes stimulated by visual light, while psychological research mainly addresses behaviours initiated by these processes. Each medical discipline has alternate names for visual light hypersensitivity, and alternative methods of investigating and treating the phenomenon, contributing to some disparity of nomenclature in the wake of the surge of medical research in the late 1990s. Ophthalmologists use the term photophobia to describe VLH, whereas neurologists may use photosensitive, photophobia, photoparoxysmal response (PPR), visual light hypersensitivity or light sensitivity. Dermatologists also use the term light sensitivity, therefore to differentiate between the organs processing the light, this project uses the term visual light hypersensitivity as opposed to skin light sensitivity. VLH is an invisible impairment that requires support to prevent disability in participation for learning activities just as any other impairment identified by a school student (Australian Government, 2005).

Research into VLH gained momentum during the late 1990s and into the early 2000s following the Pokémon incident. Investigations included visual properties of the cartoon, the effects they have on developing and developed brains and estimations of population affected. Yamashita et al., (1998) published an estimation of 6.25% of young people watching the cartoon would have been affected neurologically. Takahashi and Tsukahara (1998) reported 5% of viewers being visually affected and noted “An official report released by the Ministry of Health and Welfare (MHW) concluded that 10.4% of Pokémon-38 viewers investigated had various symptoms” (Ministry of Health and Welfare. A special study of photo-sensitive seizures. Rapid Communication Digest, 1998 in Takahashi and Tsukahara, 1998). The MHW collected 9209 questionnaire responses from students aged 6 – 18 years from the areas in which the program was aired, and 4026
students had viewed the program. Inuma (1998) reported 29.5% of the 4026 viewer reports from the MHW study cited headache or confusion, 14% cited nausea.

Research in the Aichi prefecture used EEG data to analyse whether the neurological conditions following viewing of the cartoon were typical of epileptic seizures. Takada et al. (1999) reported 93 of 95 patients had epileptic seizures, of the 93 patients, three quarters had never had epilepsy before. Takahashi, Tsukahara, Nomura and Matsuoka (1999) reviewed the research and added their own EEG graphs demonstrating the hyperstimulation across the cortex (PPR) whilst viewing the Pokémon scene is not present when filters (accommodations) are used. This empirical evidence demonstrated the effect of visual imagery to increase visual stimulation to the point of seizure within a subset of the population, as well as the possible alterations to parameters to prevent this visual overstimulation. The reported data from this social incident suggest a large percentage of the school aged population were susceptible to the visual images broadcast during the program. The heterogeneity of the susceptible percentage of the population reacting to the same stimulus imagery was evident by the diversity of adverse reactions reported. Also, research returned accommodations that can be used to decrease adverse neurological effects for students with VLH.

Investigations into ‘transitory cognitive impairment’ (TCI) are also suggestive of links with stimulus material (Binnie, 1993). Whilst the TCI itself may be of limited duration, the effects may be longer lasting (Metz-Lutz, de Saint Martin, Massa, & Hirsch, 2001). TCI is consistent with migraine, however, not predisposing for long term cognitive decline (Gil-Gouveia, & Martins, 2019).

Baddeley (1992) proposed a model of working memory inclusive of the visuo-spatial scratch-pad (p. 319). Although vision was not obviously linked with working memory, investigation by Bays, Catalao and Husain (2009) demonstrated the lateral and medial occipital cortex are key regions in maintaining working memory for normally developed individuals. Further research by Huang et al. (2011) used Wilkin’s tinted lenses for a group of participants diagnosed with migraine for viewing of “visually stressful” patterns. They demonstrated decreased cortical activation for visual areas of the brain in individuals with migraine using the tinted lenses during viewing of stressful patterns, but not when viewing non-stressful patterns. Application of Kirschner’s (2002) model of mental load and the evidence from Huang et al. (2011), it would follow that to optimise working memory (Bays, Catalao & Husain, 2009) for students with light sensitivity in educational environments, the use of digital media should not include stressful patterns.
Ma, Husain and Bays (2014) further developed the visual working memory model by analysis of activation of neurological areas for decoding and delay. They concluded that;

[by] considering only the quantity of representations and ignoring their quality provides an incomplete description of working memory .....the concept of a limited memory resource has become central to present debates, providing a consistent and intuitive account for both the decline in precision associated with increasing working memory load and the precision gains (and costs) observed for stimuli of differing salience. (p. 355)

As visual light evokes a higher cortical activation in migraine (Boulloche et al., 2010), it follows that this would be associated with proportionally higher precision costs. It is likely, then, that students with VLH under visual stress may work longer or with less effect as a student without VLH on the same material. The current research proposes that this would cause an extended duration of homework digital media use for students with VLH completing similar tasks to students without VLH.

The aspect of attention and perception overlaps with both emotional and physiological effects (Furusho et al., 2002) for different percentages of the participating young people with VLH. Students with VLH are potentially marginalised due to a combination of invisibility of the disability as well as scarcity of supporting research. The current project endeavours to fill the gap in knowledge for both group identity and individual modifiers to validate the lived experience of students with VLH. As observed by Harris and Sanborn (2014),

because media affect different people so differently, it may be the case that a disproportionate amount of media effects occur with the relatively small number of audience members who experience a very large effect, while most others experience little effect. Thus group analyses may show overall small effects, but that may not be the whole story. (p. 37)

This viewpoint of the few being affected in an exaggerated way is summarised by Ellis and Goggin (2015). They refer to the “largely unexplored and certainly unresearched widespread phenomenon of people with disabilities everyday engagement with participatory cultures” (p. 85) including in education. The current research responds to this statement by exploring the engagement with participatory cultures by students with disabilities. Concerns regarding potential marginalisation of students with disabilities include the possibility of highly stimulative visual material being presented in any high school classroom in Western Australia without any limit on parameters of luminance or flash frequency. There are no data or educational system policies to guide teachers away from this pedagogical choice.
The example given by Choi et al. (2014) was computer-based, specifically mentioning background colour of the screen. Using powerpoints for presentations at school, background screen colour can be altered easily by either teacher when using the IAW, or students during revision. However, as background screen colour cannot be altered in many simulations, mechanical intervention (coloured filter) in front of the screen would pose an alternative for students. This acknowledgement of cognitive load influence by light emitting tools reinforced the argument presented by Wilkins and colleagues (1995, 2002, 2004, 2005) regarding the importance of visual load and its effect on cognition.

As students with VLH demonstrate a proportional relationship between the variables of attention to digital media and extent of physiological effects (Takahasi & Tsukahara, 1998) understanding their engagement with digital media images is important. The Pokémon incident demonstrated that children with VLH who were paying increased attention to the program experienced more extreme physiological effects (seizure) (p. 635) whilst children with VLH who were paying less attention experienced milder effects (e.g., motion sickness). Saturated red/blue colour changes (>4Hz) were also more likely to cause adverse reactions for students with light sensitivity (Kasteleijn-Nolst Trenite et al., 2012). Harris and Sanborn (2014) comment on naiveté of assumption that all media viewed is either fully processed or even affecting viewers unless they consciously decide to pay full attention. It follows that conscious attention (by student) to a digital learning task and informed pedagogical choices (by teacher) regarding digital presentation can affect cognition. A less cluttered format on digital media can increase understanding of central information presented and memory of items (Bays, Catalao & Husain, 2009; Bergen, Grimes & Potter, 2005), whilst focussed attention on central component of the presented medium can decrease peripheral elements of visual memory (Simons & Chabris, 1999). Within a classroom, pedagogical choices are made by the teacher to increase attention paid to learning experience. These attention-increasing choices may include use of moving rather than static images on digital media (Simons et al., 2003), and use of colour (Ling & Shaik, 2002). Ironically, both are intended to improve engagement in the learning activity, however, both have implications for digital participatory pedagogies and reference evidence collected by Takahashi and Tsukahara (1998) following the Pokémon incident in 1997.

To encourage active participation in classroom activities students need to be supported within their learning environment. For students with VLH, this includes the visual light element of the classroom material culture. Teacher knowledge of technological parameters has direct implications for this element of classroom material culture. Use of large screened
digital images which include quantities of saturated red, or insertion of red/blue morphing transitions in powerpoint presentations would greatly increase the visual load for students with VLH, negatively impacting their ability to fully participate in the learning activity. Conversely, use of natural light (Buckley, 2014), decreased saturation of some digital images and alterations to seating plans (Kasteleijn-Nolst Trenité et al., 1999) would act as reasonable adjustments for inclusive digital media use.

4.3 Digital media guidelines in society

Educational learning activities require digital media to be more than a one-way communication device to receive data, to be participatory rather than passive. Documentation of the changing role of the digital media audience from passive to participatory was introduced by Rosen (2006) and amended to include education institutional audiences by Turnbull (2014, p. 60). Since teachers and students in high school are immersed in digital participatory pedagogies (Dooley et al., 2016) with classroom and assigned work using multimedia, it follows that teachers and students in high schools are Produsers (Bruns, 2008) as they apply technological convergence across learning and assessment tasks. Mishra and Koehler’s (2005) Technological Pedagogy Content Knowledge (TPCK) framework depicts the interconnection of these elements for a teacher. Koehler and Mishra (2009)’s concept of Technology Knowledge (TK), that teachers need to be capable of recognising when technology was beneficial for the learning task, and when it was counterproductive, provides acknowledgement that each students/technology interaction must be evaluated independently.

Currently, digital media is an accepted data platform for all subjects in high school, the student’s computer a tool for many uses (SEQTA, 2019). “Digital media use” conveys elements of access, device, duration, content and process. All elements are present in pedagogical choices, intentionally or unintentionally when digital media is used in classrooms. The accessibility regulations required by telephone companies are not yet required by Internet companies (Cunningham & Turnbull, 2014), despite recognition of access to the world wide web as a basic human right by its co-founder Tim Berners-Lee (W3C, 2008). The American Academy of Pediatrics (AAP) has contributed to debates about general population screentime policy for many years including the following;
• 2001 “limiting screen time (including television, videos, computer and video games) to 1 to 2 hours per day”

• 2013 “Pediatricians should recommend the following to parents: Limit the total entertainment screen time to 1 to 2 hours per day”

• 2016 “For children ages 6 and older, place consistent limits on the time spent using media, and the types of media, and make sure media does not take the place of adequate sleep, physical activity and other behaviors essential to health”

Although the AAP has been very clear that their advice was originally designed to guide use of entertainment digital media, as opposed to educational digital media, the advice aimed to counter effects such as excessive sedentary behaviours. Perhaps the possibility of high school students using up to 10 hours of digital media in one day to actively participate in learning activities (Figure 7.3) may not have been contemplated. The “unseen” aspect of long term cognitive effect in response to extended duration of digital media use is still being investigated (Wilmer, Sherman, & Chein, 2017), in the meantime the general advice from the AAP is to limit media use outside educational jurisdiction. Within the educational sphere, however, the AAP (Halstead et al., 2018) reaffirmed a policy which acknowledged potentially adverse effects of digital media use for young people who have had a concussion with symptoms of VLH. “Signs and Symptoms of a concussion and the potential problems they may pose to the student” (Halstead et al., 2013, Table 1) includes a checklist of visual symptoms; Smartboards, computers and tablets each have a space to indicate potential visual discomfort for the student. The policy advocates for “reduction of symptom provocation” and adoption of an “individualised approach”. Suggested accommodations to reduce negative visual symptoms includes “reduce exposure to computers, smart boards, videos...turn off fluorescent lights...reduce brightness on the screens...cover one eye” (Halstead et al., 2013, Table 4). These AAP endorsed evidence-based accommodations for use within the classroom (smart boards and computers) concede visual light stimuli can cause negative reactions for some students, the reactions potentially reduced by incorporation of accommodations.

In April 2019, WHO published a set of guidelines focused on children under 5 years old using three categories of screen time duration. For children less than 1 year old, screen time is no recommended at all. Children aged 1 year are not recommended to consume any sedentary screen time (WHO, 2019). This stemmed from “[a]sociations


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between screen time and indicators of adiposity, motor or cognitive development, and psychosocial health [being] primarily unfavourable or null” in a systematic review of articles in 2017 (n=337) (Poitras et al., 2017). Children aged two to four years were recommended to consume no more than one hour per day of screentime (WHO, 2019).

The increase in digital media use in high schools and the recommendations for decreasing in digital media use by young children seems counterintuitive. However, the underlying fact that each student should have their needs evaluated independently still affords support for any student with VLH.

4.4 Experienced teachers and innovative practices

In 2013 (Sproul, 2014a) found that nearly half of the teachers in this Western Australian study professed no awareness of the phenomenon of VLH (photosensitivity) or how to access support for these students. Responses from teachers regarding how they would discover information and inclusive practices, ranged between Google® and hearing from a medical professional. This suggests that access to accommodations to pedagogy need to be easily signposted within this search engine to optimise use of teacher time and success in developing TK (Koehler & Mishra, 2009).

To develop understanding of digital practices and technological pedagogies, all registered teachers attend sessions of Professional Learning. In Western Australia, renewal of teacher registration also incorporates this concept of life-long learning. The Teacher Registration Board of Western Australia (TRBWA) is responsible for maintaining the database of currently registered teachers within the state of Western Australia, as well as individual logs of professional learning completed above normal teaching duties (Professional Learning Log).

It is generally expected that professional learning claimed for the renewal of registration, is over and above the normal expectations of a teacher's role and responsibilities (including preparation, planning, programming and assessment and reporting) and aims to improve the teacher's knowledge, practice and competencies as set out in the Professional Standards for Teachers in Western Australia. (TRBWA, 2019)

The Professional Standards for Teachers in Western Australia are also known as the AITSL Standards as they

...commenced under the auspices of the Ministerial Council for Education, Early Childhood Development and Youth Affairs (MCEEDYA – now the Education Council) in 2009... The Australian Institute for Teaching and School Leadership (AITSL) assumed responsibility for validating and finalising the Standards in July 2010. (AITSL, 2011)
The scaffold of the AITSL Standards is a hierarchy of three Domains containing seven Standards and a total of 37 Focus areas with descriptors for each of four teacher career stages (Graduate, Proficient, Highly Accomplished and Lead). The three Domains of Teaching are professional knowledge, professional practice and professional engagement. The first domain includes Standard 1: *Know students and how they learn*. Within this standard is Focus area 1.6: *Strategies to support full participation of students with disability*. The descriptors within this Focus area range from Graduate: *Demonstrate broad knowledge and understanding of legislative requirements and teaching strategies that support participation and learning of students with disability*, to Lead: *Initiate and lead the review of school policies to support the engagement and full participation of students with disability and ensure compliance with legislative and/or system policies*. This differentiation of expectations and professional growth pathways provides some guidance for PL and development for experienced teachers.

The TRBWA requires 20 hours per year (100 hours per 5 years) of PL above and beyond normal teaching duties to demonstrate the continuation of learning as a teacher and incorporation of innovative practices and novel legislation. Each of these hours is logged as relevant to a particular standard and focus area. Many PL seminars entitled *School, Photosensitivity and Digital Media* were provided by the researcher at schools and community meetings prior to beginning this study. The seminars addressed the technological and pedagogical subset of TPACK (Mishra & Koehler, 2006) and addressed the requirements of 8 Focus areas within 6 Standards as shown in Table 4.1. For example, Focus area 3.4 (Select and use resources) incorporates generation of powerpoints used in class; choice of colour, background and images is critical as explained in the seminar. These areas could be logged into attending teacher’s Professional Learning Log maintained on TRBWA’s database.

<table>
<thead>
<tr>
<th>Table 4.1</th>
<th>AITSL Standards and Focus Areas (2011) fulfilled by PL seminar <em>School, Photosensitivity and Digital Media</em></th>
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<tbody>
<tr>
<td><strong>Standard</strong></td>
<td><strong>Focus Area</strong></td>
</tr>
<tr>
<td>1. Know students and how they learn</td>
<td>1.6 Strategies to support full participation of students with disability</td>
</tr>
<tr>
<td>2. Know the content and how to teach it</td>
<td>2.6 Information and Communication Technology (ICT)</td>
</tr>
<tr>
<td>3. Plan for and implement effective teaching and learning</td>
<td>3.4 Select and use resources</td>
</tr>
</tbody>
</table>
| 4. Create and maintain supportive and safe learning environments | 4.1 Support student participation  
4.4 Maintain student safety  
4.5 Use ICT safely, responsibly and ethically |
| 6. Engage in professional learning | 6.3 Engage with colleagues and improve practice |
The diversity among the teaching workforce of pre- to post-1995 born, also impacts their response to the adoption of technology. Sproul (2014a) determined low levels of teacher awareness of light sensitivity within their student groups and low levels of self-efficacy from teachers reflecting on their ability to provide evidence-based classroom accommodations to support individual students. One challenge facing classroom teachers stems from the specificity of program used by different devices within the classroom and enabling access to these programs and devices. Two factors have increased the difficulty of this task: firstly, schools encouraging students to “bring your own device” (BYOD) allow multiple device types into each classroom. Secondly, as a teacher is transferred from one school to another, there is no guarantee that device types or software will be similar, requiring additional knowledge attainment at the beginning of a contract at a new school.

Evidence continues to mount regarding the number of students displaying symptoms of VLH, some of them uniquely with digital media (Mansur et al., 2018). As the digital elements in classroom material culture increase, IEPs are increasingly necessary to afford full participation in learning experiences for students with VLH. Use of digital participatory pedagogies (Dooley et al., 2016) within high school classrooms addresses Focus Areas across six of the seven AITSL Standards (Table 4.1). These inclusive practices would serve to optimise working memory available (Ma et al., 2014) for learning tasks and decrease potential for marginalisation of students with VLH through use of digital media in classrooms.
Chapter 5  Educational Theory

This chapter provides a view of digital media rich classrooms through the lens of Vygotsky’s model of defectology. It proposes that contemporary use of digital media in high school classrooms may be enforcing a model of exclusion for students with VLH. The chapter begins by reiterating Vygotsky’s sociocultural theory of defectology. It demonstrates the use of mediating processes followed by a commentary on higher mental processes with reference to translations of Vygotsky’s lectures. The chapter continues by referring to Vygotsky’s model of defectology focussing on the element of active participation using signs and proposes a dialectic argument for inclusive classroom practices of students with VLH.

5.1  Vygotsky’s socio-cultural theory: “defektologia” (defectology)

The internalisation of observed social processes is facilitated by active participation. Vygotsky investigated the practical issues of education and remediation and summarised some elements of them in his theory of “defektologia”. In the 1920s and 1930s there was a distinct lack of services for children with disabilities, which excluded them from active participation in the new Soviet culture (Wertsch, 1985). The scarcity of specialised services led to the development of the Laboratory of Psychology for Abnormal Childhood in Moscow later known as the Experimental-Defectological Institute, where extra-normative students were observed for developmental processes. Whilst the anglicised term defectology may conjure negative connotations, Vygotsky’s use of this term was not focussed wholly on the endpoint of adverse implications. Vygotsky (Smagorinsky, 1993) expressed these children’s development as “different” rather than “delayed” or “absent”. This perspective is pivotal when applying the concept of development through active participation in cultural practices to all age groups through primary and secondary schooling.

Identification of barriers to active participation highlight potential for developmental differences. This view is supported by the work on digital media participation by Ellis and Goggin (2015) stating “disability is very much a social phenomenon, with key social determinants, contexts and dynamics, rather than something to be categorised as a medical or health phenomenon” (p. 78). More recently, when referring to digital classroom practices to remove barriers to participation, Dooley et al. (2016) coined the phrase “digital participatory pedagogies” (p. 53). Vygotsky’s theory of defectology was highlighted by Bottcher and Dammeyer (2016) to bridge the gaping divide between medical and social models of impairment and subsequent dis-
abling of students. These support Vygotsky’s original observations, that disparity creates a barrier to participation in the cultural practices necessary to develop the higher cognitive functions such as voluntary attention and language (Figure 5.1).

Figure 5.1 Diagrammatic representation of social environment and barrier to active participation in cultural practices leading to different development

“Vygotsky viewed a tool as an object oriented outward toward the physical and social reality such as pencils, books and paper” (Hogate, 2016). In the cultural context of the digital age, the concept of tools would include digital media devices. Use of these tools reflects the importance of social interactions, as participation in the external environment precedes personal use. For example, in a digital classroom, a biology student can observe an image displayed on a laptop to further link xerophytic plants to their iconic images (Figure 5.2).

Figure 5.2 Xerophytic plants

Higher mental functions first appear in the social sphere between individuals before being internalised and repeated by an individual (e.g., voluntary attention) (Vygotsky, 1981). Within the classroom the higher mental functions of language such as foundations of reading written text (lower primary school) or process of deriving mathematical formulae (secondary school) are experienced externally prior to internalisation. If a
student with VLH is provided with opportunities for experiences well placed within their Proximal Zone of Development (ZPD), the expected outcome is active participation leading to internalisation of the concept and adoption of the process. However, if the medium used to present opportunities for these higher mental functions limits access for a student with VLH, the student has decreased active participation in the learning activity (Bøttcher and Dammeyer, 2016). This would lead to decreased development in the focal parameter of the educational activity. Whilst this combination of events is not new, students with VLH have only recently been affected as the digital classroom evolved.

Just as Vygotsky advocated active participation for all children in cultural practices, Ellis and Goggin theorised the social creation of disability through erection of “unnecessary barriers, exclusion and discrimination” (p. 78). Further, Dooley et al. (2016) applied this to the classroom during the evolution of digital media as digital participatory pedagogy. With reasonable adjustments applied by a teacher with TK (Koehler & Mishra, 2009) digital learning experiences can be placed within the ZPD for students with VLH, thus avoiding creation of a cohort of students with a different developmental pathway.

**VLH creating a different developmental pathway: A by-product of classroom evolution**

Classrooms have evolved over time, cultural tools and social interactions have facilitated diverse learning activities influenced by contextual and technological elements. In the 1960s (pre digital media as cultural norm), most classrooms in Australia used chalkboards, books and incandescent lighting. A student with VLH could usually participate in these cultural practices, able to access all classroom activities. A student with VLH would rarely identify as a student with a disability (student who developed differently) in this environment, as there was little additional visual load. Use of CRT televisions was rare as video recorder/players were not commercially viable for schools, so classroom television use was restricted to real-time broadcasts. Overhead projectors used incandescent light sources to project images onto walls and screens, as did slide projectors, both tools providing a wide range of light wavelengths without flicker therefore were less visually stressful. Reel to reel film projectors may have adversely affected the students with light sensitivity due to the inherent flickering of the projected image. However, reel to reel projectors were used rarely in the classroom due to resource cost (D.A. Burtenshaw, personal communication, September 16, 2018). The 1960s classroom tools and environment created few barriers for students. The lack of disparity regarding access allowed all students, with and without VLH, to actively participate in almost all classroom activities (Figure 5.3a).
Figure 5.3  Application in classroom environment of Vygotsky’s model of social environment and barriers to active participation with different tool use

a) c1960 classroom environment providing no barrier between a child with visual light hypersensitivity (VLH) and active participation in classroom practices,

b) c2019 classroom environment barrier created by socio-cultural tool use in the classroom between a child with visual light hypersensitivity (VLH) and active participation in classroom practices,

c) c2019 classroom environment with barriers broken by accommodations provided for use of socio-cultural tools in the classroom for a child with visual light hypersensitivity (VLH) to increase active participation in classroom practices.
In the digital classroom of 2019, the teacher can choose from a range of educational tools and environments (see Figure 5.3b and 5.3c). The decreased financial cost of internet connections and increased cultural expectations of digital literacy (Merga, 2016) lead to a huge increase in classroom application. Global standardised testing for computer literacy (De Bortoli, Buckley, Underwood, O'Grady, & Gebhardt, 2014; Fraillon et al., 2014) and national online testing has provided incentives to connect with and use digital technology in schools, but at the same time requires informed choice by practitioners.

For students with VLH, the evolution of visual tools in contemporary classrooms from light reflective to light emitting including digital media have created barriers to active participation in all learning activities (Figure 5.3b). Whilst many disability issues may be considered “not similar to issues related to gender, sexuality and race” (Bøttcher and Dammeyer, 2016), VLH may be an exception. Most disabilities are caused by impairments which carry throughout the lived experience of the individual, whereas the current research reveals the evolution of societal-driven barriers to active participation in classroom practices. The current research outlines emergent marginalisation that would not have existed in the classroom material cultures of the 1960s (see Figure 5.3a). There are also similarities with the culture of the Deaf community (Goggin, 2017), within which there is impairment but no dis-abling leading to decreased active participation in social activities.

In order to examine use of digital media by students with VLH, the current research suggests construction of a dialectic model which allows synthesis of inclusive pedagogies. This contrasts with the social model of disability which focuses on the endpoint of decreased access. This dialectic model follows the work by Shakespeare (2006) and Bøttcher and Dammeyer (2012) who explored application to disability research, the social factors that erected barriers and the educational institutions that highlight incongruence between biological and social development. The decreased access incorporated with increased digital media use advances a dialectic approach to digital media based learning activities for students with VLH, as elimination of either side of the argument is not socially viable. For the student, access to digital learning activities would be determined by the student’s own model of identity as a student with VLH and the integration of this into the classroom. The National Statement of Disability in Education (2005) and subsequent documents (Thomas & Wise, 2015; University of Canberra, 2014) requires that all students with a disability should be granted access to participation in school activities and classroom practices using reasonable adjustments. Using Hegel’s dialectic model as proposed by Fichte (1982) the elements of Thesis, Antithesis and Synthesis are discussed.
The opposing arguments focus on ability for a student with VLH to actively participate in digital and non-digital classroom environments.

In Figure 5.4, the Thesis identifies active participation in non-digital media classroom practices, a lack of incongruence with other students. It echoes Vygotsky’s model in regard to barrier-less access to activities allowing development along normal lines, however, by removing digital-media-created-barriers, it impedes development in the surrounding digital-based society.

![Figure 5.4 The dialectic argument for inclusive practices when teaching a student with VLH](image)

The Antithesis identifies disparity with other students regarding ability to actively participate in classroom practices, the barrier is created by extensive use of particular cultural tools. The Antithesis echoes Vygotsky’s model depicting a barrier to participation, the social- and cultural-ly required tools creating a barrier to active participation. This forces the student to follow a non-normative path of development due to the adverse reactions and inability to actively participate. The Synthesis is a suggestion and acknowledgement that neither Thesis or Antithesis is acceptable inclusive pedagogy, so accommodations to digital classroom practices can be introduced to increase access to classroom practices and decrease incongruence between active participation of students without VLH and active participation of students without VLH. The Synthesis amalgamates inclusive pedagogy with altered parameters to facilitate increased participation without adverse reactions.

The Synthesis in Figure 5.4 would lead to the introduction of reasonable adjustments to accommodate the dis-abling effect of digital media use for students with VLH. This in turn would decrease the disparity of active participation in classroom activities between students with VLH and students without VLH (Figure 5.3c).

### 5.2 Vygotsky’s higher mental processes

Higher mental processes such as attention and language are used to create new neural connections for conceptual understanding. These demand large cognitive input, often requiring a mediating process. Using a classical definition of phenomenology, Vygotsky's analysis of higher mental function incorporated the child's intention and
advocated for “studying processes as wholes” (1931a, para. 5). In his writings, Vygotsky further endorsed a movement away from structuralism to functionalism, arguing that the “what” and the “how” of behaviour were different, “[a]nalysis of things should be opposed to the analysis of process” (1931a, para. 7). In contemporary high schools, this analysis of process is a continuing thread in validity of assessment tasks in high school, with separation of the what and the how occasionally becoming blurred in determination of student knowledge and demonstration of learned behaviours.

Vygotsky revealed cause and effect relationships to explain phenomenon, despite his own descriptors of his work as being “holistic or structural” (1931b, para.1). He referred to “the new psychology” observing the fluid process, including an understanding of its growth, as opposite to the old or traditional psychology which was “atomistic” (1931a, para. 3) focussing on combinations of elements and a static endpoint. The how of behaviour includes the external process as a consequence of the way it has been generated (its “genesis”) which incorporates habit as precursor to instinct. The development of these behaviours is lengthy as “[i]t is only when the child turns into an adolescent, that the final transition into the realm of thinking in concepts can occur” (1931e, section 8, para. 3). A child’s intentions may alter as it develops, however some of the habitual behavioural responses remain. The concept of habitual (fossilised) behaviours (Vygotsky, 1978, p. 64), is important as these are behaviours which have become automatic responses to stimuli over extended periods of time, and may initially seem static. Investigation of the complexities of these behaviours is required as they exist as more than the sum of their components. It would be expected that adolescents would demonstrate more of these fossilised behaviours than younger students, due to the extended period of their life experience. Intention of activity in a child is often different from that of an adolescent, yet the fossilised behaviours may obscure the underlying original process.

Vygotsky (1931a) further describes the situation of child intentions and making connections with two groups of children at different stages of development; the generalised two and a half year old child and the 6 year old child. For the younger child, after displaying a stimulus (pencil or watch) the child was to raise right or left hand respectively. Whilst the two alternate responses were physically able to be achieved immediately, the cognitive connection between stimulus and decision for which of the response actions were required was occasionally delayed. The delay preceded other actions, either questioning of the researcher by the child or a “tentative [movement] expecting confirmation by the researcher” (1931a, para 68). The second action was identified by Vygotsky as finding the connection “with the help of the external stimulus-
means that reminds him of the required connection” (1931a, para. 70). The older students constructed a link between the stimulus and response through physical placement of stimulus objects closer to response objective, as a reminder to support confirmation of choice. Vygotsky explained this mediated connection underlying all higher forms of behaviour using a flow diagram. Movement of thought from point A (stimulus reception) to point B (response generation) could be viewed as static and dichotomous (achieved or not achieved). However, Vygotsky encouraged investigation of mediation between connections as demonstrated by movement from point A through arbitrary point X before arriving at point B, thus breaking the notion of dichotomous position. Process around the arbitrary point X could indicate positive stimulus reception, however, further scaffolding needed to proceed to point B. This mediation was observed in the example of the younger child who used “confirmation by the researcher”, and the older child by physical object placement. In neither case was the stimulus followed directly by the response, an intermediary step (mediating point X) was required for successful completion of the task. The mediating point X was denoted as a *sign* and Vygotsky proposed the following as a general rule: in the higher structure, the sign and methods of its use are the functional, determining whole or focus of the whole process (1931b).

### 5.3 Accessibility of learning activities to develop Vygotsky’s higher mental processes

Vygotsky's analysis of development of attention and of memory rests on these assumptions of process. Education institutions were introduced to capitalise on development of higher mental functions. If educational institutions (including home school) did not exist then repetition of activities below the zone of proximal development would see limited development, as alluded to by Vygotsky (1929); regarding repetition of simple tasks such as comparing tables, studying smells, threading beads. Vygotsky posed the question; “Does this not sooner transform a normal child into a mentally retarded child rather than develop in the mentally retarded child those mechanisms of behaviour, psychology, and personality, which have not yet meshed with the sharp teeth of life's intricate gears?” (Chapter 2, section 3, para. 12) regarding the use of mediating processes in development of stimulus and response connection for the younger child between two seemingly unrelated items.

An example of construction of mediating processes can be demonstrated in a high school Biology classroom. In contemporary Biology classrooms, construction of
mediating processes can be seen using language associated with classification of xerophytic versus non-xerophytic plants. The higher mental process is language development and the “point B” is successful identification of xerophytic plants amongst other plants, that is, the scientific concept (Vygotsky, 1962). The nomenclature is novel and at first glance unrelated to the picture of a desert in Mexico. For the student the desert plant itself is the everyday concept (Vygotsky, 1962). However, mediating point X may be introduced by breaking the word xerophytic down to its roots; xero (dry) and phyte (plant), the latter term being familiar to students by Year 11. This provides a point for positioning mediating point X as a reminder of the types of plants present in the group. Initial practise with confirmation by the knowledgeable person present (teacher) continues use of this sign (deconstructed word; point X) to develop the understanding of the student.

In the 2019 classroom environment, students exhibit a range of behaviours when faced with novel information. Student use of language to create mediating process (movement through arbitrary point X) between two previously unrelated points (point A and point B) is common practice. For students with VLH, this can be challenging due to the disability potentially being caused by the classroom environment. The cognitive disability described as “unable to find words” (Gil-Gouveia, Oliveira & Martins, 2015; Petrusic & Zidverc-Trajkovic, 2014) creates a barrier to development of arbitrary point X to connections for the students with VLH. This barrier may be created by light sources or the tool (computer) used to introduce point A and point B. As light emitting tools are becoming more common, students have developed individual protective behaviours to decrease negative impact. These fossilised behaviours may exist for students with VLH, and evidence of these protective behaviours are recognised as diagnostic elements. Protective behaviours for a student with VLH may include squinting eyes when reading, shading the page when reading (Hammond, Buch, Gardere, & Ruston, 2019) or avoidance (Choi et al., 2009).

Light emitting tools engage a greater number of neurological pathways due to physical parameters than light reflective tools, therefore corresponding visual load associated with their use increases (Antithesis, Figure 5.4). In 1988, Sweller’s Cognitive Load Theory was introduced to explain his own observations in this area. These observations were based around learning new schema and included the ineffectiveness of using traditional problem solving techniques with students. His argument was that the requirement of both high order problem-solving and formation of connections for novel concepts overtaxed the “limited cognitive processing capacity” (p. 261). This theory is able to sit comfortably within Vygotsky’s theory of ZPD with respect to intellectual
development (1934). Vygotsky proposed a model of an expert student asking questions to support a novice student problem solve through novel concepts (section 3, para. 16) supporting the maturing process as well as demonstrating matured processes (section 3, para. 14). Using Sweller’s terminology, this would decrease the cognitive load required by the novice student, allowing schema creation as the problem would no longer be too difficult. For students with VLH in the digital classroom, there is an additional element to cognitive load which can decrease active participation in classroom activities. The additional load renders the process beyond the ZPD.

5.3.1 Within the digital media learning environment

The learning environment was included as a contributing element to the cognitive demands (beyond problem solving and schema creation) of a task by Paas and Merrienboër in 1994. However, it was not until 2014 that Choi, Merrienboër and Paas highlighted the gap in knowledge regarding the extent of the physical learning environment influence. Choi et al. (2014) include the “physical attributes of the built environment” as contributing to cognitive load, which incorporates any light sources – including digital media. They also mention the potential difficulty in distinguishing physical learning environment from learning task, which echoes Vygotsky’s determination to uncover mediating processes within movement from point A to point B. In the digital classroom, the tool may be a visual image on a computer and the learning task to identify plant types. Thus the tools become culturally synonymous with specific learning activities.

5.3.2 Visual load for students with VLH and persistent pain

Digital media use is an additional element to incorporate into environmental cognitive load of students with VLH due to increased luminance. For students with VLH this increased luminance is substantially increasing the visual load and in individuals with migraine affects different parts of the brain (Bouloche et al., 2010). As cognitive processing capacity must first be allocated to perception of visual material before processing can occur, this limited resource may not be able to provide for creation of new connections or synthesis of mediating processes. Huang et al. (2017) also concluded “cognitive performance decreases during migraine, and cognitive dysfunction can be related to the duration and frequency of a migraine attack” (p. 54). Recognition of how disability is “experienced and conceptualised” (Alper & Goggin, 2017) and demonstration that “each student is valued equally; supported and facilitated to avoid
marginalisation” (Florian & Black-Hawkins, 2011) is important to validate practical application of academic investigation through inclusive pedagogy.

The concept of synaptic plasticity reinforces the possible adverse effects seen by lack of habituation to visual light stimulus in individuals with migraine and the possible reinforcement of pain pathways. Students with migraine deal with frequent episodes of persistent pain for up to 72 hours per episode. Smith and Ayres (2014) introduced the Persistent Pain Neurocognitive Paradigm where “[students] with persistent pain have limited attentional and working memory resources to engage in complex processing tasks, and consequently are susceptible to impaired cognitive performance” (p. 246). They investigated the modality and redundancy effects of instruction for school students with persistent pain and concluded that even “clinically low levels of pain could significantly interfere with information retention and transference”. Mathur et al. (2015) continued this line of argument with their suggestion:

[d]uring pain conditions, patients had decreased task-related activity, but more widespread task-related reductions in pain-related activity, compared to controls, suggesting cognitive resources may be diverted from task-related to pain-reduction-related processes in migraine. (p. 347)

Using the proposed model (Figure 5.3), the findings from Smith and Ayres (2014) and Mathur et al. (2015) support the suggestion that introduction of digital media to assessment, such as online academic testing for high school students with VLH, can introduce a barrier to demonstration of academic skills using this medium, due to limited working memory and attentional resources.

5.3.3 Selective absenteeism

Students living through extended periods of high level pain have high rates of absenteeism. Smith and Ayres (2014) incorporated the pain-related anxiety and distress felt by individuals with chronic pain in their summary that pain impairs task performance. Participants in the Smith and Ayres study (2014) demonstrated low levels of clinical pain throughout the testing procedure and returned significantly lower results than on the task than the pain free participants. Whilst some students with chronic pain come to school despite foreknowledge of the pain-burden of the day, the decreased return of results on effort can lead to decreased self-efficacy (Doménech-Betoret, Abellán-Roselló & Gómez-Artiga, 2017). A decrease in self-efficacy is one of the reasons students with chronic pain choose to avoid school (Sato et al., 2007).
Students with chronic health conditions sometimes select absence from school to decrease pain (thus avoiding displays of limited self-efficacy), as well as having school absence due to unsupportable physical illness, leading to chronic school absenteeism (Krenitsky-Korn, 2011; Nijhof et al., 2011). Student identification of cost associated with participation in a task can affect engagement (Eccles & Wigfield, 2001). Chronic absenteeism is defined by the United States of America’s National Collaborative on Education and Health (2015) as “missing 10 percent or more of school days for any reason, excused or unexcused”\(^1\). In Western Australia, any student documented with more than 10% absenteeism is required by law to be reported by the school to the Department of Education and Training.

In addition to pain, another physiological stressor is ambient temperature which also has the capacity to decrease cognitive levels (Hancock & Vasmatzidis, 2003). Although many school classrooms are fitted with air conditioners, some Australian states retain the right to dismiss students from school after 12:30 pm if the temperature is above 38°C (Government of South Australia, 2017), however, this is decided on a school by school basis. This governmental policy permits school-based intervention when student cognition is challenged by environmental conditions.

Stressors include online standardised testing access for the student. Online standardised tests can create further barriers to participation in educational activities for students with VLH. Without adjustments for digital media use in the classrooms, students with VLH may manage their pain and social anxiety levels by selective absenteeism, increasing the difference in their developmental pathway. Absenteeism from NAPLAN and OLNA testing procedures makes a student ineligible to graduate from a high school in Western Australia. Application of reasonable adjustments to enable full participation for students with VLH in these testing procedures would be an important factor when assessment goes fully online from 2021\(^2\).

### 5.4 Implications for the digital classroom

Vygotsky’s models of mediating processes and use of signs can be seen in the contemporary digital classroom; construction of mediating processes such as Google\(^0\) for xerophytic plants, or use of external sign by observation of images displayed on powerpoints. However, Sweller’s Cognitive Load Theory (CLT) (1988) proposes a limited

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\(^2\) [https://www.nap.edu.au/online-assessment](https://www.nap.edu.au/online-assessment)
cognitive processing capacity to achieve these tasks. With the incorporation of elements of environmental cognitive load in CLT (Choi et al., 2014; Paas & Merrienboër, 1994), and the finding that persistent pain decreases cognitive ability as neural pathways are shared (Smith & Ayres, 2014), the importance of classroom environmental influence for students with VLH is clear, and class accommodations essential.

Sharma (2019) identified teacher knowledge of a student’s learning differences in a digital classroom as pivotal. This teacher knowledge of learning difference coupled with awareness of evidence-based accommodations would facilitate such incorporation into the learning environment. Without accommodations, an environment with high digital media use would compromise the student with VLH’s ability to construct mediating processes or use signs due to the cognitive load of perceiving the high luminance visual material. This interference with “the retention and transference of newly acquired information” (Smith & Ayres, 2014, p. 258) creates a barrier to active participation, thus diverting a group of students onto a different developmental path (Vygotsky, 1929, section 1, para. 5). Teacher awareness of how a disability can present in a classroom is discussed in Bøttcher and Dammeyer (2012). Whilst the participant in their example was attempting to focus on a fixed object by looking around it, the teacher interpreted this as “inattentive” (p. 442). Variations in teacher awareness may similarly misinterpret novel accommodations for students with VLH.

This highlights the need for investigation of awareness of VLH phenomenon and integration of accommodations for students with VLH. Both are critical to facilitate and determine active participation in our contemporary classrooms. One of the keys to applying this in practise is the application of digital participatory pedagogies incorporating adjustments/accommodations for students with VLH. The number and extent of adjustments required would be determined by the needs of the individual student. The goal for each class; that each student is enabled to actively participate in classroom practices using digital media.

The synthesis of the dialectic argument in Figure 5.4 addresses two elements for students with VLH; the Vygostkian model (Figure 5.3) outlines the potential marginalisation and the process is described by CLT evolution (Choi, Merrienboër and Paas, 2014; Paas & Merrienboër, 1994; Sweller, 1988). Without accommodations, the marginalisation of students with VLH is likely to affect absenteeism (Krenitsky-Korn, 2011), self-efficacy (Doménech-Betoret, Abellán-Roselló, & Gómez-Artiga, 2017) and working memory (Smith & Ayres, 2014).
Chapter 6  Aims and Methodology

This chapter describes the aims and methodology underpinning the current study to give a voice to the VLH community linked with education. Firstly, the chapter outlines the assumptions inherent in investigations crossing fields of education and medicine. The aim and research questions are introduced followed by a statement about the significance of the research and methods used. The chapter describes how participants were chosen and their demographic data. With a brief recount, the application for ethics approval has been included to provide insight into the complexity experienced. The development of the project instruments and analysis of returned data precedes a statement of limitations in design and analysis.

From an educational perspective, teachers’ pedagogy is informed by educational theories and by personal experience. For this research and the implications for practical pedagogy for students with VLH in a digital classroom, Vygotsky’s approach and theoretical perspective has been chosen. This perspective integrates children’s learning and development and their social worlds, as well as the reality of differing developmental pathways dependent on active participation in cultural practices. Dimitriadis and Kamberelis (2006) state that

what is constant in [Vygotsky’s] theories is the important relationship between learning and the child’s social and cultural worlds. What changes is how the relationships and forms of mediation are defined and viewed. (p. 192)

Use of digital media in classrooms is a form of mediation rooted in the social world. Connecting decades of medical research with recent technological advances and applying them to the contemporary classroom is beneficial for active participation in digital classroom activities. However, little transfer of research conclusions has occurred between research bodies and educational institutions due partly to the nomenclature differences, aims and even use of outdated equipment such as CRT televisions.

As identified in the previous chapters, the importance of accommodations for students with VLH using digital media hinges on three statements;

1  Digital media tools are light emitting tools.
2  Students with VLH experience a higher visual load from light emitting tools.
3  Increasing the visual load increases the extrinsic cognitive load, thereby decreasing the cognitive capacity available for completing a learning task.
These three statements sum to a single implication for students with VLH: use of digital media without accommodations decreases the student’s cognitive capacity available for completing a learning task. The decrease in cognitive capacity decreases the active participation in classroom practices, introducing a different developmental path for the student with VLH. The current research investigates digital media use in classroom from a social justice perspective, how the digital classroom is experienced by students and the accommodations that are currently practised in the classroom.

6.1 Overarching approach

The current research is framed by a transformative paradigm (Mertens, 2007). It aims to investigate in what ways current high school students with light sensitivity are being affected by the increase in light emitting devices in digital classrooms and how they are supported and accommodated by digital participatory pedagogies (Dooley et al., 2016). A transformative paradigm is appropriate as it addresses an area of social justice, is informed by the focal community and carries the findings through to actionable recommendations. The genesis of the current research was stimulated by observations of social injustice and inequity within the focal community. This potentially marginalised community, students with VLH and their support system of parents and teachers, contributed to the design of data collection instruments.

The transformative ontological assumption of the current research is that digital tool use in high school classrooms is socially dictated and visually inclusive. Social pressures driving adoption of digital media tools within a particular high school includes elements of contemporary technological advancements, socioeconomics (Gil-Flores et al., 2017), geographical location (Pathak-Shelat & De Shano, 2014), school mission and values statements, as well as individual teacher preferences (Biddix et al., 2015; Martin et al., 2014). Inclusive pedagogy with digital media for students with VLH requires awareness of evidence-based light parameters to avoid, as well as potential accommodations to include. The current research utilised a review of the literature of medical and societal guidelines and recommendations for use of digital media with students with VLH to inform the empirical phases of the current research (see Chapter 3).

Using assumptions about context guides the work of researchers (Mertens, 2007) and frames the site of social change. The social justice element of a transformative paradigm incorporates movement towards equity for marginalised groups. The current research highlights the unintentional naïveté of potential dis-abling mechanisms incorporated with systemic adoption of digital media in high schools. Goggin et al.
(2019) commented on the digital economy and the prospective place within it for people with disabilities, however, acknowledged two challenges; “policy frameworks, and,… systematic… programmes” (p. 44). Medical research has informed society of best practice of visual images as evidenced by globally accepted guidelines into policy (ITC; W3C), however, these are not required to be applied in Australian classrooms. The high school context uses societal tools of digital media, however, the accompanying visual parameter policy has often been overlooked. While important content policy (addressing cybersafety, social media bullying) have successfully been implemented in schools, lack of visual parameter policy (addressing flicker frequency, luminance) are allowing an increase in digital media images whose visual parameters can adversely affect students with VLH. Systematic programmes of education and awareness would be required to implement any changes through all Australian classrooms.

The current research adopted a mixed methods approach as it enables different stances to be accommodated within the one project (Mertens, 2003). This research project brings together findings from medical research, which adopts a positivist stance, and educational perspectives, which are inherently individual experiences framed within a predominantly interpretive/constructivist stance. The empirical phases of the current research utilise surveys asking students to indicate digital media use (postpositivist) and interviews where participants (including members of the VLH community) explain their experiences of digital media in the classroom (constructivist). The VLH community included individuals with VLH, their parents and teachers.

A mixed methods approach within a transformative paradigm also allows stakeholders “input into the conditions that warrant the conduct of research” (Mertens, 2007, p. 214) and allows the researcher to broaden their understanding of the research question (Creswell & Creswell 2005). Those most affected and often excluded (Alper & Goggin, 2017; Mertens, 2007), in this case students with VLH, their parents and teachers, are participants. This method has been used in other studies of impairments and disabilities such as cerebral palsy (Böttcher, 2018) and brittle bones (Hannam-Swain, 2017). To date the voices of students with VLH and their parents have not been heard, more by naïveté of the phenomenon (Sproul, 2014a) and subsequent ignorance of barriers potentially creating exclusion. Whilst the level of involvement of the VLH community does not extend to hiring members to collect data (Canales, 2013), as a member of the VLH community and a practising high school teacher, the researcher holds a subjective voice on instrument construction and elements of “sensitive data collection” (Shannon-Bard, 2015, p. 9). These elements include identification of areas of pressure within the examined system and translation of evidence-based medical
recommendations into educational accommodations. As digital media is a developing context in high schools, the current research potentially informs and transforms inclusive pedagogy for students with VLH.

6.2 Research aims

Given the increasing adoption of digital media tools within the classroom and the significant portion of the high school population identifying with VLH.

This research aims to:

- determine current digital media use in high school classrooms;
- investigate school and parent interactions on behalf of students with visual light hypersensitivity regarding accommodations and access to learning activities; and
- explore experiences of practising teachers using inclusive pedagogies for students with visual light hypersensitivity.

The findings provide insight into policy and practice and offer recommendations for future inclusive practices related to students with VLH.

6.3 Significance of this research

There are two key areas of policy-led classroom practice that should benefit from this research: inclusive education participatory pedagogy that encourages differentiation in material culture and access options for students with VLH; and the health and well-being of students with VLH.

Increased knowledge of digital media use informs development of inclusive practice, including digital participatory pedagogies (Dooley et al., 2016). Whilst Curry (2003) wrote of Universal Design for Learning (UDL) as digital technology entered schools, her comments remain accurate although the process may apply in the reverse direction. Curry used the example of a text-to-speech program opening access for a group of students previously blocked from active participation in some activities. As classrooms now incorporate higher levels of digital medium use, the concept of what is accessible to which group of students needs to be addressed. Some students who were actively participating in all classroom learning activity with light reflective tools may be negatively impacted by extended duration of digital media (light emitting tool) use. Using the approximation of 6.25% of the population affected visually by screened images as reported by Yamashita et al. (1998), the equivalent population in Australia of high school students with VLH is 240 000 students (ABS, 2018). As the level of reaction
to digital media images alters between individuals with VLH, it highlights the need to determine best general practice (universal design) as well as ability to sculpt individual education plans (IEPs) for students to allow access to learning activities. Beyond the classroom, inclusive education also includes working with parents and government agencies to facilitate equal access to all learning opportunities as required by Australian Federal Law (Disability Standards for Education, Australian Government, 2005). Evidence based on the past experiences of both parents and teachers can validate recommendations for future processes.

Promotion of the health and wellbeing of all students using digital media is at the forefront of this study. Guided by industry and health research which identifies and recommends evidence-based health related parameters for safer digital media use at school, this is relevant for all Australian students (N=3,849,225, ABS, 2018), teachers and education assistants (over 280,000 combined, ABS, 2018).

The current research also addresses Ellis and Goggin’s (2015) statement of need for research of disability participatory cultures in the educational setting, promoting movement towards a “genuinely democratic participation in media and culture” (p. 86). This perpetuates the vision of Vygotsky, making mediating processes accessible by incorporating digital participatory pedagogy (Dooley et al., 2016).

6.4 Research questions

The following questions underpin separate phases of the research and link directly to the aims.

1. What is the duration and purpose of educational digital media use during a school day (including homework)
   a) in contemporary high school education in Western Australia as reported by current students, with and without VLH?
   b) as remembered by past students (18+ years), with and without VLH?

2. What is the interaction experience of parents working with the school on behalf of students with visual light hypersensitivity regarding accommodations and access to learning activities?

3. What is the pedagogical experience of practising teachers (who have attended a profession learning seminar on visual light hypersensitivity) regarding inclusive digital media access for students with visual light hypersensitivity?
6.5 Research design

The current research uses a transformative mixed methods approach. Mertens (2007) comments that whilst a researcher usually cites “scholarly literature” (p. 213), external social influences affect inclusivity lived by students with VLH working with digital media in the classroom. A systematic literature of documents ranging further than academic articles was undertaken (as shown in Figure 1.1, Chapter 1) before embarking on the empirical phase of the current research.

In order to capture the experiences of the digital world of learning for participants, part of the research is interpretive (Cohen, Manion & Morrison, 2005) and gives voice to the lived experience of individuals. As a transformative study it “[focuses] on action. This may be thought of as behaviour-with-meaning; it is intentional behaviour and as such, future oriented.” (p. 23). It addresses the “[great] need for baseline data on digital media use and practices of children” (Alper & Goggin. 2017, p. 736) to encourage transformative practice.

The empirical phase of the current research required identification of the stakeholders within the VLH community linked with education. Following this process, the participant group chosen from the VLH community for participation in each part of the research are outlined in Figure 6.1. These four data sources are integral to the investigation of accommodations used with digital media in high schools; current students, past students, parents and teachers. Figure 6.1 also summarises focus items within each group. The arrows show direction of information and feedback; parental consent is required for student surveys, which inform teacher and past student interviews, as well as parent interviews. These insights and experiences were used to address the research questions posed (Ellis, Kent, Hollier, Burns & Goggin, 2018). This ensured the voice of the student with the disability was heard (Alper & Goggin, 2017). The design utilised triangulation of methodology (Denzin, 1997) with use of contrasting sources for data generation. This allows high confidence in validity of any similarity in findings as the similarities are less likely to be artifacts of the methodology (Lin, 1976 in Cohen, Manion & Morrison, 2000).

The sequential explanatory approach (Ivankova, Creswell & Stick, 2006) began with surveys asking about students’ current digital media use. It continued by interviewing members of the VLH community linked with education about lived experiences. This allowed quantitative data from Part A to be explained and elaborated with qualitative data from Part B, collected later (Creswell, Plano Clark, Gutmann & Hanson, 2003).
Part B of the sequential explanatory design included triangulation of perspectives from a sample of the VLH community regarding digital media use in student education. A deductive approach (Denzin & Lincoln, 2000) assessed two sets of measures; digital media use that day and change in symptomology experienced. It also allowed incorporation of mediating factors such as sleep, medication and breakfast. Whilst Patton (1980) cautions that triangulation will not necessarily deliver a united result, in the context of student’s learning, the perceived impact of digital media by all invested parties (students, parents, teachers) is seen as valuable, and any elements of inconsistency can be examined.

6.6 Ethics overview

The research complied with the National Statement on Ethical Conduct in Human Research (NSECHR), which aims to minimise adverse effects to participants as a result of their participation in research. Research carried out under the guidance of a research institution requires the approval of the selected Human Research and Ethics Committee before data collection can commence. Any institutions that are affiliated with the research may also require the research be approved by their own Human Research and Ethics Committee prior to permitting participation by their members.

The NSECHR requires that the young people involved in the research are not vulnerable through immaturity (p. 50), therefore the Survey section of the investigation had been restricted to high school students and their parents only. All the high schools in the current research included Grade 7s who reach the age of 12 by 30 June of the year they start Grade 7 (Government of Western Australia, 2019).
The initial ethics application to Murdoch University Human Research Ethics Committee (MUHREC) proposed two avenues of anonymous survey participant involvement: online through websites visited by parents of students with light sensitivity; and local (Western Australian) high schools. Online collection of data required a link of parental survey with student survey to ensure parental permission, however this was accomplished through use of student self-generated codewords submitted in the parent surveys (Appendix A.1). Outright approval was granted in June, 2016 (Appendix B.1) After four months, the global website had gained participants but no viable data, so the second avenue of anonymous student participation, local high schools, was pursued (Appendix B.2).

To gain approval for student participation (< 18 years) in Western Australian schools and activities carried out within school hours requires additional approvals. In Western Australia there are three main categories of high schools – Government, Independent and Catholic. Each high school participates in research through different avenues: Government high schools require approval from the Department of Education; Independent Schools require “no separate requirement or protocol” (Appendix B.3) beyond MUHREC approval and permission from School Principal; and Catholic schools require approval from the Catholic Education Office (Appendix B.4).

Approval was granted by MUHREC and a number of Independent schools, allowing the research to proceed, but concerns were raised about requesting medical information (pain and specific medication related to light sensitivity), therefore all questions relating to pain were removed. After extensive negotiation over 12 months without resolution with the Department of Education, the application for approval to conduct research in government schools was withdrawn. The approval process and changes made to the study are detailed in Appendix A.2.

6.7 **Sampling method**

Students undertake learning activities at the direction of their teacher whilst in the classroom, but are supported at home by a parent or carer, but both groups of adults have the ability to alter the learning environment for students. Therefore, students, parents and teachers are all linked with VLH and become the focus of individual collection instruments allowing different experiences of the same activity to be explored.

The literature review accessed information from global investigations, therefore Part A of the empirical data collection was designed to include participants from the global
community. Invitations to participate in surveys were extended through websites named in the MUHREC application (Appendix B.1 contains approval document). As this returned no responses within the first four months, the recruitment process became focused on Perth, Western Australia. An amendment to the MUHREC document followed and was approved in February 2017 (Appendix B.2).

Interview participants for were invited to participate through convenience sampling. MUHREC approval for empirical data collection Part B was granted in November, 2017 (Appendix, B.5).

6.7.1 Part A Recruitment and participants

Due to research approval constraints from the Department of Education (see Chapter 6.6), the research participants for Part A were restricted to students in Independent schools. The following paragraphs outline the recruitment and demographics of the participating students and their parents.

Current Student Participants

Current high school students were recruited through school newsletters sent to their parents. The school newsletter contained a flyer (Appendix C). A total of 167 students participated in surveys and 95 had parental consent and were included in the analysis. The demographic information matched from parental surveys to student surveys is summarised in Table 6.1 together with the participant’s categorised Year group.
Table 6.1  Demographic information for student surveys from student and linked parent surveys (n=95)

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year group (at high school)</td>
<td>Year 7 – 10</td>
<td>74 (77.9)</td>
</tr>
<tr>
<td></td>
<td>Year 11 - 12</td>
<td>21 (22.1)</td>
</tr>
<tr>
<td>Category of school</td>
<td>Independent</td>
<td>95 (100)</td>
</tr>
<tr>
<td>Category of location</td>
<td>Large city (&gt;2 000 000)</td>
<td>33 (34.7)</td>
</tr>
<tr>
<td></td>
<td>Small city</td>
<td>24 (25.3)</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>38 (40.0)</td>
</tr>
<tr>
<td>Socio-economic advantage and disadvantage (SEAD of school environment (Likert scale))</td>
<td>1 (Low)</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td></td>
<td>3 (Medium)</td>
<td>8 (8.4)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>19 (20.0)</td>
</tr>
<tr>
<td></td>
<td>5 (High)</td>
<td>17 (17.9)</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>48 (50.5)</td>
</tr>
<tr>
<td>Student reported not VLH</td>
<td>Total</td>
<td>68 (71.6)</td>
</tr>
<tr>
<td>Student reported VLH</td>
<td>Before school only</td>
<td>9 (9.5)</td>
</tr>
<tr>
<td></td>
<td>After school only</td>
<td>9 (9.5)</td>
</tr>
<tr>
<td></td>
<td>Before AND after school</td>
<td>9 (9.5)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27 (28.4)</td>
</tr>
<tr>
<td>Parent reported student with VLH</td>
<td>VLH and linked medical diagnosis</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>VLH, but no diagnosis</td>
<td>1</td>
</tr>
<tr>
<td>Sleep (from the night before)</td>
<td>None</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>54 (56.8)</td>
</tr>
<tr>
<td></td>
<td>Lots</td>
<td>40 (42.1)</td>
</tr>
<tr>
<td>Breakfast</td>
<td>None</td>
<td>16 (16.8)</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>54 (56.8)</td>
</tr>
<tr>
<td></td>
<td>Lots</td>
<td>25 (26.3)</td>
</tr>
<tr>
<td>Medication (taken that day)</td>
<td>Preventative* only</td>
<td>6 (6.3)</td>
</tr>
<tr>
<td></td>
<td>Intervention* only</td>
<td>12 (12.6)</td>
</tr>
<tr>
<td></td>
<td>Preventative AND Intervention* only</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Intervention AND Other</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Other only</td>
<td>4 (4.2)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24 (25.3)</td>
</tr>
<tr>
<td>No medication (taken that day)</td>
<td>Total</td>
<td>71 (74.7)</td>
</tr>
</tbody>
</table>

*Preventative: taken every day

*Intervention: taken only when pain starts
**Parents of the Current Student Participants**

The parent participants were recruited through advertisement in school newsletters. All participants were parents of children attending high school in Western Australian in 2017-2018. As a parent, there were two additional requirements to participate in this research; all parent participants were required to understand written English (as the survey is written in English) and have access to the internet to complete the survey.

Demographic information from the parent surveys is shown in Table 6.2.

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Male</td>
<td>5 (8.5)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>32 (68.1)</td>
</tr>
<tr>
<td></td>
<td>None given</td>
<td>10 (21.3)</td>
</tr>
<tr>
<td>Country of Origin</td>
<td>Australia</td>
<td>47 (100)</td>
</tr>
<tr>
<td>Location</td>
<td>Large city (&gt;2 000 000)</td>
<td>16 (34.0)</td>
</tr>
<tr>
<td></td>
<td>Small city</td>
<td>11 (23.4)</td>
</tr>
<tr>
<td></td>
<td>None given</td>
<td>20 (42.6)</td>
</tr>
<tr>
<td>Highest level of education in household</td>
<td>Secondary school</td>
<td>3 (6.4)</td>
</tr>
<tr>
<td></td>
<td>Trade/Apprenticeship/Technical</td>
<td>4 (8.5)</td>
</tr>
<tr>
<td></td>
<td>Undergraduate University Degree</td>
<td>6 (12.8)</td>
</tr>
<tr>
<td></td>
<td>Postgraduate University Degree</td>
<td>11 (23.4)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>1 (2.1)</td>
</tr>
<tr>
<td></td>
<td>None given</td>
<td>22 (46.8)</td>
</tr>
</tbody>
</table>

### 6.7.2 Part A Recruitment procedure

Twenty five Independent schools were invited to participate (Appendix D), the contact with 20 schools in 2017 was as follows:

a) Initial contact with the school was by phone to verify correct email address for principal attention

b) email containing principal information letter (Appendix E.1), consent form Appendix E.2) and insertion for e-newsletter (Appendix E.3)

c) non-respondents received a follow-up email after 3 months (this allowed time for school council meeting).

The same format for school recruitment was followed in 2018. Only one school chose to repeat their participation and two new schools chose to participate.

Surveys were to be completed online. Newsletters (e-newsletters) were sent to parents containing a link to the surveys. Information letters (Appendix F) were accessed
via weblinks provided within the opening pages of the surveys (Appendix G). Parents were then responsible for sharing the invitation with students. Current Student participants were invited to complete an online survey which included a self-generated pseudonym (“codename”) allowing data matching with the parent survey.

Use of Current Student and Parent survey matching facilitated extension of demographic information through the family. By using the Survey Monkey platform, another degree of deidentification was achieved as the option to collect IP addresses from participants was switched off.

The initial application to collect data from school students in Western Australia was submitted in January 2016, with the length of the approval process impacting the timeline of the research. Both Student and Parent surveys were open from April 2017 to November 2018.

6.7.3 Part B Participants

Part B of the empirical data collection of the research required participants who were linked to the VLH community in the field of education. Semi-structured interviews were designed to support the transformative paradigm of the research. The convenience sampling of three demographic groups (past student, parent, teacher) was carried out in Perth, Western Australia.

Past Students

All Past Student participants were over 18 years of age, therefore beyond the chronological age requirement of parental consent. These student participants had left high school, even if they had not successfully graduated. Six students participated in interviews which ranged in duration from 17 to 32 minutes. Despite the information in the flyer (Appendix C.2), four of the Past Student participants did not have VLH, two of the Past Student participants have VLH.

Demographic information from the interviews is shown in Table 6.3. All past students who participated in interviews attended Primary School between the years 2003 and 2012 (this would have included Year 7) and High School between the years 2010 and 2017.

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1 Year 7 was the final year of Primary School in Western Australia until 2013. In 2014 the first cohort of Year 7s attended High School, this has continued until the present day.
Table 6.3  Demographic information from student (+18) interviews (n=6)

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Male</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4</td>
</tr>
<tr>
<td>Category of high school location</td>
<td>Large city (&gt;2 000 000)</td>
<td>6</td>
</tr>
<tr>
<td>Age at time of interview (years)</td>
<td>18 – 20</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>21 - 23</td>
<td>3</td>
</tr>
<tr>
<td>Participant has VLH</td>
<td>No</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>2</td>
</tr>
</tbody>
</table>

**Parents of students with VLH**

This group of parents all had children with VLH; four with migraine, one with concussion. These students had all attempted or successfully completed Year 12 in Western Australia. Demographic information from the parent interviews is shown in Table 6.4.

Table 6.4  Demographic information from parent interviews (n=5)

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Male</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4</td>
</tr>
<tr>
<td>Country of Origin</td>
<td>Australia</td>
<td>5</td>
</tr>
<tr>
<td>Category of location</td>
<td>Large city (&gt;2 000 000)</td>
<td>5</td>
</tr>
</tbody>
</table>

**Teacher Interview**

All teachers who participated in the interviews had attended a Professional Learning (PL) seminar held by the researcher some time in 2014 or in the first semester of 2015. Demographic information from the teacher interviews is summarised in Table 6.5.
### Table 6.5 Demographic information from teacher interviews (n=5)

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Male</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3</td>
</tr>
<tr>
<td>Country of Origin</td>
<td>Australia</td>
<td>5</td>
</tr>
<tr>
<td>Category of location</td>
<td>Large city (&gt;2 000 000)</td>
<td>5</td>
</tr>
<tr>
<td>Teaching Area</td>
<td>Primary School</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>High School</td>
<td>3</td>
</tr>
<tr>
<td>Years of School Teaching</td>
<td>0 – 9</td>
<td>0</td>
</tr>
<tr>
<td>Experience</td>
<td>10 – 19</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>20 – 29</td>
<td>3</td>
</tr>
</tbody>
</table>

### 6.7.4 Part B Recruitment procedure

The recruitment flyers calling for participants (Appendix C.2) were posted on noticeboards and doctor’s surgeries as permitted by Ethics Amendment (Appendix E.5). The poster stated: “Digital media in schools: students with migraine”. The focus of migraine was carried over from online participant group to contextualise the concept of visual light hypersensitivity. In addition, migraine was used as this is a lay term easily identified by a large proportion of the population and all members of this group become light hypersensitive during an episode. The use of flyers posted in doctor’s surgeries as a method of participant recruitment was successful. The flyers directed interested parties to a website (www.photosensitivity.info/R) which hosted the information letters which contained further instructions for participation, including dates and times to call for a phone interview. Both documents displayed contact email addresses for the author and also Murdoch University’s Research Ethics Office.

Due to ethical restrictions for teachers currently practising in schools, recruitment of teachers was restricted to teachers who had attended one of the professional learning (PL) seminars and workshops facilitated by the researcher prior to beginning her PhD candidature (November, 2015). At the time of creation of the seminars and workshops, evidence-based practices and universal design suggestions were provided by the researcher’s study from her MEd (research) degree (Sproul, 2014a). The PL seminars and workshops facilitated by the researcher were held at school staff meetings at a variety of educational institutions, research conferences and an allied health symposium. Each PL session satisfied a range of AITSL standards as shown in Table 4.1 (Chapter 4) and included elements defined in Appendix J.3.

Specific information letters were accessed by pressing the button labelled “ex-student 18+” (past student), “parent”, or “teacher”. Additional information was included
in the information letters regarding student, parent and teacher requirements (Appendices H.1, H.2 & H.3 respectively).

As stated in the information letters, past student and parent interviews were conducted between 13 and 23 November, 2017. Teacher interviews were conducted between 27 November and 7 December, 2017. All three participant groups were asked for consent to participate in the interview, students and teachers had additional criterion to satisfy (Appendix I).

Following consent for interview participation, all participants were interviewed using a semi-structured approach to elaborate and explain information that was revealed in Part A.

6.8 Development of instrumentation

Findings from Chapter 2 and 3 informed the structure of instruments. As the focus of digital media use was during school hours, past research instruments were modified to suit research questions. Part A instruments were of survey design, Part B were interview design.

Part A comprised student and parent surveys, linked by unique personalised codes to provide anonymity alongside consent. The structure of the student surveys was heavily influenced by MSRP (2007) whilst the main aim of the parent survey was to provide consent and demographic data.

Part B comprised semi-structured interviews guided by the questions found in Appendix L. The Past students were asked to recollect on their own experiences (Appendix J.1). Parents of students with VLH were asked to explain and elaborate on questions linked to interactions with schools and accommodations used at home by the student (Appendix J.2). Teachers were asked to elaborate on recount experiences from the Professional Learning experience (summary of PL in Appendix J.3). Teachers were asked to elaborate on experiences with accommodations trialled in the classroom since their PL day (Appendix J.4).

6.8.1 Part A Current student survey

The current student survey addresses Research Question One (a):
What is the duration and purpose of educational digital media use during a school day (including homework)?

a. in a contemporary high school education in Western Australia as reported by current students, with and without VLH.

The survey design allowed student voice on effects, supports, barriers and accommodations used by the student as well as providing a link to the parent survey to provide consent. The largest component of the student survey was a “diary” of the activities linked with digital media and education throughout the day.

Diaries have been used in past research to examine students’ use of digital media (Appendix K.1). The scaffold for this project’s student diary (survey) was taken from a large scale longitudinal study into Australian children’s media and communication use by the Australian Communication and Media Authority (ACMA; MSRP, 2007). The ACMA study began in 1995, repeated in 2007 with the inclusion of questions reflecting new technology, aiming to record children’s use of media and communication devices in minute detail, hence reliability of this instrument has been denoted as “high”. However, the ACMA studies did not include the presence of Interactive whiteboard or data projectors within classrooms and did not differentiate between styles of mobile learning (e.g., iPad, laptop) therefore the validity of the ACMA instrument for educational digital device use is moderate. Two previous digital media diary investigations used 24-hour recall by students to complete “media use” diaries (Olds, Ridley & Dollman, 2006; Rideout, Foehr & Roberts, 2010); ACMA investigations required chronicle by students during activities, whilst an excluded diary sample used parental reflective estimation of student use (Waldie et al., 2014). Two closely examined digital media use for non-school hours (MSRP, 2007; Waldie et al., 2014) whilst two included school media activities as part of investigation (Olds, Ridley & Dollman, 2006; Rideout, Foehr & Roberts, 2010). The diary project by Olds, Ridley and Dollman (2006) did not document degree of testing, used whole classes (potentially adding teacher modifier) and did not report responsive survey design.

The construction of student diaries (survey) for this study was informed by and has many similarities to the diaries used in Olds, Ridley and Dollman (2006), MSRP (2007) and Rideout et al. (2010) therefore a comparison of factors has been constructed (Appendix K.2).

Instrument rigour

This project’s survey instrument development incorporated pilot testing, dummy calculation runs and responsive survey design (Axinn, Link & Groves, 2011). Reliability

90
was decreased due to the human variables of time approximation and “end-of-day” recall. To counter this a scaffold was incorporated to cue recall based on the school timetable. The survey in this research used elements of the MSRP (2007) formatting (Appendix K.1), however used end of day data recall similar to Olds et al. (2006) and Rideout et al. (2010). The current research retained the method of self-reporting surveys and added the element of anonymity through online access.

The developed survey assumes static digital media use across schools and students, which decreases its reliability. There is a high correlation between required information regarding quantity of digital media use in classes and the returned data as it used well defined parameters for student device use for educational purposes. This was achieved by increasing the options from the MSRP (2007) survey and targeting school days only. One element of process data or “paradata” about the data collection process (Axinn et al., 2011) altered through the course of the survey. It was related to the number of required surveys for participants to complete. In the July 2016 model, three surveys were required from each participant to follow more closely the experimental design of MSRP (2007). Following the process suggested by Axinn et al.(2011), during the course of amendments to ethics applications the design was altered, requiring only one survey per participant to achieve a higher response rate. This method of alteration in design is termed “responsive design” (Groves and Heeringa, 2006).

*Single day recall*

Choice of digital media recall time period for the proposed investigation was influenced by validity of recall research. Single day recall has been demonstrated as more reliable than longer periods of time (Baranowski, 1988; Cale, 1994) therefore the format of the student’s diary (survey) in the current research used end-of-day recall. Segmentation of the day also improves recall (Baranowski, 1988; McKenna, Foster & Page, 2004) therefore the student surveys for the current research used the student’s personal school timetable (classes) for time period segmentation (Appendix L.1). As Chang et al. (2010, n=30) demonstrated both overestimation and underestimation in computer use duration by college students and workers, it is acknowledged that the current research using self-reporting of computer use duration will return responses that are inclusive of error. Chang et al. (2010) concluded that repeated measure sampling was more successful, and commented that 21 of the participants acknowledged that some of their computer work was carried out on a device other than the device whose use was being measured. The current research aimed to allow for multiple device use during calculation of digital media use per subject (Appendix L.2).
End-of-day Surveys

This research focused on educational digital media used in classrooms rather than at recess/lunch/travelling to and from school or after school as entertainment (and this will likely underestimate total daily digital media use). As there was no existing end-of-day instrument to measure high school digital media use within the required parameters, it was necessary to modify existing instruments. The decision to use end-of-day was partly influenced by the knowledge that whilst a school may endorse the project, individual teachers may not necessarily support data collection within their classroom during the lesson, and an extra error may be introduced. Using end-of-day recall for all participants (rather than presented as an option, or forced due to circumstance) removed this potential extraneous between-student variable. Although Rudestam and Newton (2014) acknowledge the occasional need for instrument modification, they caution that norms may be affected for both reliability and validity. Rudestam and Newton (2014) continue to suggest parallel use of an established measure, however, this was not possible for this investigation because of potential error described above and introduction of Interactive whiteboard use.

Personalised surveys

The survey used in this research applied participant student’s personal school timetable (classes) for time period segmentation. Flexibility in analysis of these time segments was necessary as high schools in Perth, Western Australia use a range and combination of class durations through the school day from 40 minutes to 75 minutes at the discretion of the individual school. MSRP (2007) collected data every 15 minutes using dots allocated to each time frame (Appendix K.1). Two of the potential between-school extraneous variables were identified prior to instrument modification; the first was of differing class durations, the second was the issue of 15-minute intervals if a student was moving from class to class causing a single block to span two different subjects. To eliminate both of these variables, this project used the participating student’s own timetable as a scaffold (Survey Monkey smart logic) (Student Survey Items Appendix L.1) then collected data in quarters of the lesson (Appendix L.2).

Smart logic is an embedded option in the survey platform provided by Survey Monkey. By selecting this option and designating specific responses to be transferred to identified locations, a personalised scaffold can be synthesised. This process is demonstrated in Appendix G.2, where Questions 8 through to 15 have their answers inserted into the table in Question 18. This provides Question 18 with a scaffold for
end-of-day recall by supplying subject names, along with pull down menus offering choices for digital media use within each class.

The “quartered” lesson time frames used by this project did not require students to make judgements regarding which class to document digital media use during class changeovers (many are 50 or 55 minutes in length). This coincidence of 50- and 55-minute classes also allowed data collection time intervals to be closely aligned with the MSRP (2007) 15-minute time intervals (Appendix K.1). The 15-minute blocks were validated by the MSRP (2007) study, however, a student “is likely to overstate the total time spent on activities that only took up part of the 15-minute block (this is the same method as used in 1995)” (p. 44). This error is decreased in one aspect of the present study by using the option in the drop-down menu for data collection referring to a digital media device being used “All” session, which is unambiguous in meaning. However, additional error is introduced with portion allocation of digital media use in lessons, as well as travel time between classrooms (can take 3 or 4 minutes). Collection of data determining participating student’s time in class used two items: data from Question 16 (Appendix G.2) referred to “normal” class length and Question 17 requested any alteration to the normal class time.

The application of the modified instrument to a pilot group was undertaken in October, 2016. Using responsive survey design (Axinn et al., 2011), elements of design raised by the pilot group (including access to surveys) led to modifications to the survey instrument. These modifications included more detailed instructions preceding the Student survey question 8 (Appendix G.2), embedding the student information letter in the first page of the survey, as well as extending information describing light sensitivity in the Parent survey preceding question 6 (Appendix G.1).

**Mediating factors embedded in survey**

Mediating factors can affect perceived reaction to visual light. Five mediating factors identified in academic literature were proposed as items for the survey, four were granted approval from Murdoch HREC. A targeted search for reliable instruments for migraine diaries was carried out during November 2015 using the database Medline. The search terms used were migraine and diary. Search results were excluded if they had non-English text, were citations only, did not contain the words diary or journal in the title or were published before 2005. The eleven titles included publications were inspected for the following elements: (a) diary results (b) diary items pursuant to this investigation. Appendix M.1 shows a summary of references to diary results, diary items.
The following mediating factors were retained as stimuli for specific survey items:

- “Fatigue” is positively correlated with light sensitivity (Shigihara et al., 2010) and “sleep” deprivation is a risk factor for migraine (Verotti et al., 2012), so an item using a Likert type scale response was added asking student to rate the previous night’s sleep as None, Some or Lots.
- “Medication” for migraine can be classified as preventative or intervention. An item regarding medication was added asking student to note medication intake as None, Intervention (I took it when I started feeling unwell), Preventative (I take it every day) or Other (not for headache or migraine). Multiple answers were permitted in the online survey, allowing verification whether medication taken was in response to headache/migraine or other. Within the general adolescent population, the percentage who use analgesics for intervention headache relief is 0.5% (Dyb, Holmen & Zwart, 2006), with a higher percentage of females than males actioning this option. Use of preventative medications also highlighted potential mediating factor for some students with migraine.
- Lack of “breakfast” (food) is identified as a mediator for headache/migraine stimulus. Skipping breakfast was revealed as an identifier of those students with the more painful headache attacks (p < 0.0001)’ (Appelbaum, Cain, Darling, & Mitroff., 2013). Lots was used as opposed to good as indicator of breakfast size to prevent misunderstanding regarding breakfast taste.
- “Luminance” of light sources can trigger migraine or exacerbate symptoms. The theme of environmental light preferences was continued with a survey item investigating student preference of screen brightness as sensitivity to brightness are present during and between migraine episodes (Bruhn et al., 2007; Chu et al., 2011; Nguyen, McKendrick & Vingrys, 2012). The item focussed on student’s own computer and preferences, rather than default parameters which are outside student control. A graduated fixed response scale with the addition of Don’t know was used to measure preference of computer screen brightness.

Any items with reference to pain were required to be removed from the survey as a condition of ethics approval (Appendix M.2 & M.3), however, two items were reworded. These binary response items asked whether the student was self-reporting sensitivity to light before (Q 4, Appendix G.2) or after school (Q 19, Appendix G.2). A text box allowed the option of extra detail to be added to the student participant response.

The item regarding homework using digital media was exploratory and used only a comment box. The question required an estimation of duration of a single night’s
homework completed on digital media. However, the estimation may have been entered prior to the online homework being completed. The text box allowed for text answers to be entered, allowing for description of homework patterns or processes. The exploratory investigation aims to reveal trends for further investigation in Part B of the sequential explanatory approach.

6.8.2 Part A Parents of current student survey

Parents provide a different perspective to the phenomenon of VLH. The primary purpose for this survey was to facilitate parental consent for student participants whilst retaining anonymity within an online survey. The parent surveys were designed to link with the student surveys and provide extended demographics. The secondary purpose was to gather general information regarding accommodations as well as experienced parent/school interactions as stated in Research Question Two.

The parent survey begins to address Research Question Two.

What is the interaction experience of parents working with the school on behalf of students with visual light hypersensitivity regarding accommodations and access to learning activities?

Research Question Two refers to

- “parent” as the adult supervisor of school age participants.
- “experience”. Individual parents have different experiences of schools, policies and programs for mainstream and inclusive education.
- “schools”. By law in Western Australia, all individuals under 17 years and 6 months of age attend an educational institution.
- “parent/school interaction”. This investigation gathered quantitative data regarding frequency of parent/school interactions in advocacy for students with VLH.
- “accommodations” being any alteration to learning activities, environment or timing of tasks.
- “access” as the ability to participate fully in a learning experience.

This section was prompted by repeated questions on social media for students with migraine (Pediatric Migraine and Headache Disorders Network, Facebook page), such as “Has your child had a spike in frequency since school started?”, “How many of you
have a 504 plan for your child? Has it helped?” with varying responses. As all students with migraine have VLH, these questions are pivotal to the gap in current knowledge for parents.

As symptoms of VLH can exist for years before an official diagnosis, the survey includes opportunities for inclusion of both presumptive and official diagnoses. Also, as migraine (including VLH) may be a side effect of another syndrome, the possibility of comorbidity was incorporated into the survey. If the parent has identified their child as being sensitive to light (Appendix G.1, Question 8), then the following items were automatically added to the survey using smart logic. These items included requests for information about digital media, lighting and support provided by teachers (Appendix G.1, Questions 9 – 18). For example, Question 9 asked, “Has child 1 ever spoken to you about having a reaction to using computers and digital media at school? If yes, please give an example”. This allowed parent interpretation of student comments to be reported. Question 11 asked, “What action by teachers has been most supportive of your child’s light sensitivity?”. This item gave parents the opportunity to describe current accommodations that were being used to facilitate student’s access to learning activities.

Request for data from “previous school” as well as “current school” was prompted by parent comments online about difficulty in speaking with high school teachers regarding accommodations for students with VLH. This was held in contrast with the relative ease of speaking with the primary school classroom teacher in both access and approachability (online comments, Pediatric, Teen & Young Adult Migraine & Headache disorders parent support, Facebook page).

Demographic data as described in the information letter (Figure F.1) were requested. This included the size of the city, socio-economic advantage and disadvantage (SEAD), as well as diagnoses incorporating student’s light sensitivity. “Socio-economic advantage and disadvantage can be defined as people’s access to material and social resources, and their ability to participate in society” (Australian Bureau of Statistics, ABS, 2018). “Socio-economic advantage and disadvantage” was chosen as an equivalent descriptor for “socio-economic status” as this replacement is used for descriptive statistics by the ABS (2018). This was relevant as the “ability to participate” is central to inclusion through the model proposed in this research.

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2 504 plans (USA) are similar to IEPs (Australia)
6.8.3 Part B Past student interview

Past students provide a retrospective window into recent history on digital media use in classrooms and for homework. As the participants would have attended high school between 2010 and 2017, these data gives insight into duration of digital media use for different subjects during a period of rapid digital media uptake in schools. Students with and without VLH were invited to participate in a phone interview, allowing comparison of experience.

The student interview addresses Research Question One (b).

What is the duration of educational digital media use during a school day (including homework) as remembered by past students?

The semi-structured interviews explored the digital media experiences of students as they attended school. The Oral Use Consent Questions (Appendix I.1) allowed anonymity and consent to be given for phone interviews. Interview questions (Appendix J.1) invited memories of digital media use at both primary and high school and demographic items referring to current age and previous high school environment. Six interviews were conducted between 13 and 23 November, 2017. Of the two male and four female participants, all attended high schools in Perth, Western Australia.

6.8.4 Part B Parents of students with VLH interview

The parent interview aimed to expand on themes generated by the parent survey responses. These responses focused on interaction with schools to support continued inclusive education of identified student with light hypersensitivity. The sequential explanatory approach used in the current research allowed focus points identified in Part A to be further investigated during semi-structured interviews. Focus points included whether the school was aware of the student identifying as having VLH, accommodations used at home and best practices by current teachers.

The Parents of students with VLH interviews addressed Research Question Two.

What is the interaction experience of parents working with the school on behalf of students with visual light hypersensitivity regarding accommodations and access to learning activities?

The Oral Use Consent questions (Appendix I.2) allowed anonymity and consent for a phone interview. The questions for the phone interview (Appendix J.2) were based on the Parent survey questions. The five interviews were conducted between 13 – 23
November, 2017. Of the one male and four female participants, all reside in Perth, Western Australia. Socio-economic advantage and disadvantage (SEAD) of location surrounding children’s schools were either medium or high.

6.8.5 Part B Teacher interview

The inclusion of teachers in Part B of the sequential explanatory approach allowed investigation of lived experience on incorporation of elements of universal design. The elements of universal design were focused on increasing active participation of students with VLH in classroom digital activities. These elements of universal design would be termed digital participatory pedagogies (Dooley et al., 2016) and recorded as levels of differentiated teaching or supplementary support of students with VLH for the NCCD (Commonwealth of Australia, 2019). The teacher interview aimed to capture pedagogical influences and longevity of any changes to pedagogy following attendance at one of the PL seminars conducted by the researcher.

The Teacher interviews address Research Question Three

What is the pedagogical experience of practicing teachers (who have attended a profession learning seminar on visual light hypersensitivity) regarding inclusive digital media access for students with visual light hypersensitivity?

Research Question Four refers to

- “teachers” as educators in school learning environments.
- “inclusive pedagogy”. In the proposed investigation inclusive pedagogy incorporate two types of classroom practice. The first is alteration of classic to universal design to elevate the access of all students. The second is the group of classroom practices specific to students with visual light hypersensitivity. The term inclusive refers to the opportunity to fully access learning experiences.

Teachers were asked to complete Oral Use Consent Questions (Appendix I.3) which included verification of attendance at a PL seminar on VLH. The interview questions focussed on digital participatory pedagogies and accommodations they had subsequently used in class (Appendix J.4). The five interviews were conducted between 27 November and 7 December, 2017.

6.9 Data analysis student and parent surveys

This section outlines the procedure for inclusion of surveys, coding, cleaning, and calculating duration of digital media use whilst compensating for individualised school
timetables. The current research supersedes the previous non-flexible model by personalising the program for students, the previous research required students to enter activities every 15 minutes (MSRP, 2007).

6.9.1 Parent survey inclusion and exclusion

Exclusion of surveys prior to data analysis was based on completion of survey (Table 6.6). Two surveys were excluded as they contained no information at all (answers were not required to move to next item). Ten surveys were excluded due to partial information (participant completed no more than codenames of children). Thirty seven surveys were returned with complete data sets and parental permission and therefore included in the analysis.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of surveys in category</th>
<th>Number of surveys after this level of cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>All returned surveys</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Exclude all surveys containing no information</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td>Exclude all surveys with partial information*</td>
<td>10</td>
<td>37</td>
</tr>
</tbody>
</table>

* included student survey codenames which were collected as evidence of parental permission

Data directly dealing with interactions of parents with school was supplied by six parental responses, corresponding to six student participants and six student surveys.

6.9.2 Current student survey data coding

Student survey data was downloaded from Survey Monkey platform on December 1, 2018 as Excel (xcv). Parental survey data was downloaded on the same day to verify parental permission for student surveys. Exclusion of surveys prior to coding and data analysis was based on lack of parental permission, submission of incomplete survey or survey containing non-classroom based information. Twenty four surveys were excluded as they contained no information at all (answers were not required to move to next item), one survey was excluded as not a “school” day (“cricket” was in every space). Forty one surveys were excluded due to partial information (participant completed no more than names of classes attended). Six surveys were excluded as there was no link demonstrating parental consent for potentially underage participation in research. Ninety five surveys were returned with complete data sets and parental permission and therefore included in the analysis (Table 6.7).
Table 6.7  Anonymous online survey exclusion categories prior to data analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of surveys in category</th>
<th>Number of surveys after this level of cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>All returned surveys</td>
<td>167</td>
<td></td>
</tr>
<tr>
<td>Exclude all surveys containing no information</td>
<td>18</td>
<td>149</td>
</tr>
<tr>
<td>Exclude all surveys containing no information beyond Consent and Codename</td>
<td>6</td>
<td>143</td>
</tr>
<tr>
<td>Exclude all surveys that are not school days</td>
<td>1</td>
<td>142</td>
</tr>
<tr>
<td>Exclude all surveys with partial information</td>
<td>41</td>
<td>101</td>
</tr>
<tr>
<td>Exclude all surveys with no parental permission</td>
<td>6</td>
<td>95</td>
</tr>
</tbody>
</table>

Use of computers by subject area

The subject areas that student survey responses were categorised into was based on the following list developed for the OECD3 Teaching and Learning International Study (TALIS) (OECD, 2013), and subsequently used in the IEA4 International Computer and Information Literacy Study (ICILS) (Fraillon et al., 2014).

- Language arts: test language;
- Language arts: foreign or other national languages;
- Mathematics;
- Sciences (general science and/or physics, chemistry, biology, geology, Earth sciences);
- Human sciences or humanities (history, geography, civics, law, economics, etc.);
- Creative arts (visual arts, music, dance, drama, etc.);
- Information technology, computer studies, or similar; and
- Other (practical or vocational subjects, morals/ethics, physical education, home economics, personal and social development).

Whilst these categories may suit global investigation of computer literacy for students in their 8th year of schooling, they were limited in their application across the broader high school community due to the range of subjects encompassed by the “Other” category. The Other category was revised to become 5 categories: Administration, Certificate, Phys Ed, Religion, Food. This increased the number of student subject categories from eight to twelve. The individual subject names (classes) within these categories are shown in Table 6.8. The table sets out all student participant classes and their assigned category and code.

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3 Organisation for Economic Co-operation and Development
4 International Association for the Evaluation of Educational Achievement
Table 6.8  Assigned categories and codes for student survey participant classes.

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Words entered by student survey participants to describe their classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths</td>
<td>M</td>
<td>Maths, math, Methods, Math Apps, Math App, Math Specialist</td>
</tr>
<tr>
<td>Science</td>
<td>S</td>
<td>Science, Biology, Human, Human Biol, Biol, Physics, Chemistry, Chemistry</td>
</tr>
<tr>
<td>English</td>
<td>E</td>
<td>English, Creative Writing, Creative Writing, Literature</td>
</tr>
<tr>
<td>HASS</td>
<td>H</td>
<td>HASS, Politics and law, Business and enterprise, Humanities, Geography, Accounting and Finance</td>
</tr>
<tr>
<td>Creative Arts</td>
<td>CA</td>
<td>Drama, Fabric and Design, Music, Fashion, Photography, Dance</td>
</tr>
<tr>
<td>Technology</td>
<td>T</td>
<td>Computing, Digital Technologies, Computer graphics and design, Media, digital technology, design and technology, computer aided design</td>
</tr>
<tr>
<td>Administration</td>
<td>A</td>
<td>Assembly, Form, Thrive, LLG</td>
</tr>
<tr>
<td>Certificate</td>
<td>Ce</td>
<td>Certificate III, Cert II</td>
</tr>
<tr>
<td>Physical Education</td>
<td>PE</td>
<td>Sport, sport and fitness, Phys Ed, PE studies, Physical Education</td>
</tr>
<tr>
<td>Language other than</td>
<td>L</td>
<td>Japanese, Italian, French, language</td>
</tr>
<tr>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religion</td>
<td>R</td>
<td>Christian Ed</td>
</tr>
<tr>
<td>Foods</td>
<td>F</td>
<td>Food and Textiles, cooking, food and nutrition</td>
</tr>
</tbody>
</table>

6.9.3  Current student survey data cleaning

In their comparative article between step-wise regression and multiple imputation, Pampaka, Hutcheson, & Williams (2016) remark on the frequency of the first and infrequency of the second process through educational research literature. Following their suggestion that exclusion of entire participant responses due to missing a single data point may introduce errors not immediately apparent to the researcher, semi completed student surveys were incorporated into elements of the data analysis such as the number of students reporting light sensitivity. (However, students without parental permission were not included in the study due to requirements of HREC.) The other two recommendations by Pampaka, Hutcheson, & Williams (2016) consist of reporting the details of the missing data and reporting the sensitivity of the missing information. For example, the number of surveys returned with only consent and codename = 6 (Table 6.7) and the student surveys could be construed as sensitive as they required consent to participate to continue with the survey (“Yes” button). If the student did not wish to continue (“No” button), the survey would have ended and a blank form submitted. Interestingly, four of the six that were returned with only consent and codename used pseudonyms found in one or more completed surveys (e.g., Budgiesarefluffy), this would suggest that occasionally students were unable to complete a survey on the first attempt.
6.9.4 Current student survey calculation of digital media use by subject area and duration

Student survey items included environmental items such as sleep and breakfast, as well as “snapshot” of school day using scaffold of participant classes and digital media use by device type. There were 167 student surveys returned anonymously.

Determination of student participant Year group (7-10, 11-12) was by class name. The School Curriculum and Standards Authority (SCSA) designates specific names for Year 11 and 12 subjects within a learning area. Students in Year 7-10 study general Science, Maths, English and Humanities and Social Sciences (HASS). Students in Year 11 and 12 choose to study specific subjects within each of these learning areas. For example “Maths Methods” is a higher level of mathematics curriculum than “Maths Application” (Maths Apps) and “Politics and Law” covers different curriculum material to “Geography”. Using the self-reported names of classes, participants were categorised as students in Year 7 – 10, or Year 11 – 12.

Calculation of participating student’s time in class was a product of normal class length multiplied by number of named classes (provided by student). This was denoted as “instructional time/day” as it did not include recess or lunch time. Expected instructional time/day results were between 270 and 370 minutes. These values assumed classes began between 8:30am and 9:00am and finished between 3:00pm and 3:30pm, with approximately 20 minutes for recess and 30 minutes for lunch. Determination of the absolute value “duration of digital media use” employed only the largest reported duration from a single device type for each individual class (n=593) as demonstrated in Appendices N.1 and N.2. Duration of digital media use per device type was measured in “quarters” of a class, therefore “0” denotes no reported use of that device type within the class, “1” denotes reported use of that device type for one quarter of the class etc. Appendix N.1 displays reported digital media use by device type from seven participants for Classes 1 and 2. To calculate total digital media use per day, the single longest duration was taken from each class (rather than using cumulative durations which would ignore possibility of multiple devices being used simultaneously). Although this ignores the possibility of digital devices being used sequentially, it counters the possibility of over exaggeration of reported digital media use as reported by Chang et al. (2010).

Individual subject digital media use (relative measure) was determined by highlighting all classes within a subject area, together with the largest reported duration

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5 https://k10outline.sc.sa.wa.edu.au/home/teaching/curriculum-browser/humanities-and-social-sciences
from a single device type for each individual class (n=593). An example calculation is shown in Appendix N.3 which displays individual subject areas and largest reported duration from a single device type from three participants for each subject area attended during the day, Science is highlighted in green and English in yellow. The highest potential use of digital media in a class is 4 quarters, and total classes within a subject area are cumulative, therefore the amount of digital media used within a subject area can be calculated. Appendix N.4 calculates the percentage of digital media used within the subject areas of Science (58.3%) and English (25%) from Appendix N.3. Although the example would not be reliable as the data set of classes is so small (n=3), it demonstrates the process used in the current research (n=593) across 12 subject areas.

The data reported by student survey participants were quantitative using a relative measure of quarter class duration. Since all classes used a whole class as a reference, these measurements could be analysed and a relative mean duration of digital media use by device type determined. Appendix N.5 shows a snapshot of IAW use by three participants across six classes (the entire day), measured in quarter classes. Appendix N.6 uses this data to demonstrate process of calculation of the mean percentage of each digital media device (IAW/computer/iPad/phone/TV) used during a single lesson.

| Table 6.9 Demographic information for student surveys from student and linked parent surveys |
|-----------------------------------------------|-----------------------------------------------|
| Category                                      | Detail                                         | Number of surveys (%) |
| Year group (at high school)                   | Year 7 – 10                                    | 74 (77.9)             |
|                                               | Year 11 - 12                                    | 21 (22.1)             |
| Category of school                            | Independent                                     | 95 (100)              |
| Category of location                          | Large city (>2 000 000)                         | 33 (34.7)             |
|                                               | Small city                                      | 24 (25.3)             |
|                                               | No response                                     | 38 (40.0)             |
| Socio-economic advantage and disadvantage (SEAD) of school environment (Likert scale) | 1 (Low)                                        | 1 (1.1)               |
|                                               | 2                                              | 2 (2.1)               |
|                                               | 3 (Medium)                                     | 8 (8.4)               |
|                                               | 4                                              | 19 (20.0)             |
|                                               | 5 (High)                                       | 17 (17.9)             |
|                                               | No response                                     | 48 (50.5)             |
| Student reported not sensitive to light        | Total                                          | 68 (71.6)             |
| Student reported sensitive to light            | Before school only                             | 9 (9.5)               |
|                                               | After school only                              | 9 (9.5)               |
|                                               | Before AND after school                        | 9 (9.5)               |
|                                               | Total                                          | 27 (28.4)             |
| Parent reported student with VLH              | VLH and linked medical diagnosis               | 5                     |
|                                               | VLH, but no diagnosis                          | 1                     |
| Sleep (from the night before)                 | None                                           | 1 (1.1)               |
|                                               | Some                                           | 54 (56.8)             |
|                                               | Lots                                           | 40 (42.1)             |

103
<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>None</td>
<td>16 (16.8)</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>54 (56.8)</td>
</tr>
<tr>
<td></td>
<td>Lots</td>
<td>25 (26.3)</td>
</tr>
<tr>
<td>Medication (taken that day)</td>
<td>Preventative* only</td>
<td>6 (6.3)</td>
</tr>
<tr>
<td></td>
<td>Intervention* only</td>
<td>12 (12.6)</td>
</tr>
<tr>
<td></td>
<td>Preventative AND Intervention</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Intervention AND Other</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>4 (4.2)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24 (25.3)</td>
</tr>
<tr>
<td>No medication (taken that day)</td>
<td>Total</td>
<td>71 (74.7)</td>
</tr>
</tbody>
</table>

*Preventative: taken every day

A total of 95 student surveys were included in the analysis. The demographic information data matched from parental surveys to student surveys is summarised in Table 6.9 together with the participant’s categorised Year group.

### 6.10 Analysis of qualitative responses

The items focusing on self-report of visual light sensitivity were in two sections of the survey for Current Students. The first was near the beginning and asked students to reflect on the morning, the second was near the end to report on sensitivity to light after school. Each was accompanied by a comment box to allow for elaboration.

The comments were examined using thematic analysis (Fereday & Muir-Cochrane, 2006). This involved generating qualitative codes (Boyatzis, 1998) informed by the literature and reading through all of the comments (Boyatzis, 1998; Bowen, 2009). The list of codes is summarised in Table 6.10 as a template in the style of Crabtree and Miller (1999). The physiological based themes ranged from No sensitivity through to Pain, whereas process themes included elements linked with both stimuli and accommodations. This coding template was also used for the comments added to the Parent Surveys.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Sensitivity</td>
<td>Environmental light stimulus causes no negative reaction from participant.</td>
</tr>
<tr>
<td>Distraction</td>
<td>Environmental light stimulus causes low level negative reaction from participant.</td>
</tr>
<tr>
<td>Discomfort</td>
<td>Environmental light stimulus causes adverse reaction from participant below pain threshold</td>
</tr>
<tr>
<td>Pain</td>
<td>Environmental light stimulus causes pain for participant</td>
</tr>
<tr>
<td>Non-specific Sensitivity</td>
<td>Environmental light stimulus causes unspecified reaction for participant</td>
</tr>
<tr>
<td>Stimulus Identification</td>
<td>Specific stimulus causing light sensitivity identified</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Stimulus Avoidance</td>
<td>Articulation of stimulus avoidance as process or completed task</td>
</tr>
<tr>
<td>Accommodation Identification</td>
<td>Description of specific accommodations used to facilitate active participation in learning activities</td>
</tr>
</tbody>
</table>

Descriptions were generated from literature review, social media blogs such as Chronic Migraine Ellie (Ellie, 2016a, 2016b) and My Migraine Life (Rathsack, 2014, 2017) and Facebook pages (Pediatric Migraine and Headache Disorders Network, Migraine Again). Contextual references were combined into labels and descriptions “stimulus identification”, “stimulus avoidance” and “accommodation identification”.

### 6.11 Summary

The transformative mixed methods approach allowed the voices from the VLH community to give unique perspectives on perceived barriers and practical accommodations for digital media use in education. Part A enabled an overview of general trends. These trends included digital device types, duration of use and accommodations.

Elements of the trends identified in Part A were elaborated in Part B, as part of the sequential explanatory design. Past students described experience with digital media in education. Parents described perspective of advocacy for students with VLH and accommodations used at home. Teachers described experiences with accommodations within the classroom to allow increased participation for students with VLH.
Chapter 7  Major Findings

The major findings of the mixed-method sequential explanatory study are presented in this chapter. A systematic literature review informed the construction of a survey instrument and interview design from which the findings are drawn. The chapter begins by highlighting key findings from the literature review, which revealed the significant gap in society’s awareness of students with VLH and the lack of workplace health and safety policy documents that address the needs of this growing cohort within schools. The findings are reported in two sections that reflect the sections of the explanatory study: Part A, a majority of quantitative data collected from student surveys and demographic, quantitative and qualitative data from parents of current student surveys; Part B, qualitative data collected from interviews with past students, feedback from parents of past students and insights about teacher accommodations and awareness. The qualitative data presented in Part B are organised into themes that highlight experiences of digital media use, challenges faced and accommodations used by students with VLH.

7.1  Part A Digital media used by current students

This section captures the frequency of usage of digital media in schools presented as a percentage of class time used across subject areas. The findings build on the work of the Media and Society Research Project (MSRP, 2007) by providing descriptive statistics of contemporary educational digital media use, divided into the subcategories of school (Classroom), home (Homework) and total (Total). It adds to MSRP (2007) data by classifying school digital media use by academic subject and digital device type. Analyses between groups of students were carried out at three levels: Students with VLH vs. Students without VLH; lower school students vs. upper school students; and upper school students with VLH vs. upper school students without VLH. Preferences by groups for screen brightness is also analysed.

Data entered by students as “class length”, number of “classes” and “exceptions to normal class length” were used to calculate total instructional time per day for each student survey. There were five potential classroom digital media device types (IAW/computer/iPad/phone/TV) accounted for in this survey. Table 7.1 displays a summary of educational digital media use across the categories of School, Home and Total in minutes per day.
Table 7.1  Descriptive statistics of class durations and calculations of digital media use per day

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean (minutes, n=95)</th>
<th>Minimum (minutes)</th>
<th>Maximum (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class duration (normal)</td>
<td>51</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Classroom digital media minutes/day</td>
<td>177</td>
<td>45</td>
<td>330</td>
</tr>
<tr>
<td>Homework digital media minutes/day</td>
<td>74</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>Total digital media minutes/day</td>
<td>250</td>
<td>55</td>
<td>575</td>
</tr>
</tbody>
</table>

*Number of student days (n=95). Number of classes (n=593)*

The distribution of these data is shown in the following three figures. Figure 7.1 displays the number of hours of class time (instructional time) using digital media in one day reported in student surveys. Figure 7.2 displays the number of hours of homework using digital media in one day reported in student surveys. Figure 7.3 displays the total hours of digital media used in one day (cumulative classroom and home) reported in student surveys.

![Figure 7.1](image1.png)

Figure 7.1  Class (instructional) hours of digital media/day reported in student surveys

![Figure 7.2](image2.png)

Figure 7.2  Homework hours of digital media/day reported in student surveys
All but one student used digital media at some time during the school day, three students reported using it every class for the length of the entire class. The students reporting four or more hours of digital media use were upper school students, as determined by the subject area names entered into the survey. Upper school students demonstrating a longer period of time on digital media to complete homework than lower school was expected due to increased complexity of curricula. However the ratio of homework time spent on digital media compared to non-digital media was not known. This would be an area for future research.

In addition to total frequency of digital usage, the current research provided information regarding frequency of digital media access during different school subjects (subject use) similar to Fraillon et al. (2014). Each lesson was binary coded determined use/not use of digital media. Certificate studies incorporated use of digital media in every lesson (n=11), followed by Languages other than English (83%, n=23) and Technology (82%, n=44). The lower frequencies of digital media use within a class were Foods (28.5%, n=21) and Physical Education (27.5%, n=51).

To further investigate duration of digital media use, going beyond data collected in previous research, was the inclusion of an analysis of duration of digital media use within a single class (classtime). Mean percentage of classtime digital media use by subject area was calculated by taking the highest use device type per class and determining the mean by subject area. The highest mean percentage of classtime digital media use by subject area was Certificate studies with 90.6% (n=11), followed by Technology at 75% (n=44) and Humanities at 57.5% (n=93). The lower frequencies of digital media use in Learning Areas were found in Physical Education (14.7% of classtime, n=51) and Foods (14.5% of...
classtime, \( n=21 \)). The mean percentage classtime using digital media for each subjects area is shown in Figure 7.4, calculated using individual classes from student reports (\( n=593 \)).

![Figure 7.4 Average digital media use by subject area reported in student surveys](image1)

Due to student subject selections and timetabling, some subject areas were sampled more than others as shown in Figure 7.5. The most sampled subject area was Science with 127 classes in the sample, 34 of those classes used no digital media and 93 used some digital media. The least sampled subject area was the Certificate classes with only 11 classes being sampled, all using some digital media.

![Figure 7.5 Number of classes in sample by subject area. Unshaded column denotes no digital media used in the class, shaded area denotes some digital media used in the class.](image2)

Another variable determined by student self-reporting was use of different digital media devices within classes. Frequency of classes using specific digital media devices
(IAW/computer/iPad/phone/TV) was initially determined using a binary code for each of the classes (n=593) for each device. Table 7.2 displays the summary of these data, showing that IAW and computer use are accessed in many more classes than the iPads, phones (mobile) and televisions (digital).

Table 7.2  Frequency of class use of digital media device type

<table>
<thead>
<tr>
<th>Digital media device type</th>
<th>Number of classes accessing digital media*</th>
<th>Percent of classes used</th>
</tr>
</thead>
<tbody>
<tr>
<td>computer</td>
<td>353</td>
<td>59.5</td>
</tr>
<tr>
<td>IAW</td>
<td>316</td>
<td>53.3</td>
</tr>
<tr>
<td>phone (mobile)</td>
<td>41</td>
<td>6.9</td>
</tr>
<tr>
<td>iPad</td>
<td>32</td>
<td>5.4</td>
</tr>
<tr>
<td>television (digital)</td>
<td>31</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*Number of classes (n=593)

It is likely that the findings reflect current pedagogy used by teachers within classrooms and ease of access to personal digital devices for individual students.

7.1.1  Analysis of differences between groups for duration of digital media use and preferred screen brightness

It was important to capture the differences between groups to explore patterns and insight into usage and preferred screen brightness. The following provides comparative data between lower school and upper school students, students with VLH and students without VLH as well as upper school students with VLH and students without VLH. The findings highlight no significant difference in digital media use during school hours, however a significant difference was revealed for upper school students using digital media for homework.

Lower school and upper school students

There were four variables tested between these groups: school digital media (% of instructional time), homework digital media, total educational digital media and preferred computer screen brightness. Duration of digital media use was calculated as explained in Chapter 6. Student’s preference of computer screen luminance was ranked using a graduated fixed response scale with the addition of Don’t know. The scale was graduated using the following descriptors: very dim (opposite to bright), a bit dim, medium, a bit bright, very bright. Participants who did not answer this item were removed from the analysis (n=2), participants who answered Don’t know were also removed case wise (n=2).
As neither of the groups displayed normal distributions for three of the four variables, the data analysis was carried out using Mann Whitney U test. This test usually requires the assumptions of continuous data, two independent groups, independence of observation and not normal distribution (but same shape) to be upheld. The requirement of “not normal distribution (but same shape)” was not able to be admitted, so “means ranking” rather than “medians” were assessed (Laerd Statistics, 2018). From these data (see Appendix M.1) it can be concluded that:

i. the duration of school digital media (% instructional time) was significantly different for upper school (Year 11 & 12) students than for lower school (Year 7 – 10) students (U=497.500, p=.012).

ii. the duration of homework digital media (minutes) was significantly different for upper school (Year 11 & 12) students than for lower school (Year 7 – 10) students (U=236.000, p=.000).

iii. the duration of total educational digital media (minutes) was significantly different for upper school (Year 11 & 12) students than for lower school (Year 7 – 10) students (U=305.500, p=.000).

iv. the preferred screen brightness was not significantly different for upper school (Year 11 & 12) students than for lower school (Year 7 – 10) students (N=91, U=556.000, p=.082).

Students with VLH and students without VLH

There were four variables tested between these groups: school digital media (% instructional time), homework digital media, total educational digital media and preferred computer screen brightness. Neither group maintained a normal distribution throughout the variables, so Mann-Whitney U tests were used (means ranking).

From these data it can be concluded that:

i. the duration of school digital media (% instructional time) was not significantly different for students with VLH than students without VLH (U=834.000, p=.259).

ii. the duration of homework digital media (minutes) was not significantly different for students with VLH than students without VLH (U=786.000, p=.126).

iii. the duration of total educational digital media (minutes) was not significantly different for students with VLH than students without VLH (U=735.000, p=.055).

iv. the preferred screen brightness was not significantly different for students with VLH than students without VLH (U=810.500, p=.437).
Since no statistically significant differences were found between groups for any variables (Appendix M.2), the findings suggest that limited accommodations were made with relation to limiting screen time for students with VLH. The findings also raise some issues about students’ preferred screen brightness: Is it because students don’t know or is it because the preferred screen brightness is considered the ideal?

**Upper School Students with light sensitivity and students without light sensitivity**

Further investigation into the group identifying as upper school students (Year 11 & 12) firstly as the difference between mean rankings was close to significant in full participant analysis (Appendix M.2), secondly because the groups work with different subjects and curricula which may have had a moderating effect. The two groups were upper school students who are light sensitive (n=10) and upper school students who are not light sensitive (n=11). The three variables tested between these groups were school digital media (% of instructional time), homework digital media and total educational digital media. From this data (Appendix M.3) it can be concluded that:

i. the duration of school digital media (% instructional time) was not significantly different for upper school students with VLH than for upper school students without VLH (n=21, U=41.500, p=.339).

ii. the duration of homework digital media (minutes) was significantly different for upper school students with VLH than for upper school students without VLH (n=21, U=19.000, p=.009).

iii. the duration of total educational digital media (minutes) was significantly different for upper school students with VLH than for upper school students without VLH (n=21, U=26.000, p=.041).

These responses indicate that upper school students with VLH access digital media for a significantly longer period of time each day than students without VLH, both for homework (p=.009) and in total (p=.041).

Self reporting of sensitivity to visual light was present in 27 (28.4%) of the analysed student surveys, there were 18 (24.3%) from the lower school cohort and 9 (42.9%) from the upper school cohort. The categorisation of data was split between who reported sensitivity to light before school only, after school only and both before and after school (Table 7.3). Further analysis revealed that the majority of students reporting sensitivity to light before school only were in lower school, the majority reporting after school only were in upper school.
Table 7.3  Self reported sensitivity to light by lower and upper school students

<table>
<thead>
<tr>
<th>Period of sensitivity to light</th>
<th>Lower/Upper school categorisation</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before school only</td>
<td>Lower School</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Upper School</td>
<td>1</td>
</tr>
<tr>
<td>After school only</td>
<td>Lower School</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Upper School</td>
<td>6</td>
</tr>
<tr>
<td>Both before and after school</td>
<td>Lower School</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Upper School</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>27</strong></td>
</tr>
</tbody>
</table>

Twenty four students added comments following the items regarding VLH. Analysis of themes of revealed 23 (95.8%) indicated an adverse reaction of some type to visual light. The analysis of the qualitative data revealed three comments from students who did not identify as VLH, however described symptoms linked to the disorder: “My eyes are just tired” (SS9) which was coded as 2 (Distraction); “Sometimes I get sore eyes” (SS11) which was coded as 4 (Pain); “My eyes hurt most days” (SS129) which was coded as 4 (Pain). Table 7.4 displays a summary of the coding used for comment submitted in the current student surveys.

Table 7.4  Coding used for comment submitted in the current student surveys

<table>
<thead>
<tr>
<th>Code</th>
<th>Label</th>
<th>Identified in comments from current students identifying as VLH</th>
<th>Identified in comments from current students identifying as not VLH</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No sensitivity</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Distraction</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Discomfort</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Pain</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>Non-specific sensitivity</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Stimulus Identification</td>
<td>8</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Stimulus Avoidance</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>Accommodation identification</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

The areas of pain specified by participants were eyes (8) and head (3). Stimuli identified included sun (3), lights (3), tv (1), study (1) and concussion (1). Students who identified as not having VLH but identified symptomology and linked it with light sensitivity by using the comment box attached define an area for further study.
7.2 Part A Parents of current students’ interaction experiences

Participants (parents of current students) are distinguished by the identifiers PS1 to PS47. Each parent survey gave consent for one or more students to participate in the research. The surveys also provided an opportunity to comment regarding general observations, opinion of impact of VLH, accommodations employed at home and those requested or used at school for students with VLH.

The number of student participants given permission from individual parent surveys is shown in Table 7.5. This total is less than the number of student surveys cited as having parental permission, as some students completed surveys on multiple days (n=24).

<table>
<thead>
<tr>
<th>Number of Children</th>
<th>Number of surveys (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26 (55.3)</td>
</tr>
<tr>
<td>2</td>
<td>18 (38.3)</td>
</tr>
<tr>
<td>3</td>
<td>3 (6.4)</td>
</tr>
</tbody>
</table>

There were six parents who identified their children as students with VLH. One parent was interacting with the school on behalf of a student with VLH for the first time as the student had recently sustained a concussion, the symptoms of which included extended VLH. Table 7.6 documents the frequency (in years) of parental interactions, as well as interaction differences between previous and current school.

Five of the six parents had at some stage during the student’s school career initiated contact with the student’s teachers about VLH. Five of the six parents had at some stage during the student’s school career, requested accommodations for VLH. All parents had at some stage during the student’s school career, filed official documentation with their child’s school regarding VLH.
### Table 7.6 Parent initiated school interactions on behalf of student with VLH

<table>
<thead>
<tr>
<th>Focus of interaction</th>
<th>Previous school</th>
<th>Timeline</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal interaction with teacher</td>
<td>Previous</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (this year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>0</td>
</tr>
<tr>
<td>Request for accommodations</td>
<td>Previous</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (this year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>0</td>
</tr>
<tr>
<td>School documentation of VLH</td>
<td>Previous</td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (previous years)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (this year)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes (every year)</td>
<td>0</td>
</tr>
</tbody>
</table>

**Themes in parent survey responses**

Themes identified in survey responses by parents of current students revealed potential marginalisation of students with VLH. The themes varied from general ability to participate in learning activities to identification of specific barriers in the learning environment. Table 7.7 displays a summary of the coding and the frequency each was identified in Parent comments.

### Table 7.7 Summary of the coding and the frequency identified in comments by parents of current students

<table>
<thead>
<tr>
<th>Code</th>
<th>Label</th>
<th>Included in comments from parents of current students identifying as VLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No sensitivity</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Distraction</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Discomfort</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Pain</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Non-specific sensitivity</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Stimulus Identification</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Stimulus Avoidance</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Accommodation identification</td>
<td>6</td>
</tr>
</tbody>
</table>
Stimulus identification and accommodations are linked with reports of pain. Each of these themes are expanded in the following sections.

**VLH affects ability to participate**

Five of the six parents agreed with the statement, “Visual light sensitivity can affect Child 1’s ability to participate in school activities” as shown in Table 7.8. None of the parents of children with VLH disagreed with the statement.

<table>
<thead>
<tr>
<th>Likert scale</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>0</td>
</tr>
<tr>
<td>Disagree</td>
<td>0</td>
</tr>
<tr>
<td>Undecided</td>
<td>1</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 17 (Appendix G.1) asked, “Have there been any learning activities at school where Child 1 has not fully participated because of their light sensitivity?” included the following responses;

- There is a program online at school that cannot be printed off. The teachers did not have an alternative (PS3)
- Unsure (PS12)
- Sometimes gets a headache (PS14)
- Online tests have always been a struggle (PS30)

These responses identify the decreased participation in some digital learning activities and assessments for students with VLH. The extent to which the student with VLH is able to participate would alter between activities and individuals, however the majority of the voiced concerns were linked to online learning activities. Online learning activities are now available in all subjects and task types at the discretion of the teacher, from student-centred class roll taking/login by kindergarten students to collaborative projects using dropboxes, powerpoints, Youtube videos and some summative assessments.

---

1 Parent surveys contained the term ‘Visual light sensitivity’ as they pre-dated the terminology change to ‘visual light hypersensitivity’
**Accommodations used at school**

Five of the six parents of current students with VLH included description of accommodations used at school for their child to actively participate in learning activities;

Less computer work. (PS3)

The [school] this year rarely use computers during school hours. They use text books. Feeling better, attendance above 50%. [previously] did graded schooling, then went to a care school, as could not be accommodated as did not attend school. [Now the student] is allowed to leave the classroom or have a break. (PS12)

Seating options, she does better in natural light. Allowances to move seating in some classes, in other classes she is not allowed to. (PS19)

Wearing sunglasses, printing out all homework. (PS28)

Nothing other than a seating plan where [the student] sits at the front of the class but this is not always going to be best for every classroom in the school, teachers don't care they say that's where you need to sit. (PS30)

These comments include accommodation identification which is individualised for students. They also highlight the variation in teacher responses to IEPs.

**Accommodations used at home**

Five of the six parents of students with VLH who completed surveys included descriptions of accommodations used at home for their child to participate in learning activities after school hours, or when unable to attend school;

The house has been pretty dark, and that has helped. (PS3)

Low lights when not well. Does not attend to work at home when not well. (PS12)

We don't use fluorescent lights. Always have a break during homework online. (PS14)

Sitting next to a window, limiting time on computer, printing out any worksheets for draft copies on paper, use of tinted glasses. (PS19)

Lighting and printouts instead of working on the computer. (PS28)

Window light, desk position, non reflective surfaces. (PS30)

The comments here included stimulus identification (PS14) as well as stimulus avoidance (PS12). Four of the six parents mentioned accommodations for digital media work, and all parents include lighting in their accommodations for visual light hypersensitivity. The parents focussed on enabling by decreasing incongruence between required educational activities and ability to participate in them.
Parents provided additional comments that align with consequences of non-action or limited accommodations by teachers, that of discomfort or pain, they included;

Some teachers have been great with letting her not work so much on her computer. Other times she says she's fine and keeps working so that when she comes home she is wobbly and has a headache and feels nauseous. (PS3)

sore eyes after school. (PS28)

Prefers window light, the flickering overhead lights are distracting. [Teachers usefulness] absolutely nothing. (PS 30)

These comments were representative of survey responses and literature demonstrating the disparity in perceived teacher support of students with VLH. The comments highlight the discrepancy of differentiation in pedagogy to allow all students to fully participate in learning activities.

7.3 Part B Recollections of digital media use in school by past students

An interview was used to capture insight of digital media usage by past students. This adds a different perspective to the current research and provides comparative data for the analysis. Inclusion criteria of participants were response to the flyer and being over 18 years old. Participants (n=6) are distinguished by the identifiers S1, S2, S3, S4, S5 and S6. All participants graduated primary school after completing Year 7 (before systemic inclusion of Year 7 into high school in 2015). Therefore, comments referring to Year 8 are indicative of the first year of high school.

Themes from past student responses

Responses to the interview revealed core themes related to recollections of their digital media usage in schools. These core themes have been categorised using time periods: first memories of usage (shared resources, subject use and process use), high school usage (Year 8 and Year 12), VLH during school and after compulsory school years, and effects of VLH. The findings highlight a dichotomy of device access in early high school years and a change in process use from primary to high school years
First memories: Shared resources

All participants responded that their first memory of using digital media at school was computers during primary school on devices which were shared school resources, rather than owned/leased by the student. This was expressed using recognised social descriptors such as the “trolleys” of computers (S1, S4), or “the computers up the back” (S2) in reference to desktop computers permanently housed at the back of the classroom. Alternatively, references were given of a timetabled space within the school dedicated to housing desktop computers; “computer room” (S5) or “computer lab” (S3, S6).

First memories: Subject use versus process use

From primary school, the participants recollected specific process use more frequently than specific subject use. Word processing was the most common process;

Year 3 or 4 for an assignment we had to type it out. (S2)
we learned things like touch typing. (S3)

[we] also learned how to type. Tea towels were put over our hands. (S6)

Using the computers for a data resource or link to curriculum was most frequently remembered as Maths followed by HASS;

we had to research countries and we also had games for Maths. (S1)

mathematics games. There is one where you race other people from around the world it was in Grade 3. (S5)

High School: Year 8 memories

The range of experiences recollected for digital media use widens from primary school to Year 8; the more immersive digital media use included personal computers, “from Day 1 laptops” (S6) contrasting with the continued use of dedicated rooms of desktop computers;

We went into the computer lab for Maths once a week. There was a program that you worked your way through. (S1)

assignment for Science it was an investigation. There was also the [HASS] and English where we had to do typing and essays. (S2)

year 8 we used to do Computer Science, lots of homework learning code. That would’ve been about 6 hours per week. (S3)

You’re going to laugh, but it was about chlamydia in year 8 health I think. (S5)
Process use for digital media in early high school ranged from research, application of self-paced learning, word processing and computer coding. All memories of computer room access and use were described as periodic “I think it was bi-weekly” (S3) rather than continuous.

By Year 10 over half the students were taking their own computers to school (n=4). This change in ownership of digital media devices increased the available pedagogies for teachers, as digital media availability altered from periodic to continuous. It allowed access to the newly created digital learning management systems (e.g., SEQTA) for both class organisation of digital resources and digital based homework.

“Physical access” and “use” of digital media were no longer required to be separate elements with learning activity planning by teachers. Planned physical access to a computer room was no longer required, as students had permanent physical access to their own devices. However continuous duration of computer use was not exercised by the students who remembered taking their own devices to school.

**High School: Year 12 dichotomy**

A dichotomy of experiences for school-based activities was revealed: total reliance or increased process use. The past students who reported total reliance on digital media for organisation and resource access commented;

in year 12 [my] entire study process was based around apps from phone and computer. (S3)

absolutely everything was on [school digital platform]. Even the practise exams. We had lessons that we followed all on the student portal. (S4)

Most lessons you wouldn’t be able to do without a laptop......It organises things better. All in one place. You can’t forget a file at home. Using cloud technology to Google for collaboration is good. (S6)

The other half of the past students reported increased process use; “…typing up. Everything had to be typed” (S2) as well as some resource access, “If you want to know anything then you Google it” (S1).

The dichotomy continued with the duration of digital media interwoven with homework. Those students reporting total reliance on digital media recalled spending a couple of hours a night on their computer;
At home I guess it was about three hours per night. (S3)

A couple of hours a night in Year 12 because there were all the links and resources. (S4)

using the computer for documents and searches would take it up to about 70% of my total homework time. (S6)

Of the remaining three participants, one recalled working mostly on paper, “I write on paper but the computer was there for reference” (S5), the other two would spend about an hour each night on the computer doing homework.

Five of the six participants reported little to no use of IAWs in Year 12 because of limited resources; there were “a few but not many at the school” (S3). The remaining student reported IAW use “all the time” as “some subjects just had powerpoints for every lesson” (S4). These results identified a potential bias in resourcing across the high schools attended by participants.

**VLH in high school**

Of the six past student participants, two identified with being VLH. These past students completed high school, however identified elements of difficulty and disengagement;

My brain engages very differently when in front of the screen... When you digitise something you lose the context....The quality of my education was changed because I knew I always had backup online. It lacked a certain element of impact that would have been there if I had been [mentally] present to ask questions. I tended to treat teachers more like [an extension of their] utube videos rather than interacting with them. (S3)

In some ways [digital lessons were] really good because when you missed a class [absent through health issue], you knew that all of the information was on [school digital platform] so you didn’t have to remember to email your teacher for each class. But in other ways it was bad because by the end of the day your eyes hurt and you still knew that there was homework to do and it was all hard. (S4)

These comments identify both support and challenges faced when using digital media in the classroom. The support can be identified as an accommodation for school absences, however the challenge is continuous use through the day leading to pain (S4).

**VLH after high school**

A commonality for the participants with VLH was the continuance of long durations of digital media use after high school into tertiary and paid workspaces. In tandem with
long durations, there seemed little provision for reasonable adjustments or accommodations.

All my meetings are online.... In campaigns I would have spent five or six hours out of ten on the computer.... In fundraising I spend 11 hours per day. Some of that is meetings, sometimes writing code so that people can get the best out of a webspace, other times just emails and spreadsheets. (S3)

Everything at [university] is online. I get more migraines than I used to, but I can manage them better now than when I was in high school.... Well everyone uses computers for everything at [university]. Even when you are taking notes in a notebook, because I like to write things down, there is a powerpoint on for the lecture or the tutorial. Or the readings are online or submissions for assignments. (S4)

Both S3 and S4 reported continued long duration use of digital media following high school. Participant S3 indicates that it is a necessary requirement of employment and S4 of tertiary education. Neither indicated use of equity or access plans. This demonstrates that while digital media has increased access for many students with disabilities (Ellis & Goggin, 2015), students with VLH are impacted.

**Effect of VLH**

Both of the past students with VLH acknowledged a biological impact, either with mental health or migraine.

Year 11 and 12 I had little sleep during the week. This impacted biologically with my capacity to engage with people. In hindsight the blue lights were probably keeping me awake. I binge slept on the weekend. Mental health wise it’s probably played a part in my challenges. (S3)

really difficult because the more you have to work, the more your head gets fuzzy and hurts and then you take more medication to stop it and then you can’t think and it gets to the point where you cannot look at anything because of the pain. That is why I get frustrated at people who just go “I’ve got a headache I can’t finish it” when really they just can’t be bothered. It’s more like they just don't care because then they go and watch tv or play video games which is stupid because that's what makes it hurt more if you really have a migraine. (S4)

These comments suggest identification of barriers to full participation in learning activities and cultural practices.

7.4 **Part B Parent descriptions of challenges and support for students with VLH at home and school**

To fully understand the lived experience of students with VLH, their parents’ voices and input was required to capture the challenges, support and accommodations required.
For the purpose of this report, five names have been allocated to the children (students with VLH) of the parents interviewed. The pseudonyms chosen by the researcher are Alison, Ben, Chad, Dara and Eve, these are used for Parent Interviews 1 through 5 respectively.

Table 7.5  Student information from parent interviews

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year at school</td>
<td>In Year 12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Completed Yr 12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Did not complete Yr 12</td>
<td>1</td>
</tr>
<tr>
<td>Diagnosed with VLH</td>
<td>Permanently</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Intermittently</td>
<td>1</td>
</tr>
<tr>
<td>Diagnosed with condition other than VLH that</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>can affect school work</td>
<td>No</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Choose not to answer</td>
<td>1</td>
</tr>
<tr>
<td>Accommodations used at home</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Digital media homework estimation per night</td>
<td>More than 3 hours</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2 – 3 hours</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1-2 hours</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Less than 1 hour</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
</tr>
</tbody>
</table>

It is evident from this information that not all students with VLH complete high school, however parent P1 in this interview corresponds to student S4 in the past student interviews who continued on to tertiary study. Parent participants P2 through P5 are parents of students with VLH, however the students did not participate in the current research. Some students are concurrently diagnosed with other medical conditions that can affect schoolwork, or have VLH as a symptom. These conditions may be permanent (e.g., migraine) or short term (e.g., concussion). Whilst all schools documented the diagnosis of VLH for all identified students (Table 7.6), no parent reported extensive application of the requested accommodations.

Table 7.6  School interaction information from parent interviews

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent spoken to school about VLH</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Parent requested changes at school to</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>accommodate VLH</td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Documentation by school regarding VLH</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Action by teachers to accommodate VLH</td>
<td>A lot</td>
<td>0</td>
</tr>
</tbody>
</table>
Themes from parent interview responses

Responses from the parent interviews revealed common themes related to challenges and support and accommodations. The themes can be grouped according absences, digital media use, lighting and accommodations used at home. All four sub themes impact the behaviour and lived experience of VLH students.

Absences

Four of the five participants identified school absence as incorporated with a student having VLH, school accommodations and digital media, “it’s all tied up together” (P4). School absence was further reported in this investigation under three sub-themes; too unwell, high cost/low benefit analysis and medical appointment.

The sub theme “too unwell” referred to hospital visits as well as cumulative disabling from the school week;

after Chad had been in hospital again. (P3)

Dara would get to a couple of days of school and that’s it for the week the other days would be recovering........the homeroom teacher called but there was no way that she could physically get to school. (P4)

Hospitalisation for adolescents often necessitates a period of rehabilitation at home before returning to school. The cumulative disabling would mean that more Thursdays and Fridays would be missed, the impact on the student’s timetable dependent on unique school timetabling.

The “high cost/low benefit” analysis is perceived on behalf of the student. The cost is usually to the student’s health and/or wellbeing, the benefit being education. With a high digital presence in a classroom, there can be a high cost to the health of a student with VLH. Decisions regarding ability to pay the cost for a full day, weighed against the perceived benefit of the subjects scheduled for that day are calculated by the student, taking into account their current health status.

When asked about looking at computers or digital media, P2 responded;

Working whenever he feels able to....Ben is not able to look at a computer comfortably when having a migraine– even when it is going away. (P2)
For P4, the cost/benefit analysis resulted in Dara leaving high school.

She doesn’t go on those days she is feeling unsure.... She ended up leaving school because there was no way for her to complete her ATAR at the school she was at. We tried at another school but it was similar there. And worse because she didn’t know many people and had to explain all the time and the time away from school just got bigger and bigger. It just got to the point where anxiety at home was not worth the push to get to school. Her health is more important. So she doesn’t go to school at the moment. (P4)

“Medical appointments” were mentioned as the student and parent were “scheduling things around appointments” (P2). Specialist appointments in Perth often incur an 8 – 12 week waiting period, so even if the student is having a good day and would have been able to come to school, the opportunity is missed due to the appointment.

**Digital media use**

Parent responses on accommodation type and use were varied. Use of hardcopy rather than digital material was cited by 4 of the 5 parents;

Two teachers especially her favourite one always gives out copies of powerpoints on paper. (P1)

copy the powerpoints to paper .....sending home hardcopies of work. (P3)

handouts for powerpoints. (P4)

Photocopies of the work that is on the computer... I try to encourage her to work on paper more. (P5)

Powerpoints were a common factor amongst the parent interview responses, incorporating both negative aspects and accommodations used. Two of the five parents commented on quantity;

Apparently most of the teachers rely on powerpoints and Anna doesn’t like that. (P1)

the powerpoints are the worst things for her, she says that there are some that just go for the whole class, every class. (P4)

Hardcopy handouts from powerpoint were cited by three parents as either most supportive accommodation or a requested accommodation. As powerpoints have only recently been used in school (supplanting the overhead projectors) the impact of their adoption may yet be fully disclosed, especially for students with VLH.

**Lighting**

When asked whether the student had ever spoken to them about having a reaction to the lights at school, three parents responded with the adverse effect of fluorescent lights:
Anna doesn’t like fluorescent lights, it used to be that we could keep the lights off in the classroom but high school is harder [so many different classrooms]. (P1)

[accommodations include] avoiding fluorescent lights. (P3)

Eve doesn’t like fluorescent lights. (P5)

Two parents commented on the preference of natural light as part of the accommodations used at home and the use of darkness as relief from stimulus;

There are some classes that she likes because one teacher keeps the lights off....Having a room to escape to if Anna needs it dark. (P1)

She prefers to be in the dark, sometimes I had to go and pick her up from school. She usually would not go the next day. (P4)

All these comments involve the use of light, or its absence. Other comments included the use of break-time (P1), which alters the visual light from the current learning activity.

**Accommodations at home**

Four of the five parent responses include decreased illumination of/around the student’s work;

Not too much light. (P1)

Natural light is best. (P3)

she has her laptop really dim. (P4)

The two most commonly accommodations mentioned were use of hardcopy and limiting duration of digital media activities. Working on paper was an accommodation encouraged by four parents at home; (P1, P3, P4, P5) as well as increased breaks (P1)/decreased duration of computer work (P5).

**Reported lack of continuity of accommodations**

Throughout the responses from the parents are comments related to the lack of continuity or awareness of accommodations from teachers and schools. None of the parents reported cohesive adoption of accommodations throughout the high school, or even from all the teachers of their child. Some parents identified specific teachers within the school who would adhere to requested accommodations assiduously, suggesting that this is the exception rather than the norm. The themed comments above further suggest that accommodating students with VLH was prioritised differently for individual teachers, also that there was a lack of whole school policy regarding access for learning activities.
7.5 Part B Teacher descriptions of inclusive pedagogies for students with VLH

The teachers’ perspectives are from two primary school and three high school teachers who had attended a professional learning (PL) seminar on VLH and accommodations conducted by the researcher. Both of the primary school teachers interviewed would be categorised as general primary school teachers, spending a majority of their teaching time with one class of students for the school day. All three high school teachers interviewed were specialist teachers within a high school, working in their specialist subject areas with different classes during the school day. All five teachers had over 10 years teaching experience. Participants in this section of the research are distinguished by the identifiers T1, T2, T3, T4 and T5. Aspects of the PL seminar are incorporated to provide a context for the teachers’ responses.

Themes from teacher responses

The findings revealed in this section relate to teachers’ responses to the PL seminars conducted by the researcher and subsequent use of accommodations as part of inclusive practices to support students with VLH. The themes are Professional Learning, usage and accommodations.

Professional learning

The PL seminars conducted by the researcher were presented at different times in one of the two professional learning formats available for teachers in WA. One format was as part of a Professional Learning Day of after school meeting at a school, where attendance by teachers is mandatory. The other format was as specific PL opportunities identified by individual teachers as potentially increasing their own performance within the classroom and are therefore optional in attendance.

The initial opinion of teachers to some of the mandatory PL sessions is reflected in two of the teacher comments;

I also remember being a little pissed off that we had to stay at school [for the PL]. (T1)

Don’t take this the wrong way but I thought it was going to be a load of rubbish that we had to sit through. (T2)

Final opinions from the teacher participants ranged from expected to unexpected PL experiences;
but it ended up being worth it. (T1)
Well a lot of it made sense. (T4)
I hadn’t thought about that before. (T5)

From this small sample it was revealed that even if genuine interest for the PL was absent prior to the presentation, enthusiasm for the material was present after completion of the seminar.

When asked whether they would continue to use the strategies they had trialled as a result of the PL, all teachers replied in the affirmative commenting:

Yes, there are three that I can easily use, lights, interactive whiteboards and brightness. (T1)
without the [fluorescent] lights ... as much natural light as possible. (T2)
taking breaks. (T3)
Of course, I have been doing this for so many years that now it just needs a few additions. (T4)
Yeah. It would be stupid not to. Why would you stop doing something that was positively influencing your class? (T5)

Usage and accommodations: Interactive whiteboards/projectors/screened powerpoints

Interactive whiteboards can be used for student-driven digital tasks such as signing in for attendance\(^2\) which requires the board to be illuminated from the very beginning of the day, to presentation of powerpoints for learning tasks. Four of the five participant teachers incorporated use of IAW or screened learning activities as part of the accommodations they had trialled following the PL seminar. The teacher PL seminar suggested turning the IAW off when not in use as well as decreasing the luminance and contrast ratio of the image. Two of the five teachers had access to an IAW, the others used a television or a projector onto a traditional whiteboard. Teachers explained their use of interactive whiteboards following the PL seminar;

[I] don’t turn on the interactive whiteboard as soon as I come into the classroom anymore, just when I need it. (T1)
not having the interactive whiteboard on all the time. (T2)
Some of them [new teachers] seem to have everything on powerpoint. (T3)
not using as much powerpoint, or breaking it up... the contrast ratio thing and incorporating that in the powerpoints. (T4)

\(^2\) e.g., [http://www.communication4all.co.uk/http/IWB%20Resources.htm](http://www.communication4all.co.uk/http/IWB%20Resources.htm)
you showed that there were different spots in the class, different seats where the
distance from the screen was different, either more or less and that we [teachers]
sometimes bring kids to the front when they are being irritating, but that that could be
making things worse if they are being overstimulated by the screen. (T5)

Some of the [professional teaching experience students] I’ve had out just have
everything on computer. Everything. Digital worksheets, notes, powerpoints. (T5)

I have actually put on my IEPs for hardcopies of all the powerpoints for two students
in my [subject name] class. (T5)

One teacher (T3) commented on the extent of powerpoint use by “new” (beginning)
teachers. Two teachers (T3 and T5) specifically commented on their observations of pre-
service teachers’ and beginning teachers’ reliance on digital media for lesson
programming. The trend of increased digital reliance was supported by T4 “everything is
on computers these days” and T5 “the amount of increase in the last few years for
digitising everything has been incredible”. These comments link with the observations
reported by Twenge et al. (2018) regarding the generational shift for individuals born
after 1994 in part due to the “rapid adoption of the smartphone” (p. 778).

**Lighting**

The PL seminar reminded teachers that the eyes are receptors to light, and that too
much light entering the eyes can be hyperstimulative for anyone. The PL seminar also
reminded teachers of the flicker associated with fluorescent lights. When participant
teachers were asked about what they remembered from the teacher seminar and then
trialed, participants responded as follows;

The easiest was turning off the lights in summer. It was just like calming everyone
down..... Winter is harder because you need the lights on and they [students] all get a
little crazier anyway because they don’t get to run around outside so much. (T1)

The next day I turned the lights on and then I turned them off just to see if it actually
did make any difference. I am not absolutely certain about the kids that first day, but I
know that I felt better.....I have already taken the paper off the windows so that we
can get as much natural light in as possible. I haven’t worked out how to go the
whole day through the winter without the lights, but I try it as much as possible. Also
we use the wet area\(^3\) which has more light for some activities..... When I go into other
classrooms now and see all the lights on and the interactive whiteboard on it feels
bad. (T2)

I use less lighting in the classroom because of my own migraines...... as well as using
natural light. (T4)

\(^3\) ‘Wet area’ is known in Australian primary schools as the central open space between a group of
connected classrooms. This area usually has flooring which can tolerate water activities, hence the name
‘wet area’.
Some of the things that I picked up from boys education, you highlighted in your presentation, especially the lighting thing..... I have always done the lights thing, you know keeping the lights off and down to decrease the stimulation. That was from a boys ed PL [Boys Education Professional Learning] (T5)

The effect of lighting represented in the responses from the teachers, supported the findings of Winterbottom and Wilkins (2009) and Nicklas and Bailey (1995) regarding positive student outcomes from increasing natural lighting in the classrooms.

**Incorporation of inclusive pedagogies into whole-school practice**

Discussion of best practice between teacher peers is a valued source of insight to determine accommodation for learning activities for individual students (Sproul, 2014a p68). However, there were contradicting comments from two participating teachers regarding the teacher-to-teacher dissemination of information regarding novel accommodations for students with VLH;

Have spoken to other teachers, they tried it too. Seems really obvious but we didn’t think about it. (T1)

When I talk to other teachers it’s like they nod politely and thein dismiss it because you can see in their eyes that they don’t really understand. Unless it is policy and dictated from higher up, [it’s] not going to change much.... I can’t see it happening all over, say, my school. (T4)

Participant T1 had attended a mandatory PL session, so was discussing a shared experience sanctioned by school executives. The perspective of all discussion members would have been aligned through exposure to the same PL experience. The perception of top-down requirements is inherent in mandatory PL from the perspective of a participant (T4). This highlights the value of mandatory PL for whole-school or systemic change. Professional learning that teachers opt to attend may not be aligned with school vision and policy and may be exploratory, and therefore may not carry the weight of administrative expectations.

**7.6 Summary**

High school students spend a lot of their time at school and working on educational activities outside school. Therefore, the lived experience of students with VLH required listening to not only their voices, but the voices of those in their school and family. The current research has revealed that the amount of digital media being used by current students exceeds many estimates, and students in upper school with VLH have the longest duration of any of the groups studied.
Parents of students with VLH have voiced their concern over student absences caused by either the impairment linked with VLH or the analysis of disabling consequence if school is attended. Parents also reported the disparity between classes in high school in regards to adherence to requested accommodations to allow students with VLH to fully participate in learning activities.

Teachers have reflected on inclusive and differentiated digital pedagogies to enable students with VLH to fully participate in learning activities. The themes of lighting, powerpoints and luminance were highlighted as the easiest to modify and maintain over extended periods of time. Teachers also highlighted the perceived value of whole-school pedagogy to support these inclusive practices.
Chapter 8  Discussion

Chapter 8 begins by providing summative statements addressing each of the research questions with reference to the data collected through this project. The opening section highlights the lack of policy directly related to digital media use and the disparity of digital media policy implemented between society and schools. Evidence collected through the course of the study supports a Vygotskian model of defectology revealing the potential for marginalisation of students with VLH. This chapter concludes with a statement of strengths and limitations of the study.

8.1  Current guidelines related to digital media use

The study explored the range of policy informing digital media use active in contemporary society. Workplace Health and Safety Policies are mandatory in Australian workplaces and institutions for all workers and students, not just for individuals with a disability (prior to 2012 these were identified as Occupational Safety and Health Guidelines). Regulators for these policies include WorkSafe WA and WorkSafe Victoria.

In society, the WHO (2019) guidelines recommend none to limited duration digital media use for young children and W3C (2008) guidelines outline accessible parameters for all web content. However there is limited evidence that these parameters are transferred into schools.

8.1.1  Digital media policy in schools

There are few Workplace Health and Safety policies for use of digital media in schools. The vast majority of school policies focus on cybersafety relative to the content of the images rather than the medium with which they are delivered. The Government of Western Australia has provided resources to facilitate schools to deliver lectures about online safety for content (https://www.esafety.gov.au/education-resources). However, these efforts do not address the physiological components as addressed by evidence-based research.

The current research found one policy which raised awareness of some physiological parameters of digital media use. The Victorian Student Safety Guidelines (Technology) (2015) incorporated elements of The WorkSafe Victoria resource
Officewise – A guide to health & safety in the Office\(^1\) (2006). The latter includes suggestions of prompts for restbreaks, exercises for eye health when using digital media and getting up from the workstation chair every 20-30 minutes. These would all constitute accommodations for extensive use of digital media. The parallel WorkSafe WA resource used in industry does not include all elements of the WorkSafe Victoria document, however, does refer to the latter publication. The lack of accessible standardised Workplace Health and Safety policies for digital media use could contribute to the lack of digital participatory pedagogies (Dooley et al., 2016) used in Western Australian classrooms.

The present study found that the two most prevalent devices reported by participants to be used in classrooms were computers and IAWs. However, there were no school based policies found that addressed the potential impact of long duration use of these digital media devices. Computers were used in 59.5% of classes (n=593), with Certificate studies (see Glossary) using computers over 90% of the duration of the class.

IAW were reported by students to be accessed in over half of the classes sampled in the current research (53.3%). There are unique safety recommendations for this digital device as outlined by SMART Board\(^\circ\) (2012). These included recommended viewing distances and that 3D material that may cause more adverse effects in children and adolescents more than adults. This age specification supports data collected by Furusho et al. (2002) following the Pokemon phenomenon and echoes the report by Kasteleijn-Nolst Trenité et al. (2012) stating that adolescents were more at risk. Lack of universal design guidelines for digital media use increases the cognitive load used for environmental factors by students with VLH.

Awareness of the categorisation of VLH, impact on student participation and access requires teacher knowledge of both the challenges faced by the student (Sharma, 2019) and guidance in adjustment of material culture to increase active participation in classroom activities. According to the Teacher Resource Package Count Us In! produced by the Western Australian Department of Communities (2013), “A disability is any continuing condition that limits or restricts a person’s participation in everyday activities” (p. 7). The Vygotskian model in Figure 5.3c proposes the societal construction of barriers to inclusive practices through classroom use of digital media. The determinate of disability being the social context is not new (Ellis & Goggin, 2015; Ellis & Kent, 2011) neither is the observation that some digital media platforms create obstacles for users with a disability (Ellis & Kent, 2011). However, the current research

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focuses on compulsory school activities that may simultaneously be creating a disabling environment (Figure 5.3b), despite an alternative being available.

As revealed through this study, VLH prevents students from participating fully in learning activities, with evidence from both parents and students. VLH would therefore be considered a disability in Western Australian school systems. The NCCD guidelines (Commonwealth of Australia, 2019) categorise a cognitive disability as “A disorder or malfunction that results in the person learning differently from a person without the disorder or malfunction” (p. 36). Through this NCCD Guidelines document, the scaffold exists to support students with VLH; however the examples of reasonable adjustments for this particular disability do not yet exist.

All of these could be achieved via system based (e.g., AISWA) or health promotion agency facilitated (e.g., Epilepsy WA) Professional Learning for teachers and education assistants. Recognition of VLH as a disability requiring digital participatory pedagogies would facilitate PL focused on timely adoption of universal design elements and reasonable adjustments for individual students as reflected by teachers in the current research. Minimal awareness within educational institutions of the phenomenon of VLH (Sproul, 2014a) and how it impacts individual student learning directly affects applications for financial support. As shown in Figure 5.3c, increased teacher knowledge of VLH effects and reasonable adjustments would facilitate applications for funding to decrease marginalisation of students with VLH.

8.1.2 Digital media policies in society

Unlike schools, industry has rigorous standardised parameters guiding use of light wavelengths, flash frequencies and duration of digital media use. This extends to guidelines excluding some people with VLH from participating in potentially harmful activities unless they have consulted with a medical professional. Broadcast television is constrained by specific regulations regarding “safe” parameters for the general population; anything contravening these must be prefaced by warnings, or fines will be laid against the individual channel and program. The BBC were found in breach of Rule 2.13 of the Ofcom Code (Ofcom, 2007) after broadcasting the promotional material for the London 2012 Olympics. The visual parameters that breached the guidelines were the flash frequencies of the images. The footage was not broadcast again until the frames in breach of the Ofcom Code were replaced.

The WCAG 2.0 contains modified guidelines for a closer viewing screen (W3C, 2008, 1.4.3) demonstrating adaptation of guidelines within a prescribed material culture.
Websites constructed as part of industry communication to the public are also encouraged to conform to these content access guidelines. Currently the Australian government conforms to Level A of the WCAG 2.0, but “is being upgraded to Double A compliance over time” (https://www.australia.gov.au/accessibility).

Medical evidence continues to mount regarding comorbidity of mental health disorders and neurological conditions with symptoms of VLH, as well as inverse correlation of screentime and psychological wellbeing (Twenge et al., 2018). In response to these developments, Workplace Health and Safety policies already include recommendations to moderate the effect of extended digital media use, however investigation regarding compliance to these recommendations would be an area of further study.

8.2 Part A Duration and purpose of digital media use by current students

This section provided data comparable to and extending previous studies of media use in schools. It used student self-reports to explore the application of five digital media device types through subject areas attended during the school day as well as digital media used for homework. Analyses of differences in digital media use were examined using high school year groups and presence of VLH.

**Research Question 1a.** What is the duration and purpose of educational digital media use during a school day (including homework) in a contemporary high school in Western Australia as reported by current students?

As the major quantitative element of the mixed method study, these data provided an overview of duration and student self-reporting for presence of VLH, accommodations, mediating factors and preferred screen luminance. It also provided a small amount of qualitative data in the form of comments by students.

Construction of individual student generated timetables allowed comparison of duration of digital media use across schools (see Appendix N). Students reported a mean of 250 minutes (4 hours, 10 minutes) of educational digital media use per day (n=95, Range = 55 to 575 minutes). This result far exceeded the recommendations by AAP, published figures from CSIRO (2008) and Sproul (2014a) and projected figures by Peterson and Horn (2016). However, they fell within the range of digital media use reported by Houghton et al. (2015). Whilst these findings initially seem comparable to other quantitative studies by Media and Society Research Project (MSRP, 2007), Olds et al. (2006), Rideout et al. (2010) and Houghton et al. (2015), they differ dramatically in
the purpose for which the digital media was used and the context in which the data were collected. The MSRP (2007) data were collected using discretionary time (time outside of school), therefore their net screen time (use of digital media) mean of 243 minutes (4 hours, 3 minutes) only overlaps in the category of homework. Olds et al. (2006), collected data from television, video games, cinema and non-game computer use, therefore their “minutes of screen time” mean of 229 minutes (3 hours, 49 minutes) only overlaps in the category of computer based homework. The M2 study reported by Rideout et al. (2010) emphasises the data collected “does not include time spent using the computer for schoolwork, or time spent texting or talking on a cell phone” (p11), which excludes overlap in any of the data from the current project. Houghton et al. (2015) did incorporate digital media used during school time however did not include the use of interactive whiteboards, which were reported as frequently used in the current research. Overall, the current research indicates that digital media use in schools exceeds most industry estimates.

The digital devices used with highest frequency in classes were personal computers (59.5%, n=593) and IAWs (53.3%, n=593). For students with VLH to actively participate in learning activities using these devices requires application of digital participatory pedagogies or reasonable adjustments. Personal computers are digital devices whose physical parameters can be adjusted for an individual student if any of the student, parent or teacher is aware of the evidence-based recommendations. The current research provided information regarding frequency of digital media use in different school subjects; the highest frequency being Certificate studies with all lessons incorporating use of digital media (n=11), moving down to the lowest in Physical Education (27.5% of lessons, n=51). In the report by Fraillon et al. (2014) documenting the IEA International Computer and Information Literacy Study (ICILS), students in their 8th year of school described how often they used computers. Frequent computer use (for example “in most lessons” or “in every or almost every lesson”), gave a summary across different school subjects in Australia. However, there was no indication of duration of computer use within each class, or the diversity of devices used. The aim of ICILS and the current research have few similarities beyond itemising initial access across school subject areas. ICILS has been greatly informative, providing generic information on a global scale. However when determining fine details of digital media use in classrooms, the categories of ICILS are too broad. For example, in the ICILS (Fraillon et al., 2014), Information Technology as a subject gained the highest percentage of frequent computer use in Australia (58%), followed by Humanities (42%) and Science and English tied at 34%. The current research revealed a more detailed
picture of duration within classes and device type from a wider age range of students. Further research using a similar model to the current research would be beneficial for Australian educators regarding full day device use and development of online versus paper-based programs.

Analysis of the duration of digital media use between groups of students supports the transformative approach of the current research as it identifies areas of significant difference. The initial comparison determined whether there was any difference in duration of digital media use between students with visual light hypersensitivity (n=30) and students without visual light hypersensitivity (n=65). This section of the study was exploratory and used a self-reporting measure of VLH from students. Whilst there was no significant difference found between these cohorts using the variables school educational digital media, homework digital media, total educational digital media use or in preferred screen brightness, further analysis in the upper school (Year 11 & 12) cohort revealed significant differences in two variables’ mean rankings between students without light sensitivity (n=11) and students with light sensitivity (n=10). These two duration variables homework digital media and total educational digital media use, incorporate student’s own study habits as well as teacher selected digital pedagogies. This result was initially surprising as it indicated that students with VLH were spending more time on digital media for educational reasons than students without VLH in upper school. This result was not expected due to the negative effects (pain, nausea) caused by long duration of digital media use and referred to in this study by students (S4) and parents (PS3). However, the longer duration results are supported by two theories; the extended cognitive load theory proposed by Ma et al., (2014) and the Persistent Pain Neurocognitive Paradigm, Smith and Ayres (2014). Ma et al., (2014) suggest that working memory has limits, and in the case of a student with VLH, the extensive visual load uses some of this working memory availability. It would follow that the precision of working memory would decrease, therefore taking longer to complete a set task. Smith and Ayres (2014) continue with the argument that if pain is continually present, then “pushing through” to complete a set task takes longer as mental resources are being used to deal with the pain. Both of these theories justify students extending the duration of digital media use despite the inherent discomfort. It also supports the development of student centred cost/benefit analysis for school attendance as referred to by parents of students with VLH (P2 & P4). The inferred correlation between extended duration of digital media use and identifying as a student with VLH in upper school is an area for further research.
Official diagnoses from parental surveys gave some indication of cause of VLH including migraine and concussion. Many parental surveys returned with little additional information, reflecting the comment by Axinn et al. (2011) “even as sophistication of both survey measurement and survey analysis dramatically advances, the general population’s growing reluctance to participate in surveys poses a key threat to the field” (p. 1127). Whilst VLH can be a symptom of other medical conditions, teachers with students identifying with these conditions should be aware of the discrete effect on cognition when designing digital participatory pedagogies. An inclusive classroom using universal design supports many of the requirements of students with VLH. Parental experience of IEPs may demonstrate a perspective of deficit (Zeitlin & Curcic, 2014) however instigation of enabling parameters of universal design can minimise this in the current context. Further research of the application of digital participatory pedagogies within both primary and high school classrooms is also suggested.

The validity and reliability of online assessments such as OLNA may be decreased for students with VLH. The online medium used for testing literacy and numeracy creates environmental circumstances where potentially decreased cognitive load is available to engage with the assessment material, therefore decreasing the validity of the test. The reliability may also be challenged as no moderation is currently applied to online versus paper tests in NAPLAN for students with VLH. Therefore, a student with VLH may sit the NAPLAN via paper based testing in Year 9 and score in Band 7, yet sit OLNA online in Year 10 and exhibit a decrease in assessed ability. In this scenario, it is more likely that the medium used for testing was a confounding variable rather than a decrease in ability for students with VLH.

8.3 Part A Perceptions by parents of disparity in student support

Through comments returned with surveys, the parents of current students provided a small window into concerns regarding student support by schools and teachers, and specific enabling processes. These comments were explained in more detail in part B with interview participants.

None of the parents of children with VLH disagreed with the statement “Visual light sensitivity can affect Child 1’s ability to participate in school activities” (Table 7.5). Using the definition of disability (Western Australian Department of Communities, 2013), this indicates that these students should have access to differentiated teaching or support in educational settings, to minimise or remove the social impact (decreased participation) of their impairment. The NCCD (Australian Government, 2019) provides
outlines of different levels of support for students who learn differently, the current research suggests that students with VLH should be included in these examples. These exemplars are referred to by teachers to clarify the extent of changes to pedagogies and expectations for inclusive and differentiated pedagogies. If VLH was added to the list of exemplars, it would provide access to lists of reasonable adjustments for a little known impairment (Sproul, 2014). Further, it would increase teacher awareness of the possible dis-abling mechanisms of some parameters of digital media use and provide examples of evidence-based digital participatory pedagogies (Dooley et al., 2016) to allow active participation for students with VLH. Nationwide acknowledgement (through NCCD) of the impairment of VLH causing disability when using digital media in particular contexts would also support the whole-school adoption of digital participatory pedagogies.

Individual students with VLH would still require IEPs outlining any specific reasonable adjustments as these are unique to an individual. These actions would potentially address the frequent comments regarding pain from identified triggers expressed by parents in survey comments, as triggers could be minimised.

8.4 Part B Duration and purpose of digital media use by past students

The voice of past students was included in the current research as it provided a student perspective of changes in material culture within the classroom. Past students were also able to comment on process, ownership and physical access to digital devices.

Research Question 1b. What is the duration and purpose of educational digital media use during a school day (including homework) as remembered by past students?

Memories of the students differentiate the use of digital media as either a tool or an integrated learning activity. Word processing is distinguished from synthesis of writing by word choice in interview responses; “to type out” (S2) is used rather than “to write” suggesting that the creative activity was removed from the digital interface, reducing this particular digital interaction to information formatting.

The bias in resourcing identified by students reflects different school systems and funding allocation. Whilst this has been acknowledged and addressed in various forms by Federal and Commonwealth governments in Australia (e.g., Digital Education Revolution Program) the impetus to continue funding has decreased. Merga (2016)
proposes some of this change in stance stems from the increase of BYOD driven by individual preferences.

The description of “sore eyes” or eye fatigue after using digital media is not isolated to students with VLH. Different displays cause fatigue in different ways (Wu et al., 2007) and LCD displays trigger higher visual fatigue than equivalent text reading from paper (Benedetto, Drai-Zerbib, Pedrotti, Tissier, & Baccino, 2013). These findings support the need for universal design for students using extended sessions of digital media and accommodations for students with VLH.

One comment by S3, a participant in the student interviews, remarks on the way that “his” brain works differently when looking at a screen. All student’s brains function differently when looking at text on a screen compared to looking at text on a page (Wolf, & Barsillai, 2009). However the comment by S3 is further supported by reports of a new type of reading pattern emerging for readers of digital media; non-linear reading (Liu, 2005) involves moving around the text, scanning different sections rather than absorbing the text in the order chosen by the author. Reading text on digital media also increases the potential for decreased comprehension (Wylie et al., 2018) and dissociation with text (Mangen & Kuiken, 2014). These observations and comments support further investigation of light-sensitive classroom practices for all students.

Student S4 reported “the more you have to work, the more your head gets fuzzy and hurts”. As students with VLH have a larger extraneous cognitive load when working with digital media, this highlights the need for accommodation and scaffolding when these students work on digital media. The current research supports previous reports by Smith and Ayres (2014) identifying the pain-depleted cognitive load available for working memory and attention and Montagni et al. (2016) identifying an association between extended duration of digital media use and increased reporting of migraine in tertiary students.

The empirical study by Llop et al. (2016) concluded that students with migraine and interictal VLH were more likely to be diagnosed with anxiety and depression. In findings from the present research, a similar statement was reported by S4 who attributes part of ‘his’ mental illness to extensive use of digital media at school. Whilst the causality is not substantiated, the correlation is expected within a sample of this size.
8.5 Part B Interaction experience of parents working with schools

Parent of students with VLH provide a voice of advocacy for their children. To reveal lived experiences and observations of digital media practices of their children their voice is valid and desirable (Alper & Goggin, 2017; Hess, Molina & Kozleski, 2006). This section explores the areas of accommodations and access for students with VLH.

Research Question 2. What is the interaction experience of parents working with the school on behalf of students with visual light hypersensitivity regarding accommodations and access to learning activities?

Parents reported a range of interaction experiences when working with schools on behalf of their children who had been diagnosed with VLH. Some experiences included teachers who followed IEPs and facilitated access to classroom learning activities and supply of break times and designated low sensory areas. This supports previous findings by Bøttcher (2012). There were also parent reported experience which echoed the perspective of deficit (Zeitlin & Curcic, 2014) the outcome of the interaction garnering little if any support for the student with VLH, generating a concept of marginalisation. This is characterised in the Vygotskian model proposed in Figure 5.3b. Negotiation with adults is necessary to increase congruence between normative and non-normative lines of development for a student with a disability (Bøttcher and Dammeyer, 2016). In high school the negotiations between adults may include the voice of the student to enable the parents to find an optimal school setting (Dammeyer, 2010). The optimal school setting would provide opportunity for a student to access adjustments as characterised in the Vygotskian model proposed in Figure 5.3c.

IAW use requires elements of universal design to enable students with VLH to actively participate in these learning activities. The number of teachers who rely on powerpoints (IAW based) is quite high from second hand information expressed by parents (P1 & P4). Individual teachers making reasonable adjustments by provision of paper copies to particular students (P1) demonstrates understanding of potential marginalisation.

Selective and enforced absenteeism were linked with persistent pain, supported previous findings by Kreentsky-Korn (2011) and Nijhof et al. (2011). The cost/benefit analysis by students leading to selective absenteeism also supports findings by Sato et al. (2007) who reported that the decreased return of results on effort can lead to decreased self-efficacy, a reason for avoiding school.

The current marginalisation of students with VLH could be addressed by implementing practices collated in the current research. To date, the piecemeal approach
by parents in Australia is necessitated by the available system, however it lacks effectiveness for time and effort expended echoing the report by Dammeyer (2010). Facilitating societal awareness in schools would highlight the existence of the phenomenon of VLH, its potential effects and the reasonable adjustments available to modify these effects.

Bøttcher and Dammeyer (2012) highlighted the differences between facilitating activities at home in comparison with facilitating similar activities at school with altered material culture. The findings from the current research would suggest that the dis-abling of students with VLH is higher in the classroom due lack of cohesive adoption of accommodations throughout the individual student’s educational institution.

8.6 Part B Pedagogical experience of practising teachers

Teachers of students with VLH provide a voice of transformative potential through trialled classroom practices. They also provide a unique view to a time of day unavailable to parents.

Research Question 3. What is the pedagogical experience of practising teachers (who have attended a profession learning seminar on visual light hypersensitivity) regarding inclusive digital media access for students with visual light hypersensitivity?

The experience of all participant teachers demonstrated the ease of incorporating some of the inclusive accommodations, as well as the challenges of adopting others. The lack of guidelines for the invisible impairment or VLH, potential disability caused by the impairment or Workplace Health and Safety policies for all students provides a comparable starting point for most teachers.

The teacher PL also addressed the topic of classroom lighting. Turning off the fluorescent lights during the day was acknowledged by most of the teacher participants as a practical, reasonable adjustment and would continue to be used. Excessive lighting in classrooms has been linked to visual discomfort in some students (Winterbottom & Wilkins, 2009). In Western Australia the option exists to rely on natural lighting for an extended period of time throughout the year due to weather conditions being sunny for the majority of school terms 1 and 4, the winter months having periods of overcast weather in terms 2 & 3. Architecture of buildings is instrumental in facilitating this use of natural light, and many of the newer buildings incorporate skylights for the classrooms, encouraging use of natural light, similar to the “sunlit” school depicted in Nicklas and Bailey (1995, p. 51). Currently classroom lighting is not wielded as a
contributing factor for support of visual learning activities (Buckley, 2014). The level of light luminance required to support eye physiology differs for different tasks (Summers, 1989). However, as Buckley (2014) reported in the UK, there is little teacher awareness of environmental lighting impact. Similar results were reported by Narayanasamy et al. (2016) regarding use of environmental lighting in primary classrooms in Australia, and Sproul (2014a) for high school and primary school classrooms in Australia. Hudson et al. (2016) emphasised the need for networked knowledge of evidence-based guidelines and practical differential pedagogy for students with special education needs. Students with VLH require digital participatory pedagogies to maximise their active participation in classroom activities to limit the impact of this invisible disability on cognitive load. Acknowledgement of different levels of light requirements for different activities can maximise active participation for students with VLH.

In the current research, using principles of universal design and decreasing environmental visual stimuli for all students was reported as easily achieved for an observably positive outcome. Concerns about difficulty of systemic changes were raised by teachers in the current research. These reflected the discussion by Bøttcher and Dammeyer (2012) about constraints in organisation of accommodations for learning activities (p. 442). This is an area for further research. The value of mandatory PL in the area of inclusive digital media access was reflected in comments from two participants indicating a change in their opinion of the subject matter after the conclusion of the seminar and their trialling of the suggested pedagogies. However, there were differences in opinion as to the value peer word of mouth in changing the practice of their colleagues. This evidence would support an argument for school initiated mandatory PL in universal design strategies and reasonable adjustments for individual students. AISWA and Epilepsy WA are potential sources for future PL as they facilitate seminars to raise awareness of reasonable adjustments for students with epilepsy, however, the process was not discussed in this project.

The teachers participating in the current research each had at least 10 years teaching experience, thus the majority of their knowledge regarding incorporation of new technology such as powerpoints and online programs would have been through Professional Learning opportunities. Most likely this would have occurred whilst employed as classroom teachers rather than during their teacher education at university (Sheffield, Blackley, & Moro, 2018). This may have altered the teacher participant’s perspective on pedagogical choices for any particular activity in contrast to teachers who have recently completed an undergraduate or graduate education degree at university (Li, Yang, & MacLeod, 2019). The involvement of the teacher participants in PL regarding
VLH supports the statement by Christensen and Knezek (2017) that “veteran technology integrators should not omit professional development in emerging technology applications” (p. 28). They also concluded that in contrast, graduate teachers would be best supported by PL focused on classroom implementation rather than personal use.

The teacher participants in the current research had the opportunity to facilitate many learning activities without digital media at the beginning of their teaching careers, but participants in the current research have demonstrated evolution of teaching practice using digital media as they remain in the teaching profession and satisfy ICT requirements of AITSL standard 2.6 (Table 4.1). Following PL provided by the researcher, participant teachers returned to their classrooms to pose a repeated question; would the focus of this learning activity be enhanced by utilising digital media, or detract from the learning outcome? This repeated question links directly with the advice regarding technological knowledge (TK) by Koehler and Mishra (2009). Depending upon the outcome, digital media can be used, adjusted or bypassed.

8.6.1 Teacher resources

To address the lack of resources designed to explain the impairment of VLH and the potential for disability when using digital media, A seat up the back near the window, please (Sproul, 2014b) was written by the researcher. This handbook was distributed at teacher PL, rotary club meetings and parent meetings, written in “laymans” terms to be conceptually accessible to non-medical, non-academic parents and students. The researcher chose to use first person narrative in the handbook as the first section speaks directly to the student, designed to be read to/by younger children and incorporating them in the “us” rather than the potentially marginalised “them” of experiencing school with a disability. The second section describes some steps that can be taken by parents who are new to incorporating medical requirements with academic success. These steps include descriptions of reasonable adjustments for IEPs. The handbook includes template letters containing examples of specific accommodations that can be identified by medical professionals then used by schools. The third section was written for the teacher audience. It is forthright, offers suggestions but no solutions, and encourages individual determination of best practice. The teacher PL allowed all sections of the handbook to be examined as a future resource.

The findings of the current research have added to the knowledge regarding accommodations, reasonable adjustments and the NCCD link to school funding that would benefit teachers, parents and students working with VLH. Therefore this
handbook is being updated to reflect these developments as well as more recent research articles and a summary of suggested guidelines for IEPs.

8.7 Strengths and limitations of the study

One of the strengths of the current research is that it exists. In 2010 the researcher approached three different research institutions regarding her perceived marginalisation of students with VLH through use of digital media. Only one university was willing to consider the phenomenon could exist in the school context. Working against the tide of increasing digital media use in classrooms for nine years, this study is validated by the identification of statistically significantly different digital media practices by upper school students with VLH.

The strengths of this study include the focussed attention on educational digital media use, across all device types currently used in schools in Western Australia. The within group differences for upper school students regarding educational digital media use also opens a unique area of study.

Some of the limitations in this study are carried forward from the original title for the research project and its stimulus population (Students with migraine, classroom digital media and the maze of inclusive pedagogy). The initial focus on migraine limited the systematic literature review as well as the potential participant pool. However, the informative nature of the systematic literature review revealed the extent of the phenomenon of VLH, therefore was a necessary step to demonstrate the potential impact of the current research.

Other limitations are linked to the challenges of investigating educational application of medical research. These limitations included adaptations to research design due to ethical restrictions within educational research. For example, the discussion of pain and discomfort is not usual practice. Similarly, the range of nomenclature used across disciplines and into society is a complex network. Language accessible to students may be misinterpreted by adult researchers, specificity of medical terminology within a discipline may be applied differently within another medical discipline and neither may be well understood by parents, teachers or students.

There are also many limitations inherent in data gathering. The low sample size within a small group of schools limits generalisation of the findings to the wider population. However, the findings may be used to temper suggestions that schools use less than two hours of digital media per day (AAP, 2001). It should also be
acknowledged that Chang et al.’s (2010) research on self-reports regarding computer use duration concluded that computer use could be both overestimated and underestimated for a participant. In general, a participant responding with less than 3.6 hours computer use lead to overestimation of duration, whereas a participant responding with greater than 3.6 hours computer use lead to underestimation of duration.

Limitations of this study also include variation in research participation and digital media use as students enter a period of study for examinations. Research participation may have decreased as focus for students and parents turns to academic assessments. The reliability of homework digital media may also have been altered through this period for upper school students, thus impacting duration of total educational digital media. This limitation was also commented on by Houghton et al. (2018) as a limitation of high school investigations.

On reflection, in future projects, Student Survey Q20 would be changed to a Likert scale attitude response to the two statements I like my computer screen to be bright and I always turn my computer screen down with provision of a comment box at the end of the question. This would provide increased within-subject validation as well as allowing explanation of discrepancies such as inability to alter computer preferences in some online standardised testing.

8.8 Summary

The findings from the current research highlight potential marginalisation of students with VLH during learning activities using digital media and a need for policy guidelines is revealed. The proposed Vygotskian model (Figure 5c) proposes how reasonable adjustments and universal design allow increased participation in classroom digital media practices, decreasing marginalisation of students with VLH. The VLH community of students, parents and teachers provide perspective on variations in inclusive pedagogies and adherence to student IEPs. Although there are limitations to the study it opens a unique field for transformative practice using digital media in schools.
Chapter 9  Conclusion

This study captures the duration of digital media use for educational purposes by current high school students. It incorporates voices of the VLH community by reporting perspectives from current students, past students, parents and teachers. The view of a contemporary classroom through a Vygostkian lens of defectology identifies an area of marginalisation when learning activities require use of digital media. The study concludes by drawing attention to key findings and recommendations for policy, practice and future research.

9.1  Contribution of this research to contemporary high school classrooms

The necessity for providing equitable access to digital learning activities for students with VLH is increasing as the use of digital media in the classroom increases. Historically, evidence of the presence of VLH has been demonstrated by societal events such as the Pokémon incident, responded to by medical and technological research leading to the development of societal guidelines such as WCAG 2.0 and WorkSafe Australia documents.

9.1.1  Conceptual Contribution

The unique use of Vygotskian theory to interpret a culturally induced disability is the researcher’s contribution to the global body of knowledge. The Vygotskian theory of defectology describes the barrier to active participation in cultural practices leading to a student developing differently (Vygotsky, 1929). The marginalization of students with VLH is similarly created by cultural practices of digital media use for extended periods of time in schools. To date, adherence to societal guidelines for digital media use has not been required in Australian high schools. Evidence-based literature states that active participation in digital media activities decreases for students with VLH. The researcher transfers the context to an educational setting and superimposes Vygotsky’s theory of defectology as shown in Fig 5.3. It models the appearance of barriers coinciding with the extensive use of digital media in the classroom (Figure 5.3b) and demonstrates increased active participation in the classroom cultural practices through use of digital participatory pedagogies (Figure 5.3c).
9.1.2 Methodological Contribution

Using a transformative paradigm this research enabled evidence-based recommendations for digital media use from fields of medicine, technology and society to be compared to those used in the field of education. The current research expanded parameters for investigating frequency and duration of digital media use for educational activities by high school students in Western Australia to include IAWs and subject area factors. Upper School students with VLH reported statistically longer durations of digital media use, supporting theories of decreased accessible cognitive load due to learning environment (Choi et al., 2014).

Incorporating a mixed methods design and multiple participant groups enabled perspectives from different vantage points to assist in untangling the maze of classroom digital media and inclusive pedagogy for students with VLH. Giving a voice to past students allowed identification of changes in the material culture and process in high school classrooms over the past ten years. They expressed the shift in digital device ownership, physical access and age of introduction to digital device use. Ownership of device has shifted from institutional to individual, physical access has increased by moving from computer labs to 1-to-1 devices and age of introduction to digital media use has decreased.

Parents participating in the current research highlighted lack of guidelines to work with schools efficiently to facilitate increased access to digital learning activities for students with VLH. Knowledge of NCCD guidelines and required supporting documentation was not raised by any participating parents. This highlighted a gap in language for advocacy and knowledge of current high school requirements. Concerns regarding selective and enforced absenteeism were voiced, including the observed application of cost/benefit analysis by students to determine daily activities, supporting previous findings by Sato et al. (2007) and Nijhof et al. (2011).

Teachers participating in the current research were aware of the existence of VLH as an invisible disability having attended a session of Professional Learning regarding universal design and accommodations for digital participatory pedagogies. Their responses highlighted the practical nature of the suggested guidelines and transformative potential for students with VLH.
9.1.3 Practical contribution

The current research was initiated by an experienced need for increased awareness of VLH and evidence-based reasonable adjustments to support students. It provides information to support the inclusion of VLH as a disability acknowledged in the NCCD. It also provides a list of reasonable adjustment guidelines in IEPs for students with VLH (taken from Sproul et al., in press) targeted at digital media use in classrooms with digital participatory pedagogy. The content of the guidelines for policy and IEP inclusion are detailed in the next section.

Students with VLH and their parents and teachers would benefit from school system wide guidelines for digital media use (see recommendations below). Students with VLH and their parents and teachers would also benefit from having VLH categorised in NCCD guidelines as Level 1 or 2. This categorisation of VLH would enable reasonable adjustments, as required by Disability Standards for Education (Australian Government, 2005). Accommodations identified by parents of students with VLH used frequently at home may be adopted at school with increased awareness and acknowledgement of the potential for marginalisation.

For teachers, mandatory PL was accredited as having more effect in whole school adoption of digital participatory pedagogies. Development of higher cognitive functions is inextricably linked with use of socio-cultural tools. To support this development in students with VLH, accommodations should be utilised using both universal design and individual adjustments to student material culture.

9.2 Recommendations

This researcher recommends that students with VLH be identified through the NCCD categorisation as Level 1 or 2 (NCCD Guidelines, 2019). These guidelines specify addressing “the nature and impact of the student’s disability and any associated barriers to their learning, physical, communication or participatory needs” (p. 29). This recognises any extra resources (e.g., hard copy of all powerpoints) required to prevent marginalisation of these students. Recognition at Levels 1 and 2 acknowledges VLH as an invisible disability that can impact a student’s development within the current digital-rich school environment, can inform educators and medical practitioners and provide scaffolding to support documentation required by schools. Acknowledgement of the impact of VLH and incorporation of evidence-based accommodation could support students with VLH and their parents to navigate high school education.
Students with VLH require teachers to use digital participatory pedagogies such as universal design and individual adjustments to enable active participation in digital media learning activities. The following recommendations for inclusion into student IEPs are taken from Sproul et al. (in press). Inclusion in PL for teachers would facilitate school wide universal design for digital media based learning activities, as well as afford targeted reasonable adjustments for students with VLH.

- Image flash frequency – ensure all digital media required in learning activities uses no more than three flashes per second (Harding and Takahashi, 2004; ITU, 2005; W3C, 2008)

- Luminance/glare – decrease glare or luminance of projections, computer screens and tablets (Fisher, Harding et al., 2005; Winterbottom and Wilkins, 2009)

- Colour – avoid saturated red flashes (W3C, 2008),

- Manipulate environmental lighting – use daylight where possible, avoid high contrast with the computer screen in a dark room (Stobaüs et al., 2014; Winterbottom and Wilkins, 2009)

- Duration in front of screens – take frequent breaks (Apple Inc, 2010; Fisher, Harding et al., 2005)

- Distance from screens – increase distance, arrange seating plans so that students with VLH sit in back half of classroom when using an IAW or projector (Apple Inc, 2010; Bureau et al., 2004).

9.3 Future research

The current research has highlighted a gap in knowledge regarding long duration digital media use for students with VLH. Further investigation is called for to determine whether there is any statistically significant difference between online high school assessments and pen and paper assessments correlated with presence of VLH.

Investigation of long duration digital media use for upper school students in relation to absenteeism and mental health is suggested. As digital media use continues to increase, knowledge of any potential barriers to participation in societal or learning activities would be beneficial to schools, families and individuals. Investigation of digital participatory pedagogies would be beneficial for both primary and high school educators to inform planning and programming.
The researcher suggests further investigation into tertiary education regarding equity plans for students with VLH and preservice teacher education modules. Tertiary equity plans require access to reasonable adjustments in either undergraduate or postgraduate education. Preservice teacher education programs facilitate dissemination of information regarding future awareness of the phenomenon of VLH in school students.

The current research has echoed the disconnect between requesting and gaining accommodations in compulsory schooling. Further investigation of accommodations being practiced would inform future PL programs for current teachers, pre-service teacher educators as well as supporting funding opportunities to enable access for individual students.

As an evolving area of research lagging behind digital media development, the potential marginalisation of a group of students caused by digital media use is a current and continuing issue.

9.4 Conclusion

As a transformative study the findings have revealed a culturally induced group of students disabled by contemporary classroom material culture as well as the evidence-based recommendations to decrease the marginalisation. It has begun to untangle the maze of classroom digital media use and the need for inclusive pedagogy. Much of the previous research has focussed on accessibility to digital media for individuals with an identified impairment causing disability. The current research raises awareness of the evolution of dis-abling social practices, as well as the strength of cross discipline research to facilitate inclusive practices.
Chapter 10  Postscript

The Escher-Like Steps of postgraduate research in visual light hypersensitivity when you identify as visually light hypersensitive

This chapter describes application of accommodations available to the researcher as a postgraduate student at Murdoch University, Perth, Western Australia. It begins by outlining the interplay of VLH and digital media, drawing on evidence gained through personal experience and through the experimental process carried out for this research. It outlines the accommodations that were most successful in the tertiary setting and concludes with suggestions for post-graduate inclusions for individual Equity plans for students with VLH.

It outlines how visual light hypersensitivity (VLH) can affect any student using digital media, including postgraduates. It links the process of vision with the theory of cognitive load, includes data from recent empirical research on duration of digital media use by high school students and practical accommodations and concludes with three suggestions for future postgraduate students when beginning their candidature.

This chapter has been submitted for publication. It has been included in this thesis as it demonstrates direct outcomes from the present study and application of the findings.
“Visual light” is used to see objects. Too little light and the details of the object disappear, too much light and the stimulus becomes painful. For the majority of the population, people accept their perception and analysis of reflected or emitted light as an assumed right in all environments, equal with all others. Temporary injury or illness may be distressful and decrease work output, but can be solved, facilitating a return to business as usual. A gradual decrease in visual acuity due to age requires mechanical accommodations such as glasses or environmental accommodations such as bright lighting. In general, these challenges to vision are culturally acceptable and accommodated for in the workplace and educational institutions.

For people with visual light hypersensitivity (VLH) these challenges may be intermittent or permanent (Verotti et al., 2005) and symptoms (pain, nausea) are often exacerbated by work environment lighting (fluorescent) and extended duration of computer use. For example, individuals with migraine are clinically sensitive to light during an episode and 45% of individuals with chronic migraine (long-term) also report clinical sensitivity to light in between episodes (Schwedt et al., 2013). In comparison, individuals with concussion may only have VLH for a couple of days (Gessel et al., 2007) before returning to active participation in all social activities. Mansur et al. (2018) investigated the support provided by a non-LCD display for students with VLH symptoms following a concussion. The specific physical properties of light causing adverse reactions are unique for each individual with VLH, although there are certain commonalities, therefore support for each person’s disability require data on the interaction of each group and most inclusive participatory design (Goggin, 2017).

The intervention and case study research following the Pokemon® Pocket monster Episode 38 incident generated many stimulus theories. These included the stimulative nature of saturated red light (Harding, Edson & Jeavons, 1997; Parra et al., 2005; Yamasaki, Goto, Kinukawa & Tobimatsu, 2008) flash frequency (Ricci et al., 1998), brightness of the screen (Parra et al., 2005; Yamasaki et al., 2008) and concentration
The majority of these investigations were with participants who exhibit a photoparoxysmal response (PPR) during intermittent photic stimulation (IPS) measured during electroencephalogram (EEG). Data for individuals who exhibit VLH only is scarce, often treated as a symptom of migraine or epilepsy. However, evidence-based research suggested ways to minimise the adverse responses, adopted to different degrees in different sectors of the community. Industry requires some parameters to be included as warnings in digital media hardware instruction manuals, these include the Apple Inc. iPad (2010, 2016) and Smartboard® (2012). Business demonstrate their inclusivity of website content by gaining AAA rating according to the Web Content Accessibility Guidelines (WCAG) 2.1 (World Wide Web Consortium, 2008). At this stage, educational institutions seem to be lagging behind in adoption of both evidence-based pedagogies and provision of accommodations for people with VLH.

When I look at Escher’s lithograph *Ascending and Descending* (1960), I see certain parallels of process with research in visual light hypersensitivity whilst identifying as visually light hypersensitive - the foremost being continual upward circular movement yet not gaining any height. To achieve the (I believe) necessary changes in educational digital media policy I needed to carry out the research, which involved a lot of digital media use, which physically disabled me, which I needed accommodations for, which needed more research.... and so it continued. Fortunately, I am able to ‘see’ well in natural light environments and have completed my research project. It is my hope that my doctoral research project will provide evidence of need for adaptation to digital media policy in high schools and set precedent for tertiary education accommodations to support students with VLH.

The need for accommodations in educational institutions focuses on cognitive load. The complexity of vision, its analysis and corresponding contribution to cognitive load are all factors in the debates regarding impact of visual environment on work and education. To observe an object, visual light rays are received into the eyes, transformed into electrical signals in the retina and follow a circuitous route through many junctions before arriving in the occipital cortex (visual area) of the brain. Visual neural network activation was interpreted by Wilkins and colleagues (1995, 2002, 2004, 2005) as visual load and visual stress. As an optometrist, Wilkins has developed different lenses (for glasses) to alter an individual’s perception of visual light. The aim of the altered perception was to decrease visual load for individuals with migraine, and therefore decrease their visual discomfort. Kirschner (2002) incorporates the idea of mental load and mental effort and describes these as well as an individual’s performance as follows;
‘Mental load is the portion of CL [cognitive load] that is imposed exclusively by the task and environmental demands. Mental effort refers to the cognitive capacity actually allocated to the task. The subject’s performance, finally, is a reflection of mental load, mental effort, and the aforementioned causal factors’ (p4).

The causal factors include the environment, as such include the visual light integral to the task. These environmental causal factors could be modified to increase (or decrease) the cognitive load, altering the proportion required to complete a task.

Digital participatory pedagogy and literacy are key elements in contemporary classroom learning activities. Potter (2004, p60) describes the four dimensions of media literacy as cognitive, emotional, aesthetic and moral. The additional need for conscious control of parameters in digital media such as luminance and external lighting are alluded to in Lang (2000), which proposed a limited capacity model of media information processing. This model relies on two assumptions; firstly, that people are information processors and secondly that the ability to process information is limited. These processes can be either automatic or by conscious choice. The three sub-processes involved in information processing are Encoding, Storage and Retrieval, however encoding capabilities are inversely proportional to the cognitive load (Lang, Potter and Bolls, 1999).

Using Lang’s 2000 model, with simultaneously acknowledgment that during a migraine episode, cognitive function is compromised (Chiang et al., 2018), therefore visual information presented on digital media can erect a barrier to learning for a student with migraine. Using this method without provision of alternate access seems counterintuitive for educational institutions assuming they are aware of the potential impact of digital media for people with VLH.

As a PhD student in the field of education, my research topic is digital media use in high schools and the accommodations used by schools to facilitate equitable use for students with VLH. The self-reported student results for duration of digital media use during school hours ranged from 15 minutes to over five hours, inclusive of interactive whiteboard, computer, iPad, phone and digital television. The educational digital media use continued at home with up to 5 hours online (‘exam preparation’, Participant 27). This duration of digital media use will sound familiar to anyone partaking in research (or currently teaching in a high school). The effect of this duration of digital media use every day for someone with VLH can range from discomfort to debilitating pain. Whilst high school students are limited in their options for accessing educational activities (pedagogical choices are made by their teachers), tertiary students have more options. As
a postgraduate research student there were five tenets of digital media use for people with VLH that I have attempt to maintain during my candidature. Whilst only one is directly translatable to all high school students, the others can be adapted for high school IEPs.

1. Read research articles in hard copy. Whilst literature searches perforce must be carried out online, the analysis and in-depth understanding of previous research can be garnered more thoroughly from printouts.

2. Draft all documents long-hand then dictate onto digital media. My preferred environment for this is natural lighting, the dictation program either through my iphone (‘enable dictation’) or computer (Dragon®) with screen on lowest possible luminance. It does take a while to get used to, but saves a lot of screen time.

3. Proof read hardcopy, edit digital copy, print out, repeat. Based on both cognitive load theory (Ma et al., 2014) and “Persistent Pain Neurocognitive Paradigm” (Smith & Ayres, 2014).

4. Limit single sessions of screen time to less than 45 minutes. Compliance can return rewards of longer, low-pain study sessions.

5. Low computer screen luminance, low contrast ratio, increased view size (makes words look bigger). All evidence-based recommendations and easy to work with to decrease mental load.

As stated by Inckle (2018) the extra work load completed by academics (and sometimes students) with disabilities is not well recognised either by the time spent or emotional effort. Recognition of ability is sometimes determined by capability within a default physical environment in educational institutions. The digital age brings a raft of features, capable of both abling and disabling. As academics and educators, knowledge of digital media reasonable adjustments can only enable both our students and ourselves.

My own journey had many Escher-like stages; often seeming to step higher and higher, yet finding myself no further forward and set to repeat the process. Hannam-Swain (2018) highlighted some of the challenges faced working with university support services, both ongoing and entry level. When initially asked to specify which tasks or processes required support, Hannam-Swain could not articulate enough specifics to afford adequate support, as many parameters of the tasks were unknown. A second category of challenges emphasises the gap in knowledge as PhD study is chosen by few with chronicled life-long disabilities, and still require corroborating information from medical specialists and previous educators. Nonetheless, there have been positive precedents from my candidature which are included as suggestions (with justification) for equity plans used by fellow postgraduate researchers;
1 Allocation of space in a 2-share room (no fluorescent lights, used halogen desk lamps) rather than 8-share room (fluorescent lights). This also facilitated easier use of dictation (thanks in part to two very generous room mates over the years).

2 Allocation of limitless photocopying. Whilst not environmentally friendly, the articles printed were filed enabling ongoing referencing, and the many thesis drafts were recycled.

3 Employment of a ‘formatter’ for my PhD thesis. Whilst no editing was carried out by this wonderful person, the number of hours saved by multiple rounds of formatting permitted my use of digital media to be focussed on quality of content. 

Using these adjustments, weeks of candidature and associated resources were reduced as migraine episodes were mostly avoided. Marginalisation of post graduate students due to novel challenges for access to research materials is not justifiable in the current social climate.

Further, I encourage educators and policy makers to consider the balance of quality versus quantity of digital media use and literacy as our educational institutions evolve. Acknowledgement of requirement for study material to be transferable to non-digital media for some students would be a step towards this, as would inclusion of extended environmental accommodations for postgraduate students with VLH. The digital age is here, but the humans living in it may need some support in order to thrive.
References


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Shepherd, A. J. Visual stimuli, light and lighting are common triggers of migraine and headache. *Journal of Light & Visual Environment, 34*(2), 94-100. doi: 10.2150/jlve.34.94


Sproul, J. (2019). The Escher-like steps of post graduate research in visual light hypersensitivity when you identify as visually light hypersensitive. Manuscript submitted for publication.


Vygotsky, L. S. (1931a) *Analysis of the higher mental functions* Retrieved from Marxists Internet Archive, Lev Vygotsky Archive website: https://www.marxists.org/archive/vygotsky/works/1931/analysis-higher-mental-functions.htm


*Every reasonable attempt has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.*
Appendix A  Ethics Applications for Surveys and Interviews

Although an ethical and legal requirement to undertake research, the process has been documented here to outline the inherent obstacles and concerns raised by undertaking a study in the field of education requesting medical information working with participants under 18 years old.

A.1  Online collection of permissions

Murdoch University

The MUHREC refers to the NSECHR (section 2) which defines low-risk as ‘research in which the only foreseeable risk is one of discomfort.’ The quantifiers of this include the information collected and the possibility of identification. As the time requirement for digital media use is small, therefore not inflicting pain on any participants who may be light sensitive, use of short duration online surveys was deemed acceptable. The data were deidentified, therefore the application for Ethics approval for research was submitted by the author to the School of Education Ethics Advisor as ‘low-risk’ in January 2016. It was decided by the appointed Ethics consultant that the research required full MUHREC approval. The inclusion of cross disciplinary language and references to headaches and pain were outside the scope of the School of Education Ethics Advisor’s jurisdiction.

The Surveys were submitted to the MUHREC in April 2016. In May 2016, the response from the committee was ‘Not yet approved’ and conditions were attached to be addressed prior to resubmission.

The following suggested changes were completed before resubmission.

- Surveys – increased demographics in parent surveys, add link between parent and student surveys, remove any pain scales, use more supportive statements when talking about Digital media and schools, explain need to understand learning environments.
- Information Letters – remove specific statistics, explain linking of data between parents and children.
- Any survey items with reference to ‘pain’ were required to be removed from the survey
Outright approval was granted by MUHREC in June 2016, to collect data using 4 online blogs and websites. This involved 3 ‘diary days’ (surveys) hosted on Survey Monkey, no IP addresses collected (‘Anonymous’ selected on collector). ‘Multiple response allowed’ included in selector to permit possibility of more than one survey being opened at once by different members of the family.

In August 2016 although there had been many webpage visits, there were no completed responses, so the invitations were removed. A MUHREC amendment to research proposal for an additional participant recruitment site: Migraine Again website (https://migraineagain.com), was submitted and approved.

By the beginning of October 2016 there were still no completed responses. To move the project forward, the idea of gaining participants through occupational therapists, neurologists or general practitioners was developed. However, as hard copies of surveys and return envelopes was preferred (feedback from practitioners), this avenue of investigation was discontinued due to potential identification of participants (NHMRC, 2018, point 4.2.11).

A.2 Direct application for permissions

At the end of October 2016 it was decided to apply directly to schools for permission to call for participants through e-newsletters and flyers. The decision was also made at this time to alter the methodology from three diary days to one survey only to encourage participation. Another MUHREC amendment to research proposal for this additional participant recruitment process was submitted in February 2017 for AISWA schools and approved. CEWA schools were added to the amendment in March 2017 with the condition that ‘CEO approvals [were gained] prior to commencing in these schools.’

Association of Independent Schools of Western Australia (AISWA)

In February 2017 the initial enquiry regarding process for Ethics Committee application was sent to the Manager of School Leadership, AISWA. The following response was received the next day (Figure E.2), which enabled application to be made to individual independent school who were not within the Catholic System, ‘Thank you for your enquiry. There is no separate requirement or protocol as we are an Association not a system.’
Catholic Education, Western Australia (CEWA)

The Catholic education system in Western Australia has an external research application document. This document was completed and submitted for approval in March 2017. After addressing conditions applied to approval including incorporation of government schools in the research, support was given in principle for the research in May 2017. One of the conditions required included provision of a copy of the letter of support (Appendix E.4) to be provided to the school principals of the selected Catholic Schools.

Department of Education, Western Australia (DoE)

The Department of Education in Western Australia requires submission of an extensive Application Form for External Parties to Conduct Research on Department of Education Sites prior to any students participating in research linked with school. Initial submission of this document was August 2nd 2017, with the first feedback provided in December 2017. The list of alterations required were addressed and the application resubmitted. Two more rounds of reviews followed with lists of changes similar in length, but different in requirements. In August 2018 with no approval pending, correspondence was sent to the DoE from the school of Education terminating this arm of the project. Reasons cited for termination included inconsistency with different reviewers asking for changes to what has already been changed as a result of DoE reviewers; three people over time have reviewed the application and each person requests different information and changes not requested by the other reviewers, changes by the DoE are making data incomparable to data collected by AISWA schools, therefore increasing chance of identification of participants.

As a result of the decision to terminate the application to conduct research on Department of Education sites, the condition required by the CEWA Ethics approval was not met. This limited the schools available for research to AISWA only.

Student (+18), Parent and Teacher Interview Ethics

The application to MUHREC for interviews with students (+18), parents and teachers was straightforward. Whilst a suggestion to the author’s supervisor from the DoE intimated that permission for past students to participate in research should also be forwarded to their office, this was not carried out. The justification for not applying for DoE permission for past students to participate in research was lack of jurisdiction by the DoE, setting precedent for future research, and also taking into account the low risk and historical recount nature of the research.
Appendix B  Ethics

B.1 Murdoch HREC approval

Monday, 13 June 2016

A/Prof Judy MacCallum
School of Education
Murdoch University

Dear Judy,

Project No.  2016/033
Project Title  Digital media use in the classroom: students with light sensitivity

Thank you for addressing the conditions placed on the above application to the Murdoch University Human Research Ethics Committee. On behalf of the Committee, I am pleased to advise the application now has:

OUTRIGHT APPROVAL

Approval is granted on the understanding that research will be conducted according the standards of the National Statement on Ethical Conduct in Human Research (2007), the Australian Code for the Responsible Conduct of Research (2007) and Murdoch University policies at all times. You must also abide by the Human Research Ethics Committee’s standard conditions of approval (see attached). All reporting forms are available on the Research Ethics and Integrity web-site.

I wish you every success for your research.

Please quote your ethics project number in all correspondence.

Kind Regards,

Dr. Erich von Dietze
Manager
Research Ethics and Integrity

cc:  Dr Susan Ledger and Janene Sproul
B.2 Murdoch amendment for AISWA School inclusion, and decreasing data collection instrument to one day

Thursday, 16 February 2017

A/Prof Judy MacCallum
School of Education
Murdoch University

Dear Judy,

Project No. 2016/033
Project Title Digital media use in the classroom: students with light sensitivity

AMENDMENT: Additional recruitment site: AISWA school nurse and school psychologist offices and newsletters
Only one ‘Diary Day’ requested for students to complete

Your application for an amendment to the above project, received on 16/02/2017 was reviewed by the Murdoch University Human Research Ethics Committee and was;

APPROVED

Approval is granted on the understanding that research will be conducted according the standards of the National Statement on Ethical Conduct in Human Research (2007), the Australian Code for the Responsible Conduct of Research (2007) and Murdoch University policies at all times. You must also abide by the Human Research Ethics Committee’s standard conditions of approval. All reporting forms are available on the Research Ethics and Integrity web-site.

I wish you every success for your research.

Please quote your ethics project number in all correspondence.

Kind Regards,

Dr. Erich von Dietze
Manager
Research Ethics and Integrity

cc: Dr Susan Ledger and Janene Sproul

Division of Research & Development
Research Ethics and Integrity

Chancellery Building
South Street
MURDOCH WA 6150
Telephone: (08) 9366 6777
Facsimile: (08) 9366 6686
human.ethics@murdoch.edu.au
animal.ethics@murdoch.edu.au

www.murdoch.edu.au

CT/OS Provider Code: 0012SU
ABN: 61 616 369 313
Dear Janene,

Thank you for your enquiry. There is no separate requirement or protocol as we are an Association not a system.

We provide support and guidelines to schools and school boards about assessing and judging the suitability of different research requests/projects from universities and other organisations when asked. However this is a decision for the school Principal.

Kind regards
Nicola

Nicola Davidson
Manager School Leadership & Teacher Quality
Workplace relations & Legal

Association of Independent Schools of Western Australia
Mobile 0402 958 529
Direct (08) 9441 1679
Suite 3, 41 Walters Drive Osborne Park, WA 6017
www.ais.wa.edu.au

I acknowledge that this land that I live and work on is Whadjuk country and that the Whadjuk Noongar people are the traditional owners and custodians, who have a rich social, spiritual and historical connection to this country, which is as strong today, as it was in the past.

This email and any files transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed. If you are not the named addressee, you should not disseminate, distribute or copy this e-mail. If you have received this email in error please notify the system manager on the above phone number. Although the company has taken reasonable precautions to ensure no viruses are present in this email, the company cannot accept responsibility for any loss or damage arising from the use of this email or attachments.
18 May 2017

Mrs Janene Sproul
C/o Professor Judy MacCallum
Murdoch University
School of Education
90 South Street
MURDOCH WA 6150

Dear Mrs Sproul

RE: DIGITAL MEDIA IN THE CLASSROOM: STUDENTS WITH LIGHT SENSITIVITY

Thank you for your completed application received 9 March 2017, whereby this project will investigate the use of digital media in schools and used by students who are light sensitive. From the data a set of guidelines will be generated to encourage equitable digital media use by light sensitive students.

I give in principle support for the selected secondary Catholic schools in Western Australia to participate in this valuable study. However, consistent with Catholic Education Western Australia (CEWA) policy, participation in your research project will be the decision of the individual principal and staff members. A copy of this letter must be provided to principals when requesting their participation in the research.

Responsibility for quality control of ethics and methodology of the proposed research resides with the institution supervising the research. CEWA notes that Murdoch University Human Research Ethics Committee has granted permission for the duration of this research project (Approval Number: 2016/033).

Any changes to the proposed methodology will need to be submitted for CEWA approval prior to implementation. The focus and outcomes of your research project are of interest to CEWA. It is therefore a condition of approval that the research findings of this study are forwarded to CEWA.

Further enquiries may be directed to Jane Gostelow at gostelow.jane@ceo.wa.edu.au or (08) 6380 5118.

I wish you all the best with your research.

Yours sincerely

Dr Tim McDonald
B.5 Murdoch amendment parents and teachers

2. Amendment(s) Requested

<table>
<thead>
<tr>
<th>List requested change/s</th>
<th>Provide detail and justification for change/s (below boxes will expand as required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of phone interview with parents</td>
<td>To increase range of data, open ended questions previously accepted by Murdoch HREC in survey. See questions and letter on attachment.</td>
</tr>
<tr>
<td>Call for participants on Murdoch noticeboards, staff and student announcements and doctors surgery</td>
<td>To increase visibility of call for participants, similar format to poster on Ethicsite (see attachment).</td>
</tr>
<tr>
<td>Addition of interview with teachers who participated in workshops</td>
<td>To increase range of data, focus on information regarding practical and transferable pedagogies. See questions and letter on attachment.</td>
</tr>
</tbody>
</table>

Click for additional lines

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Division of Research & Development
Research Ethics and Integrity

Wednesday, 01 November 2017

A/Prof Judy MacCallum
School of Education
Murdoch University

Dear Judy,

Project No. 2016/033
Project Title Digital media use in the classroom: students with light sensitivity

AMENDMENT: Addition of phone interview with parents, interview with teachers, and recruitment flyers

Your application for an amendment to the above project was reviewed by the Murdoch University Human Research Ethics Committee and was;

APPROVED

Approval is granted on the understanding that research will be conducted according to the standards of the National Statement on Ethical Conduct in Human Research (2007), the Australian Code for the Responsible Conduct of Research (2007) and Murdoch University policies at all times. You must also abide by the Human Research Ethics Committee’s standard conditions of approval. All reporting forms are available on the Research Ethics and Integrity web-site.

I wish you every success for your research.

Kind Regards,

Dr. Erich von Dietze
Manager
Research Ethics and Integrity

cc: Dr Susan Ledger; Janene Sproul
Appendix C  School Flyer

C.1  Insertion for newsletter

Teens and Screens
Digital Media at School

Interactive whiteboards and computers have changed the classroom environment.

Be part of the research investigating…
How many SCREEN HOURS are used at school?
WHICH SUBJECTS use screens the most?
How are students with migraine/light sensitivity/headache/anxiety being supported?

Who: High school students and their parents
How: Students ▶️ 1 Online Student Survey (10 minutes)
Go to https://www.surveymonkey.com/r/9J2QQCX
Parents ▶️ 1 x Online Parent Survey (10 minutes)
Go to https://www.surveymonkey.com/r/MD5Q5TG

For more information email Janene Sproul at janene.sproul@murdoch.edu.au
Research Project
Digital media in schools: students with migraine

Murdoch University (Perth) is interviewing people to find out how students with migraine work with digital media. We aim to develop guidelines for digital media use in high schools. You can access a detailed information letter by going to www.photosensitivity.info/ and clicking the interview Information button.

The interview phone number is included in the Interview information letter. The phone interview will take about 10 minutes and will be recorded if you agree. You can choose not to answer a question if you don’t want to and you can end the interview at any time. Whatever you say will be anonymous.

These are the researchers working on this project:

Janene Sproul  Dr Judith MacCallum  Dr Susan Ledger

Please contact Janene – Janene.sproul@murdoch.edu.au with any questions you have. A summary of our findings will be available to you within 6 months of your interview.

This study has been approved by Murdoch University’s Human Research Ethics Committee (Approval 2016/035). You can contact Murdoch University’s Research Ethics Office (ph. 08 9380 6077) or e-mail ethics@murdoch.edu.au and they will address any concerns that you have.

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Murdoch logo used with permission
Other artwork sourced from Pixabay, free for commercial use
Appendix D  Contact with Principals

D.1  Example of email sent to Assistants to School Principals

Good afternoon XXX XXXXXX,

Thank you for your warm welcome today on the phone.

I have attached an Information Letter, Principal Consent Form and the proposed Flyer for XX XXXXXX’s perusal. If she would like to ask any questions then I would be happy to answer them.

Thank you for your help in this matter
Kind regards
Janene Sproul
04XX XXX XXX

D.2  Examples of responses from Assistants to School Principals

Hi Janene

Thank you for your email. Please find attached a signed consent form regarding the Teens and Screens study.
Our school XXXXXX is XXXX XXXXX and she can be contacted at XXXX@XXXX to set up a meeting.

Regards
XXXX XXXX
Personal Assistant to the Principal

Good morning Janene

Thank you for your email and for considering XXXX XXXX School for your research.

I passed the information onto XXXXXXXXXXX and unfortunately we will have to decline as we are already committed to a large number of studies & surveys this year.

We wish you all the best for your research.

Kind regards
XXXX

Hello Janene

Thank you for your email.

Unfortunately we will be unable to assist you with your request.

We wish you the very best with your research.

Kind regards
XXXX XXXX
Executive Assistant
Good afternoon XXXX

The purpose of this project is to investigate how much digital media (screen) hours are used in schools and also the ways students who are sensitive to light are supported. For this research, light sensitivity refers to the heightened response to visual light stimuli, inclusive of students with migraine, anxiety and depression. Prof MacCallum is working with Dr Ledger and Ms Sproul (PHD student) to collect this data. We hope to find what support best enables light sensitive students and whether there is any difference in screen usage between light sensitive and non-light sensitive students. Anything we can learn from participants based at your school can add to the development of a low risk screen safety program for schools similar to those used in industry.

Mrs Janene Sproul has taught high school Science for nearly 20 years. Her interest in this area incorporates the fields of equity, inclusive education and disability support. She will be happy to answer any questions you have regarding either this study or support material for students and teachers.

We would like your permission to post flyers (see attached) in your school newsletter. The flyer invites students and parents to take part in individual online surveys. The majority of the questions relate to different subjects, what types of devices are used in class and for how long. As breakfast, sleep and medication influence reactions with screens, there is one question regarding each of these variables in the survey. We do not ask what medication, only its type – preventative or ‘taken when needed’. Screen brightness is another factor that we are gathering preliminary information on.

The surveys are 10 minutes long, anonymous, and over 20 schools in Western Australia are being asked to support the research. All information is deidentified, and parental consent is via link with student consent. No school time is taken up, no teacher time is required.

A summary of findings from this research will be sent to you after October 2018, as well as preliminary guidelines formed from this data and medical research.

You can decide at any time to withdraw your consent to participate in this research. If you decide to withdraw, any material you have given us will be destroyed (sometimes data cannot be withdrawn or destroyed after a certain point as we would not know what data was submitted by students at your school).

If you would like to try the survey yourself, please use the codename ‘Test’ so that the data can be removed prior to analysis.

If you are amenable to these flyers being distributed by your school and have had any questions regarding the research answered, I will send through the required principal consent form for you to sign and return.

Thank you for taking the time to consider being a part of this research

Janene Sproul
Janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel. 08 9360 or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
E.2 Consent form for Principal

Consent Form for Principals
AISWA schools

Teens and Screens
Digital Media in Schools

1. I agree voluntarily to take part in this study.
2. I have read the Information Sheet provided and been given a full explanation of the purpose of this study, the procedures involved and of what is expected of me.
3. I understand that I will be asked to
   o Allow the flyer asking for participants in the research to be printed in the school newsletter or Facebook page
4. The researcher has answered all my questions and has explained possible issues that may arise as a result of my participation in this study.
5. I wish for my school to be anonymous and do not want my school named in the study
6. I understand that all information provided by participants from my school is treated as confidential and will not be released by that researcher to a third party and is required to do so by law

Name of School: _______________________

Name of Principal: _______________________

Signature of Participant: _______________________
Date: ……./……./…….

I confirm that I have provided the Information Letter concerning this study to the above participant; I have explained the study and have answered all questions asked of me.

Signature of researcher: _______________________
Date: ……./……./…….

Consent Form for Principals
AISWA schools

Teens and Screens
Digital Media in Schools
Appendix F  Survey Information Letters

F.1  Survey information letter for parent

Dear Parent/Carer

My name is Janene Sproul and I teach high school Biology in Australia. Due to the increase in use of digital media in classrooms, I am conducting a research project to examine how much digital media is used in schools and also the ways students who are sensitive to light are supported. For this research, light sensitivity refers to the heightened response to visual light stimuli. The project is being conducted as part of a PhD degree at Murdoch University, Australia.

This letter is an invitation for you and your child/ren to take part in the project, whether they are light sensitive or not. The more information gathered, the more accurate I can be explaining current school digital media use. There is also an information letter for your child that I encourage you to discuss with him/her. More than one child per family can participate, as each child would have his/her own codename and information for the project. When you add your child’s codename to your own questionnaire, it provides parental permission for your child to participate. It also links the two groups of data to allow better analysis of your child’s answers regarding school environment. More than one child per family can participate, as each child would have his/her own information for the project. Your child’s participation in the project would involve completing an online survey.

As a parent/carer of a student participating in this research, the Parent Survey provides additional information on definitions used in schools. It does not matter whether your child is light sensitive or not, all the information is helpful. The survey takes about 10 minutes and asks questions about digital media and schooling. The demographic questions in the parent survey provide information about your child’s school environment, which allows better analysis of digital media use. If you answer ‘no’ to the light sensitive question, then the survey is very short. If you answer ‘yes’ to the light sensitive question, it continues regarding light sensitive diagnoses and the educational support for your child. If you would like to add information for more than one child, then this option is offered for up to three children in the Parent Survey. Additional child/ren’s information will extend the duration of the survey for 2 - 5 minutes per child.

The time taken for the student survey should be about 10 minutes one day after school. Students are asked about amount of sleep and breakfast as this can affect light sensitivity, to comment whether they had ‘Lots’, ‘Some’ or ‘None’ of these items. It also asks whether they take medication or not. The medication question does not ask for type or amount – just whether it is taken every day (preventative) or only when the student begins to feel unwell (intervention). The survey also asks how much digital media is used in each class during the school day. As parental consent to participate in the project, you are invited to share the link to the Student Information Letter found at the bottom of this letter with your child. As with your own survey, your child/ren will be asked for their own consent to participate in the opening page of their survey.

Participation is voluntary. If you, or your child, decide to participate and then later change your mind, you are able to withdraw at any time by exiting the website. Exiting the website before completion of the questionnaire will remove the information from the research and withdrawal from research will not affect participant’s relationship with the research team and Murdoch University. The privacy and confidentiality of participants is assured since limited demographic information will be collected. The data will be stored securely on thumbdrive and hard copy within a locked drawer and can only be accessed by Janene Sproul, Dr MacCallum and Dr Ledger. The data will be stored for a minimum period of 5 years, after which it will be destroyed. Data will be destroyed in 2022 by shredding the hard copy and deleting the files on the thumbdrives (Murdoch University Library IT).

Participant privacy and the confidentiality of information disclosed by participants, is assured except in circumstances that require reporting under the Department of Education Child Protection policy, or where the research team is legally required to disclose that information. The information you provide will be used only for this project, and will not be used in any extended or future research. An overall summary of the results will be provided to the principals of each school that participates in the research.

Are there any special requirements for students to be part of this research?
Yes, there are 5. Students need to
- be between the ages of 12 and 18 years old, therefore eligible to be studying high school courses.
Are there any special requirements for students to be part of this research?
Yes, there are 5. Students need to
- be between the ages of 12 and 18 years old, therefore eligible to be studying high/secondary/prep school courses.
- have parental permission to participate in this research.
- be studying high/secondary/prep school courses. This is because the questionnaire is structured around a high/secondary/prep school timetable.
- be able to understand written English. This is because the questionnaires are written in English.
- be able to access the internet after school hours for 10 mins. This is because the questionnaires are only accessible on the internet.

Do students have to use digital media at school every day to participate?
No. All the information from students using differing amounts of digital media helps. The more information students send in, the more accurate I can be when talking to other teachers how much digital media is currently being used in schools.

Do students have to be sensitive to light to participate?
No. All the information from people with and without light sensitivity helps build a better picture.

As a parent, are there any special requirements to be part of this research?
Yes, there are 2. You need to be
- able to understand written English, as the survey is written in English.
- able to access the internet to complete the survey.

As a parent, what will happen to the information I give - is it private and confidential?
I use Survey Monkey for the questionnaires and diaries because the information collected does not contain your name, email or IP address. It is intended that the findings of this study will be published in journal articles and spoken of at conferences. A summary of findings from this research will be available from the www.photosensitivity.info website ‘Digital Media in Schools’ page after October 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by July 2018, and an email with a summary of the preliminary findings will be sent to you.

The research has been approved by Murdoch University Human Research Ethics Committee (ref 2016/033).

If you would like to discuss any aspect of this study please contact me by email provided below. If you wish to speak with an independent person about the conduct of the project, please contact Dr Erich von Dietze, Murdoch University Ethics Department, on +61 8 9360 6170.

If you and your child are willing to be involved, please close this window and return to the Survey Monkey page to complete the survey.

Thank you for your time and consideration.

Janene Sproul
Murdoch University
janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics & Integrity on Tel. 08 9360 6677 (+61 8 9360 6677 for overseas studies) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
F.2 Survey information letter for student

Student Information Letter

Teens and Screens
Digital Media in Schools

Dear Student

My name is Janene Sproul and I am a high school science teacher. I also do some research regarding digital media use during school hours.

I am asking for your help with the project because you are currently studying in high school. I am inviting students from across Western Australia to take part in this research, to gather information from different school environments. All the information adds together to give a more detailed picture of digital media use for high school students, you do not have to get migraines or to be light sensitive to be part of the research. However, in this survey light sensitivity means a person has a bigger response than expected when light from any source (the sun, inside lights, computers) are used.

What would I be asked to do?
If you agree to take part, you can complete the 10 minute survey. The Codename question (question number 2) needs to be shared with your parents. The codename is used because this survey is anonymous, it does not ask for your real name, school, or date of birth.

The survey does
- help you create a Codename. This codename also needs to be shared with your parents as it links their questionnaire answers to yours.
- get completed online after school. Please do not fill these out during school - your education is extremely important and needs all your concentration.
- ask a couple of general questions about sleep, breakfast and whether you take medication or not. The medication question does not ask for type or amount – just whether you take it every day (preventative) or just when you start to feel unwell (intervention).
- ask what type of digital media you used in each class, and for approximately how long – no exact timing needed!

Are there any special requirements for students to be part of this research?
Yes, there are 5. Students need to
- be between the ages of 12 and 18 years old, therefore eligible to be studying high/secondary/prep school courses. This removes need for exact age, to assist with information privacy and confidentiality.
- have parental permission to participate in this research.
- be studying high/secondary/prep school courses. This is because the questionnaire is structured around a high/secondary/prep school timetable.
- be able to understand written English. This is because the questionnaires are written in English.
- be able to access the internet after school hours for 10 mins. This is because the questionnaires are only accessible on the internet.

Do I have to use digital media every day to participate?
No. All the information from students using differing amounts of digital media helps. The more information students send in, the more accurate I can be when talking to other teachers how much digital media is currently being used in schools.
Do I have to be sensitive to light to participate?
No. All the information from people with and without light sensitivity helps build a better picture of how digital technology is used in schools.

Do I have to take part?
You are free to say yes or no. If you say yes, then the anonymous information will be added to other information. If you say yes, but then want to stop participating, that’s ok. Just close the online window and it will not be submitted. If you say no, that is ok too.

Do my parents/carers have to allow me to take part in the research?
Yes. As this research includes asking questions to people under the age of 18, I have to gain parental/carer consent (permission from parents/carers) for these students to take part. To keep all ages anonymous, I am asking all participants to gain parental consent.

What will happen to the information I give - is it private and confidential?
I use Survey Monkey for the questionnaires and diaries because it will not contain your name, email or IP address. This means that you cannot be identified electronically and keeps your answers anonymous. Linking your information to your parent’s survey will allow me to analyse your answers as (for example) ‘a female high school student in a city in Western Australia’, but they will still not be traceable to you.

The information is stored securely on hard copy and thumb drive in a locked cupboard and can only be accessed by myself Dr MacCallum and Dr Ledger (two Education lecturers at Murdoch University). The data will be stored for a minimum period of 5 years. Records are destroyed immediately after this period, unless the law requires them to be held longer. Records will be destroyed by shredding the hard copy and deleting the files on the thumbdrives.

After I have collected all the information for the project and analysed all of it, I intend to write about it and talk to other teachers about it. I also hope to help some students who are light sensitive and have to work with computers for school. When I do this, I won’t be able to write or tell anyone your name as the information is anonymous.

A summary of findings from this research will be available from the www.photosensitivity.info website ‘Digital Media in Schools’ page after November 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by November 2018, and an email with a summary of the preliminary findings will be sent to you.

Is this research approved?
The research has been approved by Murdoch University Human Research Ethics Committee (ref 2016/033).

Who do I contact if I wish to talk about the project further?
Please talk about the project with your parents first. Then, if you would like to talk with me more, please contact me by email. If, at any time, you wish to speak with a person who is not involved in the project about how something was handled, please contact Dr Erich von Dietze, Murdoch University Ethics Department, on +61 8 9360 6170.

OK – so how do I become involved?
You have already discussed the project and what it means to take part with at least one of your parents or guardian. Now you can say for yourself.

If you do want to be a part of the project, then you can return to the Survey Monkey page and complete the Student Survey.

Thank you for thinking about being part of this research

Janene Sproul
Murdoch University
janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics & Integrity on Tel. 08 9360 6677 (+61 8 9360 6677 for overseas studies) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix G  Survey Questions

G.1  Survey questions for parent

Please help us to investigate

Teens and Screens - Digital Media at School
An Anonymous Survey of Parents and Students

Digital media use by adolescents has increased in the last decade. This research project aims to investigate how the use of Interactive whiteboards and computers may have changed the classroom environment.

- How many SCREEN HOURS are used at school?
- WHICH SUBJECTS use screens the most?
- How are light sensitive students being supported?

As a parent/carer of a high school student you are invited to participate. Your own survey will be linked to your child's survey by entering a codename of created by your child. This ensures the anonymity of both you and your child but still allows you to give your consent for your child to participate. Both your survey and your child's survey are approximately 10 minutes long.

For further information about this study, please read the Parent Information Letter here

Participant Consent

I have read the Information about the nature and scope of this survey. Any questions I have about the research process have been answered to my satisfaction. I agree that by submitting the survey online, I give my consent for the results to be used in the research. I am aware that this survey is anonymous. I know that I may change my mind, withdraw my consent, and stop participating and I acknowledge that once my survey has been submitted it may not be possible to withdraw my data.

I understand that all information provided is treated as confidential by the researchers and will not be released to a third party unless required to do so by law.

I understand that the findings of this study may be published and that no information which can specifically identify me will be published.

1. Do you agree with the consent statements above?
   - Yes  (continue with survey)
   - No  (exit survey)
The following demographic information allows better understanding of the context in which your child learns.

2. Are you male or female?
   - Male
   - Female

3. What country do you live in?
   For example: Mexico or Scotland or India

4. Choose one of the following to best describe where you live.
   - Large city (>2 000 000)
   - Small city
   - Small town
   - Outside town/farm

5. What is the highest level of education completed in your household?
   - Did not complete secondary school
   - Secondary School
   - Trade/Apprenticeship/Technical qualification
   - Undergraduate University degree
   - Postgraduate University degree
   - Other (please specify)

In the context of this survey, light sensitivity refers to students who have a heightened sensitivity to visual light stimuli. Light sensitivity can be continuous, intermittent or triggered. This survey draws on your experience as a carer or parent. You may or may not have a child who is light sensitive, possibly as part of a medical condition like migraine. This research aims to investigate current school digital media use by all students as well as support for students with light sensitivity during educational activities. Please add information for one child at a time, up to three children. To keep information anonymous, we are referring to the first child as Child 1, the second child as Child 2 etc rather than using their real names. This is to protect them when your information is entered in the survey.

Linking your survey with theirs will assist in further understanding of current school media use and practices.

6. What is the codename Child 1 is using to complete the student survey?
   Child One

7. Of the following, which would best describe the school environment for Child 1?
   - low socioeconomic
   - medium socioeconomic
   - high socioeconomic

8. Does Child 1 show any sensitivity to light?
   - Yes
   - No
9. Has Child 1 ever spoken to you about having a reaction to using computers and digital media at school? If yes, please give an example.

10. Has Child 1 ever spoken to you about having a reaction to the lights at school? If yes, please give an example.

11. What action by teachers has been most supportive of your child’s light sensitivity?

12. Has Child 1 ever been diagnosed by medical personnel (optometrist, doctor) with light sensitivity?
- No
- No - Still waiting for diagnosis
- Yes
- Yes - with Migraine
- Yes - with Headaches
- Yes - with Epilepsy
- Choose not to answer
- Other (please specify)

13. Does Child 1 have any other diagnosed conditions that can affect their school work?

---

**Teens and Screens - Digital Media at School (Parent Survey)**

**Child 1**

Accommodations are the individual adjustments used to support your child's learning.

This section asks questions regarding school support and what light-sensitive accommodations you currently use at home to support your child.

**14. Please enter the category of school previously and currently attended by Child 1**

<table>
<thead>
<tr>
<th>School Category (Pulldown Menu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous school</td>
</tr>
<tr>
<td>Government/State</td>
</tr>
<tr>
<td>Independent or Catholic</td>
</tr>
<tr>
<td>Home</td>
</tr>
<tr>
<td>Current School</td>
</tr>
<tr>
<td>Government/State</td>
</tr>
<tr>
<td>Independent or Catholic</td>
</tr>
<tr>
<td>Home</td>
</tr>
</tbody>
</table>

Comments
15. Please choose answers regarding Child 1's previous school (if applicable) and current school.

<table>
<thead>
<tr>
<th>Previous School (Pull-down Menu)</th>
<th>Current School (Pull-down Menu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Have you spoken to any of Child 1's teachers about their light sensitivity?</td>
<td>No</td>
</tr>
<tr>
<td>I am the teacher (homeschool)</td>
<td>I am the teacher (homeschool)</td>
</tr>
<tr>
<td>Yes, in previous years</td>
<td>Yes, in previous years</td>
</tr>
<tr>
<td>Yes, this year</td>
<td>Yes, this year</td>
</tr>
<tr>
<td>Yes, every year</td>
<td>Yes, every year</td>
</tr>
</tbody>
</table>

b) Have you requested any changes to accommodate Child 1's light sensitivity? | No | No |
| I am the teacher (homeschool) | I am the teacher (homeschool) |
| Yes, in previous years | Yes, in previous years |
| Yes, this year | Yes, this year |
| Yes, every year | Yes, every year |

c) Has Child 1's light sensitivity been documented at school? | No | No |
| I am the teacher (homeschool) | I am the teacher (homeschool) |
| Yes, in previous years | Yes, in previous years |
| Yes, this year | Yes, this year |
| Yes, every year | Yes, every year |

Please describe all accommodations and how they have supported Child 1.

16. Please rate the following statement

Visual light sensitivity can affect Child 1's ability to participate in school activities

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

17. Have there been any learning activities at school where Child 1 has not fully participated because of their light sensitivity?

18. When working at home, what accommodations have you made to support Child 1?

19. Would you like to add another child's information?
   - Yes
   - No

20. What is the codename Child 2 is using to complete the study?

21. Of the following, which would best describe the school environment?

   - Low socioeconomic
   - Medium socioeconomic
   - High socioeconomic

Smart Logic embedded

‘Yes’ leads to question 19
‘No’ leads to ‘Thank you’ page and end of survey

Survey Format

Questions 20 – 32 ask parallel questions about Child 2 as Child 1
Question 33 asks whether data for another child is to be entered
Questions 34 – 46 ask parallel questions about Child 3 as Child 1
Concludes with ‘Thank you’ page as shown
Thank you for participating in this research.

A summary of findings from this research will be available from the www.photosensitivity.info website ‘Digital Media in Schools’ page after November 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by November 2018, and an email with a summary of the preliminary findings will be sent to you.

With regards
Janene Sproul
G.2 Survey questions for student

Please help us to investigate
Teens and Screens - Digital Media at School
An Anonymous Survey of Parents and Students

Digital media use by adolescents has increased in the last decade. This research project aims to investigate how the use of Interactive whiteboards and computers may have changed your classroom environment.

- How many SCREEN HOURS do you use at school?
- WHICH SUBJECTS use screens the most?
- How are light sensitive students being supported?

As a high school student you are invited to participate, your own survey linked to your parent's survey through a codename of your choosing. This helps with keeping your information anonymous. Both your survey and your parent's survey are approximately 10 minutes long.

For further information about this study, please read the Student Information Letter here

1. Do you agree with the statements above?
   - Yes (continue with survey)
   - No (exit survey)

2. Please construct a codename. It could contain a number, a colour and an animal
   
   For example: 7bluegiraffe

   You don't have to use spaces or capitals, just something you will remember and share with your parent/carer to link their survey with yours.

   My codename is

   [Enter codename]

   Next

Participant consent

I have read the Information about the nature and scope of this survey. I agree that by submitting the survey online, I give my consent for the results to be used in the research. I am aware that this survey is anonymous. I know that I may change my mind, withdraw my consent, and stop participating at any time; and I acknowledge that once my survey has been submitted it may not be possible to withdraw my data.

I understand that all information provided is treated as confidential by the researchers and will not be released to a third party unless required to do so by law.

I understand that the findings of this study may be published and that no information which can specifically identify me will be published.

3. Do you agree with the consent statements above?
   - Yes (continue with survey)
   - No (exit survey)
4. Did you have any sensitivity to light before school this morning?
   - Yes
   - No
   - Comments

5. The amount of sleep you had last night ...
   - None
   - Some
   - Lots

6. The amount of breakfast you had this morning was
   - None
   - Some
   - Lots

7. The type of medication you had today ...
   - None
   - Intervention (I took it when I started feeling unwell)
   - Preventative (I take it every day)
   - Other (not for headache or migraine)

The next questions use ‘smart logic’ within your own survey. Questions 8 - 15 set up the grid for Question 18 on the next page. Only use as many spaces as you have had classes today, however please use TWO questions for DOUBLE SESSIONS.

9. What was your Session 1 class?
   Session 1

10. What was your Session 2 class?
    Session 2

11. What was your Session 3 class?
    Session 3

12. What was your Session 4 class?
    Session 4

13. What was your Session 5 class?
    Session 5

14. What was your Session 6 class?
    Session 6

15. What was your Session 7 class?
    Session 7

16. What was your Session 8 class?
    Session 8
16. How long were most of your classes today? (Pull down menu)
- 30 minutes
- 35 minutes
- 40 minutes
- 45 minutes
- 50 minutes
- 55 minutes
- 60 minutes
- 65 minutes
- 70 minutes
- 75 minutes
- 80 minutes

17. Please describe any exceptions to this today.
For example: Form class was 10 minutes, or Assembly was 35 minutes

2018 Teens and Screens - Digital Media at School (Student Survey)

Digital Media use in class

18. Digital media use in classrooms
Please fill out the table below for each of today's classes. Leave any excess Class lines blank.

<table>
<thead>
<tr>
<th></th>
<th>Interactive Whiteboard Use (Pull-down menu)</th>
<th>Computer Use (Pull-down menu)</th>
<th>Ipad Use (Pull-down menu)</th>
<th>Phone Use (Pull-down menu)</th>
<th>Television Use (Pull-down menu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>{{Q81}}</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Half</td>
<td>Half</td>
<td>Half</td>
<td>Half</td>
<td>Half</td>
</tr>
<tr>
<td></td>
<td>Three quarters</td>
<td>Three quarters</td>
<td>Three quarters</td>
<td>Three quarters</td>
<td>Three quarters</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>{{Q91}}</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Half</td>
<td>Half</td>
<td>Half</td>
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<tr>
<td></td>
<td>Three quarters</td>
<td>Three quarters</td>
<td>Three quarters</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>{{Q10}}</td>
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<td>Three quarters</td>
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<td></td>
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<td>All</td>
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</tr>
<tr>
<td>{{Q11}}</td>
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<td>None</td>
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<td></td>
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<tr>
<td>{{Q13}}</td>
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<td></td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>
19. Do you have any sensitivity to light now (after school)?
   - Yes
   - No

20. How bright do you like your own computer screen?

   very dim (opposite to bright)  a bit dim  medium  a bit bright  very bright

21. How long will you spend on digital media tonight to do homework?
   (e.g., half an hour, one hour, three hours)

Thank you for completing this survey.
Appendix H  Interview Information Letters

H.1  Interview information letter for past student

Dear Ex-student

My name is Janene Sproul and I teach high school Biology in Australia. Due to the increase in use of digital media in classrooms, I am conducting a research project to examine how much digital media is used in schools and also the ways students who are sensitive to light are supported. For this research, light sensitivity refers to the heightened response to visual light stimuli. The project is being conducted as part of a PhD degree at Murdoch University, Australia.

This letter is an invitation for you to take part in the project, a phone interview provides additional information. It takes about 10 minutes and asks questions about digital media and schooling.

To participate: call 9360 7214.
Phone is operational 8:30am – 3:30pm

Participation is voluntary. If you decide to participate and then later change your mind, you are able to withdraw at any time. The privacy and confidentiality of participants is assured since limited demographic information will be collected. No names will be used in the published data. The data will be stored securely on a hard drive and hard copy within a locked drawer and can only be accessed by Janene Sproul, Dr MacCallum and Dr Ledger. The data will be stored for a minimum period of 5 years, after which it will be destroyed. Data will be destroyed in 2021 by shredding the hard copy and deleting the files on the thumbdrives (Murdoch University Library IT).

Participant privacy and the confidentiality of information disclosed by participants, is assured except in circumstances where the research team is legally required to disclose that information. The information you provide will be used only for this project, and will not be used in any extended or future research.

As a parent, are there any special requirements to be part of this research?
Yes, you need to be able to understand spoken English.

As a parent, what will happen to the information I give - is it private and confidential?
The data collected during the interview does not contain more than your name (for consent). No email or contact addresses are collected. It is intended that the findings of this study will be published in journal articles and spoken of at conferences. A summary of findings from this research will be available from the www.photosensitivity.info website. Digital Media in Schools’ page after April 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by February 2018, and an email with a summary of the preliminary findings will be sent to you.

The research has been approved by Murdoch University Human Research Ethics Committee (ref 2016/033). If you would like to discuss any aspect of this study please contact me by email provided below. If you wish to speak with an independent person about the conduct of the project, please contact Dr Erich von Dietz, Murdoch University Ethics Department, on +61 8 9360 6170.

If you are willing to be involved, please contact us on 9360 7214. This Information Letter is for you to keep.

Thank you for your time and consideration.

Janene Sproul
Murdoch University
janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics & Integrity on Tel. 08 9360 6677 (+61 8 9360 6677 for overseas studies) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Dear Parent/Carer,

My name is Janene Sproul and I teach high school Biology in Australia. Due to the increase in use of digital media in classrooms, I am conducting a research project to examine how much digital media is used in schools and also the ways students who are sensitive to light are supported. For this research, light sensitivity refers to the heightened response to visual light stimuli. The project is being conducted as part of a PhD degree at Murdoch University, Australia.

This letter is an invitation for you to take part in the project. As a parent/carer of a student with migraine, a phone interview provides additional information. It takes about 10 minutes and asks questions about digital media and schooling.

**To participate: call 9360 7214.**

Phone is operational 8:30am – 3:30pm

Participation is voluntary. If you decide to participate and then later change your mind, you are able to withdraw at any time. The privacy and confidentiality of participants is assured since limited demographic information will be collected. No names will be used in the published data. The data will be stored securely on thumbdrive and hard copy within a locked drawer and can only be accessed by Janene Sproul, Dr MacCallum and Dr Ledger. The data will be stored for a minimum period of 5 years, after which it will be destroyed. Data will be destroyed in 2021 by shredding the hard copy and deleting the files on the thumbdrives (Murdoch University Library IT).

Participant privacy and the confidentiality of information disclosed by participants, is assured except in circumstances where the research team is legally required to disclose that information. The information you provide will be used only for this project, and will not be used in any extended or future research.

**As a parent, are there any special requirements to be part of this research?**

Yes, you need to be able to understand spoken English.

**As a parent, what will happen to the information I give - is it private and confidential?**

The data collected during the interview does not contain more than your name (for consent). No email or contact addresses are collected. It is intended that the findings of this study will be published in journal articles and spoken of at conferences. A summary of findings from this research will be available from the www.photosensitivity.info website ‘Digital Media in Schools’ page after April 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by February 2018, and an email with a summary of the preliminary findings will be sent to you.

The research has been approved by Murdoch University Human Research Ethics Committee (ref 2016/033). If you would like to discuss any aspect of this study please contact me by email provided below. If you wish to speak with an independent person about the conduct of the project, please contact Dr Erich von Dietze, Murdoch University Ethics Department, on +61 8 9360 6170.

If you are willing to be involved, please contact us on 9360 7214. This Information Letter is for you to keep.

Thank you for your time and consideration.

Janene Sproul
Murdoch University
janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics & Integrity on Tel. 08 9360 6677 (+61 8 9360 6677 for overseas studies) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
H.3 Interview information letter for teacher

Teacher Information Letter – Phone Interview

Dear Teacher

My name is Janene Sproul and I teach high school Biology in Australia. Due to the increase in use of digital media in classrooms, I am conducting a research project to examine how much digital media is used in schools and also the ways students who are sensitive to light are supported. For this research, light sensitivity refers to the heightened response to visual light stimuli. The project is being conducted as part of a PhD degree at Murdoch University, Australia.

This letter is an invitation for you to take part in the project. As a teacher, a phone interview provides the opportunity for you to provide additional information. It takes about 10 minutes and asks questions about digital media and schooling.

To participate: call 9360 7214.
Phone is operational 8:30am – 12midday or 12:30pm – 3:30 from November 6 – 10, 13 – 17, 2017.

Participation is voluntary. If you decide to participate and then later change your mind, you are able to withdraw at any time. The privacy and confidentiality of participants is assured since limited demographic information will be collected. No names will be used in the published data. The data will be stored securely on thumbdrive and hard copy within a locked drawer and can only be accessed by Janene Sproul, Dr MacCallum and Dr Ledger. The data will be stored for a minimum period of 5 years, after which it will be destroyed. Data will be destroyed in 2021 by shredding the hard copy and deleting the files on the thumbdrives (Murdoch University Library 1).

Participant privacy and the confidentiality of information disclosed by participants, is assured except in circumstances where the research team is legally required to disclose that information. The information you provide will be used only for this project, and will not be used in any extended or future research.

As a teacher, are there any special requirements to be part of this research?
Yes, there are 2. You need to be able to understand spoken English, and have completed the professional learning on photosensitivity.

As a teacher, what will happen to the information I give - is it private and confidential?
The data collected during the interview does not contain more than your name (for consent). No email or contact addresses are collected. It is intended that the findings of this study will be published in journal articles and spoken of at conferences. A summary of findings from this research will be available from the www.photosensitivity.info website ‘Digital Media in Schools’ page after April 2018. You can ask for a copy of early results by requesting ‘Preliminary Findings’ at janene.sproul@murdoch.edu.au by February 2018, and an email with a summary of the preliminary findings will be sent to you.

The research has been approved by Murdoch University Human Research Ethics Committee (ref 2016/033). If you would like to discuss any aspect of this study please contact me by email provided below. If you wish to speak with an independent person about the conduct of the project, please contact Dr Erich von Dietze, Murdoch University Ethics Department, on +61 8 9360 6170.

If you are willing to be involved, please contact us on 9360 7214. This Information Letter is for you to keep.

Thank you for your time and consideration.

Janene Sproul
Murdoch University
janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/033). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics & Integrity on Tel. 08 9360 6677 (+61 8 9360 6677 for overseas studies) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix I  Oral Consent Questions

I.1  Oral use consent questions for past student

Before commencing this interview, your consent to participate is needed. I have a verbal consent form and will read you a short list of statements about the interview process. Your verbal consent is needed to demonstrate that this project has been fully explained to you and that you understand what it is about and understand your rights. If you agree with the statement, I will indicate this by ticking a box next to that statement.

Please indicate you are over 18 years old:
☐ Yes

Please indicate you know that:
☐ You do not have to be a part of this project
☐ You do not have to answer questions you do not want to
☐ You can stop at any time simply by telling the researcher you do not want to answer any more questions
☐ You can pull out of this project at any time, and if you do this you can ask for all your answers to be erased.
☐ Your name will not be used in anything written about this project (no one will know who you are)

Please indicate whether you agree to:
☐ being interviewed
☐ this interview being recorded
☐ some of the things you say being used (so long as your name is not used) in reports and other publications

Name of Participant
☐ Verbal consent was given: .................................. (Date / location)
☐ Verbal consent was recorded
☐ Verbal consent was given in the presence of:

Name of Researcher: ........................................ Signature of Research: ........................................

Researcher Contact
Janene Sproul
Tel: +61 (0)8 64744695
email: janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/433). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel: +61 (08) 9300 1877 or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

CRICOS Provider Code: 00125J
ABN 61 616 369 282
1.2 Oral use consent questions for parent

Before commencing this interview, your consent to participate is needed. I have a verbal consent form and will read you a short list of statements about the interview process. Your verbal consent is needed to demonstrate that this project has been fully explained to you and that you understand what it is about and understand you rights. If you agree with the statement, I will indicate this by ticking a box next to that statement.

Please indicate you know that:
- [ ] You do not have to be a part of this project
- [ ] You do not have to answer questions you do not want to
- [ ] You can stop at any time simply by telling the researcher You do not want to answer any more questions
- [ ] Your name will not be used in anything written about this project (no one will know who you are)

Please indicate whether you agree to:
- [ ] being interviewed
- [ ] notes being taken during the interview
- [ ] this interview being recorded
- [ ] some of the things you say being used (so long as your name is not used) in reports and other publications

Name of Participant
- [ ] Verbal consent was given: ____________________________ (Date / location)
- [ ] Verbal consent was recorded

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 230X/XXX). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel. +61 (0)8 9360 6677 or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

CRICOS Provider Code: 00125J
ABN 61 615 369 313

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I.3 Oral use consent questions for teachers

Before commencing this interview, your consent to participate is needed. I have a verbal consent form and will read you a short list of statements about the interview process. Your verbal consent is needed to demonstrate that this project has been fully explained to you and that you understand what is about and understand you rights. If you agree with the statement, I will indicate this by ticking a box next to that statement.

Please indicate if you have:

☐ Participated in a Professional Learning opportunity regarding light sensitivity.

(If the answer indicates in the negative, then proceed to interview exit paragraph)

Interview Exit Paragraph – thank you for your willingness to participate in this research. However, due to the requirement of previous attendance at a Professional Learning opportunity regarding light sensitivity as stated in the Information Letter, we cannot continue this interview at this time. We thank you again for your time and consideration of this Education Research Project. Should you have other queries linked to the research, please email Janene Sproul at Murdoch.

Please indicate you know that:

☐ You do not have to be a part of this project

☐ You do not have to answer questions you do not want to

☐ You can stop at any time simply by telling the researcher you do not want to answer any more questions

☐ You can pull out of this project at any time, and if you do this you can ask for all your answers to be erased.

☐ Your name will not be used in anything written about this project (no one will know who you are)

Please indicate whether you agree to:

☐ being interviewed

☐ this interview being recorded

☐ some of the things you say being used (so long as your name is not used) in reports and other publications

______________________________
Name of Participant

☐ Verbal consent was given: ___________________________ (Date / location)

☐ Verbal consent was recorded

______________________________
Name of Researcher: ___________________________ Signature of Researcher: ___________________________

Researcher Contact

Janene Sproul
Tel: +61 (0)402 748 895
email: janene.sproul@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2016/013). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel: +61 (0)8 9300 0677) or e-mail ethics@murdoch.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

CKIOS Provider Code: 001245
ABN: 61 618 360 313
Appendix J  Interview Questions

J.1 Interview questions for past student

Guiding questions for Ex-Student Interviews (18+ years)
Digital media use in the classroom: students with light sensitivity
Interviewer: Janene Sproul  Project Number: 2016/033

1. First of all, how much digital media would you use in an average day now that you have left school?
2. When do you first remember using digital media at school?
3. What schools have you attended, how would you describe them in regard to resources, size, age?
4. Can you remember and reflect back on the end of your primary schooling? Can you describe how digital media was used in the classroom at that time? In what way was it used for homework?
5. Can you remember and reflect on the early years of high school? Can you describe how digital media was used in the classroom at that time? In what way was it used for homework? Was there a change from primary to high school?
6. In what ways did digital media use at school and homework change as you moved into Year 11 and 12?
7. Did you ever modify your use of digital media (computer screen, timing, environment, glasses) in the classroom or at home during any stage of your schooling?
8. In your opinion what were the most productive learning activities at school and home using digital media?
9. In your opinion were there any learning activities that may have detrimental/unnecessary use of digital media at school and home?
10. What advice would you give students, teachers and families about digital media use as they enter into high school?
11. Before we finish, is there anything else that you would like to share about the use of digital media at school and at home?
J.2 Interview questions for parent

Thank you for completing that.

What year at school are your children?

To maintain anonymity for your children, may I refer to the student in year ... as Child 1?
...if NO then how would you like me to refer to them?

How much homework would you estimate Child 1 completes on digital media each night?
None Less than 1 hour  1-2  2-3  More than 3

Does Child 1 show any sensitivity to light?

Has Child 1 ever spoken to you about having a reaction to using computers or digital media at school?
If yes, please give an example.

Has Child 1 ever spoken to you about having a reaction to the lights at school?
If yes, please give an example.

<table>
<thead>
<tr>
<th>Yes only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you spoken to any of Child 1’s teachers about their light sensitivity?</td>
</tr>
<tr>
<td>Have you requested any changes to accommodate Child 1’s light sensitivity?</td>
</tr>
<tr>
<td>Has Child 1’s light sensitivity been documented at school?</td>
</tr>
<tr>
<td>What action by teachers has been most supportive of your child’s light sensitivity?</td>
</tr>
<tr>
<td>Has Child 1 ever been diagnosed by medical personnel (optometrist, doctor) with light sensitivity?</td>
</tr>
<tr>
<td>Does Child 1 have any other diagnosed conditions that can affect their school work?</td>
</tr>
<tr>
<td>When working at home, what accommodations have you made to support Child 1?</td>
</tr>
<tr>
<td>Please rate the following statement</td>
</tr>
</tbody>
</table>

Visual light sensitivity can affect Child 1’s ability to participate in school activities

Strongly disagree  Disagree  Undecided  Agree  Strongly agree

Is there any other information about digital media use at school that you would like to share?

For child number 2....

Thank you for participating in this research.

For results of this research you can look at the photosensitivity website page, or email me at Murdoch university.
J.3 Elements included in teacher PL (2014/2015)

Each presentation included the following elements:

1. The phenomenon of students with VLH incorporated working with students with photosensitivity, visual stress and photophobia
2. Processing visual information requires light energy being emitted or reflected from an object to stimulate cells in the eye’s retina. The retinal cells respond by sending electrical signals to the brain which are then analysed.
3. Perception/analysis of visual images can be altered by environmental factors. A student ‘sees’ written words on a board, but the colour, type of board and type of lighting can determine how the brain decodes that information.
4. The following points were suggested as Universal design for classroom practice:
   - use natural light as much as possible
   - turn the IAW off when not in use
   - 45 min digital media sessions – then take a break.
   - No stripy moving images or saturated red colours on IAW displays.
   - Decrease luminance and contrast ratio on digital media (a small decrease in contrast ratio can greatly decrease the stimulus, even though the colours don’t look that different)
J.4 Interview questions for teacher

Guiding questions for Teacher Interviews (18+ years)
Digital media use in the classroom: students with light sensitivity
Interviewer : Janene Sproul Project Number : 2016/033

Thank-you for agreeing to discuss your experience with digital media with me. By digital media I mean all screened devices – computers, phones, Interactive whiteboards, TVs and ipads.

This interview refers to the followup from PL day about photosensitivity

1. Did you attend one of the teacher PL days about photosensitivity?
2. What do you remember from that day?
3. What strategies have you trialled/used from that day?
4. In your opinion do you think that any of these strategies have supported any of your students?
5. Will you continue to use any of the strategies you trialled?
6. Please describe your own use of digital media for work?
7. Is there anything more that you would like to tell me?

Thank you very much for your participation in this project.

If you have any questions about the project, please contact me using the details on the information sheet.

Extra prompts: Can you explain more about that please?

        Can you describe these please?
Appendix K  Diary and Survey Search

K.1  Excerpt from MSRP (2007) Participant Booklet

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>6am</td>
<td>General Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7am</td>
<td>Breakfast, Getting Ready, Morning Routine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8am</td>
<td>School, Homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9am</td>
<td>School, Homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10am</td>
<td>Breakfast, Getting Ready, Morning Routine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11am</td>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12pm</td>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1pm</td>
<td>Afternoon, Day 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2pm</td>
<td>Afternoon, Day 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3pm</td>
<td>Afternoon, Day 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4pm</td>
<td>Afternoon, Day 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5pm</td>
<td>Afternoon, Day 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6pm</td>
<td>Evening, Day 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7pm</td>
<td>Evening, Day 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8pm</td>
<td>Evening, Day 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9pm</td>
<td>Evening, Day 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10pm</td>
<td>Evening, Day 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**01. WHAT WERE YOU DOING?**

- **General Activities**
- **School, Homework**
- **Breakfast, Getting Ready, Morning Routine**
- **Lunch**
- **Afternoon, Day 1 - 5**

**02. WHO WERE YOU DOING THIS WITH?**

- **At Home**
- **Someone Else at Home**
- **Someone Else Elsewhere**

**03. WHERE WERE YOU DOING THIS?**

- **At Home**
- **Someone Else at Home**
- **Someone Else Elsewhere**

---

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## K.2 Comparison of factors from diaries

<table>
<thead>
<tr>
<th>Factor</th>
<th>Media and Society Research Project, 2007.</th>
<th>Olds, Ridley and Dollman, 2006</th>
<th>Rideout, Foehr &amp; Roberts, 2010</th>
<th>This project*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period</td>
<td>3 day diary, 4th day questions</td>
<td>2, 3 or 4 times single day diary</td>
<td>1 diary day</td>
<td>1 – 4 times single day diary</td>
</tr>
<tr>
<td>Day differentia tion</td>
<td>School days and weekend</td>
<td>≥ 1 school day PLUS ≥ 1 weekend day day</td>
<td>Any single day of the week</td>
<td>School days only</td>
</tr>
<tr>
<td>Who enters data</td>
<td>student</td>
<td>student</td>
<td>student</td>
<td>student</td>
</tr>
<tr>
<td>Data entry period</td>
<td>6am – 2am</td>
<td>24 hour</td>
<td>7am – 12 midnight</td>
<td>9am – 3pm plus homework time</td>
</tr>
<tr>
<td>Data Entry Time</td>
<td>25 min/day</td>
<td>unknown</td>
<td>40 minutes</td>
<td>10 min/day</td>
</tr>
<tr>
<td>Data Entry Frequency</td>
<td>Every 15 minutes</td>
<td>One sitting</td>
<td>One sitting</td>
<td>After school</td>
</tr>
<tr>
<td>Data format</td>
<td>Multi choice – set responses</td>
<td>unknown</td>
<td>Multi choice – set responses</td>
<td>Open – no set responses</td>
</tr>
<tr>
<td>Participant reward</td>
<td>$30 reward</td>
<td>unknown</td>
<td>No reward</td>
<td>No reward</td>
</tr>
<tr>
<td>Geographic location</td>
<td>Australia only</td>
<td>South Australia</td>
<td>America</td>
<td>Western Australia</td>
</tr>
<tr>
<td>Sample</td>
<td>Random</td>
<td>Randomly selected primary school classes, whole class invitation to participate</td>
<td>Nationally representative survey. Stratified, two stage probability sample. Stage 1: random selection of schools. Stage 2: Random selection of grades and classes</td>
<td>Convenience</td>
</tr>
<tr>
<td>Sample size</td>
<td>1003</td>
<td>1039</td>
<td>702</td>
<td>167</td>
</tr>
<tr>
<td>Participant recruitment strategy</td>
<td>Cold call household</td>
<td>Within each school, a class was nominated to participate</td>
<td>Classes within each school</td>
<td>Call for participants using school newsletter and flyers</td>
</tr>
<tr>
<td>Participant age range</td>
<td>8 – 17 years old</td>
<td>9.1 - 13.5 yrs</td>
<td>8 – 18 years</td>
<td>11 – 17 years old</td>
</tr>
<tr>
<td>Factor</td>
<td>Media and Society Research Project, 2007.</td>
<td>Olds, Ridley and Dollman, 2006</td>
<td>Rideout, Foehr &amp; Roberts, 2010</td>
<td>This project’</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------</td>
<td>--------------------------------</td>
<td>---------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Diary format</td>
<td>Paper based, colour and graphics important</td>
<td>computerised</td>
<td>Paper based, sectioned into morning, afternoon and evening. :none, less than 30 min, 30 – 60 min, more than an hour. Some sections allowed 1-3 hours, more than 3 hours</td>
<td>Online, graphics incorporated</td>
</tr>
<tr>
<td>Data return</td>
<td>Reply paid envelope</td>
<td>na</td>
<td>In classes</td>
<td>Automatic, online format</td>
</tr>
<tr>
<td>Inclusion criterion</td>
<td>available to fill in the diary for three days in a row, some time within the next two weeks.</td>
<td>unknown</td>
<td>Non reposdant for previous rounds of M2 study.</td>
<td>Attend school, internet access, English literate</td>
</tr>
</tbody>
</table>
Appendix L  Format of Survey Items Using ‘Smart Logic’ Feature

Appendix L.1 shows Question 8 from the student survey depicting the text box provided for the student participant’s response. Whatever is typed into the empty text box for Question 8 is transferred by the survey platform into the first entry in the left hand column in Appendix L.2. The class chosen for this example is Maths. Question 9 in the student survey asked ‘What was your Session 2 class?’ and the text typed into the text box would be transferred into the second entry in the left hand column in Appendix L.2. (English). This allows students to focus initially on subject identification from the day.

L.1 Survey item enabling individual student timetable to be used for digital media use survey

The next questions use ‘smart logic’ within your own survey. Questions 8 - 15 set up the grid for Question 18 on the next page. Only use as many spaces as you have had classes today, however please use TWO questions for DOUBLE SESSIONS.

8. What was your Session 1 class?
   Session 1

L.2 Survey item for digital media duration and device type using individualised scaffold.

18. Digital media use in classrooms
   Please fill out the table below for each of today’s classes. Leave any excess class lines blank

<table>
<thead>
<tr>
<th>Subject</th>
<th>Interactive Whiteboard Use</th>
<th>Computer Use</th>
<th>iPad Use</th>
<th>Phone Use</th>
<th>Television Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths</td>
<td>Half</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhysEd</td>
<td></td>
<td>Half</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japanese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Each pull down menu contains the options shown, for each of Interactive Whiteboard, Computer, iPad, Phone and Television.
Appendix M  Items Removed from Investigation

M.1  Summary of academic journal references to migraine diary results and items

<table>
<thead>
<tr>
<th>Article</th>
<th>Article Type</th>
<th>Diary Results</th>
<th>Diary Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barmettler et al. (2015)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Heyer et al. (2014)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Lieba-Samal et al. (2009)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Lieba-Samal et al. (2011)</td>
<td>Empirical</td>
<td>Yes</td>
<td>Some</td>
</tr>
<tr>
<td>Nappi et al. (2006)</td>
<td>Review</td>
<td>Yes”</td>
<td>Many</td>
</tr>
<tr>
<td>Nappi et al. (2011)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Vetvik et al. (2015)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Wöber et al. (2007)</td>
<td>Empirical</td>
<td>Yes</td>
<td>Some</td>
</tr>
<tr>
<td>Yang et al. (2015)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Zebenholzer et al. (2011)</td>
<td>Empirical</td>
<td>Yes</td>
<td>None</td>
</tr>
</tbody>
</table>

M.2  Student survey

Pain levels indicated before and after school: A Likert numerical scale from 0 - 10 is used as reference to the Wong Baker FACES Pain Rating Scale. The Wong-Baker FACES Pain Rating Scale shown below was developed for children aged 3 years and older to improve assessment and consequently pain management.

**Wong-Baker FACES Pain Rating Scale** ([http://wongbakerfaces.org](http://wongbakerfaces.org))

The scale is not generally used for adolescents. However, cartoon faces remove race and gender bias and the left-to-right format was chosen because it is consistent with other scales and with English reading¹. The proposed study uses this scale as reference for pain as it is a valid visual instrument, non-biased through many sociocultural variables.

M.3 Parent survey

One question was removed from the proposed survey as the potential psychological risk outweighed the potential benefit and there was no suitable method for effective provision of psychological support if participant was not in Perth. The question removed from the survey was:

‘Do you believe there could have been a different educational outcome for your child if you had initiated a more comprehensive relationship with the school?’

Although this question could assist in identifying specific ages or stages when parental guidance regarding next steps from educators or medical professionals would be appreciated, or when educational support would be most beneficial, there is a risk of substantial adverse consequences.

These consequences could be stimulated by memories of a child in pain and linked to retrospective judgement on parenting ability (Parents of children with migraine support group, Facebook, retrieved Feb 2014). This area of anxiety and psychological distress would not be one to which support could be offered at a sufficient level. Therefore the question was not included.
Appendix N  Process of Student Data Analysis

N.1  Reported digital media use by device type from seven participants for Classes 1 and 2

Demonstrating analysis for final duration of digital media use per class.

<table>
<thead>
<tr>
<th>Participant</th>
<th>IAW</th>
<th>Computer</th>
<th>iPad</th>
<th>Phone</th>
<th>TV</th>
<th>Longest duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>f</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>g</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>IAW</th>
<th>Computer</th>
<th>iPad</th>
<th>Phone</th>
<th>TV</th>
<th>Longest duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>f</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>g</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*In response to: Please fill out the table below for each of today's classes. Leave any excess Class lines blank
N.2 Maximum digital media duration by single device type from three participants for Classes 1 to 8

Demonstrating calculation process for duration of classroom digital media use per day.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Normal class duration (minutes)</th>
<th>Exceptions to class duration (open-ended response)</th>
<th>Classes per day</th>
<th>Instructional classtime per day (minutes)</th>
<th>Highest Dig Media Use (in ‘quarters’ of class duration)</th>
<th>Classroom digital media per day (1/4 classes)</th>
<th>Classroom digital media per day (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>55</td>
<td>Form was 20 mins*</td>
<td>6</td>
<td>330</td>
<td>4 4 2 0 4 4 0 0 18</td>
<td>4 4 2 0 4 4 0 0 18</td>
<td>248</td>
</tr>
<tr>
<td>b</td>
<td>60</td>
<td></td>
<td>5</td>
<td>300</td>
<td>0 3 0 0 1 0 0 0 4</td>
<td>0 3 0 0 1 0 0 0 4</td>
<td>60</td>
</tr>
<tr>
<td>c</td>
<td>55</td>
<td></td>
<td>6</td>
<td>330</td>
<td>4 0 1 0 4 0 0 0 9</td>
<td>4 0 1 0 4 0 0 0 9</td>
<td>124</td>
</tr>
</tbody>
</table>

* Form/form room not accounted for in calculation as not categorised as instructional classtime.

N.3 Individual subject categories and largest reported duration from a single device type. n(students) = 3.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Class 1</th>
<th>DM*</th>
<th>Class 2</th>
<th>DM</th>
<th>Class 3</th>
<th>DM</th>
<th>Class 4</th>
<th>DM</th>
<th>Class 5</th>
<th>DM</th>
<th>Class 6</th>
<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>E**</td>
<td>2</td>
<td>S</td>
<td>4</td>
<td>CA</td>
<td>1</td>
<td>PE</td>
<td>0</td>
<td>H</td>
<td>4</td>
<td>CA</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>S</td>
<td>3</td>
<td>L</td>
<td>1</td>
<td>M</td>
<td>1</td>
<td>E</td>
<td>0</td>
<td>PE</td>
<td>0</td>
<td>H</td>
<td>3</td>
</tr>
<tr>
<td>c</td>
<td>S</td>
<td>0</td>
<td>M</td>
<td>0</td>
<td>R</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>E</td>
<td>0</td>
</tr>
</tbody>
</table>

* DM: largest reported duration from a single device type for identified class, measured in ‘quarters’ of the class.
** Subject categories according to Table 3.9
N.4 Calculation of the percentage of digital media used during instructional time in the subject categories of Science and English

From data in Appendix N.3.

<table>
<thead>
<tr>
<th>Data Manipulation</th>
<th>Science</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of classes</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Number of whole classes using IAW</td>
<td>1.75</td>
<td>0.5</td>
</tr>
<tr>
<td>Percentage of every class using IAW</td>
<td>58.3%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Science calculations: Number of whole classes = \( \frac{7}{4} \)  
Percentage of every class = \( \frac{1.75}{3} \times 100 \)  

English calculations: Number of whole classes = \( \frac{2}{4} \)  
Percentage of every class = \( \frac{0.5}{2} \times 100 \)

N.5 IAW use by three participants across six classes, measured in ‘quarter’ classes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
<th>Class 6</th>
<th>Total ‘quarter’ classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>b</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>c</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>14</td>
</tr>
</tbody>
</table>

N.6 Calculation of the percentage of IAW used during a single lesson

From data in Appendix N.5.

<table>
<thead>
<tr>
<th>Data Manipulation</th>
<th>IAW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of classes</td>
<td>18</td>
</tr>
<tr>
<td>Number of whole classes using IAW</td>
<td>7.25*</td>
</tr>
<tr>
<td>Percentage of every class using IAW</td>
<td>40.3%**</td>
</tr>
</tbody>
</table>

* Calculation of Number of whole classes = \( \frac{29}{4} \)  
** Calculation of Percentage of every class = \( \frac{7.25 \times 100}{18} \)  

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## Appendix O  Mann Whitney U Test Results

### O.1 Results from Mann Whitney U (Mean Rank) between groups

**Lower School and Upper School**

For the variables school digital media duration, homework digital media duration, total educational digital media duration and preferred screen brightness.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>Wilcoxon W</th>
<th>Z</th>
<th>Asymp. Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School Digital Media</strong></td>
<td>Lower</td>
<td>74</td>
<td>44.22</td>
<td>3272.50</td>
<td>497.500</td>
<td>3272.500</td>
<td>-2.509</td>
<td>.012</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>21</td>
<td>61.31</td>
<td>1287.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Homework Digital Media</strong></td>
<td>Lower</td>
<td>74</td>
<td>40.69</td>
<td>3011.00</td>
<td>236.000</td>
<td>3011.000</td>
<td>-4.901</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>21</td>
<td>73.76</td>
<td>1549.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Educational Digital Media</strong></td>
<td>Lower</td>
<td>74</td>
<td>41.63</td>
<td>3080.50</td>
<td>305.500</td>
<td>3080.500</td>
<td>-4.229</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>21</td>
<td>70.45</td>
<td>1479.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Computer Screen Preferred Brightness</strong></td>
<td>Lower</td>
<td>70</td>
<td>48.56</td>
<td>3399.00</td>
<td>556.000</td>
<td>787.000</td>
<td>-1.738</td>
<td>.082</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>21</td>
<td>37.48</td>
<td>787.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students who did not answer this question were removed from the analysis (n=2), students who answered ‘Don’t know’ were removed case wise from the final question in the analysis.
### O.2 Results from Mann Whitney U (Mean Rank) between groups of students who are light sensitive and students who are not light sensitive

For the variables school digital media duration, homework digital media duration and total educational digital media duration.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>Wilcoxon W</th>
<th>Z</th>
<th>Asymp. Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School Digital Media</strong></td>
<td>Not light Sensitive</td>
<td>65</td>
<td>45.83</td>
<td>2979.00</td>
<td>834.000</td>
<td>2979.000</td>
<td>-1.130</td>
<td>.259</td>
</tr>
<tr>
<td></td>
<td>Light Sensitive</td>
<td>30</td>
<td>52.70</td>
<td>1581.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Homework Digital Media</strong></td>
<td>Not light sensitive</td>
<td>65</td>
<td>45.09</td>
<td>2931.00</td>
<td>786.000</td>
<td>2931.000</td>
<td>-1.528</td>
<td>.126</td>
</tr>
<tr>
<td></td>
<td>Light Sensitive</td>
<td>30</td>
<td>54.30</td>
<td>1629.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Educational Digital Media</strong></td>
<td>Not light sensitive</td>
<td>65</td>
<td>44.31</td>
<td>2880.00</td>
<td>735.000</td>
<td>3080.500</td>
<td>-1.922</td>
<td>.055</td>
</tr>
<tr>
<td></td>
<td>Light Sensitive</td>
<td>30</td>
<td>56.00</td>
<td>1680.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Computer Screen Preferred Brightness</strong></td>
<td>Not light sensitive</td>
<td>62</td>
<td>44.57</td>
<td>2763.50</td>
<td>810.500</td>
<td>2763.500</td>
<td>-1.777</td>
<td>.437</td>
</tr>
<tr>
<td></td>
<td>Light sensitive</td>
<td>29</td>
<td>49.05</td>
<td>1422.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### O.3 Results from Upper School student Mann Whitney U (Mean Rank) between groups Not Light Sensitive and Light Sensitive

For the variables school digital media duration, homework digital media duration, total educational digital media duration and preferred screen brightness.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>Wilcoxon W</th>
<th>Z</th>
<th>Asymp. Sig. (2-tailed)</th>
<th>Exact Sig. 2* (1-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School Digital Media</strong></td>
<td>Not light Sensitive</td>
<td>11</td>
<td>9.77</td>
<td>107.50</td>
<td>41.500</td>
<td>107.500</td>
<td>-.955</td>
<td>.339</td>
<td>.349b</td>
</tr>
<tr>
<td></td>
<td>Light Sensitive</td>
<td>10</td>
<td>12.35</td>
<td>123.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Homework Digital Media</strong></td>
<td>Not light sensitive</td>
<td>11</td>
<td>7.73</td>
<td>85.00</td>
<td>19.000</td>
<td>85.000</td>
<td>-2.594</td>
<td>.009</td>
<td>.010b</td>
</tr>
<tr>
<td></td>
<td>Light Sensitive</td>
<td>10</td>
<td>14.60</td>
<td>146.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Educational Digital Media</strong></td>
<td>Not light sensitive</td>
<td>11</td>
<td>8.36</td>
<td>92.00</td>
<td>26.000</td>
<td>92.000</td>
<td>-2.043</td>
<td>.041</td>
<td>.043b</td>
</tr>
<tr>
<td></td>
<td>Light sensitive</td>
<td>10</td>
<td>13.90</td>
<td>139.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b Not corrected for ties.