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I see, therefore I learn: pedagogic innovation in the cognitive-visual era

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Abstract

This article is concerned with the widely-established but pedagogically-neglected cognitive truism that *anyone* who sees, learns visually. Multimedia Learning (MML) scholarship, derived from the Cognitive Sciences, identifies a common cognitive architecture known as 'dual processing' shared by all sighted people. The literature predicts that people learn better from images and text than text alone, or predominantly. Subsequent peer-reviewed research establishes the veracity of this claim in a variety of institutions and disciplines. This requires a new conversation in HE about a generalizable multimedia pedagogy, a structure though which to establish principles and practice, and a mechanism to ascertain their effectiveness. It is all the more pertinent, since we may readily capitalize on the most visual era of human history to enable a transformed pedagogy. Yet we have failed largely to take proper stock of how this 'pictorial turn' in human evolution might support the generations we teach, for whom it is already a norm. The article discusses MML scholarship and predictions and how this can interject a potentially universal innovation into HE teaching and learning. It then discusses principles by which to reify such an innovation. Finally, it advances an innovative and shareable digital research tool to test such reification and discusses initial longitudinal data from a Randomized Control Trial. It concludes by identifying a further research agenda to compensate for present shortcomings in MML theory and data development.

Keywords: Pedagogy; multimedia learning; cognition; engagement

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Introduction

It remains a convention in HE teaching to privilege text in academic content delivery. Pedagogy is dominated by such monomedia and monomedia-dominant methods(Belluigi, Alcock, Farrell , & Idahosa, 2019; Williams, 2009). In an international online survey of teaching delivery conducted by the author in 2020, 73% of 202 male-dominated respondentsprimarily used monomedia/dominant methodsin their teaching. Such a proportion has been similarly reported by Herting et al(2019) and Garrett (2016), reflecting long-established conventions since the Middle Ages (Brown, 1982). Contemporaneously,Garner and Alley (2011) note that presentation slides are primarily characterised by an average of 55 words per PowerPoint slide, data corroborated in Hertz et al(2013). Default slide layouts common to mainstream projection software like Mac OS and MS Office privilege text by presenting bullet-points and cursor in preparation for writing (in contrast with less prevalent software like Haiku Deck, whichbalances text and image content). As a result, HE teaching is structurally characterised in large part by 'strict monomedia instruction: a single stream of input powered and controlled by the audio of one teacher's voice supported only occasionally with visual scaffolding' (Lowery, 2019, p. 69).This conventionis essential and legitimate. Scholars have long held that written language is essential to the conveyance of meaning(Duncan, Tune, & Small, 2016; Davis, 2015). For neurobiologists, the written word remains an essential element of the communication and learning process that draws upon the human brain's 'complex information-processing system to decode language' (Duncan, Tune, & Small, 2016, p. 50). Indeed, for Davis, 'the neurobiological foundations of lexical knowledge are… central to understanding' how language and learning are related' (2015, p. 541).

This monomedia tendency stands in contrast with the digital visual era, and with the worlds our students inhabit before, during and after their time with us. In stands in contrast with the realities of the lived lives of billions now networked to digital visual worlds through Flickr, Twitter, Instagram, Netflix, iPhone, Facebook and the innumerable other digital visual spaces that host and draw the generations we teach. They inhabit and reproduce a multimedia world enabled by the digital revolution and its global manifestation and adoption. The term 'multimedia' refers to a pluralizing of communications beyond monomedia mechanisms that integrates text with imagery, audio, video and animation, to the extent that 'multimedia' is 'the main means of communication and expression in postmodern culture' (Tietje & Cresap, 2005, p. 15). Temporally, we and our students are encountering and traversing visuality as a plane of perception to a degree never experienced before, a movement that will not reverse without a cataclysmic transformation of planetary existence (not entirely unforeseeable). The era in which this article is written is part of what Felten (2008) refers to as the 'pictorial turn', in which routine, worldwide, everyday *communication* – the essence of the job of a pedagogue - has shifted character to multimedia-rich content as a matter of course.

Pedagogic communication in HE remains hegemonically monomedia-dominant. This is not to say that all teaching is solely monomedia; multimedia interventions happen all the time, discretely, quietly in atomic fashion, often independent of a framing pedagogic belief system or theory of communication. We may arbitrarily put images into slides when they readily help us talk about something and are easily accessible and legal to use: a map showing borders; a representation of Christ or Allah; an electrical diagram; the interior mechanisms of a cell. These are commonplace and much-needed. But it is less the case that such pedagogic activities are intellectually, pedagogically rationalised. The choice to insert a copy of the Mona Lisa, or a video of a downhill skier's method, or a macro shot revealing a spider's exoskeleton is often less located in a theory that sanctions such an approach, and more in an intuitive sense that such a thing will work. They may or may not be valuable (they almost certainly are). But they are rarely tethered to a governing framework that explains why images might be used and be valuable and lack a more developed intellectual basis in pedagogic research. MML pedagogic delivery – the use of multimedia content in teaching -is often intellectually unstructured.

The purpose of this paper is to identify and discuss a way of framing whether and why we might adopt MML methods that intersect cognitive capacity and techno-social evolution and apply them across students, disciplines and institutions so that scholars of pedagogy and teachers of things may refer to a body of knowledge to guide them in the process. It innovates by inserting MML theory into pedagogic discourse as a formal structure for debating and critiquing the use of imagery in learning and teaching. It then introduces and discusses a plausible methodology and a sharable online tool to help conduct an experiment that can compare the impact on student academic engagement of monomedia and multimedia methods. Finally, it discusses some key principles that might guide concerned pedagogues if they seek to implement MML methods themselves. The remaining sectionsare structured to discuss in greater detail a scientific rationale for the routine and formal integrationof multimedia methods in HE teaching and learning approaches; an online methodof experiment with which we might ascertain the outcome of such a pedagogic innovation; and principles that might govern how we go about such practice.

Scientific Rationale of Multimedia Learning (MML)

Multimedia Learning is a body of literature rooted in half a century of research into cognitive loading, which is concerned with how much information the brain can reasonably process in a given context. It advances two interrelated messages. The first is that teaching delivery should be 'consistent with how the human mind works and… with research-based principles' (Mayer, 2014, p. 155). The second is that biologically, universally, cognitively, people learn more deeply from words and imagery than from words alone. Accordingly, MML posits that scientifically-informed teaching delivery should consist of imagery and words, rather than over-relying on words. Imagery takes various form: it includes still images, with which this article is concerned, moving images such as film and animation, graphs, maps, illustrations, drawings, paintings, schematics and blueprints as well as gifs and memes. It is an argument for balance in audio-visual content delivery, regardless of discipline. There are three interrelated neurological elements to MML: dual processing, working memory and cognitive load(Baddeley, 2012; Ayres, 2015). Taken together, their effective use is claimed to lead to greater cognitive engagement and thence learning, since the former may be considered a proxy for the latter (Pickering, 2017; Oeldorf-Hirsch, 2018).

Dual processing refers to the brain's two separate channels 'for processing pictorial and verbal material'(Mayer & Moreno, 2003, p. 44) such as 'diagrams, animations and photographs' (Beacham & Alty, 2006, p. 11). Paivio (2007, p. 77), after four decades of research, outlines the process in greater detail. Dual coding 'involves… a verbal system for dealing with language, and a nonverbal (imagery) system for with nonlinguistic objects and events'. To best exploit the natural structure of the brain, input needs to be balanced more evenly across both channels. This is achieved by reducing written text and adding to the student learning experience apposite images that complement, represent, augment and/or reinforce words. This ensures more equitable use of each channel, rather than one carrying most of the load and the other often standing idle. This has greater significance when we recognise that 'each channel is limited in the amount of material that can be processed at one time'(Mayer & Moreno, 2003, p. 43). When transmission matches reception, to make a crude analogy, it increases engagement and learning substantially.

According to a variety of scholars(Clark & Lyons, 2010; Paas, Renkl, & Sweller, 2003; Mayer & Moreno, 2003), misaligning content transmission with cognitive reception has an additional impact on engagement and learning. Unreasonably distributed, out of balance loading of our dual processing facilities increases pressure on working memory and compromises cognitive engagement(Clark & Lyons, 2010). Working memory may be understood as 'a cognitive operation in which some bits of information are held in a store characterized by rapid decay in memory while other bits are retrieved from long-term storage' (Siegel & Ryan, 1989, p. 973). and works better when load on each channel is more evenly distributed.The more stress on working memory, the less the capacity to maintain engagement. In the late 1950's, George Miller (1957) established in a celebrated article that the number of objects we can hold in our working memory is 7, plus or minus 2. That formula has become much more complex and qualified since then, but the principle holds. Working memory is well-understood to be limited in what it can hold for any length of time (Miller, 1957; Baddeley, 2012).There is greater stress on working memory when we attempt to drive the majority of our content through only one of the two available processing channels we have. When we use excessive text, and fail to exploit visual processing, we are overloading students' working memory, and this undermines cognitive engagement.

How we combine the use of these two elements – dual processing and working memory – affects how the third process – cognitive load - functions. When working memory becomes saturated, it is referred to as cognitive overload, a phenomenon well-described and -understood in the literature (Paas, Renkl, & Sweller, 2003; Sorden, 2013). Lewis (2016, p. 877) identifies the propensity of unbalanced content delivery to 'induce a cognitive load' in audiences 'out of proportion to the content that they can learn'. This applies to any situation where the brain is being asked by someone to be active and then given too much to digest. Overloading the audio-textual channel and underusing its visual counterpart maps data and information inefficiently across limited working memory. It commonly manifests as 'Death by PowerPoint', a widely-acknowledged social phenomenon attributed to a variety of ills beyond bored audiences, including the destruction of the Columbia Shuttle (Meira, Pliskina, & Gilad, 2010) and practices in the wars in Afghanistan and Iraq (Yue, Bjork, & Bjork, 2013). Perhaps most infamously,Edward Tufte(2006), Emeritus Professorat Yale University, publicly quippedthat 'Power corrupts, and PowerPointcorrupts absolutely'. He appeared to condemn the software, but his critique was directed at how we use the platform – since PowerPoint is ideally suited to deliver balanced visual and audio-textual material. Privileging text through PowerPoint, or any other projection platform, fails to match digital communication capacity with cognitive reception duality. The celebrated business presentation 'guru' Garr Reynolds declared of the way we use such software that it ensured 'people have a hard time coping' with what we are telling to impart to them (2011, p. 33). The same lesson applies to our students, since the problem of over-loading and under-engagement is a neurological matter not specific to a location, identity, culture or other social dividing factor.

The hypothesis of MML, then, is that engagement will be greater when apposite, clear images are combined with reduced text levels, than when only, or mainly, text is used (McBride & Dosher, 2002; Hockley, 2008; Mayer & Moreno, 1998; Ayres, 2015). It refers not to a specific form of learning style, or in relation to a given discipline, or any other social or pedagogic variable. Instead, it derives the hypothesis from a biological cognitive architecture common to all human beings. The human brain is constructed in ways that ensure it works more efficiently when information is presented to it concurrently in both visual and audio-textual forms. This method might be applied in all HE institutions, in all disciplines, perhaps even in all countries (ideogrammatic languages may qualify MML hypotheses) with an expectation of improvements in engagement, and thus in learning across the board. These claims, and the scientific basis upon which they rest, both direct and sanction structured testing in an HE setting.

The following section describes how, and on which principles, a structured four year teaching and learning (T&L) experience was developed for undergraduate Years One to Three and postgraduate level students in two UK universities across five disciplines (Business and Management, Politics, History, International Relations, Postcolonial Studies). In parallel with this, an innovative online experiment, designed specifically for this task, was conducted with volunteering students on the degrees. This allowed a comparison of levels of engagement between monomedia and multimedia academic content in control and experiment groups. The next step, however, is to review how the transition was made from theoretical approach and hypothesis to real-world methods and data.

Reifying Multimedia Theory: Principles And Practice

The process initially focused on an introductory module in International Relations for which the author was responsible, attended by c.250 students annually over a twelve week period, attending lectures twice a week, each week. The objective was to transform existing PowerPoint slides from monomedia/monomedia-dominant content to multimedia, balanced content that would better exploit both audio-textual and visualkey processing channels leading to more efficient use of working memory and thence improved academic engagement. This meant reducing visible text on slides and increasing full-slide visual content: that is, each slide would be completely covered in a high quality apposite image, with a maximum of one line of text placed in a way that did not obscure any important part of the image.

This method of presentation is derived from twelve principles of cognitive sciencediscerned scientifically by Mayer (2002; 2020). That many seem to some like a lot, but once understood, they are mainly straightforward, often quite intuitive and always helpful. They have been reproduced with each iteration of his seminal work, and are represented more accessibly here by Wiley Publishing. They provide structure for an approach to reifying Multimedia Learning methods that has been arrived at scientifically, rather than anecdotally, randomly or otherwise arbitrarily.Summarised, they are concerned with the most effective use of multimedia delivery through coherence, contiguity, segmenting and signalling. Coherence refers to eliminating extraneous content that does not directly generate Intended Learning Outcomes (ILOs): no corporate logos, unnecessary text where speech can be used, no irrelevant designs for titillation, no transitions or machine-gun lettering. Contiguity refers to parallel material presentation, wherein related slide content is proximal temporally and spatially, such that textual and verbal pointers are close to that to which they point. Segmenting refers to organization and delivery of material in accordance with cognitive capacity to absorb content, by splitting material into 'bite-sized' chunks, for example. Signalling is the process by which we draw attention to key aspects of a given slide, by using arrows or underlining content, for example.

This scholarship is further supported beyond the academy, in the 'real world' of professional presentations. It is not known how many Powerpoint presentations happen in the business world, but according to the BBC and Forbes, it is in the millions per day worldwide. It has generated its own industry, consultants and gurus because it is a primary means of corporate communication (Duarte, 2008; Reynolds, 2011). The principles of Multimedia Learning have been adopted and adapted by leading experts in high-level presentations who have developed further principles of use. They are in broad agreement that text should not be dominant; that graphics including animation and video are central to retaining audiences' attention; and that overload can be reduced by applying Mayer's principles. They share the view that the visual era provides unheralded opportunities to synchronise (content) transmission and (cognitive) reception so engagement is enhanced(Kawasaki, 2012; Balliett, 2020; Ingledew, 2011; Reynolds, 2011).The professionalization of presentations rests on principles established in multimedia scholarship, whether recognised as such or not, and there is an extensive and accessible literature that offers plentiful guidance on improving how we transform orthodox lectures to communicate simple and complex meaning(Duarte, 2008; Gallo, 2020).

From the MML literature, its corporate parallel and the author's practical academic experience over six years of delivering MML methods, a number of key lessons may be distilled. A first step is slide text redistribution. Slides may no longer be covered in bullet points and words, but this does not mean we must eliminate all text. We teach complex subjects that often require lengthy description and explanation. A majority of this can be removed to 'notes view', leaving perhaps just one line (in approximately 28-point font). 'Notes view' will retain any amount of text. As a test, a PhD thesis was copied and pasted in and was absorbed *in toto*.Each slide's visible area should have one line of text only: the process forces us to be concise whilst still providing a valuable prompt for the presenter. There will likely be an increase in the number of slides, but no increase in the amount of content. It has been redistributed, not increased.

For further finesse, slide backgrounds should be black and plain, and text should be white and sans serif (there is some evidence this is easier for dyslexic learners than serif fonts, but it is not conclusive). This colour combination guarantees maximum contrast, especially useful when we cannot control, or know, how much light there will be in a teaching space. This is the case when timetabling for example is unconfirmed, when rooms change unpredictably or when we present at conferences or undertake guest lectures, as well as when curtains break and room details are inaccurate.

As well as reducing text overload per slide and thereby enhancing cognitive engagement, this process necessarilycreates space on slides for imagery, whilst the single line of text that expresses the essence of your slide can also provide the basis for an image search. There are various ways of locating apposite images. Google's Advanced Image Search (AIS)filter operates similarly to a library search engine, with key words and search strings possible. Helpfully, it also has a copyright filter, although Google cannot guarantee that an image's claim to legal ownership has been accurately represented by the uploader. There is also an increasing array of other sites like Unsplash, Wiki Commons, Flickr Commons and Pixabay that offer copyright-safe free-to-use images. Others offer more specific images, like the public access collection held by NASA. For as long as people, institutions and technologies continue to take and upload digital images, the sum total of images available to us will continue to grow. An initial search may not reveal anything; this is normal. Often, a small tuning of text, whilst keeping the meaning constant, will yield a different outcome, as will using different image sources. There may not always be an apposite image, but we do not need one for every slide. The act of redistributing text alone is already reducing cognitive overload, and the addition of any images begins the process of balancing content delivery. The future will certainly make this process easier and more effective as Artificial Intelligence (AI) is taught to seek, or create, images based on written words. Research into text-to-image conversion has been underway for some time; later generations are aiming at text-to-image outcomes (Tingting, Zhang, Duanqing, & Dacheng, 2019). The process of finding suitable images will get easier and faster; but this should not make us reticent presently. Once the image is located, final crafting should reflect the contiguity and signalling principles: ensuring verbal and textual elements clarify visual content, the rationale for use and connection with multiple elements, where necessary. An example of this process can be found below. Accompanying spoken text would focus student attention on the core relational elements, discussing the meaning of each component. Attention would be drawn to the metaphor of the hourglass, of time passing or running out. It would also be directed towards rising global temperatures, the consequences of which manifest visually in the struggling polar bear and the subsequent meltwater flooding a recognisable Western metropolis like New York. This is a complex global, social, political, environmental and economic issue, but despite such overlapping intersectional complexity, itis conveyed visually.

Figure 1 Visual metaphor for relational dynamics of global warming. Copyright of author

Ultimately, an apposite image will say what you are saying so the ILO is received through both cognitive processing channels, allowing working memory to function more efficiently and reducing cognitive overload and increasing student engagement. The process is the same for descriptive images; they feed part of the brain we may leave undernourished by our pedagogies.

An Innovative Experimental Method And Tool To Test Mml Outcomes

We would be poor pedagogues if we chose to instigate a new method of (multimedia) learning and did not then consider how to evaluate its effectiveness in relation to the older (monomedia) order. The means to this end were grounded in part in the work of Lih-Juan Chanlin (1998), Elspeth McKay (1999) and Edward Kleinman and Francis Dwyer (1999). Their work involved comparing the impact of visual methods with non-visual methods, in the same way we sought to compare the impact of multimedia with monomedia methods. The choice to compare as a method led to a randomized control trial (RCT) approach. These are quantitative, comparative, strictly controlled experiments that involve a control and experiment group, with participation in each being randomized. The RCT method remains 'the gold standard… based on its imposition of experimental order… and its production of numerical results that may not be absolutely accurate but that are unquestionably precise'. Furthermore, 'it is readily translated outside its original experimental setting, for replication, comparison, and adaptation elsewhere' (Meldrum, 2000, p. 745).

The subject and object of the research is students, and the success of the experiment depends on their participation. This factor demanded methodological innovation, since initial attempts at conducting the experiment on campus met with failure by absenteeism resulting in statistically insignificant data outcomes. Informal feedback from students who had shown up on the day suggested the experiment needed to be online somehow, which led to a new round of methodological introspection. The outcome was a WordPress website that relocated the content of the experiment from the lecture theatre to the ether.Once at the website, having been directed there by email invitation, links expose participants to consent and information forms and invite participation in the experiment via two randomizing URL links. These are attached toa monomedia and a multimedia recorded version of a 10-minute PowerPoint presentation on global warming (chosen for its generic familiarity). The monomedia version uses slides with 5-6 lines of bullet-pointed text only. The multimedia version uses full-slide apposite images with one line of text. Each image directly or indirectly represented the meaning of the text. Both versions were accompanied by the same voice recording. At the end of the 10-minute presentation, watched remotely wherever the students were connected (all in places with reliable Internet access), a link appeared to an online exit survey which asks them to agree or disagree with a series of statements elicited from the engagement scholarship defining its characteristics (Appleton, Christenson, Kim, & Reschly, 2006; Axelson & Flick, 2010; Zepke, 2013; Gibbs, 2014; Trowler, 2010; Kahu, 2013). This tool can be readily replicated with only basic knowledge of website building and content customized to suit individual needs. This in turn means the experiment may be run through multiple universities simultaneously. It could also be run and repeated worldwide for the same reasons. The site is not licensed, and interested parties are welcome to copy, adapt or ignore its approach.

Results

Quantitative RCT analysis of students' perceived levels of cognitive engagement

Hypothesis: multimedia learning methodsproduce greater student engagement than monomedia methods

The experiment was conducted twice a year (each semester) for five years in four disciplines (Politics, History, International Relations and Business Studies). Nearly 200 have participated over the duration, with males outnumbering females very slightly. All participants were 18-22. There was little differentiation across the five years in age and gender composition

Figure 1 below shows comparative values for control and experiment groups with the data aggregated for the length of the experiment, and no noteworthy deviation occurring in any given semester or year. Nor was there any noteworthy deviation between students from different disciplines or between sexes. The statements across the bottom of the table are the statements to which students responded in the online survey. The first three statements left to right concern cognitive engagement, the second three behavioural engagement and the last four concern affective engagement. The darker columns show the percentage of students agreeing with the statements concerning monomedia slides. The lighter columns show the percentage of students agreeing with the statements concerning multimedia slides. Each answered on a response scale from 1 to 10.

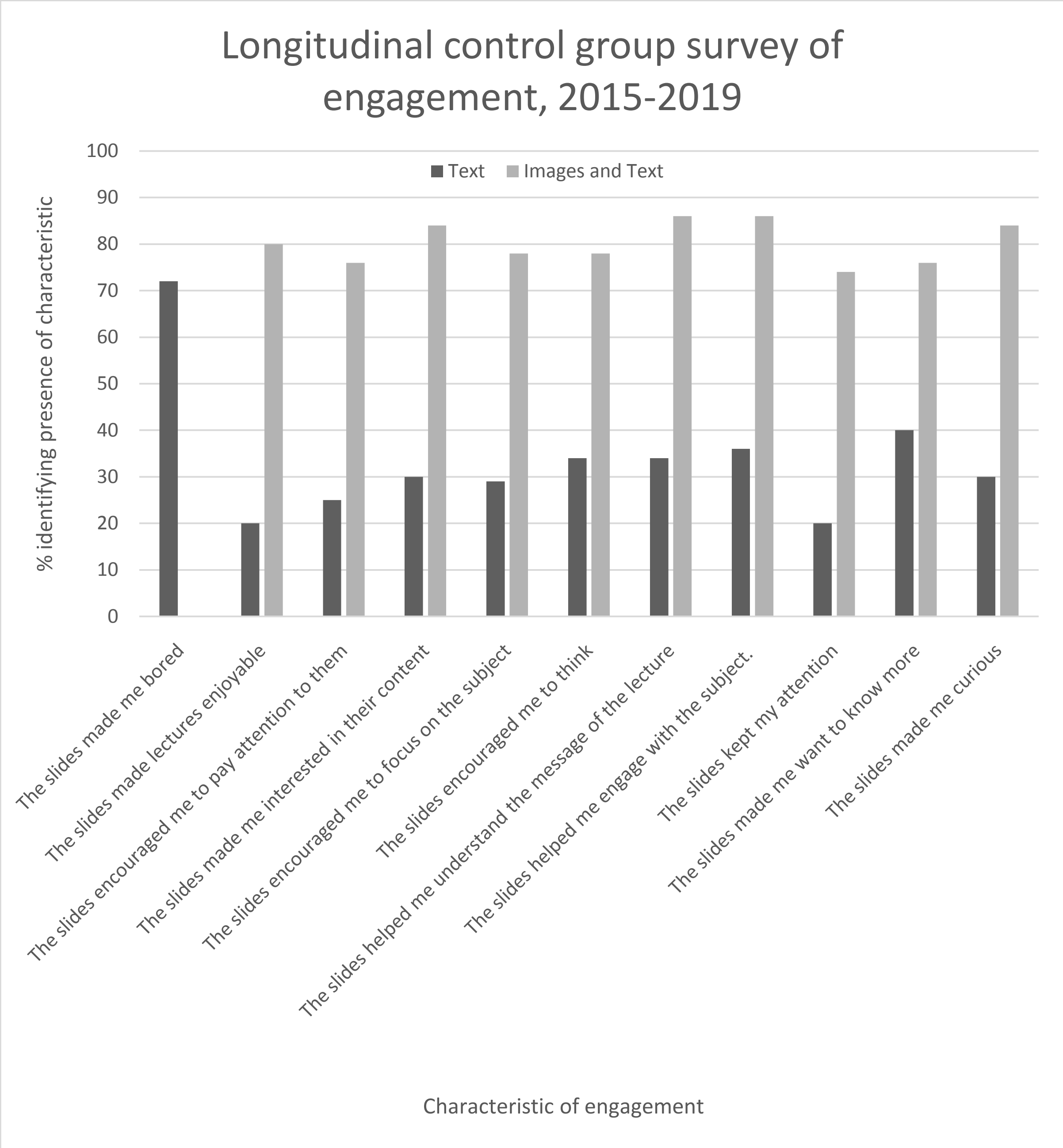

Figure 2 Aggregated longitudinal control group data, 2015-2019. X axis shows statements assessed by students in exit survey. Y axis is percentage of students agreeing with slide statements.

Testing with this research tool and approach affirmed the veracity of MML claims. The quantitative data shows the students in the experiment group viewing multimedia slides expressed much greater self-evaluated levels of engagement. The predictions of MML theory regarding the effects of pluralizing communication media were borne out in the general sense. Cognitive engagement was higher when apposite images were combined with limited text and speech in presentation slides, than when the same academic material was presented with speech and text input only. The implications are clear: where engagement is considered a valid proxy for learning, then learning will be correspondingly improved when academic material is presented in multimedia format.

However, there is a weakness in the hypothesis underpinning the research. It is conceptually constrained and anodyne in relation to the sophistication and nuance of the engagement scholarship in pedagogic literature. Where MML views and represents engagement as a largely monolithic concept, it has been disaggregated into affective, behavioural and cognitive dimensions, finding overlap and interrelated impact (Ben-Eliyahua, Moore , Dorph, & Schunn, 2018; Maguire, Egan, Hyland, & Maguire, 2017; Hewson, 2018; Nguyen, Cannata, & Miller, 2018; Singh, 2019).

This weakness sketches a programme of further research that directs our attention to the extent to which MML methods impact each aspect of engagement, and how theycompare with one other, allowing a more refined determination of value. MML is also narrow in the sense that most of its research has been directed at neurotypical students to the exclusion of neurodiverse communities. MML has particular and apparent potential here, since dyslexic learners (for example) are known to experience amplified impact of written content on working memory(Beacham & Alty, 2006; Fostick & Revah, 2018; Knoop- van Campen, Segers , & Verhoev, 2018; Eide & Eide, 2011). MML methods are understood to alleviate such pressure because balancing content delivery across both audio-textual and visual processing channels reduces pressure on working memory (above). The online MML research tool can be applied to ascertain relative self-evaluated levels of engagement between monomedia (control) and multimedia (experiment) groups in a neurodiverse (in this instance) student sample.

Conclusion

As postmodern pedagogues, we inhabit the intersection of three global vectors. We face an increasing drive and dictat to improve student engagement institutionally, nationally and internationally. We have the peer-reviewed knowledge of universal neurobiology and cognitive dual processing that allows us to enhance engagement by expanding academic content delivery from monomedia hegemony to a normalised multimedia dynamic.Further, we inhabit the most visual of all eras that would enable an examination of both. But in pedagogic circles, we seem to have done insufficient in terms of exploiting those converging vectors to create an intellectual structure that would frame and determine pedagogic efficacy and practical pursuit. MML theory sits at the apex of these vectors. It is concerned with universal engagement mechanisms; it provides the cognitive scientific basis for assessing impact; and it is concerned with the visual. It provides the necessary intellectual structure for scholarly debate around a potentially universal approach to enhance student intellectual engagement.

This article captures this convergence and argues to centre it in innovative pedagogic discourses to reify and transform HE learning and teaching across disciplines. In doing so, we also have an opportunity to add nuance to how we understand multimedia dynamics thus far. Whilst MML and cognitive science research reveal to us the means to enhance cognitive engagement, they do not properly yet consider the sophisticated dimensionality of affective, behavioural and cognitive engagement research that permeates HE pedagogic research. Nor do they interrogate extensively the evident implications of the research for inclusivity and dyslexic learning. Linking MML and academic cognitive dimensionality provides a clear structure to further research.

Given this consciousness, it is reasonable to propose that, because of common biological underpinnings and potential universal reach, we have a responsibility to engage more fully with such innovative theories and practices proven effective across national and cultural boundaries and disciplines. Given that we also have viable methods to scrutinise such approaches, we have means, motive and opportunity to integrate, facilitate and investigate what will almost certainly be seen one day as an inevitable evolution necessary to align the interior academy we shape with the exterior world our students inhabit. If we do not properly engage with this scholarship in a pedagogic context, it will be akin to burying our heads in the sand and ignoring the wheel as it rolls right past us.

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