Touching, tapping … thinking? Examining the dynamic materiality of touch pad devices for literacy learning

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ABSTRACT

As touch technologies such as phones, tablets and touch screen tables become more present within classrooms there is a need to examine the relationship between literacy and physical action, particularly non-linear reading paths. This paper presents data, that is part of an ongoing international study, to provide some insights from classroom observations of Year 5 students using iPads as well as traditional paper-based texts within their literacy lessons. This is ongoing research with a large corpus of data being analysed. We use specific examples to examine the reading and writing process for some students as they interact with the physical interface of the touch pads through the mode of gesture. Our goal was to investigate the cognitive and interactional processes that take place when the students read digital texts on a touch pad and to understand the processes used to render hybrid, multimodal 'texts' meaningful. We employ the concept of dynamism to interrogate the embodied iterative explorations students demonstrate through their learning, scaffolded by their teacher's pedagogical adaptation to the potentials of the touch technology.

Figure 1. Designing a digital text with touch technology

Introduction

The image at the start of this paper typifies the physical processing of the dynamic features found on touch pad devices, in this case an iPad. Dynamic materiality is demonstrated in the ways users can touch, tap or slide to move from one screen to another – while transferring images or text – or tap hyperlinks to access web pages. Finger actions can move, enlarge or reduce the images on the screen. A touch of a finger can correct spelling, copy and paste text or image, access an application (app) or emails. The image shows a Year 5 student using two fingers in a highly specific swipe action to move from a website to a screen that displays an app through which he has created a digital text. Although static, the blurred image indicates the speed and confidence with which he and his fellow students have adopted this touch pad technology in their class. This is perhaps a precursor of predictions for the touch technology that may be available in future classrooms, such as '*touch screen tables, robot study buddies and 3D virtual learning environments* (*SMH*, July 2012). This paper discusses the impact of such physical activity on literacy learning to raise important questions. How does the addition of touch on the screen create different opportunities for directionality and offer different reading paths? How does this affect the way students read and write on screen, process and produce information? How does touch as part of the mode of gesture influence reading and writing within this digital environment? Questions such as these are becoming more important to address as touch pads have been adopted in many classrooms without clear understandings of the relationship between literacy, learning and the way touch operates as a mode through which students physically interact with digital platforms.

Review of literature

This paper requires us to revisit prior conceptualisations of the related processes of reading and writing usually tagged *literacy*. There are problems of shared understanding when we discuss issues that depend on a clear definition of literacy. As long ago as 1991 the study of literacy was described as 'a maze of studies to match a multitude of practise, full of contradictions and paradoxes' (Meek as cited in Nel & Paul, 2011, p. 145). Reading through any range of texts that discuss literacy shows that there is still significant slippage of meaning for the term. In much work written for classroom teachers there is no specific gloss on the term literacy when the word is used in association with multiple modes of meaning. The word literacy has become an appendage for various other terms, for example *visual* literacy, *digital* literacy, *computer* literacy, *multi*-literacies etc. As practitioners and those teaching them attempt to deal with new and emerging conceptions of literacy the term 'new literacies' has grown in popularity (Street, 1997; Lankshear & Knobel, 2003; Comber & Kamler, 2005; Yelland, 2005). This term includes the multiple form of 'literacies' but avoids integrating them. The usage is commonly associated with ICT technologies and 'ways of knowing in a digital age' (Yelland et al., 2009, p. 5) and incorporates 'new textual practices' (Comber & Kamler, 2005, p119). But again there is slippage or lack of clarity for the term literacy when the discussion shifts from pedagogy to modes of communication.

The recent increase in the use of touch pad devices such as iPads adds a further complication to our conceptualisation of literacy practices when considering how students read and write with digital, mobile media. We acknowledge that the processes of reading and writing are more closely related (Walsh, 2010) in a digital environment, but for the purpose of this paper we will focus mainly on the impact of touch technology on the students' reading practices, although writing, designing and producing digital texts will be shown to be an outcome of digital reading practices. When we observe students reading with touch pads we need to account for the embodied interactivity that supports their learning as well as the more familiar embedded multiple literacies we have come to recognise. Research is needed to investigate the additional affordances that such devices offer to enable the reader to control their physical reading environment and deal with digital metacognitive knowledge (Leu et al., 2008). Reading on screen for example has been shown (e.g. Kress, 2003; Unsworth, 2003; Walsh, 2006; Bearne et al., 2007) to involve the processing of non-linear, multimodal elements such as text, image, sound and movement. But research into reading with touch technologies which incorporate gesture is gradually emerging (Jewitt, 2006).

The multimodality of reading and writing on screen has been described as 'multiplicative' (Lemke, 2002) in the way modes interact with others within a media or digital text. A useful explanation of how modes compound in meaning making processes is given by Kress and van Leeuwen who state: '…meaning is made in many different ways, in the many different modes and media which are co-present in a communicational ensemble'. (Kress & van Leeuwen, 2001, p. 111). They describe the multilayered features of communication and how each layer contributes to meaning. Lemke further explains the process as 'multiplying modalities' (2002, p. 302) suggesting that each semiotic mode is not an addition but rather increases or multiplies the

possibilities of further meanings. The usefulness of this premise is indicated when we consider the image at the start of the paper. It enables us to conceptualise how, as the student rapidly traverses from one meaning making episode to another employing different modes, the cumulative potential of his meaning making possibilities increases (Lemke, 2005). However, we are aware that the touch technologies require us to consider a blurring of the lines between literacy and action (Beavis, 2012) and query our understanding of where gesture sits with reading practices.

The 2009 PISA report (OECD, 2011) on digital reading reinforces researchers' findings on the differences between reading print and digital texts by differentiating between 'fixed' texts with a 'static existence' and electronic texts that have an 'unfixed, dynamic' existence (pp. 27–28). The distinction that PISA makes suggests that features of touch technology would allow for even more dynamic access and interaction as the kinaesthetic movement of touch supports cognitive development on a number of interrelated dimensions. For some time it has been acknowledged that reading on screen involves non linear reading paths (e.g. Snyder, 1997; Kress, 2003; Bearne et al., 2007) where the concept of a reading path is used to indicate how multimodal elements impact on the order of a reader's interaction with a text. As touch technologies provide readers with non-linear and non-sequential entry points to text on screen they increase the potential for divergent and multiple reading paths. Like the multimodal features of gaming, touch technology allows for physical movement and interaction between different semiotic domains. As researchers on gaming have shown the potential for cognitive processing within these semiotic domains (Gee, 2003; Beavis, 2012), it is pertinent to examine the cognitive impact of touch technology on literacy and learning. In the case study reported below we have been examining the impact of dynamic accessibility on thinking and learning by tracking the relationship between physical action and literacy practices.

Research into the use of touch pads is in its infancy as the early adopters of the technology begin to examine its impact on learning and teaching from a number of aspects including motivation, ICT use, pedagogic change, reading and digital design. Studies in primary school classrooms have examined touch pads as a useful source of engaging applications, which motivate students and increase reader engagement (Ciampia, 2012), or as a new interface to bring digital texts into the classroom and increase student interaction and facility with technologies (Hutchison, Beschorner, & Schmidt, 2012; Harmon, 2012). Digitally mediated pedagogy has been examined by Rowsell, Lovering, Mcquirter-Scott, & Bishop (2013), in their ongoing research which considers iPads as 'placed resources' which impact on the local classroom community. Some research demonstrates that critical reflection about touch pad functions and the associated need for pedagogic change is beginning to emerge in journals for teacher professional development. For example some work on the impact of touch pads shows increased comprehension and improved reader response (Larson, 2010), which recommends their use. However, contrasting studies such as Shephard's (2011) report on student distraction and lack of achievement for poor readers, which challenge the equation ICT integration = increased learning. Supported by the work of Kalantzis and Cope (2012) and Kress (2010) who have provided analytical frameworks for examining how students create multimodal texts using digital technologies, classroom based research is beginning to investigate how teachers are learning the value of design pedagogies (Healy, 2008; Sheridan & Rowsell, 2010; Kalantzis & Cope, 2012) It is clear that researchers are beginning to explore the educative benefits and challenges of touch pads. The studies discussed are an indication of the enthusiasm and concerns raised so far. Yet few researchers have examined the aspect of modality at the specific level of touch as their attention has been focussed on the general integration of ICT into the classroom. For example text manipulation is mentioned as an affordance that increases student interaction (Larson, 2010 p. 21; Shephard, 2011 p. 15; Hutchison et al., 2012, p. 17) but the physical aspect of this reading process is not closely examined in any of these studies. The current study addresses an area that needs consideration. If reading with touch pads makes comprehending and designing text more complex then we must examine in what ways literacy practices have been augmented through dynamic materiality to support students' learning.

Theoretical frameworks

The study draws on theoretical frameworks related to literacy and semiotics as seen in the work of researchers into multimodality and new literacies referred to above. However, as it is an empirical study based in a classroom context, it is also informed by frameworks drawn from learning theory. For example, Alexander's principles of dialogic teaching (2004) postulate a set of guidelines for pedagogic practice, which include the concept of cumulative learning which is core to our investigation of multiplicativity. Although Alexander's focus was on face to face learning where meaning is made amongst interactants through talk, parallels can be found between his dialogic principles and Lemke's

research (2002; 2005) which is concerned with meaning making that traverses different modes and media. They provide complementary frameworks for analysis as both approaches share commonalities. They both adopt a social constructivist view of meaning making as they view communication as purposeful social action created in complex, dynamic interactions. In addition, the two theorists use the concept of cumulation to explain their view of how learners build meaning across time and virtual space for Lemke and in real time and physical classroom place for Alexander. As our study examines digital meaning making practices in a school setting, our research finds useful analytic support from these theorists as well as semioticians to help us investigate the role gesture plays within multimodal interactions as students are engaged in reading tasks with touch pads. So, our discussion below is informed by theories related to literacy, multimodality and dialogic reasoning.

The study

Our research is ongoing and part of a larger study. This paper focuses on two samples of data collected in the case study of a classroom of 28 Year 5 students in an urban independent school for boys in Sydney, NSW Australia. In 2012 each student in Year 5 was issued with his own iPad at the beginning of the school year. The researchers collected classroom observations one day a week during literacy sessions over three terms as students researched, read and designed digital texts as they interacted with the physical interface of the touch pads through the mode of gesture. Data was collected in the form of video and still image recordings of the teacher and the students as they interacted, as well as field notes and the teacher's reflective journal. The data records how the students and their teacher learned how to learn with the new technology in their classroom.

Case study, an established methodology in literacy research (Barone, 2004), was chosen for the observational procedures needed for this study because of the complexity of the data. We were looking for specific examples of literacy, particularly reading behaviour, in our observations as well as the pedagogic strategies through which the teacher established opportunities for literacy development with the use of iPads and print-based materials within the literacy sessions. Considering the materiality of the iPads themselves and the affordances of different modes and interaction between modes within this touch technology we were conscious of the need to obtain video data that would allow for multimodal analysis (Jewitt, 2009).

To examine some of the differences between reading on a 'fixed' screen and reading with the dynamic screen of the iPad we are using evidence from our classroom observations taken from a sequence of lessons when students were researching a Science topic 'The Life of a Star'. As part of their work on this topic the teacher introduced the students to the app 'Corkulous' which is a digital 'idea board' that looks like a cork message board on screen. It can be used for organising ideas, note taking, mind mapping, planning, as a message centre or event planning. It is moveable on the iPad screen, its size can be varied and it allows for different features to be used, moved and varied on it, e.g. notes, labels, photos, index cards, task cards and others. It allows for file sharing and is a good example of the principles of cumulative learning in action.

The teacher demonstrated to the whole class the features of Corkulous on the Interactive White Board (IWB) to remind students of the procedural steps for successful research planning and presentation. The teacher displayed six key headings on the board in the first lesson: Define, Locate, Select, Organise, Present and Assess; and discussed each one with the students. He related the research process to the design potential and interactive affordances that the app provided so that students would recognise its benefits for their planning. He scaffolded the students through each of these processes over several lessons through discussion and a practical task. For example, to illustrate 'Define' he asked students to '*find 3 words to summarise the life cycle of a star*'. This task forced students to both conceptualise and contain their search for information.

As they worked on each research process students used the Corkulous board to organise their information by making headings with notes and recording web site links. They signalled their connections between pieces of information and photographs they added to the board by using virtual 'strings' and arrows, as shown in Figure 2.

The photo in Figure 2 shows the organisation of one child's information about the life cycle of a star using the Corkulous App.

The teacher emphasised the need to keep a record of good websites and filter out the bad ones, so the students were learning to synthesise information at

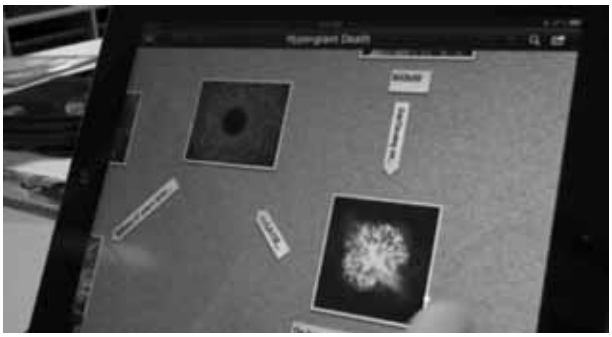

Figure 2. Using the Corkulous App

the same time they were looking for content about stars. Students were required to search for information from books or web sites and to find a minimum of five websites that provided useful information and to discard those sites that were not helpful. To do this they had to type in key words in the search engine or in particular sites (e.g. the NASA site for kids). They then had to copy and paste the URL into their notes on Corkulous under the appropriate heading. It is important to note that the teacher emphasised that students were to use a range of sources, books as well as web sites. Students used and shared some of their information with the teacher and others in the class as the lessons progressed using email, the IWB at the front of the class and dialogue.

Example 1

The sequence of photos below shows how one student Mark (pseudonyms are used for students) organised his information onto the screen using the Corkulous app. The researcher asked Mark to go through a think aloud process to talk through what he had done and why. Mark explained his information to the researcher, pointing to specific parts of the screen to describe details of a hyper giant star (in this case VJ Canis Majoris). As he does this he points to a photo he has downloaded and labelled, then he enlarges the photo as he describes its features and explains the size of the sun in comparison with the hyper giant star, before he slides the screen to present the next explanation to the researcher. The following figures present examples of Mark talking through his explanation alongside the still photos in Figures 3 and 4 of his finger pointing to the screens. His spoken comments are in italics.

Mark explains as he points to sections on the screen of the iPad:
So here we have a hyper giant star such as VY Canis Majoris, which is a red hyper giant. It's pretty big.

Figure 3. Modes of touch and verbal interaction combine

He slides his finger to the next section:
And that's the sun size compared to it – the hyper giant's life cycle.

Figure 4. Comparing the size of the sun with a hyper giant star

Mark then proceeds to explain the life cycle of a hyper giant star, pointing to and moving his finger along the direction of the visual texts he had created, including arrows, text and images on the Corkulous board. As he continues with his explanation he talks about and partly reads his text from the screen:

> ***When it's born it's a protostar and it forms into a hyper giant star. About a*** [one] ***hundred thousand years later it will explode and it becomes a hyper nova. The hyper nova's core collapses in on itself forming a singularity which is an awfully big bit*** [the text reads 'colossal'] ***of matter squashed into a very small space. The singularity expands very rapidly forming a black hole. The black hole will swallow anything including a*** [?…] ***which wanders into its path. Billions of years later it will expel all its matter and then everything will be back to normal.***

Mark then taps his final image that expands into a larger image of a mass of stars, showing that he was conscious of a final effect in the visual design of his digital text. He has created a visual conclusion that was enabled by the affordances of the technology.

It is important to note that, as stated earlier, 'reading' itself does not occur in isolation in this environment. Rather it leads into the production of a digital text that involves writing and design and the outcome of what has been learnt through the research and reading. Mark has been able to produce an explanation text that demonstrates his learning with written language, images and graphics, which are organised in a non-linear way.

Example Two

After completing their explanation of the life cycle of a star, students were required to apply this information to create a further digital text, in this case an online diary of a day in the life of a star or an astronaut. Students presented their diaries in different and imaginative ways, using factual information within the fictional diary. They presented these as an iBook with each electronic page of the diary combining written text, photos, images and graphics with different types of inserts. An example of one page from the diary of another student, Thomas, is shown in Figure 5. Like Mark, Thomas used touch to navigate between semiotic layers to create, move away from and then revisit a text as he uses knowledge accumulated from other sources, which allows him to build on his core text. As he uses both physical and mental movement he needs to reconfigure information to fit into what he already knows in a purposeful fashion that depends

on metatextual awareness. The cognitive processing needed to successfully relate information from one text to another in this manner can be viewed as a kind of mental hyperlinking.

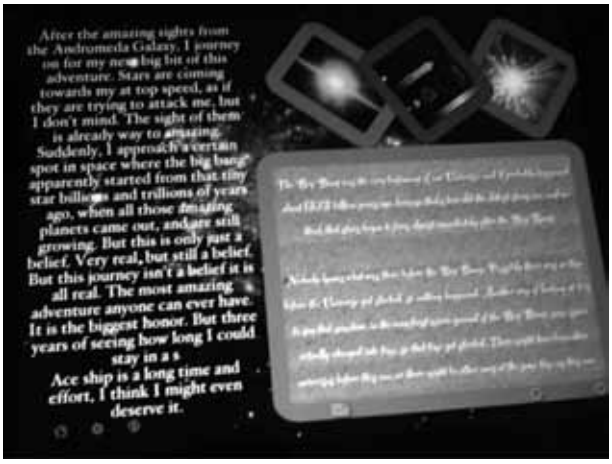

Figure 5. A page from Thomas's online diary

The image in Figure 5 shows the result of Thomas' literacy learning together with the physical actions of touching, tapping and sliding to display the written and visual texts that form this page of his digital diary. In order to meet the requirements from the English and Science syllabus he had to understand the reading and research he had completed on the life of a star, in this case the planet Jupiter. Thomas used his literacy skills to weave the factual information he had found into an imaginative diary in which he used a first person narrative to convey the perspective of an astronaut as he describes his '*amazing adventure*' after years of training and the honour it is. It is clear that design is an important aspect of this diary as it was with Mark's digital explanation text. Thomas has arranged each page/screen with the imaginative text of the diary placed alongside a separate explanation text. He includes different genres on each of his screens/pages but divides them visually with coloured frames. Dark colours are designed to depict a sense of the vastness of space. These colours are contrasted through his diary with strong use of red, orange, green and blue framing blocks of text and images, and these cohere with orange and red glows in images of the stars or Jupiter's moons. While these aspects of design are reliant on the visual mode they have been produced through the gestural mode of touch.

Discussion

Our goal was to investigate the cognitive and interactional processes (Leu et al., 2008) that take place when the students read digital texts on a touch pad and to understand the processes used to render hybrid, multimodal 'texts' meaningful (Kress. 2003; Walsh, 2010). We have employed the concept of dynamism to interrogate the embodied iterative explorations students demonstrate through their learning, scaffolded by their teacher's pedagogical adaptation to the potentials of the touch technology. The examples from Mark and Thomas are typical of how the majority of students in the class were working and they offer opportunities to consider some important issues. These are

- the relationship between traditional and digital reading processes;
- the dynamic nature of touch pad technology for literacy learning;
- the directionality of reading paths in touch pads; and
- the influence of touch on conceptions of gesture.

Each of these issues is now discussed.

The relationship between traditional and digital reading processes

It was evident that traditional and digital reading processes could not be separated as one supported the other. Similarly writing and design were integral to demonstrate students' learning from their reading and for them to produce new texts. This holistic relationship between reading and writing and between traditional and digital literacy has been established by several researchers (e.g. Bearne & Wolstencroft, 2007; Walsh, 2010). Within these tasks the students were engaged in effective reading and literacy practices. They were required to engage in traditional practices of research and content area reading as they searched websites and books, located information, selected relevant and discarded non-relevant information. They found web links, copied, pasted and filed these as hyperlinks in their notes on screen. They were both synthesising and evaluating as they organised their information with written explanations in their own words supported by photos, diagrams and graphics on their screens. It is important to note that this learning process was a result of the structure the teacher had established with careful modelling and scaffolding throughout the sequence of lessons.

The need for students to develop the ability to make these kinds of connections as part of reading digital texts is recognised in the PISA report (OECD, 2011) that acknowledges readers interact with texts at different metacognitive levels to make meaning such as drawing on background knowledge, responding, empathising, analogising, obtaining and evaluating facts, critiquing and making intertextual links (Simpson & Walsh, 2013). Vocabulary skills were constantly being developed as students were led by the teacher to be in the

habit of using an online dictionary to find the meaning of words they did not know. Both students had to use a range of both literacy and digital skills to complete their tasks. In order to meet the requirements from the English and Science syllabus Mark's work shows a sequential and coherent verbal and visual explanation text that was been generated through the cumulative processing of cognitive understanding with the material affordances of screens and their modalities. In contrast, Thomas' online creative diary is interspersed with factual information with comments on the Big Bang Theory, Jupiter's' moons and its Great Red Spot. The diary had to be structured sequentially so that specific events or facts were highlighted. The language had to be imaginative as well as involve explanation. It shows the use of several genres of recount, narrative and explanation designed with visual arrangements and effects to suit a digital screen.

All of the literacy learning processes – searching, locating, navigating, reading, notetaking, interpreting, synthesising, evaluating, writing, designing and producing – occurred within the interactive moves between books, sites and screens with aspects modelled by the teacher on the class IWB. Traditional and digital reading processes were interrelated and interdependent within the students' work. This is evidence of the holistic, interrelated process for literacy that is possible in contemporary contexts with the affordances of new developing technologies.

The dynamic nature of touch pad technology for literacy learning

In observing the students' use of the iPads the researchers were seeing the constant domination of physical fine-motor, finger movements. Students had to touch, tap and slide to move around the screen as well as enlarge or reduce the size of the screen or items in the screen. They touched, selected and positioned notes (electronic versions of post-it notes) in appropriate sizes then typed headings, for example those related to the evolution or development of a star. Students were using keyboarding skills for writing, varying font and headings for layout and editing. They were moving to and from web sites to the Corkulous board on their screen and rearranging the visual representation of their thoughts on the screen as they did this. Some of the most common actions observed as students interacted with their touch pad screens were splitting the keyboard, playing with font, paint, colours, sliding screens, minimising, maximising, and going back to an arrangement of pages. They were flipping and tapping, finding and inserting images, going to a draw facility, fingers moving all the time. They were also going back to other sites and to an online dictionary or thesaurus, emailing sites and photos to each other and demonstrating skills to others. However as already shown the physical, technical skills did not occur in isolation and were integral to the fundamental literacy and learning that was occurring. In addition to the integral relationship between traditional and digital practices, the researchers were observing dynamics in the classroom that were related to both the affordances of the touch pad technology as well as the teacher's pedagogy.

Figure 6 is one attempt, although a static diagram, to represent the dynamic processes that were occurring as students researched, recorded, read, wrote, designed and produced texts on screen. The box labelled 'Working on screen' represents the physical interface of the touch pad. While the screen is shown at the centre of the diagram it is not meant to signify a dominant, fixed entity as students were working across multiple 'screens' of different semiotic content that they were either accessing or creating. This is the multiplicative effect at play as iterative actions are used to create meaning. The box labelled 'Accessing websites' in the diagram represent the screens with information that students accessed. Other boxes indicating 'photos', 'online dictionary', 'apps' or 'emails' are included to show students were not just accessing websites. Students read, accessed and then transferred relevant information to their own screens or texts they were creating. This is where reading paths were fluid and clearly non-linear. The curved arrows represent the continual shifting between screens and sources as well as shifts between semiotic modes of words, image, sound, gesture and movement as multimodal reading paths.

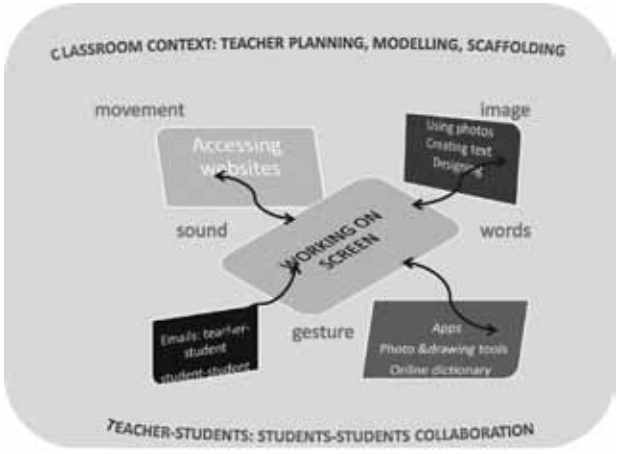

Figure 6. The dynamics of digital communication

The modes of words, image, sound, gesture and movement are shown in the diagram but are not meant to be static but occurring within the various processes.

Touch and directionality were important aspects of gesture the students incorporated in their reading processes. Students constantly used visual and tactile movements – often quickly – to and from different sites.

The directionality of reading paths in touch pads

The data has required the researchers to reconsider the concept of reading paths to take into account variations of directionality created through touch. To try to conceptualise the argument we contrast two kinds of reading practices represented in the examples above. Mark and Thomas designed what could be called 'static' texts on screen through the multiplicative effect of different modes, which communicate semantic content through print, image, colour, font size etc. They are static in the sense that the texts are fixed yet show traces of the students' research as the information has been brought to the 'surface' layer and are cohesively presented according to the construction of a text logic based on different reading paths. For example, Mark incorporated directionality in his text to create a circular reading path for his Corkulous board using arrows and strings and images and text boxes to represent the Life Cycle of a Star. Differently, the reading path Thomas chose used a visual design of overlapped framing to overlay two texts so they were both visible and it signalled that the two texts were different yet related. Both Mark's and Thomas' texts are 'closed' in the sense that the semantic boundaries of content are all located within a physical context, the one 'page'/screen, as a semiotic product.

By contrast in order to create these texts the students followed nonlinear, 'open' reading paths of another sort, which made far more use of the interactive affordances of the touch pad and display a far broader range of directionality. On numerous iterations of the research process they explored, read, cut and brought back material from various sources, which they rewrote and repurposed. It is not possible with current software to trace every page the students visited as they researched the topic of Stars but, from the video data, we observed the multidirectional reading paths students followed in their hunt for useful information through web sites, emails, books, and discussion with the teacher. The directions chosen during the research process were driven by a logic of content. The students were reading, viewing and interpreting using hyperlinks and images and key words as their directional guide posts/stepping stones to create their own individual reading paths.

We argue that the data shows traces of metatextual awareness as the students were using physical and semiotic movement to connect and reconfigure information so that they would be prepared to create and design new texts. Therefore the diagram above in Figure 6 includes both cognitive and interactional directionality.

The influence of touch on conceptions of gesture

Gesture has been described previously as a mode by scholars of multimodality (Jewitt, 2006; Kress, 2010) but it is more often dominant in the physical movement that occurs in drama, dance or film. With touch technology the kinaesthetic mode of gesture becomes more dominant and potentially dynamic in that the content the screen displays need not be as 'fixed' as on a computer screen or laptop. However, we do not yet have a systematic description expressed at the level of individual action that copes with the specificity necessary to interact successfully with touch technology on both the physical plane and within semiotic layers of meaning. The data collected for the study is highlighting the need for more to be researched in this area. For example, we speak of Mark moving the text 'off' screen to bring a new text 'on' screen to read and work on. He needed to use a highly controlled two finger swipe action to achieve his purpose. More or less fingers would have resulted in a different outcome. That is, the outcome of his action was not random; rather he was in control of a very specific 'vocabulary of action' (Beavis, 2012, p. 87). Although we do not have agreed terminology for Mark's actions, we can suggest that the student's use of touch is socially meaningful (Lemke, 2005) as it meets the criteria of matching 3 metafunctions (Halliday, 1994). The action signals ideational meaning through the student's intention to find information on the topic of stars that connects to what he already knows. It signals interpersonal meaning as the move is simultaneously a command 'go!' [from one page to another] and a question 'where is?' [information about black holes]. And finally it signals compositional meaning as the deliberative directional move makes a cohesive 'reading path' from the student's mind map about stars to a new source of information about stars on a website. His choice of actions was contingent on his purpose. This demonstrates how the student has both the physical capacity and the knowledge capital to use touch successfully on his touch pad.

Therefore, a further issue to be raised is the expansion of the role of touch within the mode of gesture. Is touch a mode itself within the new environment of touch technologies? Our observations were that often students made different tactile movements where they were playing with and exploring the features of the screen. Our close analysis of students' responses to literacy tasks has shown us the importance of considering touch to be

part of the meaning making processes students employ when they work with interactive screens. By tracking touch we have been able to propose that the physical affordances of the digital platform are an important component of the exploratory learning experience. In addition, by tracking touch we have also been able to propose that the learner's physical engagement with the task provides visible traces of their internal thought processes. When students were engaged in researching, reading, recording and designing digital texts, touch was an integral part of their communication along with the visual mode and written language. At this stage we are suggesting that touch, within these digital environments, is a new way of representing meaning and communicating. If we wish to highlight the physicality of the dynamic interface between touch pad devices and literacy learning, much more research is needed to investigate the relationship of touch to gesture and to the learning process.

Conclusion

Our analysis of the two samples of data presented in this paper has enabled us to track some aspects of the relationship between literacy and the physical action of touch in the use of touch pads. We believe that we have identified that students use multiple reading paths and that the use of touch on the screen was complementing the way students read, processed, wrote and produced information in this digital environment. The mode of touch, along with the visual and verbal modes, cannot be separated. We have shown how through the dynamic accessibility of the touch pads students' physical actions enabled them to move between multiple semantic planes of information as they worked through a sequence of literacy learning. The concepts of dynamism and multiplicativity have been useful in guiding our interrogation of iPads in the classroom context as ways of describing and understanding what we were seeing. This is a beginning glimpse of the complexities that exist in attempting to describe the relationship between physical action and semiotic meaning making.

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