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Visual and non-literal representations as academic literacy modalities

Desiree Scholtz

*Faculty of Business and Management Sciences, Cape Peninsula University of Technology,
Cape Town, South Africa
scholtzd@cput.ac.za*

Abstract: The normative understanding of academic literacy relates mainly to textual reading and writing. While texts might well be dominant, other literacies such as numeracy and visual literacy are equally dominant in higher education studies. The context of academic literacy is here located within five first-year diploma subjects where visual literacy and numeracy emerged as dominant modalities for subject content representation. Lecturers' perceptions of reading requirements for their respective subjects and a review of summative assessments provided the data for content analysis using academic literacy specifications as data codes. Literature on academic literacies and disciplinary literacies provided the framework for data analysis and discussion. The findings revealed a constellation of textual-visual-numeracy modalities that necessitated modal shifts in translating and transforming subject content across modalities. This study foregrounds the need to support first-year students with discourse analysis of visual and non-literal representations to provide epistemological access to the field of practice.

Introduction

Students entering higher education at first-year level often encounter an academic experience and academic demands very different to that of high school. In its broadest sense, higher education implies a higher order level of engagement with knowledge structures and concepts using language as mediation to develop requisite understandings. Language and literacy are not limited to textual engagement, but incorporate an array of visual literacies (e.g. graphs, maps, pictures, artefacts, observation) and numeracy, which have particular languages and literacies to navigate and mediate. Jewitt (2008a: 241) notes 'that it is not possible to think about literacy solely as a linguistic accomplishment and that the time for the habitual conjunction of language, print literacy, and learning is over'. The multiplicity of literacies is captured succinctly by Wyatt-Smith and Kimber (2009: 72) who assert that 'meaning is made, interpreted, communicated and shared through many different representations wherein verbal language might be only one'. The dominance of visual artefacts of various forms and numerical data require different ways of making meaning that are not generic to text. Text and textual engagement are no longer paramount. Unsworth (2006: 55) avers that 'literacy pedagogy can no longer be confined to the realm of language alone and that literacy education needs to account for the role of images as well as other modes of meaning-making'. Unsworth's (2006) idea of extending literacy pedagogy to 'other modes of meaning-making' is shared by several authors who have written on this subject (see Kress 2000; Jewitt 2008b; Thompson 2008; Wyatt-Smith and Kimber 2009; Archer 2010; El Refaie and Hörschelmann 2010; Mickan 2013; Prince and Archer 2014; Huang and Archer 2017).

The challenges for students in higher education do not only reside in accessing higher knowledge, but in how to engage with multiliteracies and multimodalities in the learning process. Archer (2010: 202) contends that from a student writing perspective, images are utilised in conjunction with text 'in a range of ways...to provide context, to illustrate a point, make an argument, furnish evidence and organise data' in addition to numerical manipulations and numerical representations that assist in elucidating text. Although most research on multimodal linguistics tends to emanate from a student writing perspective (Baynham 2000; Jewitt 2008a; 2008b; Archer 2010; 2011; 2014), this article explores multimodality from a student reading perspective and acknowledges the plethora of

semiotic modes prevalent in academic resources and references such as textbooks, worksheets and assessments, to name a few. The thesis presented here foregrounds the modal shifts that students need to negotiate from one modality to the other to read with understanding, to access knowledge and to incorporate such knowledge into personal schemata. Each mode has a specific purpose in or adjunct to a text, requiring a specific form of discourse analysis, since different aspects of meaning are carried in different ways by each of the modes (Archer 2010). The question raised here is whether students have the wherewithal to make these modal shifts from a modal discourse analysis and integrative content perspective in order to provide epistemic access to disciplinary knowledge. For the majority of students in higher education in South Africa whose first language is not English (the language of teaching and learning at most institutions), the challenges and layers of language knowledge become more complex. Depending on the field of study, students need to have a working knowledge of English, develop an understanding of disciplinary literacy specific to the field of study, develop an academic gaze and linguistic prowess for knowledge production and be adept at combining these different layers to read and write across the curriculum. Factoring multiliteracies and multimodal content representations into the language ability equation presents yet another level of literacy engagement.

This article focuses on different literacies and modalities in first-year diploma subjects at a university of technology, and highlights the iterative modal shifts that students need to navigate in reading and analysing subject content. 'Subject content' here refers to what students learn as part of the curriculum in any given subject that constitutes a programme of study. This article raises the question of what it means to be academically literate in a multimodal context since academic literacy is largely considered to be a tacit skill subsumed into the pedagogy of subject content. A pedagogy of literacies development is called for, given that there are several literacy focus areas at play depending on the modality being analysed. It is important to note that the ability of students to deal with the academic literacy demands of modal shifts required for reading in the discipline might support or scupper access to knowledge. Student academic support at this institution focuses predominantly on writing intensive courses, with limited attention afforded to reading in the discipline. School literacy in South Africa might be very different for the majority of students from disadvantaged school backgrounds to what is required in higher education. Given this reality, it is incumbent on higher education to provide the wherewithal for students to be able to read across literacy modes in order to provide 'epistemological access' (Morrow 2007) to the discipline. Morrow (2007) coined the term 'epistemological access' to denote that access to higher education, which is a highly contested space in South Africa, should be followed through with providing students with the tools to deal with the academic demands for epistemic access and success. He argued that the aim of access to higher education is defeated if students do not have epistemic access to knowledge systems in their respective courses of study. The application of appropriate academic literacy skills and practices is an important strategy to achieve this end.

The different aspects of literacy that are salient to this study form the theoretical framework for data analysis and discussion. A brief description of the kinds of textual-visual-numeracy content representations and literacy skills required for each of the five subjects is provided, followed by the discussion of the importance of the necessity to teach reading skills in multimodal subject contexts. Suggested reading strategies to deal with multimodal shifts, as well as digital and e-literacy, which are equally relevant as literacy modes, are not in the scope of this article.

Literacy domains

Multiliteracies and multimodality

A premise of multimodal perspectives of literacy is 'that meanings are made (as well as distributed, interpreted and remade) through many representational and communicational resources of which language is but one' (Jewitt 2008a: 246). Jewitt (2008a: 245) further asserts that the concept of

multiliteracies sets out to stretch literacy beyond the constraints of official standard forms of written and spoken language to connect with the culturally and linguistically diverse landscapes and the multimodal texts that are mobilised and circulate across these landscapes.

Given that modalities are complex carriers of meaning and interpretation, Jewitt (2008b: 357) maintains that ‘multimodality refers to a field of application rather than a theory’. In other words, the key to accessing meaning resides in the ability to read and analyse the different modalities, and to synthesise meanings such that each mode contributes to the whole.

The extended view of literacies (i.e. beyond textual reading and writing) suggests that there are multiple ways in which meaning is extrapolated based on content representation. This notion aligns with Thompson’s (2008: 144) assertion that ‘each content area is engaged in multiple forms of literacy through various modes of meaning-making’. For example, graphs and maps in engineering, budgets and forecast charts in business studies, observations and experiments in scientific literacy, all use textual, visual and numerical representations. Each mode presents different forms and interpretations of meaning. An image, observation or pie chart as modes each have ‘distinctive features or semiotic resources that can be called upon in any combination to make meaning’ (Wyatt-Smith and Kimber 2009: 72). The ‘choice of mode’, therefore, is complementary to the other such that each mode presents a particular affordance for learning, and ‘is central to the epistemological shaping of knowledge’ (Jewitt 2008a: 246). The central thesis of multiliteracies and multimodality is that although text remains the dominant modality for higher education, there are other prominent modes in different content areas that will increasingly be brought into synergistic relationships with one another. How these modal shifts are navigated to access and produce meaning deserves attention in the higher education arena. Lea and Street (2006: 373) draw attention to the complexities of modal shifts in gaining access to knowledge by noting that ‘the multimodal nature of literacy, and thus different genres, that students need to master in order to represent different types of curriculum content for different purposes, and therefore to participate in different activities’ require different kinds of literacies.

In addition to textual and visual representations, numeracy was a dominant aspect of meaning-making that formed part of this study. The ideological model of literacy posits that literacy and meanings derived from literacy forms are contextual, and socially and culturally situated. Numeracy, being contingent on other modalities is no different. Calculations, ratios and numbers on a graph derive meaning from the context in which they appear. Prince and Archer (2008: 66) note that ‘numbers do not exist on their own...they are always embedded in language’. Being literate in extrapolating and manipulating numbers correctly in context implies having competence in numerical practices. The relationship between numeracy and the practices related to numerical competence were explained by Prince and Archer (2008: 66–72) as ‘academic numeracy practices’ which are socially situated according to use in context, requiring particular competences where characteristics of the written mode do not seamlessly translate to numerical literacy. Numerical literacy is therefore much more than ‘having acquired the technical skills to decode and encode signs’, but involves ‘having mastered a set of social practices related to a set of signs which are inevitably plural and diverse’ (Prince and Archer 2008: 65).

Academic literacy: gateway to knowledge

Although many definitions and interpretations of ‘academic literacy’ have been offered by theorists in the field, this study draws on Lea and Street’s (1998: 160) view that

academic literacy in higher education points to reading and writing in the different disciplines where such reading and writing constitute the central process through which students learn new subjects and develop their knowledge.

In the multiliteracies and multimodality context, reading is not limited to texts, but includes modes of visual literacy and numeracy that present affordances for learning. Of import here is that academic literacy is not an autonomous, technical, transferable skill applied from one context to another. It involves specific forms of literacy and literary engagement ‘to learn new subjects and develop [students’] knowledge’ (Lea and Street 1998: 160). In other words, the application of appropriate academic literacy skills provides access to knowledge in the higher education context and ‘treat[s] language and literacy as social practices...taking into account their context and their different

meanings for different cultural groups' (Street 1997: 47). In the context of this article, the social setting is the vocational teaching and learning higher education environment, and the cultural practices relate to disciplinary literacies salient to professional and vocational norms. In vocational education, each discipline (such as management and engineering) and field of study in each discipline, (such as retail management and electrical engineering) has a specific language, culture of engagement and literacy practices that provide access to knowledge and entry to a professional community of practice. The ability to engage with appropriate academic literacy practices for specific content areas and modalities of learning provides access to reasoning, thinking and being apprenticed into disciplinary and professional literacies.

The plurality of literacies

Learning does not happen in a vacuum, but is always situated, contextual, cultural and time-bound (i.e. historical). As such, different factors impact on learners and the learning situation. Language and literacy are dynamic and organic depending on the learning context. Street (1997: 47) avers that 'if literacy is a social practice, then it varies with the social context and is not the same, uniform thing in each case'. By implication, literacy is not an 'autonomous...universal, technical skill...that is the same everywhere and simply needs transplanting to new environments' (ibid.: 49). The variations of textual-visual-numerical literacy in practice necessitated theorising 'the plurality of literacies' (Street 1997: 47) applicable to varying disciplinary contexts. Street (1997: 49–50) cautions that the 'multi' in multiliteracies, 'whether the particular literacy is in the visual, media or print domain', should not be thought of as separate literacies, but as 'some complex mix...so that the mix of visual, print and other aspects depends upon cultural and contextual features'. For example, multiliteracies applicable to business studies, engineering or health sciences would require different literacy practices associated with reading different forms of content representations in given contexts. Literacies, therefore, represent a constellation of diverse ways of meaning-making and it has become necessary, according to Goodfellow (2011: 133–134), 'to open our thinking to an expanded concept of literacy... and literacy practices that make for effective learning'. For this article, first-year subjects in diploma qualifications at a university of technology provide the backdrop to foreground 'the plurality of literacies' and 'multiple literacies' (Street 1997: 47) in a vocational education context.

Disciplinary and content area literacy

Higher education is generally demarcated along disciplinary knowledge areas and fields of study. These demarcations are becoming markedly fluid given the prominence of interdisciplinary and multidisciplinary curricula. There are, however, distinct differences in qualifications contingent on the discipline from which knowledge draws. The differences are characterised by

the way that knowledge is created, communicated, and shared within a discipline [such that] the discipline itself and the ways of thinking in that discipline determine the kinds of strategies to use in order to understand texts (Hynd-Shanahan 2013: 94).

The implication for learning is that first-year students as aspirant professionals should be schooled in the requisite academic literacy practices and pedagogy of the discipline. To this end, Baynham (2000: 17–18) calls for making 'the concerns of disciplinarity and disciplinarization' overt in the disciplines that students are reading themselves into. Reading in the discipline requires far more specificity given the different cognitive processes required for analysis of multimodal formats across different subject content (see Baynham 2000; Hyland and Tse 2007; Shanahan and Shanahan 2012; Carney and Indrisano 2013; Hynd-Shanahan 2013; Loveland 2014). Horning (2007), for example, asserts that to acquire appropriate disciplinary reading strategies and to develop the expertise of reading in a particular subject area, students need to understand the genres and conventions of that discipline.

Disciplinary literacy emphasises the differences among disciplines (Hynd-Shanahan 2013) and refers to 'the use of discipline-specific practices to access, apply and communicate content knowledge' (Loveland 2014: 8). As such, disciplinary literacy requires particular literacy tools appropriate for particular content areas. Disciplinary literacy has particular reference to this study

given the differences in subjects in vocational qualifications. Of import here is that disciplinary literacy resides in how particular literacy practices are applied to particular content representations in order to access meaning and construct knowledge. Becher's (1987: 262) study on 'relevant scholarly literature', i.e. journals on sociology, physics and history, revealed that knowing the 'structure of the body of knowledge which comprises that field...are useful in enhancing our understanding of the process of intellectual enquiry, and of the way that process differs between different knowledge domains'. The modalities of text, visual representations and 'academic numerical practices' (Prince and Archer 2008) in specific disciplinary contexts require specific tools for meta-analysis to interpret and understand subject content which might be different across disciplinary and subject areas.

Research context and method

This study formed part of a bigger study on academic literacy (i.e. reading and writing) in three-year diploma qualifications at a university of technology (UoT). UoTs in South Africa offer mainly vocationally oriented education to equip graduates with knowledge, skills and attributes for workplace readiness, as well as for further academic and professional development. Central to learning is understanding how subject content is presented in the field of study and knowing what skills to apply to access content knowledge. The focus of this article is, firstly, to foreground the academic literacy practices required to interpret and access knowledge in multimodal, multiliteracy content representations, and secondly, to call for overt pedagogy to develop requisite skills to negotiate multimodal shifts. Semi-structured interviews were conducted with lecturers who taught each of the subjects selected for this study, i.e. major subjects in five different qualifications. A major subject is taken from the first year to the final year in a diploma programme of study. The subjects were purposively selected to represent content areas with which students in different fields of study would engage. Two subjects in business studies, each with an administration and a management focus, represented the typical major subjects that underpin business studies qualifications, and a subject each in engineering, health sciences and science education completed the purposive sample. In other words, for major subjects students would need to engage with similar academic literacy practices for various modalities from the first year of study with incremental levels of difficulty and increasing academic demands to the final year of study. Of import here is that if students do not master the modal shifts and discourse analysis across the textual-visual-numerical literacies continuum from the first year of study, this might well limit access to propositional knowledge and scupper academic performance in subsequent years of study. The literacies and modalities noted for each subject are lecturers' perspectives of the kinds of reading practices that students would need to apply for their respective subjects. In addition to the interviews, document analysis was conducted by reviewing the summative assessments for each of the five subjects to determine the kinds of textual-visual-numeral shifts students were required to navigate. The document analysis served to verify the kinds of modal shifts required for respective subjects as reported in the interview data. The constructive alignment approach to teaching and learning (Biggs 1996) was adopted at this institution and by implication, academic literacy requirements for summative assessments should be an extension of those required for teaching and learning as described by the subject lecturers. Academic literacy specifications used for standardised tests in South Africa, such as the National Benchmark Test (NBT), were applied as the analytic codes for the interview data and the document analysis. These specifications are considered to be the typical kinds of academic literacy practices with which first-year university students would need to engage in a higher education context. The specifications include, among others: understanding vocabulary in context; separating essential from non-essential information; discourse analysis of text; establishing the communicative function of sentences; drawing conclusions; making inferences; identifying metaphors; and analysing visual representations in relation to text and numeracy in relation to text and visual representations. The interview and assessment data were subjected to content analysis using the academic literacy specifications as analytic codes. This first level of data analysis, where the data were classified according to the academic literacy test specifications, served as a meta-analysis for visual and numerical literacies in relation to text.

All institutional research and ethics protocols were followed and observed. Although the principles of modal shifts as discussed in this article apply to most higher education subjects, this study does not make claims of generalisability beyond the subjects of this study.

The data and findings are presented according to different fields of study (i.e. business administration, business management, engineering, science education and health sciences) to foreground the different literacies embedded in the various diploma programmes of study. Salient extracts pertaining to reading were extrapolated from the interview data. Below are verbatim extracts from interviews conducted with lecturers during the interview process.

Data and findings

Business administration

The content area focus and content representations for this subject were reminiscent of typical business administration courses offered at this institution. Subject content was vocationally oriented and as such, the kinds of textual-visual-numeracy features aligned closely with practices in the professional sphere of work.

The need for students to be able to analyse text in relation to visual representations and numeracy and the need to teach students visual and academic numeracy practices were noted by the business administration lecturer as follows:

...pie charts and bar graphs, are they able to extract information from a pie chart, like 50% of the income for this company goes towards...we teach them how to analyse a pie chart...you cannot assume that everyone can analyse a chart or a graph.

Many business-related subjects incorporate forms of visual literacy and numeracy to augment and illustrate textual content. For example, graphs for trend analysis or sales figures in relation to accompanying narratives are common. The excerpt above illustrates the integration of different modalities in communicating how subject content may be presented in different formats complementary to one another. However, the point to note is the lecturer's acknowledgement that reading and analysis of visual representations need to be taught since these representations carry meanings that contribute to knowledge building of subject content. In other words, specific academic literacy skills salient to each modality would need to be applied to provide access to content knowledge.

With reference to assessments for this subject, all term tests were contextual, requiring textual analysis with illustrations or calculations, including: (a) tables and graphs with data for analysis and manipulation; (b) translating data from text to visual representations and vice versa; (c) analysing illustrations and diagrams that represented a concept; and (d) calculations requiring basic numeracy skills.

An example of a question taken from a summative assessment required students to analyse the question and numerical data, then

Calculate the: (a) direct costs; (b) total cost of production; (c) total profit; (d) profit for Partner A, and Partner B. If you had to decrease the selling price by 35%, what would the new selling price be?

While this question centred on the manipulation of numbers, the question analysis included establishing meanings of terms, relating numbers to words, i.e. extrapolating the correct numbers to calculate 'direct costs' and 'total cost of production'. In addition to text and numbers, a graph was included from which numerical data were extrapolated for each calculation required. The correct answer for each sub-question was dependent on the correct sequencing of calculations, similar to planning the flow and coherence of a textual response. In other words, in order to arrive at the correct answer for each sub-question, the graph and text had to be interpreted correctly in relation to the numbers provided. On the one hand, it might be argued that the interpretation of visual and numerical representations might be similar to textual analysis in that specific procedures are followed in the process of analysis. These processes would include, for example, analysing the text or visual representation as a whole, understanding vocabulary in context, extrapolating main ideas

from supporting details, understanding the communicative cohesive devices used in each modality, and making inferences and drawing conclusions. On the other hand, it is important to note that visual representations such as graphs and charts each have a unique structure for analysis, with accompanying numbers and words having interpretations specific to each representation. As noted by Street (1997), academic literacy is not an autonomous set of skills transferable from one context or one modality to another. Reading and analysing a graph might require similar reading skills to a text, yet the structure and visual analysis are very different. This speaks to applying specific multiliteracy skills to appropriately analyse multimodal representations of subject content.

Business management

The business management subject, although text dominant, incorporated a fair share of graphic representations and numeracy which were considered by the lecturer to be

...quite critical...they would need to do calculations...draw a simple graph and then explain the trend in the graph. They first need to calculate and make sense of the numbers and then explain in their own terms using proper construction of sentences. For them to be able to explain the trend, there's a link between academic literacy and numeracy.

This excerpt reveals the interdependence of multiliteracies and the multimodal text-visual-numeracy continuum, with different modalities being complementary to the other. Although each modality has its own purpose in communicating content knowledge, they are not disparate entities but form a composite whole. For example, numerical data had to be selected from a table, appropriate calculations were required, followed by analysis and interpretation in order to 'make sense of the numbers' and 'explain the trends in the graph...using proper construction of sentences'. Textual-visual-numerical analysis is a complex iterative process. Students would firstly need to understand the content provided in each mode individually, and secondly make sense of each mode for a holistic understanding. In order to do this, several scaffolded steps would need to be applied, such as: (a) reading and analysing the text or question; (b) reading and analysing the visual representations; (c) determining which numbers to extrapolate to complete the calculations; and (d) defining the steps to be followed for the numerical equations. In order to make meaning of graphs and pie charts in relation to text, students would need to analyse texts and visual representations, align textual and visual representations, extrapolate relevant data, and complete calculations. This iterative process of analysis would necessitate reading all modalities with understanding, analysing vocabulary in context, extracting the key points of information from each modality, then applying numerical calculations and manipulations as required. The reading shifts from text to graph and text to numbers reveal the complexities of firstly analysing each modality independently, and secondly analysing the content representations in relation to one another.

Summative assessments for this subject included analyses of case studies incorporating text, manipulation of numeric formulae and flowcharts, and graphs to be drawn. The kinds of questions in the summative assessments aligned closely with the lecturer's expectations of the kinds of academic literacy shifts that students would need to negotiate in the course of study. The data showed that students in business administration and management studies were required to work beyond texts. Analytics in the form of visual representations for trends and profit analysis have become commonplace in the classroom and the workplace. Drawing on inferences from data findings, academic literacy for paragraph writing and research essays seems no longer adequate for vocational business and management courses of study.

Engineering

The major subjects in most engineering diplomas relied heavily on observation, the analysis of sketches in relation to text, graphs, tables, and numerical literacy. The vocational focus and the close alignment between workplace and classroom practices were noted by the lecturer as follows:

In terms of the workplace, they will work from data to sketch...they take the sketch and process it and reproduce it. If I send them out to do a survey, they collect data in a table or whatever and from that data they should be able to produce site layouts...they translate the information they've collected into some graphical representation.

This excerpt refers to different representations of subject content, i.e. drawings, tables, site layouts and 'some form of graphical representation'. The basis of understanding subject content was the ability to read and interpret the different modalities of visual representation in relation to numerical and textual data. Having to negotiate, interpret and understand the multiplicity of literacies simultaneously and how these different representations have a synergistic relationship in producing new meanings is often not taught overtly. According to the lecturer, students 'should be able to produce' visual, textual and numerical outputs.

The inextricable relationship between text and visual representations and the reliance on visual modalities were explained as follows:

It's one thing to read it in text. It will not make sense...if you cannot show it, if you cannot draw the instrument over there, show the line of sight over there, chances are you cannot work out the reading...or the particular height...for that point. So it's one thing to read the text, but if one can read the text, make sense of the text by producing this diagram, this will be a working diagram for going to the field to actually do the work.

Reading skills for this engineering subject required accurate interpretations of both text and drawings that would lead to new understandings in preparation for fieldwork. The ability to juxtapose textual and visual literacies and then narrate the respective interpretations and meanings were core to this subject. Furthermore, the lecturer explained that numerical manipulations would need to be 'translat[ed] to a table or a graph'. The reference to translation 'to a table or graph' engenders a sense of fluidity from text and numbers to visual representations and vice versa, i.e. shifting from one modality to another to extrapolate meanings from different modalities for different purposes.

Each modality and form of content representation for this subject, such as texts, numbers, graphs, tables, surveys, observations and drawings, had its own purpose, function and form of analysis. Yet, each modality was not a discrete entity when used next to one another. In other words, developing content knowledge for this subject was contingent on the ability to apply multiliteracy reading skills (i.e. reading skills for texts, graphs, surveys, observations, etc.) to multimodalities simultaneously. Of import here is that reading literacies were not limited to pen and paper. For this subject, students were required to conduct on-site observations and surveys of land areas where specific literacy skills for reading and analysing a site or area were apposite. The application of literacy skills such as understanding vocabulary in context, separating the main details from supporting details and applying appropriate forms of discourse analysis pertaining to analysing an area would be equally appropriate, although for a very different modality. The lecturer for this subject noted that the ability to infer whether a graph depicted 'a road or a pipeline' was especially important when data from surveys and observations were translated to graphs. Although surveys and observations are practical tasks, they are nevertheless content representations that require particular reading skills, reasoning and interpretation, drawing inferences and conclusions and using terminology to access and demonstrate content knowledge.

The kinds of questions in each of the summative assessments were closely aligned to the excerpts from the interview data. Each question in the term tests consisted of a textual scenario for analysis, with accompanying data, graphs and drawings, or students had to complete a drawing and populate a graph for further analysis and inferencing. Most questions required numerical manipulations. The emphasis on numeracy was borne out by the lecturer's claim that

[n]umeracy is a big, big deal for us. We want them to be able to work out values, distances, directions and so on, so that they can plot these maps, plot the profiles. They must be able to design. It's based on numeracy. In theory tests we give them the data and we ask them to show that they can do the deductions.

An example of navigating textual and numerical analysis taken from a summative assessment is presented below:

A trench of trapezoidal section is to be excavated to house the foundation of a dam wall. This trench is to be 50m long with side slopes of 1:1.5. The bottom of the trench is designed to be level and 1.6m wide. After taking levels at 10m stake values, along the centre line length

of the proposed trench, the natural ground levels are determined. These levels are given in Table 2 below. If the formation level of this excavation is to be constant at 78m: Use the Prismoidal rule to estimate the volume of material to be excavated. Clearly label the remaining columns that you have used.

Table 2

Stake value	Natural ground levels	Formation levels
0	79.3	
10	79.5	
20	78.9	
30	80.7	
40	79.1	
50	78.9	

The kinds of literacy skills required for this engineering subject included academic numerical literacy, i.e. interpreting numerals, equations and values to be translated to written responses, calculations and sketches. The data suggest that academic numerical literacy would be essential to understanding subject content and translating text to visual representation since numbers accrue meaning from the context in which they appear. Based on the data provided, disciplinary literacy for this subject revealed a strong tendency towards academic numerical literacy in relation to a range of textual and visual modalities.

Science education

This subject has a mainly practical focus and includes experiments, observations, illustrations and drawings of plant and human anatomy as modes of learning. The lecturer for this subject uses cartoons as part of teaching and learning in tutorials and assessments. The lecturer noted that students were required ‘to interpret the cartoon...that’s not always literal’. Cartoons are usually contextually bound and would require specific literacy skills for analysis that would incorporate analysing the text, whether metaphorical or literal, analysing the caricatures or picture in relation to the text and relating this to the register in which the cartoon was portrayed. Cartoons have several layers of meaning ‘since they typically combine the verbal and visual semiotic mode to create meaning’, and as such ‘reading cartoons is a highly complex process that requires people to draw on a whole range of different literacies’ (El Refaie and Hörschelmann 2010: 195). Cartoons are prime examples of literacy being socially situated in cultural or other practices and might include actual, non-fictional or metaphorical references embedded in cultural, religious or national symbols. In their study, El Refaie and Hörschelmann (2010: 195) found that cartoons

require a particular form of literacy [that not only] encompasses the ability to read visual grammar but also an understanding of the cartoon genre and how it is constructed, with a view to conveying particular meanings within a specific social and cultural context.

The complexities of cartoon analysis noted here begs the question as to whether students are taught these skills overtly or whether they are tacitly acquired. The implication of tacit acquisition is that a student might miss the point of the cartoon and access to learning subject content in a different way.

The literacy demands for science practicals included analysing text in relation to observations and drawings, given that textual literacy and visual literacy were to be interpreted in tandem with the other. The plurality of literacies (scientific literacy, academic literacy, visual literacy, numerical literacy) and their concomitant literacies skills for analysis would necessitate iterative shifts from one modality to the other.

The example below illustrates the different layers of analysis:

The diagrams below represent the different protein fibres that are found in the cytoskeleton of eukaryotic cells. Study the diagrams and then answer the questions that follow. Use the letters A, B and C in your answers.



Which of the protein fibres:

- is the longest?
- moves materials inside the cell?
- is stable and the most durable?
- forms cellular extensions such as pseudopodia in *Amoeba*?
- spontaneously forms filaments even in a test tube?

The underlying skills for analysis would include: (1) understanding and clarifying subject-specific terminology in the question and sub-questions; (2) analysing the question and sub-questions; (3) analysing the diagrams in relation to one another; (4) analysing the diagrams in relation to the question; (5) relating each sub-question to the diagrams; and (6) arriving at a plausible answer to each question by shifting between diagrammatic and textual analysis.

The lecturer explained that for this subject visual communication might have a greater impact on creating meaning and understanding than textual analysis. For example,

...for one type of phenomenon or event or process it's better to look at the diagram or the flowchart...will explain it better than the description because you can easily see how this Step 1, Step 2...how they follow on each other...they need to be able to read the graph... understand the variables with the independent and dependent...they need to be able to understand a table...how to read a table and fill in missing information.

This excerpt shows that visual literacy was prominent in this science education subject. Students were required to analyse and understand different visual representations on their own and in relation to a text. With reference to numerical literacy, it was reported that students would need to 'work out percentages, maybe ratios...fractions...they must be able to at least do simple mathematics'. Like academic literacy skills are used to analyse texts by identifying key words and phrases, academic numerical literacy is required of students to select particular numbers and formulae in relation to understanding vocabulary in context, i.e. extrapolate essential from non-essential numbers and information to arrive at particular answers. Numerals and numerical manipulations would only derive meaning from the context in which they were applied in relation to the accompanying textual explanations or contexts provided.

The summative term tests for this subject focused primarily on the analysis of visual literacy such as labelling and interpreting diagrams and cartoons, and on numeracy. Only the final test included a reading article as a context for questions. According to the lecturer, science education was a content area with its own 'scientific literacy' demands that relate to specific knowledge representations, 'either in the form of text or drawings, diagrams, flowcharts, graphs and tables...that's all part of scientific literacy'.

Health sciences

For health sciences, the lecturer noted that the ability to interpret visual representations such as graphs and subject-specific images to access knowledge was 'very important'. The artefacts and images were specific to the field of health sciences and had to be analysed and interpreted in the context of disciplinary terminology. The ability to read and to extrapolate the salient bits of information from the artefact had implications for understanding patients' conditions and knowing how to

respond accordingly. Reading and analysing artefacts for this qualification required a particular kind of literacy unlike any other modality encountered above, thereby foregrounding the distinctiveness of multimodalities and multiliteracies in disciplinary and content-area literacy. In addition to reading and analysing artefacts and images, the lecturer required students to *'be able to read from a graph and write words about what is going on in that graph'*. This subject represented different literacies where the analysis and understanding of one type of literacy (e.g. a text, table, graph or image) was interdependent on others. By way of explanation, data on a graph might draw on information from an image, both which might need to be translated into text to explain 'what is going on in that graph'.

Numerical literacy was considered to be

...the basis of the subject – they need numerical skills, because they need to work out deciles and the exposure factor...they need to use fractions and percentages.

Numeracy was especially evident in assessments. A review of the term tests revealed short scenario-type questions requiring written responses, diagrammatic representations or numerical manipulations. The assignments included the analysis of a combination of visual representations and essay writing.

Test questions included brief scenarios to set a simple context as noted below:

An object with a height of 30mm is placed 70mm from a biconcave lens. The focal length of the lens is 35mm. Determine the magnification formula.

The test questions might appear brief, but in order to respond appropriately students needed to understand the use of the terminology in context, analyse sentence structure, select relevant information (words, numbers, graphics) in order to gain an understanding of what the question actually required. This illustrates a typical procedural-type question where the answers may only be arrived at by following specific reading procedures. Reading shifts from artefact to graph and numerical interpretations, and from visual and numerical modalities to text were commonplace for this subject, which was primarily practice-oriented in a medical facility. The teaching and learning settings and locations for this subject and each of the subject discussions above (i.e. on-site surveys, classroom and external experiments, observations and field work) contributed significantly to the

Table 1: Examples of multimodal domains in selected subjects

Visual and non-literal representations	Engineering	Business and management	Science education	Health sciences
Examples of visual representations	Graphs Drawings Tables Pie charts Maps	Illustrations, e.g. Pie charts; Bar graphs; Tables;	Illustrations, i.e. drawings of human and plant anatomy; Cartoons	Illustrations. i.e. drawings of human anatomy; Graphs; Tables
Numeracy	Formulae Calculations Ratios Percentages	Formulae Calculations, Ratios Percentages	Formulae Calculations Ratios Percentages	Formulae Calculations Ratios Percentages
Observation practicals	Observation Site surveys Site drawings Field work	Not applicable	Observation Experiments Field work	Observation Field work
Artefacts specific to a field of study	Reading data from site survey equipment	Not applicable	Not applicable	Analysis of subject-specific artefacts images derived from artefacts

multiliteracies and multimodalities with which students needed to contend during their courses of study.

Discussion

The examples of visual and non-literal content representations relate to discipline-specific and content-specific areas of study. The data and findings illustrate the modalities prevalent in different diploma subjects, requiring different literacies for engagement.

The examples provided in Table 1 are not exhaustive as they do not include other common forms of content representations, such as using PowerPoint for oral presentations, designing posters or developing flowcharts to elucidate explanations. These non-literal modalities were used in all subjects and provide a broader scope of the range of literacy engagement required for each subject. As noted earlier in this article, given the range of modalities, the question of what it means to be academically literate will assume different meanings depending on the discipline and field of study. To this end, Jewitt (2008b: 362) maintains that there is a 'need to rethink what it means to learn and to be literate [which] is a thread that runs through multimodal educational research'. Jewitt (2008b) questions, for example, how different content representations impact thinking, reasoning and learning, in this case, within a higher education vocational context. What this study shows, however, is that academic literacy is situated and complex, and that academic literacy skills are not transferable from one content area and one modality to another (Lea and Street 1998).

All five subjects noted here incorporated different modalities of visual literacies in relation to text. While modalities across subjects might be similar, i.e. illustrations, graphs, tables, these modalities are applied in the context of content representations in each subject of study. The point to note here is that although drawings, graphs, tables and experiments might be common, they are not generic across subjects given their content area specificities. What could well be similar are the academic literacies' engagement in reading and analysing visual modalities. Reading and analysing graphs and tables would have similar procedural practices for discourse analysis as would a text or an artefact. For example, skimming and scanning, intensive reading, separating essential from non-essential information, extracting salient bits of information, drawing conclusions and making inferences would be applicable to textual, visual and numerical content representations. However, it is the modality that determines the approach and method of reading and analysis and how one mode relates to the other. Irrespective of 'whether the particular literacy is in the visual, media or print domain', the different modes resemble a 'complex mix', requiring an analysis of cultural and contextual features to make sense of how each modality contributes to meaning (Street 1997: 49–50). The 'choice of mode', therefore, is complementary to the other such that each mode presents a particular affordance for learning, and 'is central to the epistemological shaping of knowledge' (Jewitt 2008a: 246). An inability to apply the requisite academic literacy skills to a specific modality might have dire consequences to accessing content knowledge. Hence the call for disciplinary academic literacies to be taught in order to equip students with the skills to read, analyse, understand and assimilate content knowledge from content representations particular to the subject of study. Teaching students generic academic literacy skills (whatever this would imply) would fall far short of this ideal. Often in the first year of the same qualification, different subjects have different content representation modalities, implying that different modal shifts are applicable in different subjects. Given the range of modalities and the different skills required to analyse each modality, the question as to whether students are adequately prepared to engage with modal shifts remains key. Non-literal content representations do not feature independently, but are relational to other literacies and require an understanding of the kinds of genre shifts salient to the textual-visual-numeracy continuum of content knowledge.

Concluding thoughts

Academic literacy as the gateway to epistemological access and to knowledge acquisition requires 'deploy[ing] a repertoire of linguistic practices appropriate to each setting' or learning environment (Lea and Street 1998: 159). The central thesis presented in this article relates to the range of academic literacies to be 'deployed' (Lea and Street 1998: 159) for textual-visual-numerical reading and analysis to access meaning. The modal shifts required suggest fluidity and iterative movement

since the different modalities are not entities in themselves. The mainstream understanding of multimodality is that modes are integrative and present a combination of meanings. Where modes are transformed from one to the other, such as from text to a chart or graph, new meanings and insights might be derived. The point to note here is that each form of content representation or modality requires distinctive analytic skill sets, with a combination of analysis to arrive at a composite meaning of the relationship between two or more modes used in tandem. The caveat presented here is that if students are not taught to master these analytical skill sets, they might be denied 'epistemological access' (Morrow 2007) and affordances to learning the knowledge systems and structures of disciplinary content representations.

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