Volume 1

Disciplinary Literacy

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Foreword

It is a great honour for me to be able to write this Foreword to a first full volume of the ELIS Research Digest. It is published for the ELIS Conference 2015 which in turn is a part of ELIS’s celebration of SG50 - 50 years of Singapore independence.

The publication is also aligned with the theme of the ELIS Conference 2015 that emphasizes the role of English in schools since independence. The conference celebrates 50 years of English in Singapore schools and provides an opportunity for teachers and researchers in Singapore and beyond, as well as ELIS staff, to look back and celebrate a wide range of achievements in English Language Education while at the same time preparing for the future from what is an already very strong foundation.

This volume brings together six separate issues all devoted to the important topic of Disciplinary or Subject literacy, that is, how English is used across the whole school curriculum. Disciplinary Literacy is a key component in the ELIS programme and of its continuing mission and this volume underlines its importance for the current and future development of the highest levels of English in Singapore schools.

The ELIS team who have compiled the issues in the volume over the past year have undertaken to provide a key link between published international research in disciplinary literacy and the needs of educators at all levels. The volume is compiled on the founding principle of ELIS that building effective communication skills within each subject area is central to the highest achievements in language use. The volumes cover research into many different aspects of classroom writing, reading and talk in all aspects of the curriculum.

The intended audience for this volume is the research, academic and teaching community, as well as key policy makers within the Singapore Education system, to help them understand these issues better, and hopefully, to encourage researchers in Singapore particularly, to look further into key areas of national relevance. This volume is a model of how to do this. Throughout it is lucidly written and presented without in any way oversimplifying complex issues of language use and classroom pedagogy. The issues are always helpfully formulated in such a way as to allow teachers to make their own decisions for their students and in some cases to foster and support teachers undertaking action research in their own classrooms. The digest also runs in parallel with a further wide range of Research Summaries on the ELIS website.

Everyone in education would like to read material on areas that would help them in their own teaching and in their students’ learning. However, finding the material and then reading long texts that may not be directly relevant can be time-consuming. This very helpful repository of Research Summaries fulfils this purpose in a very supportive and professional manner.

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Disciplinary Literacy: A Study of the Literature

Summary

Disciplinary literacy is a growing area of interest as educationists see the need for students to not only have generic literacy skills (the ability to read and write) but to also have the language skills they need in order to fully understand and work with the different types of texts, whether spoken or written, that are typical in the subject areas they study. The suggestion is that different disciplines (or subject areas) have thinking and language practices that are specific to them and that students are likely to be held back from a full understanding of the content of such disciplines to the extent that they do not master the related language and thinking practices.

What constitutes disciplinary literacy varies from writer to writer. All see reading and writing as essential components but some also emphasize such areas as appropriate thinking skills and related oral skills. For example, for historians (and therefore, it is suggested, for students of history) a text can be analysed in terms of who the writer was and how the writer’s historical position may have affected the content. On the other hand, for a scientist, the writer of a text is largely irrelevant. What is important is the logic of the content. Thus, it is suggested that the thinking skills demanded by the two disciplines are different.

As this field is relatively new, the available literature generally focuses on the theoretical aspects and there is very little reported experimental research that supports this approach to teaching in the disciplines. There is a need to work with researchers, discipline experts, teaching practitioners and even students to establish what the special language requirements of specific subject areas are and how they are the same or different from non-specialist language. Once that work is done, it will be easier to outline the specific needs of the disciplines.

Introduction

The focus of this Digest is disciplinary literacy. This term relates to students and the content subjects they take such as Mathematics, the Sciences, the Social Sciences and the Arts. There are a number of related concepts and terminology to disciplinary literacy. For example, Moje (2008, p. 97) suggests that the following terms are used interchangeably depending on the writer – secondary school literacy, subject area literacy, subject-matter literacy, content area literacy and disciplinary literacy. In this review, we will touch on some of these terms but will focus on defining and evaluating the concept of disciplinary literacy.

The interest in disciplinary literacy first grew in the USA as a result of the perceived difficulty of raising or even maintaining the literacy levels of students in subject areas. For example, Bennett (2011, p. 51) notes that America is in ‘an adolescent civic literacy
crisis’ where performance levels in Social Studies subjects are extremely low and students are bored with Social Studies. She suggests that a way out of this crisis is through a focus on disciplinary literacy. Altieri (2011, p. 5) points out that our view of literacy has changed. We now expect students to deal with a much greater amount and variety of texts as the development of information technology makes more and more available. They need to learn how to approach texts in the different disciplines.

These concerns are not peculiar to the USA. A. Wilson, Jesson, Rosedale, and Cockle (2012, p. 1) point out the New Zealand Curriculum makes it the responsibility of every subject-area teacher to meet the needs of students in developing the literacy and language skills required in their subject area.

It is worth noting that there are other approaches to literacy in school subjects including approaches based on a systemic functional linguistic (SFL) framework. Examples of the latter are Christie and Derewianka (2010), and Fang and Schleppegrell (2010). This is another major area of study to be looked at in a future Digest and so has not generally been included because of space limitations although Fang and Schleppegrell (2010) is discussed here as their article also relates disciplinary literacy to an approach based on the SFL framework.

**Disciplinary literacy in the literature**

What then is ‘disciplinary literacy’? McConachie (2010, pp. 15-16) reports that the term ‘disciplinary literacy’ was first coined in 2002 by the Institute of Learning at the Learning Research and Development Center of the University of Pittsburgh. She points out that their use of ‘literacy’ was unusual as it was not restricted to its usual meaning of ‘reading and writing’ but also included content knowledge, thinking, speaking, etc. She offers the following definition:

**Disciplinary literacy involves the use of reading, reasoning, investigating, speaking, and writing required to learn and form complex content knowledge appropriate to a particular discipline (p. 16).**

Moje (2007, p. 13) reviews four different approaches to disciplinary literacy that she found in the literature.

1. **Teaching cognitive literacy processes**

This approach is built on the assumption that ‘learning to read (and write)’ should develop into ‘reading (and writing) to learn’. However, according to Moje (2007, p. 14), the cognitive literacy strategies taught in this approach focus more on further developing the reading skills of the students (i.e. on the first stage of ‘learning to read’), albeit in the context of content subjects. Despite this, she notes that research that has been carried out shows that these strategies appear to have had some success in developing student ability to read content subject texts.

2. **Teaching epistemological processes of the disciplines**

This approach suggests that the knowledge processes used in a particular subject or discipline along with the type of text produced can be taught to students so they
can more readily access the material of that subject or discipline. Students’ learning of the thinking methods of the discipline is seen as important. The approach has been most commonly used in History learning where there has been some criticism of textbooks that present History as a fixed set of indisputable facts when expert historians interpret artefacts that are sometimes contradictory. Moje (2007, p. 22) then reviews Science classes where the thinking methods are quite different from those of History. She notes that, beyond looking at such aspects as specialist terms, temporal cues and subtexts, this approach lays more emphasis on modes of thinking than on the language of the disciplines.

3. Teaching linguistic processes of the disciplines

This approach involves teachers guiding students through the process of deconstructing texts (highlighting the grammatical and lexical features of the texts), jointly constructing new texts using the features found and, finally, getting students to independently construct their own texts. In this way, students are helped to familiarize themselves with the texts in a particular subject area.

Moje (2007, p. 26) suggests, however, that the approach is currently missing out on an important opportunity by focusing only on academic texts. She points out that, in their free time, young people do read texts that may have very similar language features to those of academic texts and these texts could be used to bridge the gap between everyday language and school language.

4. Teaching linguistic and discursive navigation across cultural boundaries

The fourth approach seeks to get students to learn that the different styles of communication that they meet are cultural in nature and are negotiated by the communities that use them. Thus, academic discourse of whatever type is not immutable but can vary by situation and over time. The approach starts with the students’ own knowledge of texts, text practices, and interests and then moves on to teaching disciplinary text processes. The teaching emphasizes the purposes, norms and conventions for making knowledge in the disciplines. The focus of the approach is on showing the links between everyday communication and subject specific communication. Moje (2007, p. 32) notes that this approach tends to focus on everyday language and has thus left the definition of academic language rather vague. Much of the work in this approach has been done in the language arts and social studies areas with much less done in the sciences.

Moje (2007, p. 34) suggests that it might be possible to productively combine these four approaches to disciplinary literacy so that prior and expert knowledge, the linguistic and rhetorical styles of disciplinary experts, the technical vocabulary of texts, and motivation and interest could all be considered together.

In a subsequent article, Moje (2008, p. 98) advises that it would be best to set up disciplinary literacy programmes rather than get content teachers involved in teaching literacy practices and strategies, i.e. she emphasizes the second of the four approaches listed above.
Shanahan and Shanahan (2008) consider disciplinary literacy to be ‘(l)iteracy skills specialized to History, Science, Mathematics, Literature, or other subject matter’ (p. 44). They (p. 43) suggest that early strong reading skills do not necessarily translate into an ability to deal with the special language requirements met in subject classrooms and, as students rise through the school, they need ever increasing specialized literacy skills. They propose three levels of literacy: basic literacy, intermediate literacy and disciplinary literacy (Shanahan and Shanahan, 2008, p. 44). As the child moves up the levels and their literacy skills become more and more specialized by subject area, these skills may not always be transferable across subjects.

Here are the definitions of each level that they give:

- **Basic Literacy**: Literacy skills such as decoding and knowledge of high-frequency words that underlie virtually all reading tasks.
- **Intermediate Literacy**: Literacy skills common to many tasks, including generic comprehension strategies, common word meanings, and basic fluency.
- **Disciplinary Literacy**: Literacy skills specialized to History, Science, Mathematics, Literature, or other subject matter.

The focus for Shanahan and Shanahan is very much on reading. In fact, they do not mention oral skills at all.

Fang and Schleppegrell (2010) argue for an approach to disciplinary literacies based on Systemic Functional Linguistics (SFL) which they call ‘Functional Language Analysis’. (This fits in with the third category in Moje (2007)’s list above.) They suggest that students can be helped to analyse selected short texts according to the experiential, textual and interpersonal meanings embedded in the text. They will then learn the preferred language functions used in that discipline and be better able to apply the same principles to other texts. Their approach does not exclude spoken text but the examples they give are all from written text.

Altieri (2011, p. 6) emphasizes a slightly different interpretation of literacy, one that is similar to that mentioned by McConachie (2010) cited earlier. In the same way, she suggests that previously the concept of literacy focused only on reading and writing but points out that in the 21st century:

*Literacy is a complex, multifaceted concept that changes as society changes. Students must not only be able to read and demonstrate understanding but also be able to view and comprehend a wide range of texts and make intertextual connections. Students also must be able to share knowledge through written and oral communication and through visually representing information (p. 6).*

Thus, she emphasizes the need to develop student oral skills as well as written skills.

Bennett (2011) defines disciplinary literacy as an approach that involves ‘the use of reading, investigating, analysing, critiquing, writing, and reasoning required to learn and form complex knowledge’ (p. 52). She goes on to say that disciplinary literacy is an approach
that combines content with discipline-appropriate habits of thinking. The belief is that knowledge and thinking must go together in order to develop the deep conceptual knowledge needed to do well in the various disciplines.

Buehl (2011, p. 15) offers an adaption of the model from Shanahan and Shanahan (2008). The third level, the disciplinary level, is now broken up into a set of different arrows thus emphasizing that the skills at this level are more specific to each subject discipline. The length of an arrow indicates the competence of an individual in that particular subject (discipline) area. Thus, for example, a reader could be fairly comfortable with Literary Fiction but less so with History and be weakest in Maths, and the Biological and Physical Sciences.

Dehm Bamford (2011) considers disciplinary literacy to be ‘the practice of teaching students how to use reading, writing, and other literacies, in order to learn and form complex content knowledge’ (p. 1). She draws a contrast between content area literacy and disciplinary literacy by pointing out that the former focuses on teaching generic literacy skills that can be used across the disciplines or subject areas while the latter sees each discipline as a discourse community with its own specialized language and approaches (p. 8). These must be navigated by any learner and thus literacy forms an important part of any study of the subjects in question and is not an add-on. It thus involves, she suggests (p. 13), the reading, reasoning, investigating, speaking and writing skills needed to learn the knowledge and concepts of the subject area.

A. A. Wilson (2011, p. 435) feels that a generic approach to literacy does not take into sufficient account the discipline-specific features of texts. In her article on content area literacy, she seems to use that term in a sense that is very similar to that for which others use disciplinary literacy, emphasizing as she does the need to focus on discipline-specific characteristics. She (p. 441) highlights that these discipline-specific characteristics are not immutable but may change in response to changed societal needs. She thus argues that it is important that these characteristics are not taught as rules. Students should learn the purposes and uses of the different types of text and how these may vary across the disciplines. The approach she suggests would include learning the use of multimodal representations and seeing how different modes for expressing meaning (texts, graphs, etc.) may be good for certain purposes but not for others.

Colwell (2012, p. 2) states that behind the concept of disciplinary literacy is the assumption that, within any discipline, there are specific beliefs and processes associated with the reading and understanding of texts in that discipline. By teaching students those beliefs and processes, we help students build up competence in the discipline.

In her paper on adolescent literacy, Goldman (2012, p. 90) suggests that 21st-century literacy makes extra demands on readers in four ways. First, readers have to go beyond what the text says; they must also consider its meaning by synthesizing and evaluating the content. Second, they must be able to
apply those skills differently depending on the subject. Third, advances in technology mean that there are vast amounts of information which readers must evaluate and select from. Fourth, readers must learn to connect what they learn in one context to topics in other areas. In summary, readers must select, interpret and synthesize what they learn from reading. She says that content teachers have a dual responsibility to teach disciplinary content and disciplinary literacy (p. 93).

In their paper, Shanahan and Shanahan (2012) contrast content area literacy with disciplinary literacy, two different constructs which they felt had been confused in the literature. They believe that content area literacy focuses on teaching generic reading skills that can be used across all subject areas by students. Such coaching tends to help only weak students. However, disciplinary literacy focuses on discovering the reading approaches used by subject experts and then teaching these to students. The advantage of this approach, they feel, is that it is likely to help student at all ability levels and is more acceptable to content teachers as it relates more directly to their subjects.

Billman and Pearson (2013) suggest disciplinary literacy is about ‘how to do reading, writing, talking, and thinking in school subjects’ (p. 25). They argue strongly that the practice of disciplinary literacy should start as soon as students enter school (or, preferably, before) as they arrive at school already using language to learn and talk about the world (p. 26). They argue against setting literacy as a goal. Instead, it is a set of tools to be used in the learning process (p. 27).

Fang and Coatoam (2013, pp. 627-628) distinguish between disciplinary literacy and content area literacy. For them, the supporters of content area literacy believe that the reading/writing requirements are largely the same across subjects and thus expect students to use fairly generic skills and strategies in learning subject content. As opposed to that, disciplinary literacy focuses on developing a student’s ability to utilize the skills used by content experts and these vary from subject to subject. They go on to suggest that disciplinary literacy is grounded in the belief that each subject has its own ways of presenting content and that these are best learnt as part of the subject. Importantly, they believe that ‘being literate in a discipline means understanding of both disciplinary content and disciplinary habits of mind (i.e. ways of reading, writing, viewing, speaking, thinking, reasoning and critiquing)” (p. 628). Thus, their view of disciplinary literacy covers a broad range of skills, including not just reading and writing but also speaking and thinking among others.

Roberts (2013, p. 20) argues for an approach similar to that of Buehl (2011), i.e. that at the disciplinary literacy level there is a multiplicity of specialist literacies. His own specialization is History and he argues that History as a discipline requires an understanding of the past, a critical view, and the ability to communicate effectively areas of understanding and knowledge not required in other subjects.

One common feature to all the explanations of disciplinary literacy discussed above is the belief that different disciplines or subjects demand different literacy skills and students need to learn these skills in order to master the respective disciplines. However, there are
differences in which particular skills are emphasized. As noted by McConachie (2010, p. 16), the word ‘literacy’ has traditionally connoted ‘reading and writing’ and all the explanations include some reference to reading and writing. Shanahan and Shanahan (2008) and Buehl (2011) focus on these two areas. Bennett (2011), Colwell (2012), Goldman (2012) and Roberts (2013) add thinking like the specialists to the mix. In tune with what McConachie (2010, p. 16) describes as the original intent of the creators of the term, Altieri (2011), Dehm Bamford (2011), Billman and Pearson (2013), and Fang and Coatoam (2013) all include speaking as well. Finally, Moje (2008, p. 99) even suggests that a student who has learnt well in the discipline may need to communicate through oral language, visual images, music and artistic representations and not just through reading and writing.

One other area that A. A. Wilson (2011, p. 441) adds to this mix is the suggestion that students should learn that the disciplinary practices have been developed by the experts to serve purposes that may change over time and circumstances. These are not rules that cannot be changed given the appropriate circumstances.

The models from Shanahan and Shanahan (2008) and Buehl (2011) discussed above suggest that at the primary school level students and teachers need to focus on the basic or intermediate levels of literacy in all areas of study and that it is at the secondary (or tertiary) level that communication becomes more differentiated between subjects (or disciplines). This is in part confirmed by Moje (2007), who, in explaining the focus of her article, suggests that disciplinary literacy becomes more clearly differentiated at secondary and postsecondary levels (p. 3). Fang and Coatoam (2013, p. 628) also discuss this issue and come to the conclusion that, while disciplinary literacy is certainly more clearly differentiated at secondary and tertiary levels of education, instruction in disciplinary literacy can start as early as in upper primary. In fact, Juul, Hebard, Park Haubner, and Moran (2010) propose activities for use with children as young as eight years, using different ‘disciplinary lenses’ to question texts, that is asking the questions and making responses appropriate to different disciplines such as science and history.

Teaching disciplinary literacy

A number of writers have reported that introducing the notion of literacy skills into the subject area classrooms has not been easy. Terms such as ‘content area literacy’ and ‘disciplinary literacy’ have been problematic with teachers in the schools. Colwell (2012) found that the subject teacher she worked with was not happy with a focus on ‘literacy’ and only cooperated with the research when she felt that the approach being suggested was the same as ‘critical thinking’. Colwell (2012, p. 27) goes on to suggest that the pre-service training of secondary school teachers could actually be an impediment to their willingness to take up disciplinary literacy. She feels that the focus for such teachers on developing content knowledge might lead them to believe that literacy was not an important consideration in the content class. Moreover, she quotes evidence that some pre-service teachers had chosen to teach content subjects in order to avoid having to deal with students’ reading and writing skills. She thus believes it important to prepare pre-service teachers to
be ready to focus on areas of literacy.

McConachie and Petrosky (2010a), Moje (2008) and Shanahan and Shanahan (2008) have all highlighted the difficulty of getting teachers of subject areas other than language to take on board the idea that they may be responsible for the communication and literacy skills of students in their subject areas. Many feel that this is the sole purview of the language teachers. Even those content teachers who believe in the importance of helping students read and write in their discipline may feel ill-equipped to help them (A. A. Wilson, 2011, p. 435).

Goldman (2012, p. 94) suggests that one reason for the poor teaching of ‘reading-to-learn’ subject matter is that it involves a lot of factors that can vary independently (different strategies, different texts, different goals, ensuring interaction with peers, etc.). Working with all these factors together can be a difficult task. These problems are very much an issue in approaches to disciplinary literacy. Moje (2008, p. 104) also talks of the complex ‘repair work’ that teachers may be involved in helping students learn the subject matter. She also wonders how well the teachers themselves are prepared in the thinking of the disciplines they are trying to teach.

According to McConachie (2010, p. 21), for teachers to teach and guide the students towards disciplinary literacy, they themselves must be familiar with the structure and organization of knowledge common to the subject they are teaching. They need, she says, to have the content knowledge and the habits of thinking associated with the subject (discipline) as well as the teaching techniques and practices needed to support the students’ learning. She goes on to suggest that the classroom should become an apprenticeship into the discipline (p. 22), i.e. teachers must demonstrate the accepted approaches to the subject area and then get students to use these approaches while the teacher scaffolds their learning. In order for this to happen, the students must solve given problems and the teacher’s job then becomes the presentation of problems that are sufficiently challenging but not beyond the capabilities of the students. To maximize student use of the appropriate language and strategies, the students can be organized into groups so that their processing can be monitored by the teacher. The questions the students are asked can be on the subject content or on the ways of working (or habits of mind) related to the subject. Nagy and Townsend (2012, p. 96) point out that the learning in subject areas is not simply about getting students to learn lists of vocabulary. To really learn the subject and the related vocabulary and concepts, students need to have constant and repeated exposure to their use.

McConachie (2010, pp. 30-31) goes on to elaborate five interdependent principles for implementing disciplinary literacy:

**Principle 1: Knowledge and thinking must go hand in hand.** The suggestion is that learning knowledge without understanding is short-term. Students soon forget the decontextualized facts they have learnt once the exams are over. Similarly, thinking without the requisite knowledge is futile. Thus students need to learn the two together.

**Principle 2: Learning is apprenticeship.** The activities in the classroom apprentice
students into the disciplines (subject areas) they are learning. For the apprenticeship to succeed, the students must carry out activities related to the discipline and come to understand the habits of thinking of the discipline that direct the reading, talking and writing they do. They need to be able to articulate what activities help to communicate the disciplinary ideas and why.

**Principle 3: Teachers as mentors of apprentices.** Teachers provide an array of approaches that help initiate students into the thinking and approaches of the discipline, scaffolding their development appropriately.

**Principle 4: Classroom culture socialises intelligence.** This principle emphasizes that the classroom culture should encourage students to believe that they have something to contribute to the learning process and that they can ask questions, discuss and evaluate the content they are learning so that they become more competent in the discipline.

**Principle 5: Instruction and assessment drive each other.** Different forms of formal and informal assessment procedures are used to feed into the apprenticeship so that students can see how they are developing in the discipline. The assessment matches the instruction, replicating many of the activities that are appropriate to the discipline. The assessment results feed into the instruction for both teacher and students.

McConachie and Apodaca (2010, pp. 190-191) give a list of features of a student apprenticeship (which they suggest can also be used in training ‘apprentice’ teachers in disciplinary literacy approaches). The five features are:

1. modelling and observation (where the activity is modelled and the students ask questions and comment);
2. active practice (where students take over the activity in a controlled environment);
3. scaffolding (where learners can be helped to complete a task by their teachers or more competent peers but where the help is reduced over time);
4. coaching (where the teacher or more competent peers observe and challenge the students at work); and
5. guided reflection (where students reflect on what they have done, evaluating and considering ways for improvement).

McConachie and Petrosky (2010b) give a table in Appendix A of their book (pp. 197-214) that gives a framework showing how these principles would work in practice for students and teachers in four core subject areas – History/Social Studies, Mathematics, Science and English Language Arts.

Murnane, Sawhill, and Snow (2012, pp. 9-10) also offer some suggestions for post-primary teachers although their ideas are exclusively related to reading. The suggestions include developing a reason for reading, showing how to read actively, teaching reading strategies, studying different subject-related genres and pre-teaching important vocabulary.

**Assessing disciplinary literacy**

Inevitably, once disciplinary literacy is defined, the question becomes how we recognize when a student has developed such literacy. McConachie (2010, p. 21) suggests that students must show they have
learnt the core ideas and concepts as well as the ‘habits of thinking’ of the subject area or discipline in order to be said to be disciplinary literate. Murnane et al. (2012, p. 3) note that advanced literacy is not just a matter of decoding a text. It involves using that skill to access knowledge, to evaluate argumentation, to synthesize and to learn new topics.

Fang and Coatoam (2013, p. 630) believe students’ disciplinary literacy can be assessed by giving authentic tasks that allow them to demonstrate control over the reading, writing, thinking, reasoning and enquiring skills that are required by the particular subject area. They suggest this would call for subject teachers and literacy teachers working together to devise such tasks along with the scoring criteria particular to those tasks and subject areas.

**What the evidence tells us**

Unfortunately, approaches that incorporate disciplinary literacy are relatively new and much that has been written has been theoretical rather than based on experimental studies. Moje (2007, p. 35) notes that much of the writing on disciplinary literacy is theoretical and that very few classroom trials have demonstrated student learning gains in any standard way, with a number of studies failing to provide sufficient details of the actual research for the research to be replicated. This is confirmed by Goldman (2012, p. 90) who notes that little has been done experimentally for the emerging field of disciplinary literacy. Most of the work is descriptive rather than experimental. However, she emphasizes that, despite this, the work that has been done is instructive. Colwell (2012, p. 5) similarly claims that little has been done to turn the theory of disciplinary literacy into workable classroom practice that accomplishes the intended goals while appealing to both teachers and students. Shanahan and Shanahan (2012, p. 14) point out that the empirical roots of disciplinary literacy is not focused on teaching specifically and that there has been little research on the effectiveness of disciplinary literacy in the classroom. The results of the research that has been done have been mixed. Fang and Coatoam (2013, p. 629) also suggest that so far the work in the area has been largely theoretical with a focus either on making a case for the approach or on highlighting the language differences between subject areas. They claim that empirical studies have been limited in number with very few meeting the evidence standards of the *What Works Clearing House*.

A. Wilson et al. (2012) carried out a study to see how far the disciplinary literacy practices recommended in the New Zealand Curriculum appeared in actual classrooms. They chose to observe twelve classes in five of the best performing schools given by teachers chosen by their schools on the basis that they were the top performers. The researchers chose this approach because of the belief that they were more likely to see the target practices in this type of class. They found there was little evidence of disciplinary literacy practices even in these classes. They suggested that one possible interpretation was that disciplinary literacy was not related to student ability in a subject. However, they felt it was also quite possible that these effective teachers, recognizing the difficulty students had with disciplinary texts, were reinterpreting the texts for the students thus helping them learn the content and perform reasonably well. They felt, however,
that this was likely to leave the students without the thinking and language skills appropriate to the subjects, thus disadvantaging the students in the longer term.

One source of research evidence that may well be seen as support for the principles of disciplinary literacy as defined by writers such as McConachie (2010) could come from research into the brain. Bransford, Brown, and Cocking (2000), and Donovan and Bransford (2005, pp. 1-2) report that three principles have now been well established in brain research:

1. **Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.**

2. **To develop competence in an area of inquiry, students must:**
   i. have a deep foundation of factual knowledge,
   ii. understand facts and ideas in the context of a conceptual framework, and
   iii. organize knowledge in ways that facilitate retrieval and application.

3. **A ‘metacognitive’ approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.**

   Learning must start from what the learners know (or think they know) so it must be learner-centred. It must be based on the knowledge that has to be mastered. That is, it must be knowledge-centred. The learning must also be assessed so that the next steps in learning can be decided on. In other words, it must be assessment-centred. Finally, it must be community-based as the learners learn from each other and from the environment they live in. The teacher is not the only source of learning.

These principles underscore the need for students to communicate. If they do not talk or write, their misunderstandings will not come to light and they will not have the opportunity to be corrected. A simple example given is the notion that the Earth is round. According to the writers, many students have difficulty imagining the Earth as a sphere as it would mean that objects at the ‘bottom’ of the sphere would fall off. They thus tend to redefine the teacher’s use of ‘round’ as ‘like a pancake’. If students are not helped to correct this false image of the Earth, their understanding of and ability to incorporate certain facts will be seriously impeded. When helped to develop the appropriate concepts, students are better able to remember facts that fit in with the concepts. Moreover, by getting students to talk about and monitor their own learning, teachers help students take over their own learning.

Bransford et al. (2000, p. 134) and Donovan and Bransford (2005, p. 13) expand the three principles gleaned in brain studies into a four-item framework which, they believe, is consonant with the three principles. According to this framework, learning must start from what the learners know (or think they know) so it must be learner-centred. It must be based on the knowledge that has to be mastered. That is, it must be knowledge-centred. The learning must also be assessed so that the next steps in learning can be decided on. In other words, it must be assessment-centred. Finally, it must be community-based as the learners learn from
each other and from the environment they live in. The teacher is not the only source of learning.

**Moving Forward**

Moje (2007) suggests that much more detailed research needs to be done to demonstrate the benefits of disciplinary literacy if it is to gain traction. Moreover, she suggests, a lot more work needs to be done to clarify what language is used to what audiences and why. This will involve working with experts in the disciplines, with teachers in the school subjects, with teacher educators and even with the school learners themselves (p. 36). At the same time, she advises that a parallel study into the everyday language of the young people who form the target group should be undertaken. This would allow for an understanding of the differences and similarities not only in the language but the cultural reasons for those, an understanding that would inform classroom practice.

In a similar vein, Shanahan and Shanahan (2008, p. 57) note that their work has shown the benefits of getting disciplinary experts, literacy experts, high school teachers, and teacher educators working together to work on the training needs of pre-service secondary teachers. Instead of trying to persuade teachers of content subjects to adopt in their subjects approaches to reading developed by reading experts, they worked together with the experts from a variety of areas such as discipline experts and this helped focus attention on the literacy skills relevant to the particular subject areas.

There are a large number of potential subject areas that could be studied but the writers reviewed here have generally worked with a few groupings. The most common number of groupings seems to be four with McConachie and Petrosky (2010b), Shanahan and Shanahan (2008), A. A. Wilson (2011) and others generally using the groups History, Social Studies, Science, Mathematics, and Literature/Language Arts.

As mentioned earlier, Goldman (2012, p. 106) suggests that one of the difficulties in introducing disciplinary literacy is that the content teachers themselves have not been exposed to ‘doing History’, ‘doing Maths’, etc. As they do not have the experience themselves, they have difficulty passing on the necessary skills to their students. They need to engage their students through classroom discussions that show them the literacy and thinking skills necessary for ‘doing’ the subject they are teaching. Reading and writing, as well as speaking, can then be seen as tools in learning the subject. She sees preparing teachers for this as a long-term project involving not only demonstrations of how it can be done but also the formation of learning communities among the teachers.

Dehm Bamford (2011, p. 3) mentions the belief that student teachers who have taken courses in content literacy during their pre-service training may not be implementing the skills learned when they enter their schools. This could be because of time constraints in the syllabus, a lack of understanding of the importance of such literacy by the teachers and a simple resistance to seeing literacy as part of the content of their subject area.
43). Until teachers accept that preparing students for life beyond school involves preparing them to think and communicate effectively in every area of the curriculum, the problem is likely to continue.

References


Murnane, R., Sawhill, I., & Snow, C. (2012). Literacy
Towards Disciplinary Reading

Summary

Increasing attention is focused on reading in the content areas in the upper primary and secondary grades. This is because reading helps students in learning content in various disciplines. The development of vocabulary, in particular, is closely linked to the acquisition of concepts as knowledge is represented by words which make up the schemas that readers use as background knowledge required for comprehension. In addition to developing the vocabulary knowledge of students, there is a need for content subject teachers to teach explicit discipline-specific reading comprehension strategies to their students so that students can read like a scientist or historian.

To help pre-service and in-service teachers adopt discipline-specific reading strategies in the classroom, teacher educators can design courses that focus on discipline-specific literacy instruction that goes beyond directed study skills and textbook-based reading skills for upper primary and secondary teachers. For lower primary teachers, more professional development on vocabulary instruction will help them adopt a more deliberate and systematic instructional approach to developing their students’ vocabulary and comprehension. Leaders in education can plan for these reforms in reading instruction by having a long-term orientation towards reading instruction so that students are capable of reading across disciplines at the end of their school years.

Introduction

There is an urgent need to address literacy skills which are associated with twenty-first century demands given the current economic climate (Murnane, Sawhill, & Snow, 2012). There has been a growing awareness that reading ability affects achievement in school and post-school life. Increasingly, assessments based on more authentic and challenging tasks are designed to tap the higher level literacy skills that are directly relevant to academic success and to contemporary workplace demands.

Higher-level skills refer to the ability to learn from texts which are more complex at the word, sentence, and structural levels, which present greater conceptual challenges to the reader, contain more detailed graphic information, and require the reader to synthesize information (Carnegie Council on Advancing Adolescent Literacy, 2010). At the end of their secondary school education, students are expected to possess high levels of literacy that include the ability to reason while allowing for the systematic development of ideas, the ability to make sound choices, and the ability to make and understand persuasive arguments (The American Diploma Project, 2004).

Indeed, Murnane, Sawhill, and Snow (2012) noted that students are now required to acquire deep reading comprehension skills. Deep comprehension skills include reading to learn totally new subjects, to gain access to the world of knowledge, to synthesize information across different sources, to analyse perspectives on an issue, to critique arguments on a variety of dimensions, and to assess the credibility of sources of information. Students have to go beyond simply acquiring simple comprehension skills that enable them to read relatively neutral texts to answer brief comprehension questions if they wish to explore fields such as history, science, and mathematics, to achieve educational success in postsecondary education, to earn a decent living in a knowledge-based labour market, and to participate as citizens in an increasingly complex world. Yet, Shanahan and Shanahan (2012) believe that many teachers are not
prepared to address the multiple challenges that adolescents face when reading and learning from academic texts across the disciplines.

Literacy educators and reading researchers have recognized that reading not only helps students develop general language proficiency, it also helps them in content learning (e.g., Kucer, 2005; Smith, 2004). However, Shanahan and Shanahan (2012) pointed out that it has been documented that pre-service and in-service content subject teachers have resisted content area reading methods because they were not interested in applying generic routines. Content area reading methods are thought to be generic reading approaches because they focus on general study techniques and reading approaches that can help someone understand or remember text better in any discipline. In content area reading approaches, the type of text in question is not given much attention.

In contrast, disciplinary reading, as defined by Shanahan and Shanahan’s (2012) view of disciplinary literacy, emphasizes the unique uses and implications within each discipline. In other words, reading strategies are discipline-specific. For example, Shanahan and Shanahan (2012) found that content area reading approaches assumed that students could learn vocabulary in the same way across the subjects and that teachers needed to guide students using approaches such as making connections among concepts or analyzing semantic features of words. However, they argued that there were discipline-specific distinctions in vocabulary. For instance, science vocabulary terms tend to be constructed from Latin and Greek (e.g., herbivore), whereas history is rife with openly metaphorical terms such as the Dark Ages and the Gilded Age.

Shanahan and Shanahan (2012) noted that content subject teachers found it difficult to integrate content area reading routines into their already full agenda of instruction because these reading approaches did not fit well with the kind of texts that they used in the classroom. Thus, Shanahan and Shanahan (2012) thought that disciplinary reading approaches might be more appealing to these teachers because the insights and strategies of disciplinary reading were drawn from the disciplines themselves, which were more tied to the teachers’ identities as mathematics, science, English, or history educators. These instructional practices drawn from examinations of disciplinary texts and studies of expert interactions with such texts might help encourage teachers to use disciplinary reading procedures in the classroom.

**Reading in the primary grades**

As explained above, a good foundation in reading is key to reading content subject texts in middle school or the upper primary grades. To ensure that students possess enough reading skills towards the end of primary school so that they will be ready for reading in content subjects such as science and history, research has shown that the following needs to be implemented in primary schools: (a) an emphasis on instructional approaches; (b) more curriculum time for children’s learning; (c) a long-term orientation towards reading instruction and reform; and (d) professional development for harder-to-master skills such as vocabulary, conceptual and content knowledge, and comprehension.

**Emphasis on instructional approaches**

Studies have documented that more emphasis is needed on instructional approaches (Duke & Block, 2012; Murnane, Sawhill, & Snow, 2012). Duke and Block (2012) discussed the role of instruction in improving reading achievement in the primary grades. Reviewing research on improving primary grade reading published since 1998, they found that interventions in cognitive flexibility—the ability to simultaneously consider letter-sound and semantic information—have resulted in significant gains for reading comprehension in young children. For example, teaching children about multiple-meaning words such as spell or plane, and multiple-meaning sentences such as The woman chased the man on a motorcycle helped them gain reading comprehension.

Instruction on word-reading skills, especially in kindergarten and first grade, has led to improvements in reading achievement in decoding, i.e., the student’s ability to recognize printed words accurately and efficiently. Gamse et al. (2008) reported that the Reading First programme produced a positive and statistically significant effect on decoding among first-grade
students in the United States as a result of increased instructional time spent on reading instruction (phonemic awareness, phonics, vocabulary, fluency and comprehension). However, there was no significant effect found on reading comprehension for students in grades one, two or three. Given the observation by Donaldson (2011) that kindergarten through third-grade teachers in 22 high-poverty low-performing American schools who took part in the Reading First programme over a period of three years typically spent an average of 23 per cent of their literacy instruction time on comprehension instruction and that less than 50 per cent of the teachers observed provided vocabulary instruction, this non-significant finding is not surprising. Furthermore, the type of vocabulary instruction tended to be the teaching of word definitions.

Connor, Morrison, and Petrella (2004) also found little time was spent on reading comprehension instruction for 73 third-grade American students from 43 classrooms in a large Midwestern city. They reported that less than one minute per day on average was spent in teacher-managed reading comprehension strategy activities (whole class, small group or individual activities directed by the teacher). It should be noted that the results of this study indicated greater reading comprehension growth, over the span of one year, for children, with low to average reading comprehension scores at the beginning of the school year, who received more teacher-managed reading comprehension instruction.

Hemphill and Tivnan (2008) tracked first-grade predictors of literacy development over time in 16 urban Boston schools in America and found that although beginning-of-first-grade letter-word identification and word attack skills were the strongest predictors of reading comprehension at the end of first grade for low-income students, vocabulary was the best predictor of reading comprehension at the end of second and third grades. In other words, for at-risk populations, teachers need to focus on a wide range of language and literacy skills because these skills undergird later reading success. The authors suggested that reforms on vocabulary instruction could complement instruction on decoding skills in preschools and kindergartens as weak early vocabulary appeared to limit children’s growth in comprehension abilities. They also identified larger teacher effects on literacy achievement, which is consistent with the findings from a large-scale study on variability across schools and teachers as larger teacher effects were found in schools with lower socioeconomic status levels as opposed to higher socioeconomic status levels (Nye, Konstantopolous, & Hedges, 2004). They suggested that the Boston districts’ strong emphasis on developing word fluency through expanded classroom libraries, home reading programmes, a city-wide emphasis on writing development, and expanded time on task by instituting district-wide literacy blocks were effective components of the children’s literacy experience and might have contributed to the children’s achievement in word reading.

Since Hemphill and Tivnan (2008) have shown that vocabulary and language knowledge surpasses word reading as a predictor of reading comprehension by the later primary-school years and that vocabulary instruction promotes reading comprehension, we will now turn our attention to studies discussing why vocabulary instruction is crucial for students to become successful readers. Developing the vocabulary knowledge of students is important because it mediates the acquisition of conceptual and content knowledge which brings about higher knowledge of content subjects.

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As Murnane, Sawhill, and Snow (2012) explained, knowledge, some of which is acquired outside reading, is one of the major inputs to successful reading comprehension as knowledge creates the framework on which reading comprehension builds. They also noted breadth of knowledge is often represented by vocabulary which is essential to any existing schema in the reader’s knowledge. Readers need to hang individual words on these schemas that they use as the background knowledge required for comprehension. Vocabulary development is therefore very closely linked with concept development.
In the same vein, learning the language for a discipline is related to forming rich conceptual networks of words and understanding how these words are related to each other (Nagy & Scott, 2000). Goldschmidt (2010) reported that in a study of 100 Grade 2 to 5 teachers, the science-literacy integrated programme Seeds of Science/Roots of Reading intervention, which teaches students explicitly to read, write, and discuss as scientists do, resulted in substantially higher student performance in science content, vocabulary, and writing, but not in reading. The author reported that the experimental group teachers spent less time on reading than the control group teachers, which could account for the non-significant result in reading performance. Thus, to improve reading comprehension in science, more time on the explicit teaching of reading strategies specific to science may be needed as the results showed that student gains in reading achievement were related to higher science content post-test scores. This approach to improving reading comprehension may also be extended to other disciplines.

The following studies show that a more deliberate systematic vocabulary instruction programme can help develop students’ vocabulary and comprehension effectively in the primary grades (Brabham & Lynch-Brown, 2002; Beck & McKeown, 2007). Brabham and Lynch-Brown (2002) compared the effects of three types of reading-aloud styles—just-reading, performance reading, and interactional—on the vocabulary acquisition and comprehension of 117 first graders and 129 third graders. In the just-reading treatment, pre-service teachers asked the students to listen to the story without asking questions or making comments and produced verbatim readings that lasted for about ten minutes. Subsequently, they asked students to write or draw silently and independently for twenty minutes. For the performance reading treatment, the teachers used scripted comments and questions that targeted specific words and concepts, and invited discussions during the first five minutes of the session. This was followed by a verbatim oral reading of the text by the teachers and a discussion with scripted questions for twenty minutes. Interactional readers used scripted questions to encourage story-related interactions before, during, and after the reading of the story. For all treatments, these sessions were repeated over three consecutive days to maximize vocabulary and comprehension gains. The authors found that the interactional reading-aloud style had statistically significant effects compared to the other read-aloud styles. Students acquired more vocabulary from stories read aloud with word explanations done throughout the lesson. Performance reading did not produce maximum gains in vocabulary. The interactional read-aloud style also produced a significant effect for comprehension, with the effect size being larger for third grade students compared to first grade students. Therefore, Brabham and Lynch-Brown (2002) proposed that teachers should time their word explanations to occur throughout the lesson to facilitate word acquisition and comprehension from read-alouds in the early primary grades.

Similarly, in the first of two studies on which they reported, Beck and McKeown (2007) found that students from an urban low-achieving all African American primary school learned significantly more words when advanced vocabulary from books was taught deliberately than when the books were just read aloud. The mean gain for 52 kindergarteners in experimental classes was 5.58 words compared with 1.04 words for the 46 students from comparison classes and the effect size was strong. In contrast to Brabham and Lynch-Brown’s (2002) study, vocabulary instruction took place after the story had been read and discussed because the authors’ goal was to enhance general vocabulary development rather than comprehension. Thus the story only provided a rich context with which to spur vocabulary growth.

In the second study which took place in a different school in the same school district, Beck and McKeown (2007) found that the vocabulary gains were twice as large when the vocabulary instruction time doubled and the results showed that more vocabulary instruction was beneficial for both kindergarteners and first graders. The words taught in this second study were largely

Students who read multiple texts scored higher on history content and used the heuristics of a historian—sourcing and corroboration—more often than those who read traditional textbook material.
adjectives and adverbs because they were more abstract and thus conceptually more difficult. In learning the words, children were asked to make decisions about the appropriateness of contexts for the words they learnt, develop new uses for new words, and explain whether these uses made sense.

Murnane, Sawhill, and Snow (2012) underscored that the practice of reading aloud is particularly good for struggling readers in the primary grades because these students find it daunting to decode multisyllabic words, i.e., translate the sounds or meanings of these words from the written to spoken form. Releasing the need for these students to decode therefore allows them to discuss and evaluate competing interpretations of a character’s actions and competing explanations for physical phenomena without having them read the texts. These students can subsequently read and integrate information from different sources, thus engaging in deep comprehension activities.

More curriculum time for children’s learning

Murnane, Sawhill, and Snow (2012) advocated more curriculum time for children’s learning in the primary grades especially in content area subjects as more time would help children acquire the necessary skills in vocabulary, conceptual and content knowledge, and comprehension, skills that are essential in the middle grades and above to read texts of increasing complexity and more varied genres. They believe that this will help ease the transition from the lower primary to upper and post-primary grades where students with marginal reading skills and good readers with limited vocabulary stores face the challenge of reading texts whose literacy demands deviate from those of books that these children read in earlier grades.

Duke and Block (2012) argued that although expectations of what children should be able to do at the end of primary grades were greater than what they had ever been, the amount of curriculum time had not kept pace with these increased demands. They suggested that educators and policy makers needed to consider lengthening the school day or year, making full-day kindergarten available to all children, investing heavily in preschool education, and making more deliberate use of the time that students have outside of school.

Long-term orientation towards reading instruction and reform

Duke and Block (2012) proposed a long-term orientation towards reading instruction and reform in schools because they believe that one of the key obstacles that had prevented the adoption of best practices in teaching reading was a short-term orientation towards reading instruction and reading instruction reforms that focused on easier-to-learn reading skills at the expense of harder-to-master reading skills such as the teaching of vocabulary, conceptual and content knowledge, and reading comprehension strategies. They think that schools tended to have a short-term orientation towards reading instruction and reform as it was easy to show reading improvements in terms of phonological awareness, alphabet knowledge or letter-sound knowledge, and word reading in a short period of time. In contrast, it was harder for schools to show gains in reading comprehension, vocabulary, and conceptual knowledge quickly because they were harder to measure and harder to achieve.

Professional development for harder-to-master skills

Duke and Block (2012) underscored that a major obstacle to improving reading in the primary grades in American schools was teacher expertise because the curriculum alone could not bring about changes in students’ development of vocabulary, conceptual and content knowledge and reading comprehension skills. Therefore, they supported professional development for harder-to-master skills such as vocabulary, conceptual and content knowledge, and comprehension. This lack of skills may have resulted in the teachers’ avoidance of teaching these skills to their students, focusing instead on easier-to-master skills such as decoding.
Disciplinary reading in the secondary grades

Shanahan and Shanahan (2012) highlighted that, entering the secondary grades, students are engaged in reading practices that differ substantially across disciplines. They need to be socialised into literacy practices specific to each discipline when they read in their areas of specialization. Instructional programmes need to teach students to ‘read like a scientist’ or ‘read like a historian’.

To date, there have been a few quantitative studies investigating the effectiveness of disciplinary reading at improving literacy achievement or subject matter success in secondary schools (De La Paz & Felton, 2010; Nokes, Dole, & Hacker, 2007). Nokes, Dole, and Hacker (2007) conducted an intervention that involved 246 students, aged 16 to 17, in eight history classrooms in two secondary schools in the United States. The students were randomly assigned to one of four interventions to test the effectiveness of different types of instruction and texts on secondary school students’ learning of history content and a set of heuristics that historians use to think critically about text. Students who read multiple texts scored higher on history content and used the heuristics of a historian—sourcing and corroboration—more often than those who read traditional textbook material. The findings of this study suggest the value of having a collection of thoughtfully selected texts for the learning of historical content. Students who were taught the heuristics with multiple texts also scored significantly higher than their counterparts who used traditional textbooks with or without heuristics to study content. Thus, the authors felt that this provided empirical support for the teaching of historiography along with content in the history classroom.

De La Paz and Felton (2010) found that an experimental group of 81 students receiving instruction in historical reasoning and a pre-writing strategy for composing argumentative essays, wrote essays that had significantly greater historical accuracy, and were significantly more persuasive than those of the comparison group of 79 students. Both groups of students read the same primary and secondary source documents, and received feedback on written essays on the same topics. What was different was the instruction received. Teachers instructing the experimental group modelled the historical reasoning heuristics and the planning strategy for writing an argumentative essay. Students learnt strategies for reconciling primary and secondary accounts offering conflicting information or perspectives of a historical event, and to plan and compose argumentative essays. However, it should be noted that unlike Nokes, Dole, and Hacker’s (2007) study, it is unclear the extent to which the historical reasoning heuristic strategy contributed to the higher quality student work compared to the writing argumentative essay strategy.

To ensure that they teach disciplinary reading effectively, Shanahan and Shanahan (2012) believe that educators need to think about the different needs of proficient and less proficient readers when they plan reading instruction. They propose that proficient and less proficient readers might need differentiated reading procedures. For less proficient readers who get easily distracted or who do not think much or well about what they are reading, teachers can have them summarise what they read, ask questions about information in the text, and set purposes for their reading. For proficient readers who do not have trouble concentrating on the text but who do not always engage in the highest levels of interpretation, reading strategies could include guiding students to think more effectively in a discipline-specific manner. However, Shanahan and Shanahan (2012) also pointed out that struggling readers could also benefit from disciplinary reading approaches because these instructional approaches might stimulate them to engage with text.

Earlier researchers suggested that to promote literacy engagement in adolescents, students should be given a choice of books (Goldman, 2012; Harmon, Wood, & Stover, 2012; Thames & York, 2003), a choice of topics (Harmon, Wood, & Stover, 2012), and a choice in the order they completed a task (Harmon, Wood, & Stover, 2012).
2012). However, Harmon, Wood, and Stover (2012) cautioned that while choice was important, a balance between student choice of text and teacher selection was needed to ensure that students were given academically significant and realistic choices.

Harmon, Wood, and Stover (2012) suggested that when choosing texts for adolescents, teachers needed to choose texts that were accessible to their students as texts that were too difficult for students, even with support from the teacher or peers, might not be productive for learning. They also argued that students were not able to successfully engage in higher-level, critical reading of texts that did not match their ability level. Teachers might have to modify instruction or texts so that students’ understanding of the texts can be supported or extended (Bain, 2010; Reisman, 2012b; Roberts, 2013). Roberts (2013) noted that as students become more familiar with the language of a given discipline, the need to modify the text will diminish. Reisman (2012b) described how his research team modified primary source documents such as historical government reports, diaries, letters and speeches according to three principles of adaptation: (a) focusing, (b) simplification, and (c) presentation. They first excerpted from each source the portion of the document that shed light on the historical question under investigation. Second, they simplified the vocabulary, conventionalised spelling and punctuation, and re-ordered sentences into more straightforward sentences while attempting to preserve the document’s original language and tone.

The following sections show what teachers can do before and during the reading of the text to help students make meaning from it.

**Before reading**

Researchers have suggested the following pre-reading activities for use in the classroom (Harmon, Wood, & Stover, 2007; Reisman, 2012a; Reisman, 2012b; Roberts, 2013): (a) the activation or building of important knowledge to stimulate interest and motivation to learn, (b) the stimulation of interest and motivation to learn the topic to be addressed, (c) the provision of a purpose for reading, (d) explicit instruction on genres and discourse structures; and (e) the provision of reading tools such as organizers.

The activation or building of important knowledge is an essential component in preparing students for reading (Harmon, Wood, and Stover, 2007; Reisman, 2012a; Reisman, 2012b; Roberts, 2013). Teachers could begin their lessons with a review of relevant background knowledge in the form of a lecture, a video, or textbook questions, or prime students’ background knowledge by offering them an incomplete or inaccurate account of a historical event, for example (Reisman, 2012b). This could help their students activate and use relevant background knowledge to fully understand a text (Goldman, 2012; Lesaux, 2012) by relating the concepts within the text with what they have already acquired.

Harmon, Wood, and Stover (2012) proposed stimulating students’ interest in learning the topic to be addressed. This interest to read the text will motivate them to start and finish reading it (Lesaux, 2012). At the same time, teachers could provide students with the purpose for reading the text (Harmon, Wood, & Stover, 2012; Murnane, Sawhill, & Snow, 2012; Thames & York, 2003), and reading tools such as organizers (Goldman, 2012). These reading tools could highlight the different text genres explicitly taught by teachers (Murnane, Sawhill, & Snow, 2012).

**During reading**

During the reading process, the use of prompts has been proposed to stimulate response and help students grapple with important and difficult concepts (Murnane, Sawhill, & Snow 2012). Demonstrating how to understand difficult oral and written texts can be particularly helpful to students who struggle with such texts (Harmon, Wood, & Stover, 2012; Murnane, Sawhill, & Snow, 2012). Giving students multiple documents offering different perspectives can reinforce the value of multiple perspectives to decode sources.
of evidence (Bennett, 2011; Roberts, 2013). Letting students engage in repeated readings of the same text helps students to become more efficient in recognizing words, especially high frequency words, and in increasing their reading rate, as well as to broaden their understanding, develop conceptual ideas, clarify information and find new facts in content area classrooms (Harmon, Wood, & Stover, 2012).

Having students discuss the texts as a class, group or pair is helpful as learning occurs through social interaction (Bennett, 2012; Goldman, 2012; Harmon, Wood, & Stover, 2012; Reisman, 2012b; Thames & York, 2003). Goldman (2012) found that in the nine interventions that she reviewed, by focusing on varied types of text from science to history, and sharing a dialogic orientation, students were more active in articulating meaning in and around text and had improved literal and inferential comprehension. Goldman (2012) described an approach to teaching literature that was developed and tested by Judith Langer and her colleagues, which focused on classroom discussion. Langer and her colleagues found that dialogic classroom discussion was significantly related to performance on tasks requiring students to adopt interpretive stances in literature.

Goldman (2012) also cited studies by Catherine O’Connor and her colleagues which examined the impact of introducing a conceptually based mathematics programme with dialogic discourse to students from grades four to seven on their reading and mathematical achievement. The teachers in these studies encouraged students to provide multiple answers to a problem, to explain how they arrived at the answer, and why their method worked. In the event of students having different methods, the teacher facilitated discussion of why more than one method worked. If the answers were different, the teacher asked which answers were the most reasonable in mathematical terms. Teachers revoiced students’ contributions in mathematical language. The results of this study indicated students who participated in classroom discussions using mathematical language scored higher on standardised achievement tests of reading and mathematics than those who did not engage in such talk.

Professional development to improve disciplinary reading

There has been research reported on professional development to improve disciplinary reading instruction (Lesley & Matthews, 2009; McArthur, 2012; Pytash, 2012). Courses dealing with reading in the content areas were found to be not favourably received by pre-service teachers because the one-size-fits-all approach did not take into account the literacy practices that are specific to each discipline (Pytash, 2012). Content area reading strategies were perceived as teacher-directed study skills and textbook-based reading skills that drained time away from content area instruction (Lesley & Matthews, 2009). Pytash (2012) explained that teacher educators were in the process of moving pre-service education courses from content area literacy instruction for content subjects to a more discipline-specific literacy instruction as conceived by Fang and Schleppegrell (2010), Moje (2008), Olson and Truxaw (2009), and Shanahan and Shanahan (2008).

Another issue to be addressed is that pre-service teachers demonstrated behaviours reminiscent of passive, reluctant and struggling readers, possessed little self-efficacy as readers, and showed negative literacy identities as readers (Lesley, Watson, & Elliot, 2007). Lesley, Watson, and Elliot (2007) argued that such deeply rooted negative attitudes towards reading might deter these teachers from teaching reading in their content area classrooms and they believed that teachers needed to see themselves as capable of reading across multiple genres of text within their discipline and across disciplines. Both pre-service and in-service teachers also need to see reading and writing as tools that students need to develop subject matter knowledge (McArthur, 2012). To help pre-service teachers become better readers in at least their own discipline so that they can role-model reading in their discipline, researchers have investigated the following

Both pre-service and in-service teachers also need to see reading and writing as tools that students need to develop subject matter knowledge.
professional development programmes involving pre-service teacher participants as readers (McArthur, 2012; Pytash, 2012):

(a) Doing a metalinguistic think-aloud journal (McArthur, 2012);

(b) Writing reflections of their experience as readers and of the implications for classroom practice (McArthur, 2012; Pytash, 2012);

(c) Discussing genres particular to their discipline (McArthur, 2012);

(d) Analysing anchor texts representative of a genre (Pytash, 2012); and

(e) Closely following teacher educators annotating a text and closely studying a piece of writing for structure, purpose, audience, form, content, language and mechanics (Pytash, 2012).

McArthur (2012) emphasized that pre-service teachers should recognize the importance of background knowledge, technical vocabulary, the lexical density of text, and specialized knowledge needed to understand a given text when they plan lessons and select texts for their lessons. To help her pre-service teachers think about disciplinary reading, she gave them a metalinguistic think-aloud journal assignment where they had to write their thinking associated with what was written in a text related to their discipline. However, she first modelled the thinking she did while reading a new text related to her discipline. She then asked the pre-service teachers to choose a primary source document from their field and complete the journal at home. Next, the teachers partnered with someone outside their discipline to discuss the ways of thinking, background knowledge, text structures and text features, specialized language and cognitive reading strategies that they encountered while reading the document. For example, history majors shared that reading in history always began with finding out the author of the document and the time period while a mathematics major explained that visualising was important in his discipline. These discussions helped them to understand better the reading strategies specific to their discipline and how they could plan their classroom instruction to communicate to their future students the way experts approach the reading of a text.

Thus, in pre-service education, Bain (2012) suggested that teacher educators could identify practices of discipline-specific reading for learning content and frame them in a way that would help pre-service teachers use them in their teaching. For instance, when selecting a text, Bain (2012) explained that history teachers are required to understand the content as well as anticipate their students’ understanding of the content so as to be able to identify the texts that can support, extend or challenge their students’ thinking. If teachers think that the text might contain challenges for their students in terms of structure, vocabulary or assumed background knowledge, they will need to frame their instruction in such a way as to help students establish the purpose for using the text, develop the knowledge necessary to comprehend it, and the skills required to read it.

One possible way of easing the transition necessary for literacy instruction is for pre-service teachers to work with skilled veteran teachers who have been carefully selected to model a particular aspect of effective teaching (Bain, 2012). Bain (2012) suggested that pre-service teachers could go to a wide range of instructional settings and work on important practices—selecting and using texts for instruction, planning for instruction, assessing and learning from students, and developing student writing—in different settings before they start their student teaching.

**Conclusion**

To help prepare our students to cope with the increasing demands in school and the workplace, we need to address issues related to the amount of curriculum time spent in helping students reach a high level of literacy, the type of instruction that fosters the development of literacy, and the professional development needed to implement reading instruction in both English language and subject content classrooms. The quoted research indicates that in the lower primary grades, teachers need to have a more deliberate and systematic approach to teaching vocabulary to allow students to acquire enough vocabulary to develop conceptual understanding in subject
matter in the upper primary and secondary grades. Teachers in the upper primary and secondary grades need to engage in discipline-specific reading instruction to support student learning. Leaders in education also need to have a long-term orientation towards reading instruction and reform for both primary and secondary grades in order to bring about the necessary changes that will enable students to engage in disciplinary reading.

References


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Talk in the Classroom

Summary

This issue of the ELIS Research Digest looks at the importance of talk in the classroom. Talk can take place between the teacher and a whole class or between the teacher and an individual student. It can be between individual students working in groups or between an individual student and the whole class. The studies reported in this Digest suggest that talk in the classroom is essential to the cognitive and linguistic development of students across the whole curriculum. However, it seems that restrictive forms of question and answer sequences are still dominant in classrooms and teachers are sometimes unsure of the practicality of alternatives. However, classroom talk allows teachers to more easily monitor their students’ understanding of complex concepts. As a result, they are then in a better position to take remedial measures before it is too late. It is also through such talk that students develop the thinking and language necessary for them to learn the required concepts.

Introduction

The term ‘oracy’ was first used by Wilkinson (1965). He used it to refer to the oral skills of speaking and listening in the context of learning and development. He argued:

Where children are ... placed in situations where it becomes important for them to communicate – to discuss, to negotiate, to converse – with their fellows, with the staff, with other adults ... This is basically how oracy grows: it is to be taught by the creation of many and varied circumstances to which speech and listening are natural responses. (p. 59)

Since then, oracy has become an important part of educational syllabi around the world. While the term oracy will be used frequently in this Digest, the focus is on the speaking skills in learning in general but with a particular emphasis on their role in subjects or disciplines. A later issue of the Digest will focus on listening.

Traditionally, language has been divided into four main skills – listening, speaking, reading and writing. Until the mid-19th century, schools tended to focus on the written language. Foreign languages were taught through the study of grammar rules and lists of vocabulary that were combined in the analysis of written texts or in the formation of decontextualized sentences. In the mid- to late-19th century, a growing number of linguists began to question this approach that had failed to produce proficient users of foreign languages. One of the grounds for questioning the approach was the suggestion that the learning of a language (as in the mother tongue) should begin with listening and speaking, followed later with reading and writing (Richards & Rodgers, 2001).

Vygotsky (1978) theorized that we learn through social experience. He hypothesized the existence of the ‘zone of proximal development’ or ZPD, the gap between what a child could achieve alone and what he/she could achieve with the help of a more knowing other. That other could be an adult or a more competent peer. He believed that language and cognition developed together and that this development was not purely internal to the individual but was also dependent on the social community in which the individual was located. He believed talking was important not just to clarify understanding but also for the individual to learn how to communicate. The adult teacher may be tempted to interrupt a group conversation to help the participants reach a conclusion but this may be counterproductive as the talk itself is part of the children internalizing the concepts. This does not mean that language and cognitive development will take place
naturally. Teachers need to learn skills of observing, questioning and encouraging useful peer interaction and the skill of knowing when to step in and when to let the children carry on without them (Mooney, 2000).

Sticht (2003) stressed the importance of oral skills as the base for literacy skills in a discussion of a number of studies done in the United States on adults with reading difficulties. He suggested that the practice of giving written intelligence tests to estimate their reading potential was misguided. He quoted data from a study (Sticht & James, 1984) of 2,000 adults that showed that, contrary to expectations, native speakers of English with reading difficulties had listening grade levels not far ahead of their reading grade levels. He felt that this gap reflected their true reading potential and that there was a need to improve their vocabulary and content knowledge through their oracy skills before they could make a lot of progress in reading. Only then would the phonics, phonemics and decoding skills become useful, i.e. oracy must come before literacy. It is worth noting that data for adult learners of English indicated a similar situation in that their reading and listening grades were close together. However, in their case, their average reading level (grade 4.8) was slightly higher than their average listening level (grade 4.4) as had been expected for learners for whom the language was a foreign language.

Jones (2007) stressed the importance of speaking and listening in the development of understanding. She suggested that, in trying to speak our thoughts, we often come to a clearer understanding. Making implicit thoughts explicit is a powerful learning tool for children as well as for adults. Many theories of development stress the importance of talk with peers and with a knowing adult as well as of language as a tool for sense making or thinking together. Jones (2007) believed that the important speaking and listening skills could be most easily developed through dialogic teaching, the development of metacognitive awareness, and proper planning and assessment. She suggested that there were four aspects of speaking and listening skills that needed to be planned for: social, communicative, cultural and cognitive. She reported that, contrary to the fears among some teachers that student talk would be unproductive, research had shown that, given an appropriately structured task, students used talk to clarify their own thinking and to help others.

Types of talk

This section looks at different types of classroom talk and some of the terms that have been used to identify and contrast them.

The term ‘dialogic teaching’ will appear a number of times in this Digest and thus it is important to define it here. While the different writers reviewed below may emphasize different aspects, the main features are agreed on. Dialogic teaching is ‘collective’, involving the whole group. It is reciprocal in that teachers and students work together to move the talk and the learning forward. It is ‘cumulative’ in that students and teachers build on ideas that others have contributed. It is ‘supportive’ in that it generates a risk-free environment where each individual helps the rest. Not all dialogues in the classroom are dialogic. Some simple Initiation, Response, Evaluation (IRE) sequences that are commonly found in classrooms are not dialogic as they do not allow for any real contribution from the students. In the following example, the dialogue is completely controlled by the teacher.

Teacher: What is the capital of Thailand?
Student: Vientiane.
Teacher: No. Were you paying attention when we did this yesterday? It is important to learn about our neighbours.

The teacher already has an expectation of what the student should contribute and will not (cannot) accept any other response. In contrast, in dialogic teaching, the students are in a position to give information and opinions and ask questions. This may happen in an IRE sequence but it can also come in other forms of classroom talk. The important point is that talk builds on the student contributions as in the following exchange:

Teacher: Where would be a good place to go for a holiday?
Student: JB.
Teacher: JB. That's interesting. Why would you choose JB?
Student: I like JB. (Encouraging nod from
the teacher.) It is easy to get to and it’s just like Singapore.

In this sequence, the teacher accepts the contribution of the student and then asks for the reasons for the choice thus encouraging the student to respond with a longer turn.

The sequence of IRE mentioned above was found to be a pervasive discourse pattern in schools in the 1970’s. It was seen as very limiting for the students as usually, as we have seen, their response was little more than a few words and, more importantly, was limited to regurgitating information as demanded by the teacher. Westgate and Hughes (1997) noted that there had been a re-examination of this IRE sequence that accorded it greater functionality, emphasizing the possibility of extending the final stage to giving longer feedback and thus revised to IRF (where F stands for feedback). However, they felt that there were some continuing concerns because the student contributions were generally still very brief.

P. Thompson (2008) repeated this concern. He felt that the IRF sequence as it was generally used was ‘univocal’ in that it centred around the input and ideas of the teacher and, as a result, student turns were very short. He also felt that the alternative focus on teacher-student talk and talk in collaborative small groups tended to emphasize the ‘internalization’ of learning. He believed this needed to be balanced with longer student turns in the more formal setting of the whole class as this would help with the important step of ‘externalizing’ learning. He suggested that such monologues from students were not univocal provided they were in response to other people or other texts. In the study he reported on, teachers in six primary and four secondary schools in the UK encouraged talk by providing for whole class activities such as class discussions or debates that built on past learning and on reports regarding school and out-of-school experiences contributed by the students. The length of student turns grew from an average of 2.8 words to 13.7 words over the period of the study.

Scott, Mortimer, and Aguiar (2006) used selected episodes from science classes in Brazil to look at how the science teacher used different approaches to talk in the lessons. They found it useful to use two dimensions: the dialogic-authoritative dimension and the interactive-noninteractive dimension to classify four approaches. They suggested there was a tension in the science classroom between the needs to present the school science point of view and to relate to the students’ everyday views of the world. As a result, the teacher in the episodes reviewed moved from a dialogic-interactive stage where she sought the students’ everyday views of ‘heat’ (with some students talking about ‘cold heat’ and ‘hot heat’) through to an authoritative-noninteractive stage in which she introduced the school science view of the concept. Later, she moved back to a more dialogic stage as she got the students to apply the principles they had just learnt to a new set of problems.

This (emphasis on the ‘internalization’ of learning) needed to be balanced with longer student turns in the more formal setting of the whole class as this would help with the important step of ‘externalizing’ learning.

Scott et al. (2006) went on to ask, if in the end it was necessary to introduce the school science view, why the teacher then took time to entertain the students’ everyday views. Their answer was that students needed to make connexions through thinking and talking. The student talk allowed them to express their own views and then relate these to the scientific principles they subsequently learnt.

Given these arguments, Scott et al. (2006) expressed concern that dialogic teaching formed a relatively small part in the teaching of science. They suggested that there were a number of reasons for this. First, there was a common view that the teachers’ job was simply to pass on the school science view and that the students’ views were out of place. Second, in order to deal with student perceptions, teachers first needed to develop their knowledge of what these perceptions might be and how they could respond. Third, many teachers confused dialogic teaching with an interactive/authoritative approach in which the teacher asked questions but ignored responses that did not fit the school science view. Fourth, teachers felt that dialogic teaching took up too much time that they could ill
afford. Finally, there was a very limited body of evidence (other than the analysis of classroom talk) that showed that this different approach actually had an impact on student-learning outcomes. Despite these difficulties, the authors felt that sequences of teaching that included dialogic teaching as well as authoritative teaching would allow for more meaningful learning.

Similarly, Stein, Engle, Smith, and Hughes (2008) had concerns about the balance of talk in the maths classroom. Maths teachers had correctly taken on board the idea that K-12 students needed to have the voice or ‘authority’ to discover their own mathematical solutions to problems but had failed to balance this with the need for the students to be ‘accountable’ to the discipline of maths. It was not enough to give students a task to work on in groups and then listen to multiple solutions without helping students understand how mathematical principles related to those solutions.

They suggested that one of the difficulties was that experts in pedagogy demonstrated techniques that were difficult for teachers to immediately adopt without further assistance. They suggested five practices that teachers could adopt to help them achieve the required balance: anticipating, monitoring, selecting, sequencing and connecting. Each practice is the preparation for the next. For example, anticipating is needed for monitoring and monitoring, in turn, is needed for selecting.

Before giving a problem to students, teachers needed to anticipate the solutions the students might come up with, including possible incorrect ones, so that they could prepare their responses. They then needed to monitor the group work so that they could plan the most productive way of using the student contributions to help them move towards the required mathematical concepts. They needed to select which groups would present to the class and in what sequence so that the presentations would help students correct common misconceptions and develop a mathematical view while not undermining the students’ ‘authority’. The final step was to connect what the students had learnt to the discipline of maths. In this way, students could learn to talk about maths with authority but be accountable to the mathematical principles of the discipline. To do this, teachers needed to contribute to any classroom dialogue just as much as the students.

Commenting on the teaching of oral skills in Britain, Doddington (2001) focused on a different aspect. She suggested that the more recent trend of only teaching ‘effective communication’ in terms of the more formal stages of the careful pre-planning of areas such as purpose and audience was inappropriate and resulted in restrictions on the kind of language children were allowed to use in class. She believed that spoken language was not generally something that individuals first rehearsed in their minds and then presented to an audience. People developed their ideas, their identity and their interdependence with others as they spoke. It was thus important that individuals learnt to listen to others as well as to speak. In order for teachers to help students to become good communicators, they needed to demonstrate through their own practice that other people’s utterances could be food for thought and not just prompts for interrogation. Rather than teach the spoken skills as something internal to the individual which could be improved through rule-governed rehearsal, they should encourage the students to see them as a collaborative tool.

Goh and Doyle (2014) suggested that students needed to develop two kinds of oracy for academic learning. The first consisted of presentation skills in which the process closely resembled that for written texts. Students prepared the texts beforehand and might revise them several times before actually doing the presentation, (i.e. similar to the ‘effective communication’ that Doddington (2001) referred to). The second was ‘exploratory talk’, which more closely resembled everyday talk in that it was spontaneous and not prepared. It was more likely to happen in group work where students stated their ideas, defended them and responded to other students’ talk. The aim was to come to a...
better understanding of the topic by thinking together. This type of talk was believed to help students learn language that used the vocabulary and structures of the subject or discipline they were studying. The teacher could then help the students move from this exploratory talk to talk that more closely matched that of experts in the subject.

Silver, Raslinda, and Kogut (2014) discussed the different types of student talk and how the teacher could affect these. They contrasted the traditional pattern of Initiation, Response and Feedback (IRF) with dialogic teaching. In the IRF pattern, the teacher tended to dominate the talk in the classroom as individual students were usually expected to give short, factual responses in the second step (Response). Such a pattern had a place in teaching but needed to be balanced with dialogic teaching which allowed for student talk that was collective, reciprocal, supportive, cumulative and purposeful. (As mentioned earlier, in dialogic teaching, students are given the opportunity to work together as a class or in groups to build up a learning conversation that builds on what individuals say in a supportive environment. Teachers continue to help direct but do not dominate.)

Silver et al. (2014) went on to contrast exploratory talk with disputational and cumulative talk. In disputational talk, students worked as individuals making assertions and counter-assertions, thus not building knowledge together. In cumulative talk, students uncritically accepted what others said. These two types of talk were contrasted with exploratory talk where the students suggested and counter-suggested, building on what had gone before in a critical but positive manner. The writers cautioned that encouraging exploratory talk was not just a matter of giving students tasks or putting them into groups. The teacher needed to plan the activities carefully to ensure that they provided opportunities for exploratory talk, a point also made by Jones (2007) as mentioned on page 27 of this Digest.

Stahl (1994) discussed one of the simplest ways of increasing talk in the classroom. He found that, by increasing the ‘wait-time’ used by teachers from what research had shown to be around 1.5 seconds to 3 or more seconds a number of benefits accrued:

- The length and correctness of student responses increased;
- The number of ‘I don’t know’ and no response answers decreased;
- The number of volunteered answers by a larger number of students greatly increased; and
- The scores of students on academic tests tended to increase.

Teacher behaviour also tended to change:

- Their questioning strategies tended to be more varied and flexible;
- They decreased the number but increased the quality and variety of their questions; and
- They asked additional questions that required higher order thinking skills on the part of the students.

Stahl (1994) preferred the term ‘think-time’ to ‘wait-time’ as he felt it more closely reflected the purpose of the pause. He suggested there were eight points where the pause could be made. These included not just pauses after teacher questions but also pauses during student responses, after a student’s response, during a student’s independent contribution, at a point when the teacher was thinking of a response to a student, during a teacher presentation to give students time to think, during the completion of a task by students and at certain points to give impact.

This need for talk in the development and learning of students is generally accepted for the development stages of early childhood. However, the need for talk at later levels of education may not always be so obvious. The following sections of this Digest thus review some of the literature dealing with oracy at different stages of education in order to clarify what may be needed at each stage.
Preschool

Saracho and Spodek (2007) summarized the research on the development of language in the child’s early years and the role the teacher could play. They noted how one study (Hart & Risley, 1999) had shown that the number of words that a child had exposure to had a significant effect on their language development at the age of 3 and on their literacy development at the age of 9. It had also shown that engaging in dialogue with other children and adults had a significant effect as well. They pointed to the conclusion by McKeown and Beck (2005) that children needed to explain and elaborate their ideas in order to learn to make sense of the decontextualized language they would meet in school. Saracho and Spodek (2007) emphasized the importance of play in which children could become more aware of different points of view and more knowledgeable of the physical world and the variety of social roles. Such play helped them to learn to communicate with peers and adults.

Saracho and Spodek (2007) recommended that in the preschool years the emphasis should be on oral language experiences, a prerequisite for children to learn and understand the relationship between spoken and written language. There should be a variety of activities, such as play, children’s literature, storytelling, puppetry, and creative dramatics. They should be encouraged to express ideas, listen to the ideas of others and then go back to their experiences to see if these ideas held up.

A study of a Japanese kindergarten in Kobe by Shirakawa and Iwahama (2009) showed how these principles worked out in practice. In one example, one child complained to the teacher that another would not let her play house. The teacher encouraged the child to go back and find out the reason for the refusal. When it turned out that the second child felt the ‘house’ was too small for two children, the teacher encouraged the first child to think of a solution. The result was the two children working together to enlarge the ‘house’. The point was that, with the encouragement of the teacher, the children were learning to understand the views of others, and to discover new ideas through social contact.

In the early years in preschool and school, the child is developing both oracy and numeracy. Some (see, for example, Clements & Sarama, 2009; Farran, Lipsey, Watson, & Hurley, 2007, April) fear that increasing the time for an intensive mathematics course, while helping in the development of numeracy, might at the same time detract attention from the development of oracy. This might then have a negative impact on later academic success as various aspects of oral language skills such as vocabulary, grammar and narrative discourse processes have been shown to be good predictors of later academic performance (see Hart & Risley, 1999; McKeown & Beck, 2005). This might be a particularly important consideration for children at risk of academic failure.

Focusing on the maths programme had no detrimental effect on the learning of oracy skills. In fact, it led to improvements in some oral language skills with children from the programme able to give more complex explanations of a story with fewer promptings.

Sarama, Lange, Clements, and Wolfe (2012) suggested, however, that there might be links between learning literacy and mathematics. Children recognize whole words first and only later learn to analyse them in terms of syllable and phonemes. Similarly, they initially see numbers as units and only later come to understand that numbers can be broken down into their parts (i.e. that five can be obtained by adding two and three). In the same way, learning the letters and mathematical concepts of shape may have some crossover as both require the recognition of shape.

In a study in the USA of an intensive maths programme that included an emphasis on shape, communication skills and problem solving, Sarama et al. (2012) investigated the effect of the programme on oracy skills based on a sample of some 1,300 students (average age: 5 years old) from 43 schools divided between experimental and control groups. They found that focusing on the maths programme had no detrimental effect on the learning of oracy skills. In fact, it led to improvements in some oral language skills with children from the programme able to give more complex explanations of a story with fewer
prompts. The authors were particularly impressed as measures for these skills were taken some months after the maths programme had been completed. They believed this success was due to the emphasis in the maths programme on the students explaining the reasons for their thinking.

**Primary**

The work begun in preschool continues in primary school, except that at this level, a process of focusing on different subject areas in specific timeslots becomes more noticeable. Moreover, there is increasing pressure on teachers in a target-driven syllabus to focus on results and areas that are easily measurable (Palmer, 2003).

Palmer (2003) felt that, although speaking and listening activities were built into the curriculum of England and Wales, teachers under pressure of time tended to drop such activities as they were rather ephemeral to teach and report on. The result was an emphasis on writing that actually resulted in poorer writing as the students had neither the vocabulary nor the ideas they needed to write well. She felt that it was important that, across subjects, well-qualified teachers modelled the literate spoken language. This was particularly important for children from economically disadvantaged homes as they usually did not have such models at home. Moreover, she suggested, if the predicted scenarios of future growth in speech-controlled computerization were correct, such literate speech would replace handwriting, spelling and keyboard skills as an important skill for the workplace.

Similarly, Kotler, Wegerif, and Levoi (2001) noted that children in the northern English city of Bradford who did not use English at home had average reading results at age seven (known as Key Stage 1 in England and Wales). However, their results plummeted when they came to Key Stage 2 at the age of 11. Kotler et al. (2001) believed that these bilinguals were able to cope with the basic decoding necessary to succeed at Key Stage 1 but were not able to comprehend texts at Key Stage 2 because they had not learnt the oral language forms that would help them with concepts necessary to succeed in school reading. They did not have the opportunity to do so at home and in their social groupings and, in class, most oral contributions from students were single word answers to teacher questions. In a piece of research to check on this, Kotler et al. (2001) used adult ELT Talking Partners to work with small groups of such students over ten weeks and found in all post-test results a greater improvement in reading measures for the experimental group than for the control group. In one (the Renfrew Information test) of the four measures used to test the two groups, the difference between them was statistically significant. In one of the schools in the study, the principal was convinced that the students’ writing had also benefited.

Seto (2002) pointed out that the Primary Mathematics Syllabus in Singapore at that time included the aim of enabling students to use mathematical language to communicate mathematical ideas and arguments precisely, concisely and logically. To check if her class could do that, she decided to ask her Primary 4 students to do oral presentations instead of the written practice exams they were doing in preparation for their forthcoming exams.

Initially, she encountered some resistance from some of her pupils who suggested that the lesson was more like an English than a maths lesson. The first presentation, however, clearly indicated to her that her pupils were having some conceptual problems with fractions and decimals and, as a result, were not placing them correctly on a number line. The follow-up remedial work led the class to look at fractions and decimals not only in terms of numbers but also in terms of time, weight, length, and volume. A second presentation required the pupils to research number lines used in real life and then to present to the class, an exercise the class enthusiastically and creatively embarked on.

In a third presentation, the pupils had to say
whether ‘¼ kilo of peanuts’ was the same as ‘¾ of the peanuts’ giving reasons for their answers. While the groups came up with quite different answers, the important thing was that they were now able to listen to each other’s presentations and carefully consider what others said. They had begun to learn from each other.

For Seto (2002), the exercise showed that talk in the maths class helped the teacher identify areas of conceptual weakness among the pupils, enabling her to make the necessary changes to the teaching. It also allowed the pupils to learn from each other and prepared them to be wrong and open to the ideas of others. This was despite the initial reluctance of the pupils who were not used to this approach. As an assessment tool, however, the presentations had one disadvantage as far as some of the pupils were concerned. The presentations had to be done in sequence and pupils felt that, as a result, those who came later were at an advantage as they could learn from the experiences of the earlier presenters.

In another study also done in Singapore, Vaish (2013) looked at the questioning techniques of teachers who were working with students who had weak English language skills at the time they entered the school system. She found that the number of questions did not correlate with the amount students contributed independently. Instead she concluded that the important thing was whether the class was dialogic or monologic. In a monologic class, the teacher may ask the students many questions while still not allowing students any control over classroom input, ignoring student contributions that do not fit in with the pre-ordained lesson. In a dialogic class, as discussed on page 27 of this Digest, the teacher allows the students to contribute their ideas, sometimes even without the teacher asking questions. The teacher then takes up the student input and integrates it into the lesson. Vaish suggested that such a teacher was truly listening to the students and believed that he or she would be a more effective teacher.

The two studies above support the arguments mentioned earlier by P. Thompson (2008), who came to largely the same conclusion, suggesting that in classrooms where student talk was common, the teachers were in authority but were not the authority. They were equal partners in a discussion with their students although they had the added responsibility of guiding the direction of the discussion. However, he preferred to use the terms ‘dialogic’ and ‘univocal’. He felt that the term ‘monologic’ suggested that monologues or extended turns could not be dialogic and not involve others. He felt that the contrast ‘univocal’ versus ‘dialogic’ was more useful as monologues could be part of an ongoing dialogue.

Writing about the UK, Westgate and Hughes (1997) suggested that there was a great deal of ‘depressing evidence’ (p. 128) suggesting that teachers continued to restrict dialogue with students to questions that limited their responses to what the teachers were looking for. However, they suggested that there was mounting evidence of the communicative and cognitive benefits for students when teachers shared their ideas with the students and encouraged or allowed them to add their own (Mercer, 1995; Norman, 1992). Children tended to benefit less from adult attention to the forms of their talk than from being taken seriously as conversational partners by an adult. Encouraging students to develop communicative and collaborative learning and group problem-solving skills at every level of schooling benefited them and gave them the skills emphasized by future employers.

The need for students to speak is not restricted to language classrooms. D. R. Thompson (2012) pointed out that, as students talked about their thinking of mathematical concepts, they not only allowed their teachers to see and evaluate their learning, they also internalized and solidified their own learning. The classroom became more student-centred and engaging. She went on to demonstrate how textbook exercises could be modified to encourage this in the classroom.

Presenting a similar approach, Kaur (2012) noted that research had shown that the highest student achievement occurred in schools where high level thinking and reasoning were encouraged. She
introduced some simple strategies for adapting textbook tasks and showed how a teacher in a Singapore primary school had used these to encourage her students to reason aloud and communicate while they reviewed the four operations, $+$, $-$, $\times$ and $\div$, with numbers less than 40.

In a one-year study of two teachers and their students in a maths primary class in New Zealand, Alton-Lee, Hunter, Sinnema, and Pulegatoa-Diggins (2010) were able to document the significant progress in maths of the students who were mainly Maori and Pasifika, i.e. from non-English speaking homes. The researchers worked with the two teachers to help them to reflect on their own teaching. Over the year, the teachers introduced the students to collaborative approaches and encouraged them to work together to find solutions to maths problems and to give reasons for their solutions in a supportive environment. They taught the students to avoid the cumulative and disputational talk that had been the norm and instead to argue their ideas in a productive manner. The result was that both teachers were better able to diagnose and respond to the students’ learning processes thus raising the standard of their ability in maths.

**Secondary and beyond**

As students move up the education system, their areas of study become more and more differentiated. The focus is then on the importance of talk in a range of subjects, including language, mathematics, science and humanities. In the first study in this section, the writer looked at the role of talk in helping her class of boys tackle their writing problems.

Contrary to what she had been led to expect with regard to boys’ performance in class, Beattie (2007) noted that the boys in her Year 8 literature classes in the UK had no difficulty in taking part in discussions. They did not individually try to dominate the discussion but cooperated with each other. As a result, the discussion led to some sophisticated ideas being discussed. However, when the boys were then asked to write on the same topic, they had difficulty even beginning the process and the results were poor. During the discussion, Beattie had noticed that the boys looked for assurances from her (their teacher) and their peers when they spoke and she hypothesized that it was the dialogic nature of the discussion that had helped the boys develop their ideas. However, the discussion held prior to the writing task did not help in the writing. She subsequently found that allowing the boys to complete the writing process together in class in cooperative groups helped. She found they shared their writing willingly, sought opinions and were much better prepared to redraft what they had written.

Mercer, Wegerif, and Dawes (1999) believed that language had three important functions: cognitive, social/cultural and pedagogic. They suggested that teachers needed to help students use the three functions by developing exploratory talk (see also page 29 of this Digest) in order to improve their talk with group peers. In exploratory talk, students encourage all members of their group to contribute to the discussion, challenge contributions while explaining the justification for the challenge and then offer alternatives until finally a group decision is reached. Mercer et al. (1999) showed in a study in three middle schools in England that such exploratory talk could be developed with appropriate material. However, they could not show a statistically significant increase in thinking skills, which they put down to the small size of the experiment and variation in the teaching by different teachers.

In a subsequent article, Mercer (2008) reported on the results of research done with a group of 8 to 11 year-olds in the UK divided between matched experimental and control schools. In the experimental schools, different types of classroom practice (teacher-led whole-class sessions, talk between a teacher and members of a small group and talk within student groups) were integrated within an overall pedagogic design over several months. Teachers introduced some ‘ground rules’ that encouraged reasoned debate and exploratory talk in class. The researchers used Raven’s Progressive Matrices test as a pre- and post-test to assess the students’ reasoning both individually and in groups. The post-tests showed that groups from the experimental schools were better able to solve together the problems on the test than those from the control schools. Moreover, individuals from the experimental schools were also better
able to solve the problems when working on their own than individuals from the control schools. Mercer (2008) suggested that this could be because the students from the experimental schools had learnt the problem-solving strategies from their groups or it could be that their reasoning skills had improved because they had ‘internalized’ exploratory talk or it could be because of a combination of the two. One other result was of interest. The experimental students showed significant gains on tests of maths and science.

Pantaleo (2011) reported on her work with a class of 12-year-old students in British Columbia, Canada. In her article, she focused on one group of three students, two of whom came from non-English speaking homes. She showed, using selected sections of the transcripts of their group work, how they worked together to develop ideas about the book they were looking at and at how they then incorporated those ideas into their writing about the book.

Pantaleo (2011) indicated that it was the collaborative nature of the talk that allowed the students to develop their ideas through exploratory talk. She suggested that this may not always come naturally to students. The teacher’s own pattern of oral communication in the classroom would signal to students the kind of talk expected. Professional development and self-monitoring by teachers through audio- or video-recording their own teaching could help them analyse how well they encouraged student talk. They could also help students to look at their group talk and examine how participants contributed to the group’s thinking.

Hogan, Rahim, Chan, Kwek, and Towndrow (2012) approached the question of student talk from a different point of view. They noted that studies had shown that, in classrooms throughout the world, the Initiation, Response, Evaluation (IRE) sequence was dominant. Generally, this was seen as an issue as it was felt this situation restricted students to performative talk, i.e. to giving short, factual responses, and prevented the development of dialogue. However, Hogan et al. (2012) hypothesized that the strong results of Singapore students in international testing suggested that the dominant IRE sequence could lead to other types of talk such as procedural talk (about how a problem could be solved) and conceptual talk (for example, about meaning and explanations). They surveyed over 1,000 secondary students in 30 randomly selected Singapore schools with regard to questions asked in mathematics classes and found evidence that suggested that other forms of talk could result from the IRE sequence.

Chin (2006, 2007) discussed the questioning used by teachers in science classes she observed in Singapore. She suggested that, as a result of the large class sizes, the constraints of having to cover the prescribed curriculum, and the pressures of examinations, teaching was dominantly whole-class instruction or discussion. However, she distinguished between the authoritative approach where the teacher leads students through a question and answer routine to present one specific point of view and the dialogic approach where the teacher encourages original contributions from the students. She identified four categories of question routines of the dialogic type: Socratic, verbal jigsaw, semantic tapestry and framing. She noted that in many cases the questioning followed the common IRE pattern but felt that this could be appropriate if the teacher planned the questioning carefully to develop student knowledge by building on their responses. She did, however, recognize the limitations of her studies which inferred cognitive functions from verbal data and assumed that one student voice represented that of the whole class.

In a discussion of the teaching of maths in the early years of secondary school, Daykin (2004) complained that there was a perception that maths was less language-dependent than other subjects such as the humanities and sciences. In contrast, he suggested that high-quality maths teaching could not take place unless students frequently communicated their ideas orally as cognitive, metacognitive and linguistic development were especially closely linked in maths. He believed that such skills as hypothesizing, generalizing, predicting, testing and verifying were linguistically and cognitively
closely related developmentally.

Daykin (2004) suggested a number of simple approaches that could be used to achieve increased talk in the maths classroom. These included teachers asking students to explain their thinking, giving more wait-time after questions, praising all contributions, encouraging students to expand on their answers and avoiding answering the questions themselves. He warned that results would not be immediate as it would take time for students to acclimatize to the new conditions.

Drawing on the work of Cummins (1984), Daykin (2004) suggested that there were two ways of simplifying difficult tasks, especially in the earlier stages of maths. The teacher could either make the task and related language less cognitively demanding or move it into a context that could be more easily understood. He claimed that students must learn the concepts and related language in preparation for later, more complex concepts that built on the concepts that were currently being learnt. It was thus better, he suggested, to give a relevant context that helped with the understanding of the concept rather than simplify the language and/or concept.

One particularly interesting activity that Daykin (2004) suggested was giving pairs or groups within the class different tasks to solve. They had to then explain the task and how they had solved it to the rest of the class, who would later be required to do the same task for homework. The class was allowed to question the reporting pair or group. In this way, the whole class had an interest in the explanation being given.

In a study in Singapore, Pang and Dindyal (2012) focused on a group of junior college students who were studying mathematics. They looked at the errors that the students had made on a test item involving the use of Proof by Mathematical Induction (PMI). Through interviewing a selection of the students, they were able to see where the students had gone wrong. Moreover, they learnt that even some of the students who got the item correct had not really understood the principles behind the computation and were thus unable to explain why some of their fellow students’ answers were incorrect. Some admitted they mechanically did what they had been taught to do although they could not explain their answers. Pang and Dindyal (2012) noted that having students talk about their understanding of concepts provided teachers with the opportunity to understand their students’ difficulties and thus to strengthen their own pedagogical content knowledge.

Dannels (2001, November) discussed the need to learn communication skills at university level in order to satisfy the requirements of future employers for employees who could work in multidisciplinary collaborative teams. In one study, she compared two groups of students given a chemical engineering design group task which they had to present to a mixed audience of chemical engineering faculty, representatives of sponsoring industries and fellow students. Each group consisted mainly of chemical engineering students but also included students from industrial engineering, food science, computer science and economics. The experimental groups were given tuition in speaking and writing communication skills. In their presentations, the experimental groups actually scored lower than the control groups. Dannels (2001, November) suggested that this might have been because the students were already in a new, stressful situation and adding the communications course at that point might have compounded the problems. Perhaps more importantly, feedback from the students showed that group members had difficulty explaining their ideas across disciplines so the final presentations ended up as disjointed collections of their ideas. They also had problems deciding on the best way to deal with the very mixed audience they had. Dannels (2001, November) suggested that the students needed to learn how to communicate their knowledge and understanding to different audiences as part of their courses.
Teacher professional development

While the main consideration in this Digest is how oral language is used to help in the cognitive development of students, questions inevitably arise regarding two related areas: the language skills of the teachers themselves and the teachers’ real understanding of the role of language in their teaching and the students’ learning.

It may seem that the first of these would be a question relevant only to education systems such as Singapore’s where teachers are sometimes heard using a local language variety (Singlish) rather than the standard espoused by the system. However, Ferst (1999) reported on a case in the UK where a trainee failed his first teaching practice due to poor oral skills. The complaint was that he used the pronunciation and grammar of his local dialect. Ferst (1999) worked with the teacher in order to help him through his second teaching practice. It was apparent in the sessions that the trainee teacher felt that the language he used was part of his identity and he felt uncomfortable using the more standard forms. Ferst (1999) encouraged him to see the learning of the standard forms as an additional resource that he could use in relevant contexts. She felt it was also important for teachers to understand that it was incumbent on them to help their students develop skills in the standard language as this was the prestige variety and its use could open up employment and other opportunities for their students.

Ferst (1999) emphasized that the success she had with the trainee was based on the building of a relationship of mutual trust. They worked together on developing a programme and, at all times, she showed respect for him and the local variety he spoke. She felt that, without such a relationship, it was quite possible the trainee’s bruised ego would have prevented him accepting the assistance she offered.

In terms of pedagogy, the study in a New Zealand primary school by Alton-Lee et al. (2010) mentioned on page 34 of this Digest showed the importance of professional development that involved teacher reflection. Both teachers involved in the study had previously been engaged in a numeracy development project that had looked at ways of getting students to talk but they had adapted what they had learnt to fit into their established practices. In the study, they worked with one of the authors to look in detail at how they taught and how this affected their students. As a result, they were able, over the period of the study, to change the way their students participated in the class and worked together as co-learners. Alton-Lee et al. (2010) felt it would probably be too much to expect such transformational self-reflection in pre-service training as the teacher trainees would not have enough of their own teaching to review. However, in this example of in-service professional development, the benefits in terms of the students’ learning left little doubt about the importance of such reflection.

Assessment

The approach to assessment that is adopted within an educational system inevitably affects the approach to learning and teaching that is found in schools. Administrators, teachers, parents and students are all aware of the importance of assessment especially in results-oriented educational systems such as that of the UK.

Hodgson (2007, 2008) reported on the trial of an oracy assessment system for schools in Wales. The materials were based round text from Gulliver in Lilliput and involved pupils at Key Stage 2 (their sixth year at school) developing and presenting a story and a presentation on a famous person. The pupils’ home background varied from totally Welsh-speaking to totally English-speaking. The five teachers in the study reported that the pupils had really enjoyed the tasks they had been given, the teachers had been surprised by the quality of some of the presentations, they had found they had been able to learn a lot about the pupils’ strengths and weaknesses and the pupils were able to evaluate their own performances.

Similarly, Oliver, Haig, and Rochecouste (2005) reported on a study they did in 13 secondary schools in Western Australia that looked into how teachers assessed the oral skills of their students. This was usually done through ‘performance’ tasks, such as presentations, despite the fact that some teachers realized that giving presentations to their peers was a very painful experience for many students. Some of the teachers seemed to
see oral skills and presentations as synonymous but many also recognized that there were social and discussion aspects that were also important areas to assess. Unfortunately, they did not feel competent to assess these other areas.

A number of teachers in the study emphasized the importance of oral skills across the whole curriculum. They noted the importance of oral skills in the development of general literacy and in content areas. Their students also recognized the importance of oral skills for their future. They saw that, in the workplace, they would need to be able to persuade, show empathy and explain in standard Australian English but they were not very confident of doing so even with people of their own age. As young adolescents, they used language forms that they felt emphasized their identity but recognized this would be inappropriate at work. Oliver et al. (2005) felt it was important that teachers be helped to set up assessment of the oral skills that focused on those aspects that would be important for students in their future workplace and help students see the relevance.

Gan (2010) reported on a study of the group discussion task in the oral test used in Hong Kong. A comparison of a high scoring group and a low scoring group showed a big difference in the type of discourse used in the task. In the high scoring group, the participants first established what the required task was and then worked towards a solution by offering suggestions, counter-suggestions and reasons for any suggestions. Their enthusiastic involvement in the task was indicated by overlaps in turns and interruptions.

In the low scoring group, the participants simply offered their individual contributions to each part of the task and then moved on. However, Gan (2010) pointed out that there was still cooperation but, in this group, the focus of the cooperation was on language rather than on the content. When a participant was unsure how to say something, other members in the group offered assistance. Gan (2010) noted that the teacher of the second group had adjusted the task (as was allowed) and provided the low level group with supporting questions. This might have resulted in the group feeling that the task required simple, individual answers to the given questions rather than the kind of discussion used by the high scoring group.

Gan (2010) concluded that the group task authentically represented the interactional skills of the students. However, there was a need to look into how variations in the task given might affect the students’ understanding of what was required and thus how they performed.

Doherty, Kettle, May, and Caukill (2011) noted the importance that employers placed on communications skills including oral skills. This, they noted, had resulted in a growing emphasis on oracy in university courses that prepared students for the workplace. In order to examine the role of oracy in such courses, they compared a business course (with 1,000 students) and an information technology course (with 360 students). In the first course, assessment included a group written project. While there was no help given to students as to how to communicate and work with each other, the areas of assessment included ‘professionalism’. Where group communication broke down, the individual members were marked down on this component. Doherty et al. (2011) suggested this was an example of ‘oracy for learning’, i.e. oracy was seen as a tool for learning in all subjects.

In the second course on information technology, the students worked in teams, keeping minutes of their meetings, team evaluations and team reflections. Assessment included a group presentation of a project that was preceded by two tutorials preparing and practising the presentations. The assessment then focused on oral performance rather than content. Doherty et al. (2011) suggested that, in this case, the focus was on ‘oracy as a competence’, i.e. oracy was seen as a subject in its own right.

Doherty et al. (2011) suggested that there were some validity issues in including oracy in assessment that needed to be solved. Validity was an issue when assessment areas included a skill that had not been taught but it was also an issue when the ‘authentic’ test activity was assessed.

As young adolescents, they used language forms that they felt emphasized their identity but recognized this would be inappropriate at work.
differently from the way it would have been in the workplace.

**Conclusion**

The studies reported in this Digest suggest that, at the different levels of the various education systems around the world, talk in the classroom is essential to the cognitive and linguistic development of students across the curriculum. However, it seems that the restrictive forms of the IRE sequence are still dominant in classrooms, partly because teachers are sometimes unsure of the practicality of the alternatives. Yet, it is through classroom talk that teachers can more easily monitor the students’ understanding of complex concepts across subject areas and be in a position to take remedial measures before it is too late. It is also through such talk that students develop the thinking and language related to the subjects they study.

Westgate and Hughes (1997) noted the difficulty of identifying the qualities of appropriate classroom talk and how these can be measured or quantified. They felt there was an important need to identify the strategies that teachers could use to help students develop the kind of talk that would benefit them rather than having them indulging in easy-going discussion and opinionated vagueness that some authorities had suggested resulted from group work. Armed with such strategies, teachers in all classrooms would be much more confident in encouraging the kind of classroom talk that would help their students learn. The studies presented here provide some suggested strategies.

However, it is to be hoped that their call is taken up by even more researchers so that teachers can be given research-backed practical guidance on how they can encourage the kind of classroom talk that the research reported here seems to indicate is essential to the linguistic and metacognitive development of our students across the whole school. Moreover, as suggested by Doherty et al. (2011), some consideration needs to be focused on how oracy and communication can be taught, learned and assessed validly as part of the subjects the students are studying.

**References**


Assessment of Disciplinary Literacy

Summary

This digest focuses on the assessment of disciplinary literacy in the classroom, which is a relatively new area of study. There have been comparatively more studies looking at the assessment of disciplinary literacy in science and history classrooms than in other subject matter classrooms. These studies suggest that the use of self-assessment tools such as scripts and scoring rubrics can help students develop the discipline-specific skills required in written and oral assignments. This digest provides suggestions on how future research on the assessment of disciplinary literacy could be conducted so that teachers could implement effective assessment practices of disciplinary literacy in the classroom.

Introduction

Assessment of disciplinary literacy is an emerging area of study. As Shanahan and Shanahan (2014) pointed out, the testing of disciplinary literacy is a new idea and standardised disciplinary reading and writing tests are not currently available. Moreover, not all subject matter teachers welcome the practice of disciplinary literacy as they may feel that they are not prepared to teach literacy as well as content. However, Carney and Indrisano (2013) noted that American teachers are now responsible for apprenticing their students into the literacy practices specific to their discipline. The question is how these disciplinary literacy practices will be assessed in the classroom.

Conducting research in assessment of disciplinary literacy is important because assessment has the role of supporting learning and helping raise student achievement (Black & Wiliam, 1998). It is part and parcel of the daily life of teachers and students. Through the collection and examination of evidence of student performance, teachers are able to make informed decisions regarding the students’ achievement of the learning objectives. This then leads to further action from the teachers. For example, if a teacher were to assess the disciplinary literacy skills of a science student by examining the student’s use of evidence in a scientific argumentation essay and discovered that they did not use the relevant evidence to support the claims that they made, she would design a follow-up lesson to help students learn the discipline-specific literacy skills.

Although general principles of assessment may be learnt through a generic teacher education programme, the content and context are paramount in the implementation of such assessment principles (Edwards, 2013). According to the American Federation of Teachers, National Council on Measurement in Education, and National Education Association (1990), teachers should be skilled in choosing and developing assessment methods appropriate to instructional decisions regarding the subject, the level at which the subject is taught as well as the profile of their students. In this digest, we will be specifically looking at how educators could assess disciplinary literacy within content areas.

This digest will focus on formative assessment of disciplinary literacy within content areas, in particular, science, history, geography, and mathematics. Different disciplines have different assessment practices in disciplinary literacy. The assessment in each discipline communicates what knowledge is valued and equated with achievement in that discipline (Edwards, 2013). This is because, Edwards (2013) explained, by choosing what to assess and what not to assess, educators are indirectly communicating to students the aspects of the curriculum which are more important or less important to disciplinary practitioners. After all, it is generally the assessment instruments that dictate what
teachers teach and students learn. To make disciplinary literacy a focus in the classroom, it must also be a focus in assessment practices.

Science

Edwards (2013) pointed out that science teachers should know the important dimensions of science learning, suitable assessment methods, and specific approaches and activities. He argued that science teachers’ assessment capability is closely linked with the science teaching context. Abell and Siegel (2011) underscored that a science teacher’s pedagogical content knowledge for assessment is related to a core set of values and principles about science learning and assessment that guide assessment decision making. These values and principles, they affirmed, interact with four categories of science teacher knowledge of assessment: (a) assessment purposes, (b) what to assess, (c) assessment strategies, and (d) assessment interpretation and resulting actions. These four categories also interact with one another.

In considering what to assess, teachers need to look at the literacy practices in their particular discipline. These vary across and within subject disciplines. For example, Carney and Indrisano (2013) contended that each discipline has its own text types that represent the ways of thinking in the domain. Indeed, Unsworth (2001) listed types of written practice that are associated with science, such as procedural recounts, explanations, descriptive reports, expositions, and discussions. Certain genres or text types such as procedural recounts are associated more with science and it is highly unlikely that they would be used in disciplines such as literature or history. Even within science, Unsworth (2001) noted that the use of particular genres tends to vary across fields. For example, in less well established areas of the discipline such as eco-science, genres featuring exposition and discussion tend to be more prevalent.

Science teachers often have to pay particular attention to scientific terminology, another area related to literacy. Morgan (2012) investigated how one science teacher in an Australian middle school assessed her students’ prior knowledge of scientific vocabulary to describe a bridge by asking them to write a description of a bridge that the students chose together after having viewed a selection on an interactive whiteboard. Assessing the students’ written work, the teacher found that both competent and developing writers in her class lacked knowledge of technical language required in the subject discipline.

Based on this assessment of the initial writing task, the teacher was able to prepare a lesson plan to address the lack of technical vocabulary in science. For example, she introduced explicit vocabulary building activities and contextual use of the technical terms to explore their meanings and use. They included (a) using the terms in spelling lists, (b) developing ‘like word’ lists and taxonomies of related terms, (c) the teacher modelling sentences and extended prose writing using these terms, (d) labelling of diagrams, (e) joint teacher and student construction of texts using these terms, and finally (f) students independently constructing texts using these terms.

After having done the activities described above, the teacher asked the students to repeat the baseline data task of describing the bridge. The writing samples collected indicated that the students’ writing had become more complex. Students were able to extend their writing and use more precise technical terms. For the more advanced students, their texts had become shorter as the precision of the terms that they used to describe attributes of bridges reduced the need for long explanations in non-scientific language. Students who had written a single sentence in the baseline writing test were subsequently able to write several and also included a number of terms from the glossary and class discussions. Students who had written several paragraphs at the initial writing task wrote texts of similar length but with more concise language such as ‘The Erasmusbrug is a cable-stayed bridge with a modern abstract design … the sub-structure is very detailed … on one side of the main support there are two thick cables connected to the deck. On the other side there are many more, thinner cables … It has a large, stable frame which is supported by the sub-structure’. It was a major improvement because, as Morgan (2012) pointed out, in the initial writing task, students tended to use cumbersome plain language descriptions of the bridge such as ‘it is slightly bent towards the top, but is only bent for
a good appearance’.

In this study, the teacher was able to use her initial assessment of her students’ level of scientific vocabulary to introduce literacy activities supporting the learning of the scientific vocabulary that students needed to be able to adopt their new roles as scientists and write like them. This resulted in increased student interest in writing, with students taking pleasure in having a wider vocabulary to draw upon to explain their ideas.

In a study conducted in two American primary schools in the Pacific Northwest, the two teachers involved allowed students to self-assess and provide feedback to peers, as they introduced important scientific language, tools, and practices of investigation. It was found that students achieved significant gains in communication scores, indicating that they had gained mastery over the language and practices of scientific presentations and writing (Herrenkohl, Tasker, & White, 2011). The communication score was one component of the total project score that included asking questions, developing descriptions, explanations and models, analysing alternative explanations, scepticism, and extending the research.

The two teachers involved in the study encouraged meta-talk by asking students about their ideas, and by building upon them as a learning opportunity. The first teacher reviewed the differences between the scientific terms – theory and hypothesis – by revisiting a sample project and by pointing out to students the advice in the Web of Inquiry system regarding the differences between these two terms. The Web of Inquiry is an interactive website where students carry out scientific inquiry projects to develop and test their theories; learn scientific language, tools, and practices of investigation; and self-assess and provide feedback to peers. The teacher also introduced a set of scientific terms that were new to her students after having found out that they were unfamiliar with scientific language.

To help her students understand the new scientific terminology, she linked their everyday experiences to the new terms. Using an example about the relationship between breakfast and schoolwork, she introduced the concepts of theories and variables, and actively led students towards building a plausible theoretical model that not eating breakfast might have a negative effect on performance on schoolwork. She drew circles around each independent variable and boxes around dependent variables, underscoring the differences between independent variables such as type of food and digestion time and dependent variables such as concentration and energy. She then connected the circles to the boxes to show the possible relationships between these two types of variables. Subsequently, she connected this graphic representation to a scientific explanation of theories, hypotheses, and experimental design.

After an experiment regarding the effects of standard and flood conditions at a river delta, she asked students to explain the differences in the observable patterns between standard and flood conditions. She referred them back to the scientific language used in the Web of Inquiry software that encouraged students to identify patterns among independent and dependent variables. Using guiding questions, she asked them to think aloud about the explanations for these patterns. Her students wrote down what had been discussed in the Web of Inquiry report and presented their results orally to their fellow classmates in the way that was modelled by their teacher.

In summary, before assessing the oral presentations and written reports on their science projects, the first teacher led her students through the process of developing theories and hypotheses, designing experiments, collecting reliable data and analysing it around the content area of landforms. She framed science as a way of exploring the world based on uncertainty, where data are used in scientific argumentation to support the theoretical positions taken by scientists. To help her students act like scientists, she used compelling examples from real-life

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**Through their class presentations and written reports, students were assessed by their teachers and peers on how they functioned like scientists in their community, and on how they used language like scientists to communicate to their audience.**
scientific work to engage their thinking and change their practices to move towards the model of inquiry presented by the Web of Inquiry. She encouraged students to use scientific argumentation and viewed student oral presentations with follow-up question-and-answer sessions as opportunities for students to practise these argumentation skills. She used their sessions of planning their final presentations as opportunities to draw out scientific thinking and to challenge students to review their findings by emphasizing multiple hypotheses and theories so that her students could communicate like scientists in the final assessment on oral presentations. She probed their understanding and modelled questioning that they might encounter from their peers who represented the community of scientists.

The second teacher facilitated classroom discussion using questioning and voicing techniques, creating a space for intellectual discussion which valued all student contributions. She used students’ thinking as a starting point, focusing on intuition and the following up of students’ observations of the world by helping students design experiments based on thoughtful reasoning. She gave students opportunities to test their hypotheses and retest them with more experiments because the same phenomenon could lead to different hypotheses and experiments. She wanted students to know the importance of developing alternative hypotheses through her lessons.

During class time, she asked students to use their prior experience and understanding to verbally generate possible theories about heat gains and losses. She led them through a process of articulating a possible theory based on their observations from their lives and then turning it into a research question for investigation. She documented the research questions as their thinking changed. She spent time helping her students collect evidence and data in large classroom data tables. Subsequently, she led students in the designing of an experiment to test the change in temperature of a fixed volume of water in the sun compared to that in the shade. She led them through discussion of the issues involved in the planning and design of an experiment. After the experiment, she discussed with them the potential methodological issues that could have affected the patterns of data. The students voiced out the possible explanations for the data inconsistencies and tried to reconcile their findings with their initial hypotheses.

The instructional practices of these two science teachers showed that they could help students learn the language of science, scientific tools and practices of investigation. Through their class presentations and written reports, students were assessed by their teachers and peers on how they functioned like scientists in their community, and on how they used language like scientists to communicate to their audience.

Sandoval and Millwood (2005) underscored that explanations are a central artefact of science and that their construction and evaluation imply core scientific practices of argumentation. Thus, science teachers had to assess whether their students were engaging in the right kinds of argumentative practices and whether the arguments made sense. Students, they felt, needed help from science educators to coordinate evidence with their causal claims. Students had to cite appropriate data to warrant their claims by pointing to specific features of inscriptions such as graphs and diagrams in their explanations to support a claim. That is, science educators needed to help students learn how to construct scientific arguments.

Sandoval and Millwood (2005) highlighted that there were two important points regarding the practice of argumentation in science. The first is that scientific theories are not discovered in the world but are explanations constructed to make sense of the world. The second point is that scientific theories are accepted on their degree of persuasion rather than on some inherent truth. In order to make sense of the world and to propose persuasive accounts of how things happen, scientists combine various forms of inscription, i.e., graphical representations of objects of interest such as a photograph of a bird, a graph or a table of numbers, into persuasive arguments. Thus, students who are novice members in the discipline of science need to master these inscrptional and argumentative practices.
Sandoval and Millwood (2005) found that in their intervention study which used an explanation software to help 87 high school American biology students in two Midwestern schools write about the content of their explanations on the topic of natural selection, students were attentive to the need to cite data, but they did not provide sufficient evidence to support their claims in writing. Their references to specific scientific inscriptions (e.g., graphs, tables, diagrams) or evidence in their arguments frequently failed to relate specific data to specific claims. The authors proposed that, to change students’ ideas about the nature and role of scientific inscriptions and of arguments, teachers had to create a sustained scientific discourse. This could be achieved by creating peer assessment situations within the classroom context in which students challenged each other’s claims and evidence. The students could consider in greater depth what particular inscriptions meant and how they combined to produce converging evidence for or against particular explanations because they were assessed on their inscrptional and argumentative practices deemed important by scientists.

Science teachers designing rubrics should take into account content and language development when they plan the assessment of student learning, including disciplinary literacy relevant to the content area. These rubrics have to align with the learning objectives of the lesson or unit. For example, Bergman (2013) identified that one language objective in Grades 9 to 12 is for students to be able to express if-then statements to a partner about the different plate boundaries in an earth science lesson while the content objective is for students to be able to identify four types of plate boundaries. However, Bergman (2013) pointed out that, to promote scientific inquiry, it might be better to offer in the rubric clear communication of expected lesson outcomes but to avoid revealing any learning outcomes before the appropriate moment. For instance, the teacher could tell students that the lesson outcome was to investigate the properties of alkali metals but avoid telling them what would happen if alkali metals were to react with water. Students would then come to their own conclusions at the appropriate moment.

**History and Geography**

For the discipline of history, the heuristics of sourcing, corroborating, and contextualisation that historians use to help them develop their situation model of events from the multiple texts that they have read, is paramount. The assessment of these skills in history is usually done with a writing task associated with a rubric. To investigate the effectiveness of more content-focused versus heuristic-focused instruction with the use of multiple texts or a traditional history textbook, Nokes, Dole, and Hacker (2007) conducted an intervention study that assessed the learning of these skills by 246 11th-grade American students in two secondary schools in four conditions: (a) traditional textbooks and content instruction, (b) traditional textbooks and heuristic instruction, (c) multiple texts and content instruction, and (d) multiple texts and heuristic instruction. Only the heuristic instruction explicitly taught sourcing, corroborating, and contextualisation.

After a three-week intervention, students were re-administered the content knowledge and heuristics essay tests that they had taken before the intervention. The results showed that students who read multiple texts scored higher on history content and used sourcing and corroborating in their essay test more often than students who read traditional textbook material. Moreover, students who read multiple texts with a focus on heuristics outperformed in historical content those who read traditional textbooks irrespective of whether the focus was on historical content or heuristics. Students who read multiple texts and were taught heuristics also performed significantly better in sourcing and corroborating than students in other groups. Thus, to help history students gain a deeper understanding of history and allow students to think and write about history as historians do, teachers should plan assessment tasks that require students to read multiple documents that enable them to engage
in the heuristics of sourcing, corroboration, and contextualisation in their writing.

De La Paz and Felton (2010) assessed the written work of low to average 11th-grade students who had received historical reasoning strategy instruction compared to those who had not. The 79 students in the control group read the same primary and source documents and received feedback on written essays on the same topics as those in the intervention group. They found that compared to students in the control group, the 81 students who received historical reasoning strategy instruction wrote essays which were rated as having significantly greater historical accuracy, and were significantly more persuasive, with more elaborated claims and rebuttals within each argument.

The students in the intervention group were taught the first component of the historical reasoning strategy Consider the Author. They were taught to consider the following points:

1. Occupation and credentials of the author;
2. How the author came to know about the events (whether the author was an eyewitness or whether he/she had first-hand information or whether the author was relying on hearsay);
3. Date of written document (whether the author wrote the document after the event had occurred, and had the opportunity to select the information to include in the account); and
4. Effect of author’s viewpoint on his argument (The author’s motivation in writing the document influences its content. Students need to evaluate the author’s opinion to see the extent to which it seems biased or provides a full and complete account of the events.)

Students were then taught the second component Understand the Source. They had to consider how the type of document (e.g., an actual treaty, a personal letter) would reflect different values of the author. The type of document also tells the reader whether it is a record without interpretation or a concise overview or an interpretation evaluated by informed peers. Students needed to find the assumptions underlying the argument and the world view of the source. They were expected to use the assumptions to critique the source. The world view of the source was defined as the overall opinion about the topic, which students had to figure out by looking at the accuracy of the facts in order to arrive at their own conclusions.

Subsequently, students were taught the third component Critique the Source which is the process of corroboration involving the comparison of the details of one source against those of another in determining the trustworthiness of the source. Students were taught to look at the details within each source as well as across the sources with the following questions:

1. What evidence does the author give?
2. Are there any factual errors?
3. Is anything missing from the argument?
4. What ideas are repeated throughout the readings?
5. What are the major differences in ideas?
6. Are there any inconsistencies? and
7. Does the evidence prove what it claims to prove?

Finally, students were taught the fourth component Create a More Focused Understanding where they were prompted to look at what was open to interpretation, what was reliable and credible, and how each source deepened their understanding of the historical event in order to come to a more focused understanding.

After describing and modelling the historical reasoning strategy, the social studies teachers showed students the writing strategy, a sample structure for writing, a list of transition words, and then used the sample essay to show students how the author of the essay had located the evidence in the documents and how it exemplified elements of text structure. In the next lesson, the teachers used additional essays previously written by students to point out the missing components of these essays and to highlight what worked well in them.
The results of this study indicated that the experimental group students were able to write more elaborated claims in the post-test despite an initial disadvantage in the development of claims and overall writing quality in the pre-test compared to the comparison group students. The students’ writing showed disciplinary thinking that one would expect of historians. Their writing demonstrated that they understood relationships between series of events that they had read about in the primary and secondary sources. They also used more document citations and quotations to further their arguments in the post-test. This study used explicit instruction on what it means to engage in disciplinary literacy activities in the classroom. Students were repeatedly exposed to document-based questions combined with direct instruction in historical reasoning processes along with exemplars, which is one of the recommended practices in assessment. As a result, low- and average-achieving students could demonstrate high levels of writing proficiency compared to their comparison counterparts. The guiding questions and exemplars given to students helped them understand the specific literacy skills assessed in history.

In one higher education setting, it was found in a study conducted by Rouet, Favart, Britt, and Perfetti (1997) that, after having studied seven documents regarding a specific historical event, eight French graduate students in history (i.e., discipline specialists) included more contextual statements in their writing than 11 graduate students in psychology (i.e., discipline novices). The statements from history graduate students were also more focused and elaborate. History graduate students tended to write historical context statements that referred to general historical knowledge or principles while psychology graduate students tended to write general context statements that referred to principles not specific to historical reasoning. In other words, the discipline specialists also expressed an opinion about the structure of the problem space, i.e., the interpretations that could be found in the documents, whereas most discipline novices expressed an opinion about which side was right. Discipline specialists included more contextual statements than discipline novices. These contextual statements were divided into (a) problem context statements referring to the specific context of a historical event, (b) historical context statements referring to general historical knowledge or principles, and (c) general context statements referring to principles not specific to historical reasoning. Specialists tended to use historical contextual statements in their essays as well as more sophisticated reasoning strategies combining sourcing, corroboration, and contextualisation heuristics in a single thread of argumentation. It can be seen that history experts value historical context statements and use multiple heuristics of sourcing, corroboration, and contextualisation in their writing. Teachers should therefore design writing tasks that assess these aspects, which are important to discipline specialists, so that students are encouraged to focus on them as part of their learning of the discipline.

In the discipline of geography, Panadero, Tapia, and Huertas (2012) compared the effects of two assessment tools, namely rubrics and scripts, on the writing skills as well as self-regulation and self-efficacy among 120 secondary school students from two public schools in Spain. The authors defined rubrics as self-assessment tools with three characteristics: (a) a list of criteria for assessing the important goals of the task, (b) a scale for grading the different levels of achievement, and (c) a description for each qualitative level. Scripts were defined as specific questions structured in steps to follow the expert model of approaching a task from beginning to end and specifically designed to analyse the process followed in doing the writing task although they could also be used to analyse the final text produced.

Two social science experts with vast experience in analysing landscapes established the assessment criteria for the writing task. The questions for the scripts as well as the scoring categories for the rubric were based on those assessment criteria. The script to learn how to analyse a landscape and write the text comprised five components. The first component was the general impression of the landscape. The second was perspective with the following questions:

1. From where am I seeing it?
2. Are there different planes? and
3. What is in each of them?

The third component comprised features which were subdivided into natural and human features. The questions on the natural features included questions on relief forms, types of vegetation, presence of rivers, amount of rainfall, and the colours of the landscape. The questions on human features included questions on the location, type, and shape of settlements, and questions on the presence and type of communication routes, and economic activities.

The fourth component was the interpretation with the question, What natural, human or both features contributed to the landscape looking the way it does? The questions on natural features included the type of soil, weather, erosion and sedimentation, earthquakes, and constructing agents such as volcanoes and coral. The questions on human features included What activities modify the landscape and What effects do they have?

The last component was classification of the landscape. The questions helping students to classify the landscape included Is the landscape mostly natural?, Is the landscape mostly agrarian- Are there farms and cultivation?, and Why do I think that way? The criteria for the scoring rubric mirrored the five components for the scripts.

Panadero et al. (2012) found that the use of self-assessment tools promoted a higher level of self-regulation while students went about the steps required to do the writing task than if no self-assessment tools were provided. Scripts seemed to improve self-regulation more than rubrics. They also found that the use of self-assessment tools increased the quality of student writing. They felt that the use of rubrics and scripts had a positive effect on student writing because they included the key aspects relevant for the writing task.

Mathematics

There is a dearth of intervention studies on assessment of disciplinary literacy in mathematics classrooms. However, the work of Zhu, Zhu, Lee, and Simon (2003) may shed light on what type of mathematical language could be assessed. They pointed out that information in mathematics may be presented by verbal propositions or in diagrams or pictures of some kind. Different forms of representation are suited for different contexts and can also be combined in mathematics for solving problems efficiently. For example, in geometry, although formal proofs are carried out propositionally, diagrams are drawn to help comprehension. The authors gave the example of a theorem in the form of a verbal proposition: If two parallel lines are cut by two transversals that intersect in such a way as to bisect one of them, the triangles thus formed are congruent. If students draw a diagram in the proof of the theorem, they need not posit elements such as vertical angles at the intersection of the two transversals in their writing as these elements will have already been represented in the diagram. Thus, students could be taught to combine a variety of representations that may be efficient for solving mathematical problems.

The authors also suggested that students needed to be taught that, in mathematics, information comes both in the form of verbal propositions and diagrammatic representations because the diagram makes evident the existence of objects and relations between objects that are only implicit in the verbal statement. The diagram thus helps students to solve the mathematical problem. For students to take seriously the learning of this feature of maths, it is important that this be included in assessment processes. Students also need to know how to translate verbal propositions into algebraic propositions to solve certain problems and thus should be assessed on whether they are able to express themselves in the different forms of mathematical language.

Directions for Future Research

Very few studies that have a component regarding the assessment of disciplinary literacy have used an experimental or quasi-experimental design to show the effectiveness of the disciplinary literacy skills acquired. It is also not clear whether self- or peer assessment actually contributes to better student outcomes in literacy skills. Research also has not shown what
knowledge and skills teachers, especially primary school teachers, who tend to be generalists rather than specialists in the subjects that they teach, need to be able to teach disciplinary literacy skills effectively in the classroom.

In teacher education, there also needs to be a focus on assessment of disciplinary literacy as teachers will be responsible for teaching and assessing subject-specific literacy skills in the classroom. For example, Abell and Siegel (2011) asserted that there was the need to understand science teacher assessment literacy more deeply so that teacher preparation and professional development programmes could be designed to meet their needs. Fuentes et al. (2014) suggested that pre-service primary teachers might need to have additional preparation in the technical vocabulary of science and mathematics.

In using rubrics and exemplars to help students write more effectively, it is not yet known which types of assessment practices are most effective in each discipline. For example, in an experimental study conducted in Maryland in ninth- and tenth-grade biology, algebra, English, and government classrooms, Schafer, Swanson, Bené, and Newberry (2001) found that teaching students how to write using holistic generic rubrics and exemplars was effective for the subjects of algebra and biology, but not for English and government. The authors hypothesised that the rubric training that the English and government teachers had received did not have an impact on student work because the teachers were resistant to instructional change in response to their training in rubric preparation. They also felt that the clarity of the rubrics might have affected instruction in English and government classes. The lower exact agreement in scoring rates for English and government student written work seemed to indicate that the rubrics were open to multiple interpretations.

Panadero and Jonsson (2013) suggested that future research concerning formative assessment in the classroom should include the following:

1. The effect of the design of rubrics (e.g., holistic vs. analytic, few levels vs. several levels, task specific vs. generic);
2. The effect the use of rubrics has on students with higher levels of self-regulation compared to those with lower levels;
3. How students actually use rubrics through an analysis of student work at different stages of submission or through the use of think-aloud protocols;
4. Which meta-cognitive activities need to be used together with rubrics to influence the effects of rubrics (e.g., feedback, self-assessment, peer assessment);
5. The influence of gender on the use of rubrics and the possible mediating variables such as motivation and confidence; and
6. More experimental or quasi-experimental designs and the reporting of effect-size data to draw firm conclusions about rubric efficiency.

Conclusion

The quantity of research on the assessment of disciplinary literacy in different subject areas still varies a great deal. In some subject areas, there appears to be little or no material to date. It is therefore critical for discipline experts and literacy educators to examine together the disciplinary literacy practices engaged in by scholars in each discipline so that subject matter teachers can design assessment tasks that reflect these practices to which students are being apprenticed. To become a member of a given discipline, students have to emulate the reading, thinking, and writing practices of the community. Therefore, subject matter teachers need to plan their assessments - whether formative or summative - to help students acquire these practices. For example, in history, the historical reasoning strategies of corroboration, contextualisation, and sourcing are valued and should be assessed in history writing tasks. In science assessment tasks, teachers should assess how students combine inscriptions to form scientific arguments for a plausible theory.
Prior research has demonstrated that teachers can use self-assessment tools such as scripts and scoring rubrics to effectively scaffold the writing and oral skills required of students in some disciplines. Further studies are needed to examine whether the same can be applied to other areas such as government studies. Teachers can also model the use of discipline-specific terms and argumentation practices during questioning and discussion sessions that students will subsequently employ in their oral presentations and writing assignments. These instructional and assessment classroom practices will contribute to an increase in the level of disciplinary literacy found in student work in each discipline and will bring students a step closer to being full-fledged members of the respective discipline communities.

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Writing in the Different Disciplines

Summary

Each discipline differs from others in what counts as knowledge and the ways in which knowledge is created (Kamberelis, Gillis, & Leonard, 2014). This issue of the Digest begins by conceptualising the importance of writing in the disciplines. It then examines the disciplinary writing in the classroom through two lenses, looking at: one, how disciplinary experts (and learners) approach and produce written texts differently; and, two, how language use in each discipline differs from that in others as experts convey knowledge through the writing of texts in discipline-specific ways. Research on disciplinary writing generally falls into these two categories. The studies reviewed focus on both approaches’ mutual goal of distilling instructional strategies that are effective in helping students learn subject content matter and in developing their disciplinary writing. Such discipline-specific strategies include the explicit teaching of technical vocabulary, using model texts, making thinking processes explicit, and engaging students in the work of professionals in the discipline. These instructional strategies necessitate more opportunities for pre-service and in-service teachers to develop their understanding of what constitutes writing in their respective disciplines, as well as the instructional practices that improve students’ writing. The studies cited validate the benefits of professional development opportunities in the context of collaborative programmes. These studies emphasise exploring disciplinary distinctions in writing, identifying instructional practices that teach these distinctions, and importantly, validating the effectiveness of those strategies in the classroom.

Introduction

C. Shanahan and Shanahan (2014b) posited that there was a growing recognition that disciplinary distinctions exist beyond just content. One marked difference is in the way that knowledge is represented linguistically in the production and evaluation of writing in the different disciplines (Fang & Coatoam, 2013). For example, the conventions that writers follow for structuring arguments differ from discipline to discipline (Hyland, 2013). In science-based disciplines, knowledge is communicated by a process of accumulating the different components of an argument, following a set of strict rules (Paltridge, 2004). In history, however, arguments are produced interpretively, taking into account the strength of the evidence, the views of people in the past, the credibility of authors of texts, and the context of the argument in the time and place under consideration (De La Paz & Felton, 2010). Another writing-related difference between disciplines is the way that writers’ attributes are conceptualised (Gimenez, 2012). For example, in medicine, criticality requires good clinical reasoning, and understanding of evidence-based medicine and ethics, whereas in history it entails examining evidence as well as acknowledging ambiguity and the ideologies involved in a historical event (Jones, 2009). The implication of these disciplinary differences is that writing instruction should be customised to address the kinds of writing that represent the ways of thinking and communicating valued within each discipline (Draper, Broomhead, Jensen, Nokes, & Siebert, 2010).

Writing interventions

The literature on writing intervention is extensive. Writing often contributes significantly to learning (Bangert-Drowns, Hurley, & Wilkinson, 2004). Meta-analyses by Gillespie and Graham (2014), Graham, McKeown, Kuhiara, and Harris (2012) and Graham and Perin (2007) indicated that strategy instruction, which involved the direct and explicit teaching of students to independently use strategies for planning, revising, and editing texts, had a significant effect on the quality of writing.
across a diverse group of learners, including those with learning disabilities. Yet the findings from the research reviewed suggest that classroom literacy practices have not been adequate in preparing young people to write in the disciplines.

Studies demonstrated that the discursive practices of different disciplines appeared in texts and teacher talk in elementary school (Moje, 2010), in which students were increasingly exposed to information texts (C. Shanahan & Shanahan, 2014a). The instructional practices of elementary school writing, however, are not reflective of disciplinary writing (Cutler & Graham, 2008). In middle and high schools (Grades 6 to 12), the demands of texts are increasingly discipline-specific (Freebody & Muspratt, 2007), but research and policy studies reviewed by T. Shanahan and Shanahan (2012) indicated that students rarely received overt writing instruction, in either literacy or subject area classrooms beyond the seventh grade.

Each discipline holds particular ideas and beliefs about what constitutes knowledge (Kamberelis et al., 2014). These ideas, however, are rarely discussed or taught, and students’ difficulties in producing discipline-specific texts can be masked as linguistic problems throughout their education (Lillis & Scott, 2007). The findings from a report by the US Department of Education (Rampey, Dion, & Donahue, 2009) indicated that 25% of American high school graduates lacked the skills to meet the demands of college writing courses, and, as a result, the industry spent billions of dollars on professional courses to improve their workers’ writing.

In response to students’ poor writing performance, academics (e.g., Goldman, 2012; McConachie & Petrosky, 2010; Moje, 2007; T. Shanahan & Shanahan, 2012) have called for an increased emphasis on disciplinary literacy with the aim of equipping students to approach literacy tasks with a greater sense of agency and an appropriate set of responses in order to meet the increasingly specialised demands of the disciplines as they progress through school.

The previous issues of this Digest have cited a range of studies that suggest how students can better grasp the content of different subjects when they have mastery of the thinking and language practices that are specific to those subjects. This issue continues in the same vein with its focus on disciplinary writing. This review of approaches and instructional practices involving disciplinary writing covers a range of disciplines, from language arts and literature (e.g., Beattie, 2007; Faggella-Luby, Graner, Deshler, & Drew, 2012; Wilder, 2012), sciences (e.g., Stoller, Horn, Grabe, & Robinson, 2007), mathematics (e.g., Schleppegrell, 2007; Sinclair & Pimm, 2008), to humanities (e.g., Pytash & Morgan, 2014; Somerville & Creme, 2005). It also looks at a range of learners from elementary schools (e.g., Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012; Metz, 2008; Monahan, 2013), secondary schools (e.g., Coffin, 2006; De La Paz et al., 2014; Pytash, Edmondson, & Tait, 2014), and tertiary institutions (e.g., Gimenez, 2012; Hunter & Tse, 2013).

Academics have called for an increased emphasis on disciplinary literacy to equip students with a greater sense of agency and an appropriate set of responses in order to meet the increasingly specialised demands of the disciplines as they progress through school.

### Approaches to disciplinary writing

Moje (2007), in her review of the literature on disciplinary literacy, identified four approaches to teaching disciplinary literacy: (a) cognitive literacy strategies; (b) linguistic and discursive navigation across cultural boundaries; (c) epistemological processes of the disciplines; and (d) linguistic processes of the disciplines. These approaches are described briefly below.

#### Cognitive literacy strategies

Cognitive literacy strategies, such as Concept-Oriented Reading Instruction (Guthrie et al., 2004), focus on the role of the reader, emphasising his or her motivation in applying cognitive strategies to processing any text, whether rooted in the disciplines or found in everyday life. Thus, while such strategies have demonstrated positive effects on students’ reading and writing (cf., Graham et al., 2012), attention to specific demands of the practices and texts found in the disciplines is markedly missing, and disciplinary writing remains at a basic level.
Linguistic navigation across cultural boundaries

The second approach, teaching linguistic navigation across cultural boundaries, aims to get students to perceive texts as situation-dependent, mutable texts open to negotiation by the communities that use them. Writing instruction revolves around examining young people’s knowledge, text practices, and interests as a basis for teaching disciplinary text processes, and providing opportunities for them to practise navigating across the different discursive and linguistic communities of secondary schooling and their everyday lives.

Somerville and Creme (2005) have explored the approach in the discipline of archaeology. They studied the effects of introducing free writing—writing in prose for a set time without worrying about what or how the student writes—into a first-year archaeology course in a university in the UK. In the nine-week course involving 19 students, the development of archaeology as a discipline that encouraged making known diverse viewpoints (Joyce, 2008) was explored alongside three two-hour writing workshops run by a writing specialist. Each workshop ended with a 20-minute free writing task: the first task was to write a short account (500 words) about any archaeological object, site or monument that students found interesting; the second a short account of an archaeologist’s work and influence; and the third a short account of the cultural change that the student experienced through the course. The authors concluded that these free writing tasks had a significant effect in allowing students to articulate their own voice more clearly. The work they did in the free writing contributed in a large part to the structure of the final essay. Compared to a previous cohort, the students involved in the study showed greater understanding of the requirement to use ‘archaeological imagination’ by explicitly developing the distinct viewpoints used (as opposed to simply using a historical recount), and consequently obtained higher scores.

However, this approach is not without its weaknesses. It tends to focus more on documenting and analysing texts written by young people and their cultural practices and to leave the text practices of the disciplines relatively vague. Detailed analyses are not typically offered as ways of clarifying for teachers how connections can be made between the everyday text practices of youth and the writing practices of the disciplines. Additionally, the focus on linguistic features of the discourse communities is noticeably absent, with attention to language taught as common ways of speaking, performing, reading, and writing, as opposed to specific examinations of the functional linguistic features of the texts written by members of the disciplines (Moje, 2007).

For the purposes of identifying writing-related disciplinary distinctions and examining instructional practices involving disciplinary writing, the two approaches discussed above—cognitive literacy strategies and linguistic navigation across cultural boundaries—present difficulties because of the relative lack of discipline-specificity in studies involving these approaches (Moje, 2007). This Digest focuses, in the following sections, on the remaining two approaches covering the epistemological and linguistic processes of the disciplines.

Epistemological processes of disciplines

Studies involving the teaching of disciplinary epistemological processes are less interested in generic cognitive strategies and instead focus on three main goals: (a) specifying the cognition (i.e., thinking processes) of experts in the disciplines as they produce written and oral texts; (b) comparing the cognitive processes of these experts to learners of the subject; and (c) applying those cognitive processes to educational practice (Moje, 2007, p. 17). The following studies, set in history classrooms, typify these three goals.

A study by Young and Leinhardt (1998) focused on specifying the cognition of an exemplary history teacher, who through the use of primary documents in an Advanced Placement (high school) American History class, engaged her five students in a year-long course to construct an evidenced interpretation of issues through historical reasoning and writing. The teacher, through a continual engagement of the students in the cognition of historical authorship, involved them in active discourse aimed at discussing core disciplinary ideas using primary and secondary source readings rather than textbook chapters using worksheets. It was found that students’
written pieces grew in content knowledge, integrating period knowledge more sensitively, and, in their linguistic dimension, evaluating and qualifying claims and evidence more actively.

Rouet, Favart, Britt, and Perfetti (1997) cast light on the cognition of experts and learners when they are engaging in historical writing. They investigated the influence of discipline expertise on students’ reading, evaluation, and use of multiple documents about a historical controversy. Two groups, 11 graduate students in psychology (history novices) and eight graduate students in history (history specialists), both engaged in doctoral programmes in a French university, studied two controversies regarding the history of the Panama Canal. For each controversy, the students studied a set of documents, wrote an opinion essay, and evaluated the documents for usefulness and trustworthiness. It was found that the history novices tended to write general context statements that referred to principles not specific to historical reasoning, while the history specialists tended to write historical context statements that referred to historical knowledge or principles. The authors suggested that it was this discipline expertise that helped the history students connect information sources and interpretations to their representation of the situation or problem, moving towards a more disciplinary act of historical argumentation.

De La Paz et al. (2014) conducted a study in the US to gain preliminary data on the effectiveness of cognitive apprenticeship in improving the abilities of academically and culturally diverse middle school students to compose historical arguments. Cognitive apprenticeship is an instructional approach which makes expert thinking and literacy practices visible to novices through teacher modelling. De La Paz et al. (2014) also measured teachers’ level of fidelity (i.e., the degree to which teachers implemented the intervention) to the proposed intervention in order to determine how it influenced students’ writing outcomes. The 18-day course, conducted with 157 eighth-grade students, involved the 13 eighth-grade teachers providing students with a scaffolded approach to working with multiple primary historical sources. This approach was premised on research findings indicating that teachers could help students to develop disciplinary writing by assigning argumentative and analytical writing in combination with reading multiple texts (e.g., De La Paz & Felton, 2010; Monte-Sano, De La Paz, & Felton, 2014; Young & Leinhardt, 1998). At the beginning of the year, students in both control and intervention groups demonstrated similar abilities in writing. At the end of year, however, the authors found that there were significant improvements in the intervention group’s ability to write historical arguments. Also, higher levels of teacher fidelity to the intervention were associated with higher quality student historical arguments.

Research into teaching epistemological processes (e.g., De La Paz et al., 2014; Rouet et al., 1997; Young & Leinhardt, 1998), by and large, has not emphasised the role of language except where it is required to process the different language cues (e.g., subtexts, technical vocabulary, contextual or temporal cues, place names) demanded by the discipline. Content experts, however, use distinct language patterns to construct their disciplinary texts (Hyland, 2013). Fang (2012a) argued that recognising discipline-specific ways of using language could help students develop a sense of how a discipline organises knowledge and construes value through language, enabling them to write more effectively in the disciplines. The next approach to disciplinary writing aims to identify these language patterns.

Linguistic processes of the disciplines

Kamberelis et al. (2014) posited that disciplines differ in the way linguistic structures are used by experts to convey knowledge to each other. One approach for differentiating language patterns within writing arose from systemic functional linguistics (Halliday & Matthiessen, 2014). A functional linguistics approach aims to help students reduce difficulties when approaching texts by uncovering meaning that might
otherwise remain hidden (Fang & Schleppegrell, 2010). For example, Halliday and Martin (1993) identified four linguistic aspects of expository text that challenge readers:

- **Technicality**, the use of technical terms in discipline-specific ways;
- **Abstraction**, which is achieved through the use of technical terms and nominalization (i.e., transforming grammatical constructions such as complex phrases and verbs into nouns);
- **Information density**, a measure of how much information there is in a text; and
- **Authoritativeness**, achieved through the use of technical vocabulary, declarative sentences, passive voice, and generalised participants.

Nominalization is a language feature that Fang, Schleppegrell, Lukin, Huang, and Normandia (2008), using a functional linguistics approach, have studied across subjects. Their analyses suggest that while nominalization was frequent in history texts, it was not unique to history, and occurred in all secondary school subjects. However, it served different functions in each type of text. For example, nominalizations in science texts, such as ‘this involuntary dividing of cells’ and ‘the loss of control’, extracted previously presented information and served as the grammatical subject, a point of departure for continuing discussion on the topic (Fang, 2012b). Other nominalizations such as ‘interaction’, ‘production’, and ‘growth’ enabled the compacting of information into nouns, as in the example of the use of ‘interaction’ in the following text:

> The cell cycle is controlled by proteins called cyclins and a set of enzymes that attach to the cyclin and become activated. The interaction of these molecules... controls the cell cycle (Fang, 2012b, p. 25).

In the given text, the noun ‘interaction’ condensed the information given in the preceding sentence, allowing that information to be further used in its entirety. Halliday and Martin (1993) explained that nouns are a key grammatical resource in scientific discourse for creating technical objects, developing logical reasoning and achieving precision and concision.

Fang (2012b) stated that, in its use of nominalization, history distinguished itself from other disciplines in that texts were populated with ‘metaphoric abstractions’, ‘things’ that were nominalizations derived from processes and qualities (p. 29). The examples cited by Fang (2012b) include ‘the kidnapping and murder’, ‘the trial’, ‘the viewing’, ‘murder’, ‘protests’, ‘decision’, and ‘ruling’. He asserted that it was primarily through these nominal structures that historians conceptualised events as ‘things’ and infused their perspectives into the interpretation and judgement of the historical event.

Hyland (2009) has done extensive research in the field of academic writing, uncovering disciplinary writing distinctions using a 1.5 million word corpus of research articles across eight disciplines together with four million words from student dissertations and interviews with 30 academics. The main differences he found between disciplines were in:

- **Citation practices**, the inclusion of references to the work of other authors;
- **Reporting verbs**, verbs such as ‘suggest’, ‘argue’, and ‘describe’ to refer to their literature;
- **Hedges**, devices such as ‘possible’, ‘might’, and ‘likely’ that function to withhold complete commitment to a proposition;
- **Self-mentions**, instances when writers intrude into their texts through the use of ‘I’, and ‘we’;
- **Directives**, devices that instruct the reader to perform an action or to see things in a way determined by the writer, expressed largely through imperatives such as ‘consider’, ‘note’, ‘imagine’ and verbs that express obligation like ‘must’, ‘should’ and ‘ought’; and
- **Lexical bundles**, frequently occurring word sequences that help shape texts, such as ‘at the same time’, ‘in the case of’, and ‘on the other hand’.

These differences, Hyland (2009) argued, reflected how writers in the different disciplines drew on different linguistic resources to develop their written texts, establish their credibility and persuade their readers. He stated that the instructional implication of his findings was the need for teachers to take into account in their classroom practices the ways in which texts are
created in these disciplines.

Having reviewed the various approaches to disciplinary literacy, we now turn in the following section to examine a range of studies which focus on instructional practices that involve disciplinary writing.

**Instructional practices across the disciplines**

The following studies represent the two approaches foregrounded in this issue of the Digest (i.e., epistemological and linguistic processes), though they may at times overlap. The studies are arranged according to the discipline in which they were undertaken and, where possible, in chronological order of the students’ stage of schooling.

**English language arts and literature**

It is important to note at the outset that this discussion of the English language arts curriculum is based on the American context.

English language arts has as its primary goal the development of students’ capacity to read, respond to, evaluate, and create texts (Christie & Derewianka, 2010). In her review of American syllabus documents, Tay (2009) summarised the key features of the language arts curriculum in the following description:

> It focuses on the development of literacy, cultural understanding, and creative and critical thinking. The processes of speaking, listening, reading, viewing, writing, and representing are to be developed in an integrated manner rather than separately. Students will engage in a range of experiences and interactions with a variety of texts so that they will be able to use language effectively and purposefully in an array of contexts. (p. 299).

Tay (2009) observed that in Singapore, language arts had been interpreted in a variety of ways according to differing schools’ needs. Both American and Singaporean syllabuses were similar in their focus on an integrated approach to language teaching, which had long been a cornerstone of the Singapore Ministry of Education (MOE) English Language syllabuses. However, a key distinction that distinguished the MOE English Language syllabuses from the American syllabuses was the explicit teaching of language skills and grammar, which Tay (2009) stated was an essential component in English language teaching in the context of Singapore’s bilingual policy. This difference is important to note as the majority of studies cited in this section focus largely on language arts in the American context, and thus should be not be taken to generalise to the English Language or Literature disciplines in Singapore or elsewhere.

English language arts approaches texts in distinctively personal ways. Divergent understandings of texts are encouraged as students interpret them through personal life experiences (Rosenblatt, 1995). Individual expression is emphasised as students write (Wilson, 2011). This primary purpose of expressing individuality contrasts with the shared historical contexts and group affiliations in the discipline of history (Wineburg, 1991), and the emphasis on expressing thoughts contrasts with the practice of reporting observable outcomes related to objective physical phenomena in the disciplines of science (Bazerman, 1988). In the language arts at primary school levels, writing processes emphasise the specific devices and techniques through which individual thoughts can be expressed in a story-telling way, using non-technical vocabulary and simple clauses linked into sentences through coordination (and) or subordination (as, although, until) to capture the dynamism and fluidity of speech (Fang & Schleppegrell, 2010).

However, English language arts is not exclusively focused on the content of texts: there is an emphasis on processes that students use as they write these texts (Flood, Lapp, Squire, & Jensen, 2003). Thus, explicit instruction on writing processes and strategy instruction is also considered as a central domain of this discipline, and has been consistently shown to produce results with primary and secondary school students (Graham et al., 2012; Graham & Perin,
For example, Faggella-Luby et al. (2012) explored the effectiveness of strategy instruction across a number of studies. They analysed studies that looked at students in Grades 4-12, selecting only studies that involved struggling adolescent learners and/or those with learning disabilities. Six of the 33 studies were judged to include discipline-specific strategies (e.g., story planning and monitoring strategies, mnemonic strategies and character development strategies) in writing composition for the English language arts classroom. All six studies showed evidence for the effectiveness of strategy instruction, though one study's results indicated that writing quality was not maintained across time or with another teacher.

According to Fang (2012b), while texts of diverse types and modalities were used in the language arts curriculum, literature remained the focus of study. He suggested that because literature related closely to concerns, emotions, behaviours, imaginations, and other aspects of human life, it drew on the use of everyday language and its creative manipulation for aesthetic ends to give literary texts a special character. He further posited that students might find it challenging to interpret figurative language (e.g., metaphor, simile, symbolism) and peculiar vocabulary (e.g., archaic words) in the literary texts they read, suggesting that instruction in such language patterns, which constructed literary knowledge, was a necessity to develop students’ disciplinary writing abilities, an idea shared by Showalter (2003).

Wilder's (2012) review of syllabuses, assignments, exams and interviews from 20 professors who taught literature courses at an American university aimed to uncover the goals and methods of the literature courses. She found that while the professors’ descriptions of their expectations for students’ writing strongly suggested the disciplinary genre of literary analysis, the writing of assignments was not emphasised due to logistical constraints such as large cohort sizes. The professors who did emphasise writing seemed to teach it without explicit instruction in discourse practices specific to the discipline of literature. They stressed instead issues of mechanics, coherence, and identification of technical terms, reasoning that there was no expectation to impose literature-specific writing strategies on their students, since they were not expected to go on to become literature experts themselves. Links were not made between the subject content knowledge and the students’ own writing. The advice consistently given to students related to generic writing strategies, leaving the rhetorical choices that students could make in their disciplinary writing largely implicit. Wilder (2012) attributed the wide variation in students’ writing abilities to the professors’ methods of teaching. More importantly, she observed that explicit instruction in literary discourse practices would support less adept students or students less familiar with the subject in acquiring better writing. She found that students that received occasional help from teaching assistants to use special topoi (i.e., traditional literature themes or formulae) were significantly more likely to receive higher grades in the course.

In the UK, Beattie (2007) investigated the effects of talk on improving her students’ literature writing in her all-boys classrooms across various grades from Year 7 to Year 10. She observed that despite excellent student oral presentations of characters that they had read about in texts, their subsequent written pieces on the same topics were poor in quality. Through interviews, her students explained that they lacked the confidence to write, but thrived on the reciprocal nature of oral work. She found that getting her students to talk about their writing to her and their peers, in order to make explicit their thinking processes as they wrote, motivated them to interact with their peers to seek approval and clarification.

The teacher found that getting her students to talk about their writing to her and their peers, in order to make explicit their thinking processes as they wrote, motivated them to interact with their peers to seek approval and clarification.
It is worth noting the suggestions by McConachie and Petrosky (2010) to encourage greater disciplinary writing in the language arts classroom: (a) offer opportunities to learn core concepts and habits of thinking; (b) follow a rigorous curriculum that mirrors the work of the discipline in its tasks, texts, and talk and that positions learners as apprentices; (c) offer opportunities to engage in meta-understandings of their learning through reflection on their studies; (d) encourage practices that enable socialising intelligence by encouraging risk taking, help seeking, question asking, problem solving, and reflective analysis; and (e) have practice assessed through multiple forms of informal and formal assessments that gauge student mastery of literature concepts, their habits of thinking, investigating, problem-solving, and talking.

The studies reviewed here suggest that the two approaches, that of explicitly teaching epistemological processes—through instruction in writing processes and strategies—and of teaching linguistic processes—through instruction in language patterns that construct literary knowledge, use of topoi, and literary discourse practices—represent useful interventions for developing disciplinary writing within the language arts classroom. In the following section, we turn to writing in the disciplines of the natural sciences, with a sustained focus on instructional practices from these two approaches.

**Natural sciences**

Duschl, Schweingruber, and Shouse (2007) suggested that children come to school with a foundational knowledge of the natural world and are constantly making sense of the world around them, linking their understanding to the domains of science, such as those corresponding to mechanics, human cognition, matter, and the living world. Duschl and his colleagues argued that this basic scientific knowledge and their daily experiences are important starting points for building deeper expertise. Various studies support this: Juel, Hebard, Park Haubner, and Moran (2010) described young learners learning about how scientists and historians think; through an extended science curriculum, Metz (2008) demonstrated that first graders could develop the ability to frame questions for investigation and to continue with ‘elaboration of research design, data collection and analysis’ (p. 158) modelled after scientists; and Cervetti et al. (2012) described a study in America in which primary school students were engaged in doing science and were simultaneously learning about reading and writing practices in science.

Cervetti et al. (2012) developed an instructional programme for 47 fourth grade classrooms that involved students in reading and writing as they planned, conducted, and made sense of their own investigations. The authors used every opportunity to share with students the values, dispositions, forms of reasoning, and methods of inquiry that are part of scientific knowledge building. In their inquiries, students read an account about a professional scientist describing his own investigations, including the processes that he used to record information and reason about the evidence he gathered. They then used this as a model for their own inquiry process and to compare their results with his, just as professional scientists use the work of other scientists to make sense of and interpret their own results. Cervetti et al. (2012) found that these opportunities to use language to talk, read, and write about science had a positive impact on students’ literacy learning. In the writing measure, the treatment group (47 classrooms), when compared to the control group (another 47 classrooms), made significant gains in five out of seven writing dimensions: use of evidence, introduction, clarity, science conceptual understanding, and vocabulary count. Other studies of science-literacy integrated programmes corroborate these positive effects on writing (e.g., Goldschmidt & Jung, 2010; Palincsar, Magnusson, Collins, & Cutter, 2001; Romance & Vitale, 2001).

Learning the vocabulary of a discipline is the basis for the forming of rich conceptual networks of words and the understanding of how these words are related to each other (Nagy & Scott, 2000). In Morgan’s (2012) study (elaborated on in Issue 4 of this volume), it was observed that the science
teacher of an Australian middle school, upon assessing her students’ level of technical language knowledge in science and finding it to be lacking, provided instruction for scientific vocabulary that students required in order to engage in scientific writing. As a result, the advanced students developed more complex, concise and precise writing pieces, while students who had written little before the intervention were able to write longer pieces.

Wilson, Smith, and Householder (2014) examined the ways in which two groups of 17-year-old students from an American high school used writing to solve authentic problems through engineering design processes (i.e., define a problem, gather information, generate ideas, evaluate ideas, and communicate the solution). The group that engaged in the greater number of writing practices created more convincing problems. However, both groups forgot important discussion points in presenting their ideas. Both teams also faced difficulties in communicating their solutions, frequently expressing frustration at being unable to select words that were peculiar to the field of engineering. The authors asserted that teachers could support adolescents’ engineering activity by modelling how engineers approach problems, including making their thought processes explicit and visible through the use of writing artefacts, and providing structured opportunities for students to evaluate their own literacy practices at each stage of the design process.

The high degree of specificity in disciplinary writing is evident at the university level. Nesi and Gardner (2012), through a large scale corpus study of close to 3,000 assignments of over six million words across 30 disciplines in UK higher education, identified 13 different ‘genre families’, ranging from case studies through empathy writing (i.e., accounting for different perspectives in writing to answer questions of why people acted as they did) to research reports, which differ in social purpose, generic stages, and the networks they form with other genres. Gimenez (2012) noted in his study that students in supposedly similar fields such as nursing and midwifery were given very different writing assignments and were expected to write differently according to their fields’ different perspectives of criticality, evidence and impersonality. He stated that examining the relationship between disciplines, attributes, and written communication could provide ways in which novices of a discipline could gain access to disciplinary writing and thus become more central members of their professional community.

The call for disciplinary literacy programmes where content teachers collaborate with literacy experts to create appropriate, discipline-specific writing assessments has been supported by several academics (Moje, 2008; Perin, 2001; T. Shanahan & Shanahan, 2008). A paper by Stoller et al. (2007) reported on a sustained collaboration between applied linguists and chemistry faculty to create and validate writing assessment instruments for a ‘Write Like a Chemist’ course in an American university, a multiple-year effort to form valid analytic and holistic assessment instruments to be used by chemistry faculty to assess the writing performance of chemistry majors. Early in the project, applied linguists introduced the chemists to the idea of analysing genres in terms of context, organisational features, vocabulary and grammar features, and scientific conventions in three professional genres (i.e., journal articles, scientific posters, and research proposals). The chemists then conducted analyses that required an understanding of chemistry content and suggested additional features for further investigation. As a result of the sustained efforts, the authors identified the most common moves in the three genres. For instance, they illustrated that the move structure of a journal article’s ‘results’ section showed how writers moved from ‘setting the stage”—by reminding readers about the project and methods—to ‘telling the story of scientific discovery’—by highlighting unexpected results. Another notable outcome was the creation of a 1.5 million-word corpus of chemistry texts using tools from the field of corpus linguistics, which made it possible to analyse the language of chemistry in order to identify common and generalisable linguistic patterns for instructional purposes.

These studies suggest that the disciplinary writing in the natural sciences can be developed in the following ways: (a) through an epistemological approach of providing opportunities to use language—through model texts, inquiry practices, collaborative talk, and authentic
problems for pupils to inquire into to scaffold their own scientific thinking processes; and (b) through a linguistic approach of examining the relationship between disciplines and language features common in scientific texts, as well as through the explicit teaching of scientific vocabulary. As will be seen in the next section, the same principles can be applied in the discipline of mathematics.

**Mathematics**

Burton and Morgan (2000) argued that mathematics is a language of words, numerals, and symbols that are at times interrelated and interdependent, and at other times disjointed and autonomous. Schleppegrell's (2007) synthesis of research by applied linguists and mathematics educators focused on identifying the linguistic structures used in mathematics. She found that the linguistic aspects of mathematics that distanced it from everyday use of language included: (a) the multiple semiotic (meaning-making) systems—symbols, oral language, written language, and visual representations—that go beyond what ordinary language can express; (b) the highly technical vocabulary that make oral and written language challenging; (c) the grammatical patterning that brings together long, dense noun phrases in clauses and sentences constructed with *being* and *having* verbs that present a variety of meaningful relationships; and (d) the frequent use of conjunctions that have specific mathematical meanings different from their everyday use. Hillman (2014), in her review of literature on mathematical literacy, offered instructional suggestions to teach mathematical linguistic features not unlike those identified by Schleppegrell (2007).

The identification of these linguistic distinctions highlights the need for teachers to explicitly teach the language of mathematics. Adams (2003) observed that, more than in any other discipline, the construction of mathematical knowledge depends on the spoken explanations and student interactions with the teacher. She suggested that teachers could move students in the elementary classroom from everyday language into the mathematics register by helping them recognise and use mathematical language rather than informal language when they were defining and explaining concepts; by working with them to clarify ambiguous meanings of words that exist in both everyday vocabulary and mathematical texts; and by explicitly evaluating students’ ability to use technical language appropriately, for instance through having students talk about mathematics as they solved problems, encouraging them to articulate patterns and generalisations.

Pugalee (2004) suggested that teachers could help students to construct mathematical understanding by requiring them to share their reasoning and verification processes in writing. In an exploratory study investigating the impact of writing during mathematical problem solving, he found that his ninth-grade algebra students (*n* = 20), after a two-week enrichment period where they engaged in journal writing that focused on describing their thinking, were significantly more successful in problem solving tasks than students who merely verbalised their thinking.

Sinclair and Pimm (2008) examined forms of spoken mathematical reasoning that undergraduate mathematics students (*n* = 40) employed when working in pairs on geometric tasks. They wanted to distinguish how experienced mathematical students spoke when working on problems from the conventional way that formal mathematics was supposed to be written. Through an analysis of 20 videotaped episodes of students working in pairs at computers to solve tasks, the authors identified significant differences between students’ speech and writing. A major difference was in the precision of language used. Sinclair and Pimm (2008) argued that mathematical writing was more precise than verbal explanations, with logical uses of connectives such as ‘because’ (i.e., to state an effect and explain its cause), as exemplified in this extract from a book by Birkhoff and Mac Lane (1953)—‘Because of the correspondence between matrices and linear transformation, we need supply the proof only for one case’ (p. 227). In the students’ utterances, however, ‘because’ was used far more often in a
pragmatic sense (i.e., to assert a claim and posit justifications), for example: ‘No, because the rotation point is gonna be over here’, and ‘Yeah, the original one because then... That didn’t work. We did it wrong’ (Sinclair & Pimm, 2008, p. 875). Similarly, Sinclair and Pimm (2008) claimed that mathematical writing expressed a high degree of certainty. In contrast, it was observed in the students’ speech that clauses with modality were used frequently to express students’ uncertainty, as evidenced in the following examples: ‘Maybe that’s the line’; ‘But I don’t know if that’s right’; and ‘That would work, wouldn’t it?’ (Sinclair & Pimm, 2008, p. 878).

The authors concluded that having shown how written mathematical explanations were generally more precise than verbal ones, there was a case for engaging students in writing during mathematical problem-solving.

O’Halloran (2005) stated that any analysis of classroom discourse ‘must necessarily take into account the multisemiotic nature of mathematics, and the shifts between the written/spoken modes and the shifts between language, symbolism and visual display’ (p. 206). She observed that the functions and grammar of mathematical symbolism and visuals were not typically discussed, and argued that mathematics teachers needed to explain, from a linguistic perspective, how these devices had developed historically as semiotic resources fulfilling particular functions. This understanding, she explained, would allow students to make use of the options provided not just by language, but also by these devices in order to solve mathematical problems.

These studies from the discipline of mathematics indicate the importance of explicitly teaching mathematical language in order to disambiguate everyday language for the purpose of precise mathematical writing. They suggest that teachers should have students construct both verbal and written explanations of their mathematical reasoning in order to evaluate their explanations more accurately. Having seen the importance of spoken and written language in mathematics, in the next section, we will go on to review studies that highlight the epistemologies in the social sciences and humanities disciplines, and reiterate the need for the explicit teaching of linguistic features, in order to improve disciplinary writing.

Social sciences and humanities

Wineburg (1991) argued that the act of writing in history was not simply a process of recording or even imagining how the participants felt as an event was happening. Instead, writing in history was an act that required one to ‘understand the bias’ (p. 496) of a source. In his study, he observed the think-aloud procedures of eight historians and eight high-ability undergraduates as they read historical documents and ‘wrote’ their own texts in their minds—a pretense of deliberating with the authors of those historical documents by talking to themselves (Wineburg, 1991, p. 503). He found that it was not the literal text or the inferred text that historians comprehended in order to write, but the subtext, a text of hidden and latent meanings. Subtexts of historical documents have two spheres: the first sees the text as a rhetorical artefact from which historians try to reconstruct the authors’ purposes through an examination of the use of language for persuasion (i.e., the words authors use to convince); and the second sees the text as a human artefact, which relates to how texts frame reality and disclose information about their authors’ assumptions, world views, and beliefs (i.e., the types of people the authors are). He found that historians used this ‘sourcing heuristic’ (Wineburg, 1991, p. 510)—the strategy of reading the subtext—nearly all the time (98%), while students used it less than a third of the time (31%), suggesting that it was incumbent on history educators to apprentice their students in historical habits of mind.

In history, the most frequent written genre is that of argumentation, which usually involves taking a set of documents and creating a new text with them. Historical argumentative essays follow a particular discourse type and require the ability of students to produce knowledge transformation, as opposed to simply knowledge telling (Scardamalia & Bereiter, 1987).

Young & Leinhardt’s (1998) earlier cited study
involved analysing how five students responded to four document-based questions over a year, tracing how organisation, document use, and citation language indicated the degree to which the students transformed and integrated information in disciplinary ways. It was found that students moved from knowledge telling (listing period and document content as discrete information bits) to knowledge transformation (integrating content as interpreted evidence for an argument) over the period of the study. This strongly suggests that history instruction—one that engages students in the discipline by providing multiple source readings, that involves students in active discourse aimed at reasoning about historical ideas using textual evidence, and that invites students to act as authors constructing an evidenced argument rather than as memorizers of content—can support the development of complex writing skills even when these writing skills are not the object of explicit instruction.

Coffin’s (2006) study used linguistic analysis to develop a description of the types of written texts typically required by secondary school history curricula. She found three dominant genres required for successful writing in the classes: recording, explaining, and arguing. She also found that as students progressed through secondary school, they were expected to use more technical language, to engage in more abstract writing, and to use linguistic processes such as nominalization. This description informed the subsequent professional development intervention in which 17 history teachers worked with Coffin and other linguistic specialists to integrate the teaching of these genre-specific language practices to facilitate students’ writing skills with the development of historical knowledge. Evidenced in their vocabulary and grammar choices, teachers showed a significant growth in their level of explicitness with reference to the language system, which they began to see as integral to learning history. They also focused more on raising students’ awareness of the form and function of different history genres. Consequently, students’ writing improved, demonstrating more purposeful text organisation and clearer structure than before the intervention.

Meta-analyses have also identified the instructional approach of studying model texts to be effective for teaching writing (Graham et al., 2012; Graham & Perin, 2007). The use of mentor texts in an economics high school class was explored in a study conducted by Pytash et al. (2014) in a private school in America. The study sought to understand the development of disciplinary writing of 12 students as they used a mentor text in an economics class over a four-week period. Each class was 90 minutes long and alternated between three and two days a week. For two weeks, students read and deconstructed a white paper. Each day began with a teacher leading and modelling the analysis of the text for both content and form. She emphasised the language choices that the author of the white paper used to make claims and support his positions, and explored the author’s background to identify biases that might sway his positions and purposes for writing the white paper. Students then worked in collaborative groups to examine additional sections of the text, discussing their ideas and thinking subsequently as a class. The remaining two weeks were spent on students’ research and drafting of their own policy paper. The authors found the mentor texts provided students with knowledge of: (a) how to structure their paper; (b) the discourse of economics including tone, specific vocabulary use, and the persuasive use of statistics; and (c) why economists write—to inform one another of current policies or economic theories.

Hunter and Tse (2013) evaluated a programme by an Australian university seeking to integrate the processes of writing and knowledge construction in the context of a macroeconomics classroom. They found that when cohorts of around 300 to 400 students went through writing workshops conducted independently of the discipline, students performed worse in their macroeconomics writing assignment. In contrast, when a cohort (n = 309) went through an embedded programme addressing discipline-specific writing processes and providing macroeconomics concepts, they performed better. This offers evidence that subject lecturers who explicitly teach the writing processes in their discipline, coupled with the use of subject
content, can benefit students in terms of helping them improve the quality of their writing. The findings also suggest that general writing strategies that are taught outside of a discipline, such as in the cognitive literacy approach, do not contribute to enhancing disciplinary literacy.

In the disciplines of the social sciences and humanities, the studies reviewed indicate the following useful practices to develop disciplinary writing: (a) providing instruction in the strategy of reading the subtext of history texts or in the 'sourcing heuristic'; (b) providing multiple source readings which engage students in active discourse aimed at reasoning about historical ideas using textual evidence, and mentor texts that provide scaffolds on discourse structure, tone, vocabulary use, and conventions in economics writing; and (c) giving explicit instruction in vocabulary, grammar, and text organisation choices.

**Teacher professional development and support**

This issue of the Digest has focused on studies that suggest the importance of the teacher in providing instructional interventions to improve students’ disciplinary writing, such as disambiguating technical vocabulary, using mentor texts, making thinking processes explicit, and engaging in the work of professionals of the discipline. Reviewing the literature from the past two decades, however, Lesley (2014) reported that very little research exists on methods for preparing teacher educators to support the development of disciplinary literacies. Moreover, she found that most textbooks preparing undergraduate pre-service teachers for literacy instruction were predicated on a generalisable knowledge base of strategies that can be used across the curriculum, as opposed to being discipline-specific. MacMahon (2014) conducted a study in Ireland, reporting on the level of disciplinary literacy support provided by three subject teachers for students with literacy difficulties in the subjects of history, geography, and science. It was found that the teachers’ lack of professional knowledge in (a) conceptualising literacy, (b) supporting students with literacy problems and (c) teaching subject vocabulary was a significant challenge to pedagogical change at the classroom level.

Reflections by Monahan (2013), a science and English teacher, exemplify this problem. Through a six-week writing programme, she aimed to develop her sixth grade pupils’ expository writing which she had found lacking in voice. She believed that teaching her students about argumentative writing through a simultaneous investigation of science topics would promote greater voice and engage students in the collaborative building of subject knowledge. She engaged her students in a variety of writing activities such as journaling, graphic organisers, quick-writes, and reflections, and participation in a debate. Finally, students wrote an argumentative essay within the confines of a science topic. The author concluded that she had succeeded in achieving her aim of developing students’ scientific knowledge and argumentative writing. However, she conceded that their arguments were outside the disciplinary boundaries of scientific writing, and that their authorial and aggressive voice undermined their persuasiveness within the field of science. She suggested that this outcome could have been avoided had she collaborated with other language arts and content area teachers to mine mentor texts for the voicing practices of disciplinary experts.

Studies cited earlier in this Digest validate the usefulness of a collaborative programme in developing disciplinary writing (e.g., Coffin, 2006; De La Paz et al., 2014; Stoller et al., 2007). One teacher education programme at the University of Michigan has an innovative solution: it offers subject-specific teaching coursework and clinical rounds practice, modelled on the rotations that medical interns do through various specialties, that provide opportunities for novice and veteran teachers to examine similarities and differences in language use, text structures and genres, and assumptions about knowledge and learning across disciplines (Bain, 2012).

The work of Johnson, Watson, Delahunty, McSwiggen, and Smith (2011) in mathematics and geography exemplifies a team approach to understanding these disciplines and exploring similarities and distinctions between them, as viewed by the subject matter experts. Johnson and colleagues, who were literacy educators in teacher preparation programmes at two
universities, explored literacy practices with two mathematicians and a geographer in order to identify the skills that teachers would need to pass on to their students.

One major result of their collaboration was the identification of useful disciplinary strategies that were subject-specific. They found that mathematics students needed opportunities to play with or work through the knowledge they were learning, which could occur when students worked in small groups to (a) think aloud about their mathematical thinking, (b) engage in ‘what if’ conversations about the patterns they identified, and (c) use the language of mathematics with think-alouds while creating proofs.

The authors noted that the language of geography was specific. It also borrowed from multiple fields such as social and physical sciences, and as technology advanced, so did the terminology specific to these technologies, which fed into the fields that the language of geography comprises. They suggested that students read geography texts with specific, up-to-date vocabulary and then practise by taking and making notes in graphic organisers, in order to identify intertextual patterns as well as for the collection and organisation of information to make those intertextual connections.

Importantly, they garnered three learning points with implications for teacher preparation and development in the field of disciplinary literacy.

First, they found that what occurred in primary and secondary schools, to a large degree, was knowledge transmission through lectures and talk about the disciplines, rather than the actual practices of the disciplines of mathematics and geography. Teacher educators and teacher candidates need to be apprenticed into gaining adeptness in these practices.

Second, teacher educators need to be able to read and write successfully within their disciplines in order to apprentice their own students. Programmes that promote or even require such expertise within the disciplines should be developed for teacher candidates.

Third, both literacy teachers and subject teachers are, in essence, teacher educators, and there is value in exploring the topic of disciplinary literacy collaboratively for improving the opportunities that learners may have in constructing knowledge of content and practice in the disciplines.

Christie and Derewianka (2010) conducted comprehensive research for over 20 years with Australian primary and secondary school students, analysing approximately 2,000 of their written texts from English, history and science disciplines using systemic functional linguistics. They summarised how major linguistic resources developed from early childhood to late adolescence, and across the three subjects. Through their findings, the authors proposed that teachers should be informed about how writing developed from early childhood to late adolescence in order to better monitor their students’ progress, anticipate challenges ahead, identify sources of difficulty, and teach writing skills that might otherwise remain implicit. Additionally, the authors presented important principles to consider when creating writing programmes:

1. It is important to understand how students learn to write according to their stage of writing development;
2. Teachers of all subjects should be encouraged to use a framework of language;
3. The teaching of writing should focus on the genres to be written, the raising of students’ awareness of language resources and a repertoire of knowledge and skills;
4. Teachers should introduce and use a metalanguage for talking about, interpreting, playing with and critiquing written language from the early years of schooling in order to raise students’ consciousness of language; and
5. The metalanguage used should slowly progress across the years, using selected traditional and functional terms.
Conclusion

The studies reported in this issue of the Digest highlight that the approaches of teaching epistemological and linguistic processes to students comprise a host of instructional practices. The studies suggest that these instructional practices or strategies have the potential to develop students' writing in the disciplines at their varying levels of study.

Table 1 summarises the strategies covered in each of the disciplines. Some of the strategies were not part of the studies' interventions, but raised as instructional implications by the respective authors.

These approaches and strategies may present useful starting points for subject teachers endeavouring to develop their students' writing. While implementing these strategies requires sophisticated skills that call for collaborative disciplinary literacy programmes involving both subject teachers and literacy consultants, the models reported in the studies indicate that there are schools that have found solutions to fit their varied contexts. It is incumbent on curriculum planners, schools, and partners to find their own way to build teachers’ professional knowledge and capacity in developing these strategies, such that students in turn are apprenticed into creating written pieces that are valued and celebrated in the different disciplines.
Table 1

**Instructional Practices to Develop Disciplinary Writing**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Epistemological and linguistic processes</th>
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<tbody>
<tr>
<td>English arts</td>
<td>• Explicit instruction on writing processes and strategy instruction (Graham et al., 2012)</td>
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<td></td>
<td>• Teaching the creative use of everyday language, figurative language, and peculiar vocabulary in literary texts (Fang, 2012b; Showalter, 2003)</td>
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<tr>
<td>Literature</td>
<td>• Instruction on literary discourse practices, including the use of special topoi (Wilder, 2012)</td>
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<td></td>
<td>• Modelling expert practice and getting pupils to talk about their thinking processes and seek help as they write (Beattie, 2007)</td>
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<tr>
<td>Science</td>
<td>• Modelling the scientific inquiry processes of a professional scientist involved in his own investigations (Cervetti et al., 2012)</td>
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<td></td>
<td>• Instruction for scientific vocabulary that students require for scientific writing (Morgan, 2012)</td>
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<tr>
<td>Nursing/midwifery</td>
<td>• Examining relationships between epistemologies, attributes of disciplinarians and written communication (Gimenez, 2012)</td>
</tr>
<tr>
<td>Engineering</td>
<td>• Using writing to solve authentic problems through engineering design processes (Wilson et al., 2014)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>• Collaboration between applied linguists and chemistry faculty to create valid writing assessment instruments (Stoller et al., 2007)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>• Moving students from everyday language into the mathematical register by having them practice technical language when defining and explaining, and clarifying ambiguous words (Adams, 2003; Hillman, 2014; Schleppegrell, 2007)</td>
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<td></td>
<td>• Getting students to share their mathematical reasoning and verification processes in writing (Pugalee, 2004)</td>
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<td></td>
<td>• Contrasting verbal and written explanations to increase precision and certainty in mathematical writing (Sinclair &amp; Pimm, 2008)</td>
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<td></td>
<td>• Working in small groups to think aloud thinking, engage in hypothetical conversations about identified patterns, and use of the mathematical register with think-alouds while creating proofs (Johnson et al., 2011)</td>
</tr>
<tr>
<td></td>
<td>• Explaining how mathematics symbolism and visual were developed historically as a semiotic resource in order to fulfil particular functions, from a linguistics perspective (O’Halloran, 2005)</td>
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<tr>
<td>History</td>
<td>• Engaging in cognition of historical authorship (Young &amp; Leinhardt, 1998)</td>
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<td></td>
<td>• Engaging in cognition of historical argumentation (Rouet et al., 1997)</td>
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<tr>
<td></td>
<td>• Making expert thinking and literacy practices visible through modelling (De La Paz et al., 2014)</td>
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<td></td>
<td>• Using multiple primary historical sources with analytical writing (Monte-Sano et al., 2014)</td>
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<td></td>
<td>• Teaching the sourcing heuristic, or strategy of reading the subtext (Wineburg, 1991)</td>
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<td></td>
<td>• Collaboration between linguistic specialists and history teachers to integrate genre-specific language practices in history curricula (Coffin, 2006)</td>
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<td></td>
<td>• Use of mentor texts (Pytash &amp; Morgan, 2014)</td>
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<tr>
<td>Economics</td>
<td>• Use of mentor texts (Pytash et al., 2014)</td>
</tr>
<tr>
<td>Macroeconomics</td>
<td>• Integrated programme with explicit instruction in writing processes and delivery of subject content (Hunter &amp; Tse, 2013)</td>
</tr>
<tr>
<td>Geography</td>
<td>• Use of geography texts with specific, technical, up-to-date vocabulary and the practice of taking and making notes in graphic organisers (Johnson et al., 2011)</td>
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References


Research on Evaluation, Standards, and Student Testing and University of California.


Frameworks for Disciplinary Literacy

Summary

This final issue of the volume on disciplinary literacy reviews the literature on what disciplinary literacy means in terms of the desired behaviour and skills that students must develop. The issue looks at various attempts to draw up a general framework of such behaviours to be used by all disciplines or a set of multiple such frameworks to cover different disciplines. It then looks at the four broad discipline areas identified by McArthur (2012) — science, mathematics, the social sciences and the arts and humanities — and the teaching principles that teachers should use in each. There are commonalities that could indicate that it may be possible to have a single framework of what disciplinary literacy might mean in terms of teacher skills across the disciplines. However, there also appear to be some differences across disciplines that may make it more difficult to fit everything into a single framework. It is also noted that much of the research so far has examined to what extent current classrooms conform to a certain model of disciplinary literacy. There is now a need to look at how far particular models promote required student outcomes. Finally, the review reports the views of researchers regarding the need for professional support for teachers from all levels of the education service, including principals and training institutions. Teachers, too, need to work together in professional learning communities to provide the needed mutual support.

Introduction

Previous issues of this volume of the ELIS Research Digest have looked at different aspects of disciplinary literacy, reviewing the growing amount of literature that emphasizes the importance of developing disciplinary literacy skills among the student population. The term ‘disciplinary literacy’ (or ‘subject literacy’) refers to more than the basic general literacy skills of being able to decipher written text and being able to write a text. Disciplinary literacy includes learning to think, listen, speak, read and write in the way subject specialists do, i.e. to think and communicate in the way they do. This may include text (spoken or written) but it can also include pictures, diagrams, formulae and video, i.e. any aid to communication that may be used by specialists.

For teachers and educationists, this leads to a new set of questions. What skills and behaviours constitute student disciplinary literacy? How do we help our students develop disciplinary literacy? What kind of classroom environments will help our students develop those literacy skills? Will such classrooms vary by subject area or will the requirements be the same for all? This issue of the ELIS Research Digest will review what the literature says about these questions. In particular, it will note any guidelines, frameworks or sets of guiding principles that could help educationists, including classroom teachers of both language and content subjects, to understand what needs to be done to help students develop the literacy skills necessary to communicate in subject areas.

In the next section, it will look at the literature that attempts to describe what the literacy skills required of students might be. In a subsequent section, it will look at how the literature suggests teachers can develop classroom environments in which students can be helped to develop those skills.

Developing frameworks of disciplinary literacy skills for students

In the USA, the Common Core State Standards have provided a ready source of descriptions of the skills that students need to master by the end of school. One such guide to the standards, Framework for English Language Proficiency Development Standards corresponding to the Common
Core State Standards and the Next Generation Science Standards (Council of Chief State School Officers, 2012) provides details of the expected language competencies of students vis-à-vis the Common Core State Standards and the Next Generation Science Standards (from now on referred to as ‘the standards’) in three disciplines – English language arts, mathematics and science. (It is expected that educators from other subject areas will use these guides as models for drawing up their own frameworks of standards.)

The writers of the Framework (Council of Chief State School Officers, 2012) pointed to the increased demands on language built into the standards. As a result, they repeatedly emphasized the need for students to develop their language skills in combination with their learning in the subject areas. This required language varied according to subject and needed to be learnt in combination with other ways of presenting concepts such as with mathematical symbols, for example. The writers noted that, in the early grades, the students’ language would not be precise but as the students progressed through the grades, they learnt to be increasingly precise. In science, students needed to read, write, view and visually represent as they learnt scientific models and concepts. In the process of developing these skills, they needed to listen to others, present and defend their ideas and develop shared conclusions. The writers suggested that the language used in class would be different from everyday language. However, it would not be the same as that of expert scientists either although it would grow closer to the latter as the students progressed up the grades.

For each of the three subject areas, the Framework (Council of Chief State School Officers, 2012) first listed the required standards and then analysed the related embedded analytical tasks and receptive and productive language functions. For example, for the mathematical practice, ‘Construct viable arguments and critique the reasoning of others’, one of the analytical tasks was ‘Justify conclusions, communicate them to others, and respond to counterarguments’. One of the related receptive language functions was ‘Comprehend ... questions and critiques using words or other representations’ (Council of Chief State School Officers, 2012, p. 22). Finally, one of the related productive language functions was ‘Critique or support explanations or designs offered by others’.

Lee, Quinn, and Valdes (2013) examined the Framework (Council of Chief State School Officers, 2012) and illustrated how there were commonalities across and differences between the requirements of the subject areas considered. They illustrated these with a diagram in which they demonstrated that certain required skills were common to all the three subject areas. For example, in science, mathematics and English language arts, there were references in all three to engaging in arguments using evidence. However, there were also skills specific to each of the subject areas, such as making sense of problems and persevering in solving them in mathematics, planning and carrying out investigations in science and demonstrating independence in reading complex texts in English language arts (Lee, Quinn, and Valdes, 2013, p. 3).

The focus of the Framework (Council of Chief State School Officers, 2012) was very much on student competencies, the first of the expected teacher concerns mentioned in the Introduction to this issue of the Digest. The following sections look at what the literature is saying about possible frameworks that can help teachers help their students, the second issue mentioned.

Frameworks for helping students

The task of helping students with disciplinary literacy may not be simple, however. Sfard (2001) noted that there was often a gap between research results and their possible application in classrooms. Ametller, Leach, and Scott (2007) also pointed out that there could be difficulties using insights from educational research to help in the design of actual teaching programmes as the research dealt with large grain (general) principles as opposed to the fine grain details that teachers needed to consider when preparing their teaching. The large grain research thus did not help with the fine grain decisions of everyday teaching. However, it was essential that the effort be made to reconcile the two as otherwise the research effort would be wasted and teaching would suffer from the lack of input from scholarly research. Ametller et al. (2007) indicated that the fine grain tools they had developed for teachers were informed by evidence from research and advocated
that more such research evidence-informed (REI) approaches to subject teaching design should be developed.

Baker et al. (2008) noted that it would be difficult to measure the effectiveness of any new strategies without some measure of how far teachers had been able to implement them, i.e. the fidelity with which the strategies had been followed. They developed an instrument for doing this for science teaching. This will be discussed further below.

DiCerbo, Anstrom, Baker, and Rivera (2014) reviewed the literature regarding the need for English Language Learners (ELL’s) to understand the language used in subject content areas. While the needs of the ELL’s were the focus of the study, they felt that much of what they covered could be applied to any student who had had little prior contact with what they referred to as Academic English, i.e. ‘the language used in school to help students acquire and use knowledge’ (DiCerbo et al., 2014, p. 446). For students to learn, they needed help to gain competence in that language. It was not that the students lacked language; they were not language deficit. However, they did need assistance to learn the language variety of the school and how it could be used.

DiCerbo et al. (2014) noted that Academic English (AE) could be differentiated from social (everyday) English, the language the students would be more familiar with, at three levels: vocabulary, grammar and discourse. Even within the school, the language of communication between students and teachers regarding general matters, such as classroom organization, would be different from the language that dealt with subject content. Furthermore, language could vary even then with, for example, the language used in preparation for a presentation being different from the more formal language of the actual presentation.

DiCerbo et al. (2014) noted that the Framework for English Language Proficiency Development Standards corresponding to the Common Core State Standards and the Next Generation Science Standards (Council of Chief State School Officers, 2012) indicated a growing consensus on what the features of AE were. However, they claimed, research still did not provide a definitive answer as to whether AE could be taught and, if it could, what the best ways of teaching it were. Suggestions that subject content teacher trainees should be given a better understanding of the language demands of their subjects had not been universally welcomed as this would add further burdens to an already busy training programme. However, one alternative possibility, it was suggested, was to build language features into the curriculum.

There were a number of techniques that teachers could use to help students. DiCerbo et al. (2014) suggested that the balance of talk between teachers and students should be shifted towards the students. Teachers should use follow-up questions to student answers, non-evaluative listening, instructional modelling and challenges to students to produce longer utterances. One way of giving students the chance to practise decontextualized discourse was to ask them to explain to the class something they alone knew about. In this, they could be helped by the teacher asking questions that encouraged the students to use ‘expanded discourse’. In terms of writing, opportunities to prepare longer written texts could help students rehearse the skills they needed.

The research quoted by DiCerbo et al. (2014) focused primarily on academic language (AE) functions, such as functions involving asking and answering questions, explaining cause and effect and persuading. To help the students cope with these functions, teachers needed to support students in understanding and using them as well as the related vocabulary and grammar. This was true even of subjects such as mathematics as the literature had shown that language, including grammar, was important in solving mathematics problems. There was, however, a tendency for teachers of all subjects to focus simply on the vocabulary related to content. One way of helping students was for teachers to model their own use of language in the process of solving mathematics problems, for example.
McConachie et al. (2006) suggested that disciplinary literacy was based on the idea that students could only gain a deep understanding of a discipline (or subject) by using the habits of thinking, talking and writing found in that discipline. It was important to remember that literacy was not a separate area that the teachers had to set aside time to deal with. It was an important part of the teaching of content. This belief would affect the work of many teachers in the four main discipline areas of science, mathematics, history and English language arts.

McConachie et al. (2006) proposed a framework for disciplinary literacy that contained five principles. The first principle was that knowledge and thinking should go hand in hand, that is, in order for students to develop the complex knowledge of a discipline, they needed opportunities to read, think, talk and write about the concepts following modelling by the teacher. The second principle was that learning was an apprenticeship, through which students learnt the thinking and methods of the discipline such as knowing the criteria for a good scientifically oriented question, i.e. that it started with ‘what’ or ‘how’ and included something that could be measured and compared. Initially, students could use simple vocabulary but over time would learn the specialized terms. The third principle was that teachers mentored the students by designing lessons that made explicit disciplinary approaches by, for example, asking students to provide evidence in support of their ideas. The fourth principle was that instruction and assessment drove each other. Teachers monitored student discussion, questions, etc. as part of formative assessment that would allow them to adjust the lessons according to student needs. The fifth and final principle was that classroom culture socialized intelligence in that, in such classrooms, teachers treated students as thinkers, readers and writers who could take risks, solve problems and be responsible for their own learning.

In the book edited by McConachie and Petroisky (2010), there was again an emphasis on the four core academic areas with separate chapters on history, mathematics, science and English language arts. In her chapter on disciplinary literacy, McConachie (2010), although she listed nine principles as the foundational tools of disciplinary literacy, emphasized the same five principles listed in McConachie et al. (2006) detailed above. She also stated that the foundational model for disciplinary literacy was ‘diagonal learning’. In this model, the horizontal axis represented ‘Growth in habits of thinking’ used in the particular discipline while the vertical axis represented ‘Growth in content knowledge’ of the same discipline. The diagonal between these two axes represented learning that combined growth along both axes at the same time – students learnt new content as they learnt new ways of thinking and vice versa.

Reflecting the four core academic areas mentioned by McConachie et al. (2006), McArthur (2012) also suggested that there were four broad discipline areas: science; mathematics; social sciences (including history); and the arts and humanities (including English language arts). (See also Moje, 2007.) Each had its own knowledge structure and ways of thinking, its own language and its own ways of looking at the world. For example, science used an empirical approach combined with logic to investigate the world. He pointed out the disciplines were different in terms of their text structure; their technical vocabulary; their unique grammatical functions; and their lexical density (the relative frequency of content-related vocabulary).

The sections below review work on disciplinary literacy in each of the four areas identified by McConachie et al. (2006) and McArthur (2012) with the third represented by history and the fourth by English language arts. Through this review, some of the similarities and differences between subjects and writers can be noted.

**Disciplinary literacy in science**

Chin (2006) looked at the traditional triadic dialogue of Initiation (by the teacher), Response (by the student) and Follow-up (by the teacher) or IRF as used by two teachers in their science classes in Singapore. While the IRF dialogue had often been criticized as limiting student roles to giving short,
factual responses to teacher questions, Chin (2006) found that teachers were able to foster some discussion and student thinking when they incorporated a number of techniques within the IRF exchange. First, the teachers avoided immediate positive or negative evaluations. Second, they acknowledged the students’ contributions. Third, they restated (or revoiced) student responses confirming that they (the teachers) had understood and ensuring that the whole class could hear. Fourth, the teachers’ subsequent questions built on students’ earlier responses and stimulated use of various cognitive processes. Based on these observations, Chin (2006) drew up a table illustrating possible F moves in response to student responses within the IRF framework. Using these techniques, teachers could lead students into various cognitive processes such as hypothesizing, predicting, and explaining. Chin (2006) did point out, however, the need to be aware that some students found any direct challenges threatening and such challenges might cause them to avoid making any contributions.

Ametller et al. (2007) noted that research had shown that science learners’ explanations of phenomena were often quite different from accepted scientific explanations. There was also evidence that learner explanations were fairly consistent across cultures and were resistant to the teaching of the correct scientific explanations. Ametller et al. (2007) looked into this using an approach influenced by Vygotsky (1978) who believed that higher mental functioning was influenced by the learner’s social settings.

Ametller et al. (2007) started from the idea that scientific explanations were developed through the social discourse of scientists. In a similar way, learners’ alternative explanations were developed through their social discourse. They further suggested that thought and language were not separate, but that language was the tool through which thoughts were first developed within a social setting before being internalized by the individual. The authors suggested that the process of internalization by an individual was extremely important. Students might start with their own ideas concerning certain phenomena based on their everyday social setting. In order for the students to understand the scientific explanations they were to subsequently learn, they needed to process them through talk and make them part of their own ideas and thinking.

Ametller et al. (2007) looked at the fine grain decisions in teaching science with regard to content and pedagogy: for example, deciding which details should be taught and in what order. They offered two tools to help with these decisions. The first, learning demands, delineated what scientific explanations needed to be learnt and how these might be different from everyday explanations of the phenomenon in focus. The second, the communicative approach, referred to how teachers interacted with students in order to develop scientific ideas described in terms of two dimensions: authoritative/dialogic and interactive/non-interactive. (This use of ‘communicative approach’ should not be confused with the term used in language teaching as described in Richards & Rodgers, 2001.) In authoritative mode, the teacher presented the school/scientific view. In the dialogic mode, the teacher and/or students talked about differing views. In a non-interactive section, the speaker (teacher or student) presented in a monologue whereas, in an interactive session, some discussion took place.

These two dimensions formed a matrix. Where a particular teaching section lay within the matrix depended on the teaching intent. For example, where the intent was to raise a question in students’ minds such as why a light bulb lit instantly and no time was needed for the electricity to travel from the power source to the bulb, the section would be dialogic and interactive. Later, when the teacher summarized why this was the case, the session was more likely to be authoritative and non-interactive. An analysis of the classroom talk would allow an assessment of how far the communicative approach at any time supported the teaching purposes. The authors suggested that this fine grain approach to lesson preparation or analysis would help teachers in a way that research focusing on large grain issues could not.

Ametller et al. (2007) believed that, just as the language of school science developed in the discourse of practitioners (science teachers, curriculum designers or textbook writers), so the language of other subjects developed in the discourse between practitioners in those subjects and, thus, the same general approach could be adopted. However, each subject was likely to
have its own set of language and learning demands to consider. They believed that the evidence showed that research evidence-informed teaching of the type they advocated would result in students having a better conceptual understanding. While teachers had choices of how to present within their classrooms, there was a need for them to take into consideration the ‘learning demands’ of their subjects (such as, in science, the difficulty students had in conceptualizing an electric circuit as a system) and then to offer analogies that would help them.

As mentioned earlier, Baker et al. (2008) developed an instrument to evaluate how far teachers were implementing the strategies that were thought necessary to foster a science classroom discourse community. This was part of a programme, The Communication in Science Inquiry Project, that saw talking and writing as central to the learning of science while at the same time noting that it was essential to teaching effectiveness that the teacher have good content knowledge.

The Discourse in Inquiry Science Classrooms (DiISC) instrument was to be used by trained researchers and was designed to measure the teacher’s use of certain strategies. The instrument consisted of five sets of instructional strategies that made up five scales:

- Inquiry
- Oral Discourse
- Writing
- Academic Language Development
- Learning Principles

Like many of the researchers discussed here, Baker et al. (2008) felt that the fostering of a classroom discourse community was essential to the learning of science. Their focus was on assessing prior understandings, linking facts to conceptual frameworks, metacognitive monitoring, setting performance expectations and providing formative and summative feedback, all learning principles also described in Bransford, Brown, and Cocking (2000).

Each of the scales was made up of a set of processes that could be checked for by an observer. For example, the Inquiry scale included the following processes:

- Engaging with scientifically oriented questions.
- Giving priority to evidence, which allows students to develop and evaluate explanations that address scientifically oriented questions.
- Formulating explanations from evidence to address scientifically oriented questions.
- Evaluating explanations in light of alternative explanations, particularly those reflecting scientific understanding.
- Communicating and justifying proposed explanations.

The authors explained that the instrument had gone through four drafts before the final version. The first draft was based on a review of research results. Later drafts were based on input from teachers, administrators, language experts, etc. The instrument results were also compared with the results of a survey of 187 students regarding their science lessons. A correlation of .80 had been achieved.

The authors stressed that no single lesson could cover all the strategies listed in the instrument. Similarly, no single class observation could be a full measure of the strategies employed by a teacher. Thus, when a researcher used the instrument to look at teaching, the observation programme would need to cover a series of lessons or units rather than just single lessons or units.

Bintz and Moore (2007) proposed a similar instrument, the Interdisciplinary Curriculum Framework. This framework had three central elements: content, learning process and pedagogy. It had six ‘curricular engagements’: text clusters; learning strategies; hands-on engagements; representing and reporting on data; multidisciplinary learning extensions; and assessment for and assessment of learning with the latter an important tool for helping the teacher support learning, reflection and differentiation. The important difference was that whereas Baker et al. (2008) were proposing a finely-designed instru-
ment for research into science teaching, Bintz and Moore (2007) were proposing an interdisciplinary curriculum guide to teachers on how they could support students in learning the literacy skills in the different subjects. The broad similarities, however, might point to the possibility of developing a detailed guide for teachers to use in developing their lessons.

Mercer, Dawes, and Staarman (2009) noted that despite research indicating the need for teachers to consider how they could encourage learning through their talk with students, evidence indicated that closed questions that demanded little input from students still dominated the world’s classrooms. (A survey of UK teachers found they emphasized student politeness and ‘good grammar’ more than anything else.)

Mercer et al. (2009) analysed the talk of two primary teachers teaching science in UK classrooms. (The two were from a larger sample of 12, all of whom had expressed an interest in dialogic teaching.) They found the amount of talk of the two teachers was not that different (85% and 88% of all the words spoken in the class) and the types of questions they asked were very similar. The authors felt there were some subtle differences that could have been important for teaching. (For example, both teachers allowed students to work in groups but only one allowed the discussion to last more than one or two minutes.) Despite these differences, neither teacher stimulated the kind of ‘dialogic/interactive’ discussion that would have allowed students to make lengthy contributions. In addition, neither picked up on student contributions to advance their lessons or to be discussed in any detail. The authors concluded that even teachers who showed interest in dialogic teaching might need reassurances that it was an effective way of teaching science and might need to be made more aware of the importance of their own contributions to classroom talk.

Spiegel, Bintz, Taylor, Landes, and Jordan (2010) noted that there were more published disciplinary literacy materials for teaching science than for other areas of the curriculum. As a result, science teachers were in a better position to focus on their own teaching. They described two lessons taught by two teachers who were introducing disciplinary literacy approaches into their classrooms. The first teacher focused on two essential features of science disciplinary literacy: the students developing scientifically oriented questions and using the evidence to develop and evaluate explanations in response to those questions. In doing so, she used moves from Accountable Talk, a list of moves developed at the University of Pittsburgh. The authors noted that the talk and writing in the classroom (in groups or in whole class discussion) provided the teacher with formative assessment opportunities that could help her respond to the needs of individual students.

In the second lesson Spiegel et al. (2010) described, the teacher focused more on the three remaining essential features: students formulating explanations from evidence, evaluating their explanations against alternative explanations and communicating their proposed explanations. Getting the groups to select relevant data, develop explanations and then compare their explanations to those of other groups before going back to refine their explanations resulted in the students having a much more robust understanding of what a scientific approach entailed.

While Carpenter (2011) was writing with regard to courses on academic writing in the disciplines that are not the focus of this Digest, his suggestion that scientific literacy was a layered combination of a number of interrelated literacies might be useful in highlighting the complexity of subject/disciplinary literacy in subject classrooms as well. He suggested that there were four literacies involved:

- Communicative literacy. This referred to the understanding that writing (and presumably speaking) was about communicating with an audience. Thus, students would not be helped by the mechanical application of a set of rules. They needed to learn to respond to the purpose, audience and context of their writing while being fully aware of the conventions of their subject areas.
- Graphical literacy. Students needed to learn the purposes of the different graphical representations and how they could be used to summarize complex sets of data or concepts that would otherwise be difficult to explain briefly in words.
- Technological literacy. Students had to learn how to use technology not only in the laboratory but also as a tool for communication. It
was important, for example, that they learnt how to look for articles on relevant scientific topics using databases on the Internet. They also needed to learn how to use word processing and graphic software to produce the reports they would need to prepare.

- Sociocultural literacy. The students needed to learn how to work with others in the production of reports and to take into account the different audiences for their reports whether they were scientists, other experts or a general audience.

These literacies cover the same kinds of student skills discussed in an earlier section of this issue. The important point that Carpenter (2011) made was that he believed that these literacies could and should be taught in a layered way, i.e. integrated into assignments so that the students learnt different literacies in combination. He emphasized that learning literacy rules without a context did not help as this could lead to the mechanical application of those rules in inappropriate ways. He felt that students could be helped to understand by being asked to analyse scientific texts and the reasons for the way they had been written.

Cook and Deaton (2012) felt that science teaching had focused too much on teaching facts that had little connection or application to the children’s lives. In order to promote science literacy and better understanding of science, the authors felt students must be involved in their own learning, solving problems, discussing questions and working in groups so as to learn together scientific thinking and talk in interesting ways. The authors suggested a case study approach in which students were required to collect, sort andanalyse information from different sources, consider a variety of opinions, and come up with alternative solutions to locally relevant issues, weighing the costs and benefits. The emphasis was on providing relevance for the students and giving them opportunities to voice their own views with suitable support from the evidence they had collected. There was also an emphasis on making the learning socially meaningful. According to Cook and Deaton (2012), a good case study was relevant to the students, presented a challenging problem with a number of possible solutions, encouraged discussion and cooperation among the students, had a human ‘empathy’ angle and was relevant to the subject curriculum.

Although his article focused on English language learners, Bergman (2013) suggested that all students could benefit from the sheltered instruction approach he described. The approach had a lot in common with science inquiry but also emphasized the need to look at language needs in drawing up lesson plans. He suggested adding into the actual lessons many of the features advocated by other writers reviewed in this issue. These included giving clear expected lesson outcomes at the start of lessons without giving ‘the answer’ to the inquiry that would be part of the lesson; drawing on students’ prior experience; providing opportunities for student-student interaction; and the teacher modelling the thinking and talking.

Lee et al. (2013) believed that, with support, students could learn the language skills for science within the subject lessons as they learnt the science. When preparing models of concepts and processes, students needed to read, write, view and visually represent their ideas. They had to talk and listen as they discussed their hypotheses with others. The authors believed that students should be heard no matter what their language skills were and they should be encouraged to speak and to listen to each other to create meanings. In this way, they would learn the subject while becoming more sophisticated language users.

Lee et al. (2013) suggested that teachers could use four principles to encourage this kind of talk: problematize the content; give the students authority; make sure students were accountable to others and the subject for their ideas; and provide relevant resources. Further, the teacher could help with the subject language by making it explicit and showing that it was a tool to talk about the subject and not something to replace everyday language, i.e. a tool that the students as learners of the subjects would develop over time.
Disciplinary literacy in mathematics

In looking at the learning of mathematics, Sfard (2001) proposed ‘thinking-as-communication’ as a theoretical base from which to work. The idea was that thinking was a form of communication – internal communication with oneself.

From this position, Sfard (2001) went on to discuss learning mathematics as an initiation into mathematical discourse, i.e. to a special form of discourse. Often, the rules of this discourse were not explicitly taught but were learnt ‘on the run’. In any discourse situation, participants came with their own sets of rules and understandings and it was through the discourse that adjustments were made between the participants. Some of the participants, such as teachers, were more authoritative and would have greater influence on how the rules developed. The less authoritative, in this case the students, would then learn new rules of communication and thought. However, this process did not always go well and teachers needed to be ready to assist.

Bakker and Hoffmann (2005) looked at a class of students aged 12 to 13 years in a Dutch school as they learned to use graphical representations of data. They concluded that students initially needed to make their own diagrams (or graphs) but then move towards the conventional, experimenting as they did. In the process, they needed to be stimulated to reflect on what they were doing. In the classroom they studied, Bakker and Hoffmann (2005) found that this occurred most commonly in whole-class discussions when the teacher and students discussed the students’ graphs and what was represented. In this latter stage, students learnt to talk about abstractions such as the ‘majority’ and to be more precise in their speech (and thus in their thinking). The graphic and diagrammatic representations could then be used to help students to conceptualize and predict (such as what would happen to a graph if the heights of an older set of students were plotted). Using various graphical representations of the same data could help students see the common structures underlying those representations. In this way, diagrams and talk worked together to help student learning and understanding.

Anthony and Walshaw (2009) collected the principles for teaching mathematics from across the research literature and developed a set of ten principles that should be found in an effective mathematics classroom. These ten principles formed a framework for a teacher’s classroom approach. The authors’ focus was on effective pedagogy within a community of practice in the classroom which was part of a larger, changing network that included the school and the home. The students’ individual and collective knowledge evolved within the dynamics of that learning community. The ten principles together were designed to encourage such a community of learning.

The first principle, an ethic of care, related to teachers caring about student engagement and managing student expectations and obligations with regard to who could speak when and what listeners should do. Students should be confident enough in their own skills to be able to consider the ideas of others and deal with any mathematical challenges they might face as a result.

The second principle, arranging for learning, recognized that the effective teacher provided opportunities for students to learn individually and together. The authors suggested that students sometimes needed time on their own in order to think more deeply about ideas. At other times, they needed to work with other students so that they could share and thus reinforce what they had learnt. Teachers needed to establish the proper student role behaviours such as listening to others, providing support for ideas, etc.

The third principle, building on student thinking, involved teachers in understanding the students’ level and the common ways in which students at that stage of learning interpreted the principles being taught. This necessitated teachers monitoring the skills of the students through their talk and writing. This could be done through discussion that focused on known areas of difficulty such as the relationships between fractions, decimals, percentages and proportions.

The fourth principle, mathematical communication, emphasized the need for teachers to model the communication of mathematical concepts through speaking, writing and concrete representations so that students learnt the mathematical conventions. The authors suggested that revoic-
ing could be a useful technique for teachers allowing them to take student ideas, check the assumptions behind them, negotiate meaning with the students and move on to new ideas or concepts.

The fifth principle, mathematical language, focused on the need to teach students the mathematical language required. The authors suggested that teachers might need to help students with particular language aspects such as the use of prepositions that might be unusual to the students in certain contexts. On occasions, the teachers might find it useful to initially use language the students were more familiar with to achieve understanding while continuing with the eventual aim of getting students to use the subject related language.

The sixth principle, assessment for learning, involved teachers collecting information on what students knew, how they learnt and what they were interested in as part of the everyday activities of the classroom. The questions being asked by teachers and students were an important source of such information.

The seventh principle, worthwhile mathematical tasks, emphasized the need to select tasks that helped students see how mathematics was relevant to real world issues such as work, leisure and home and how mathematics related to other subjects. Moreover, the tasks should be more than practising algorithms; students needed to be challenged to understand the mathematical concepts.

The eighth principle, making connections, related to students being encouraged to see how different aspects were linked and come up with alternative solutions to problems. The classroom atmosphere should support students trying out alternative solutions to complex problems, explaining their thinking, and listening to the thinking of other students.

The ninth principle, tools and representations, related to teachers using a range of modes to help students understand. These included the number system and algebraic symbols but also included analogies, stories and technology. While doing so, the teacher needed to take care that the students truly understood the teaching aids, such as number lines and tens-frames, that were being used.

The tenth principle, teacher knowledge and learning, focused on the need for teachers to have a good grounding in mathematics and in how students learnt in order to be able to clearly explain to students and, at the same time, challenge them to learn more. Teachers needed to be aware of what students were likely to find difficult so that they could prepare to help.

Anthony and Walshaw (2009) emphasized that their concept was of teaching as part of a systems network. Their idea was thus not to prescribe the actual detailed practice but to emphasize pedagogical practice leading to student outcomes.

Bill and Jamar (2010) described a mathematics lesson comparing two long-distance calling plans to illustrate learning on the diagonal proposed by McConachie (2010). (See p. 75 of this issue.) They showed how the lesson was designed to give practice in mathematical ways of thinking at the same time as the students learned the content. As the topic related directly to students’ out-of-school experiences, there was the added value that students could relate the lesson to their own lives.

The authors argued that critical thinking was not a skill that could be learnt independently of content and then used across the curriculum. Critical thinking had to be learnt and applied in specific content. The learning was a type of apprenticeship.

Bill and Jamar (2010) went on to suggest that the support of principals was important in helping teachers learn the techniques and approaches that were needed in disciplinary literacy classrooms. While teachers could go to outside courses to learn the theory, they needed to be given time at school to work with other teachers to reflect on their teaching and develop their approaches. Principals could support the learning further by using non-evaluative observations to discuss with teachers their implementation of the approach and ways that the principals could further support them.
**Disciplinary literacy in social sciences**

As in much of the available literature, this issue of the Digest will take history as representative of the social sciences. In fact, it is difficult to find any work on other disciplines. This could be an area of future work.

Mandell (2008) offered a framework for history that gave history teachers a quick way to check whether their lessons were covering the required aspects of historical inquiry. She defined “historical literacy as an understanding of what history “is” and what historians “do”” (Mandell, 2008, p. 55). She felt that teachers should be proficient in the language of history so that they could use effective approaches to teach this to their students. They needed to learn the skills, processes and concepts used by historians. Their students were to learn that history was not a set of facts but a way of thinking about the past. She suggested there were three steps:

- Asking questions about the past.
- Collating sources and evaluating the evidence.
- Drawing conclusions based on the evidence to answer the questions.

Asking the right questions was an important first step. To encourage students, teachers could start sessions with relevant questions, a task that could be handed over to students over time. In the discussion, students needed to be trained to provide supporting evidence for their views. Over time, they should be able to weigh the significance of their evidence.

Damico, Baildon, Exter, and Guo (2009) pointed out that the approach to history had recently changed. Previously, histories had often been considered to be objective texts with clear distinctions between fact and opinion. More recent approaches to history had emphasized that histories inevitably included the personal biases and views of the historian writer. They pointed out that active, expert readers employed various strategies while they read such as asking questions, thinking about the importance of an item, and synthesizing the content with prior knowledge. Among students too, prior views and background could affect their understanding of the histories they read and it was important for teachers to help them discuss, compare and contrast the cultural backgrounds they brought with them when approaching different historical texts.

Ravi (2010) showed how the five principles advocated by McConachie et al. (2006) could be realized in the history classroom by describing a unit on immigration into the USA. The unit started with students listing reasons for immigration based on their own personal knowledge or experience. From that base, the teacher introduced a source text for the students to identify the reasons for the immigration of an individual. In this way, in increments, the students learnt to ask the kind of questions historians ask, to develop conclusions and to give evidence for their views. The teacher used classwork and group work to monitor student progress and to make adjustments to the unit.

**Disciplinary literacy in the arts and humanities**

The academic area of the arts and humanities is grossly underrepresented in the literature on disciplinary literacy with only English language arts being covered. Thus, this discipline will be taken as representative here although it is possible that many will question how representative one discipline can be of the rest in this broad area.

Petrosky, McConachie, and Mihalakis (2010) noted that the typical English language arts lesson continued to be IRF dominated instruction that emphasized information transmission and rote learning. Such classes were dominated by a focus on details of language, word and sentence structure. They used an example of a teacher discussion and a lesson case study to show how the five principles of disciplinary literacy suggested by McConachie et al. (2006) could be applied in an English language arts lesson. They felt that the past two decades of curriculum development had wrongly focused on simplifying reading materials and teaching approaches in order to help those weak in reading. Instead, they thought the focus should be on developing a disciplinary approach that would allow the students to learn to deal with texts with increasing sophistication. Teachers could encourage students to analyse texts on their own with the teachers modelling the approach when needed.

Petrosky et al. (2010) indicated that, for the proposed changes in teaching to take place, princi-
pals had to be aware of the work teachers needed to do to develop the necessary skills in collaboration with their colleagues and to lend their support in every way including providing time for them to continue their study of disciplinary literacy. They felt the changes would not be sustainable if teachers did not reflect on their teaching together with colleagues.

In the same vein, Park (2013) thought teacher reflection important and thus looked at the understanding of disciplinary literacy in literature held by a group of pre-service teachers in a small college in the USA. She noted that the two theoretical frameworks which she used in her study both emphasized that the difficulties students might have in learning did not necessarily indicate any language deficit. It was more likely that it was related to them meeting an unfamiliar type of discourse as each discipline had its own way of knowing, using language, thinking and even believing. Park (2013) noted that, in English literature, there were a number of different approaches and, thus, discourse possibilities, such as those of the formalists and reader-response theorists. Her study looked at how the pre-service teachers dealt with these differences in the belief that it was important that teachers should reflect on the different discourse approaches in their discipline in preparation to helping their students.

Among the group of pre-service teachers in her study, Park (2013) found that disciplinary reading represented a number of different approaches and tasks. For example, reading could mean paying close attention to the language and form of the text. On the other hand, it could refer to looking at the social and cultural aspects built into the particular text so that the readers could better understand themselves and the human condition. It could also involve literary criticism, knowing how to talk about literary theory, or interpreting texts. While many of the pre-service teachers acknowledged that there were a number of different and valid approaches, some were critical of other approaches. For example, some felt that a close analysis of the language of a text led to a myopic view of the text and they very much favoured a focus on the content and its meaning for life. Even those who advocated close reading of texts had different views regarding its purpose: some believed that it would help students learn the craft of writing while others emphasized the approach as a way for the reader to better understand their personal responses to the text.

Just as the pre-service teachers had different beliefs regarding the role of literature in schools, they had varied approaches to teaching. However, there were some common themes such as the importance of frequent practice with multiple texts including with those from popular culture as well as with canonical texts, perhaps asking students to explain what they saw as literary texts, and asking for their reasons in order to force them to think about the issue.

A second theme related to engaging in dialogue in class about the purposes of studying English. In the dialogue, students and the teacher could share their beliefs and hopes through the examination of literary texts.

The question was what would be counted as misreading a text and who it was who should decide what a valid reader response was.

Conclusion

This issue of the ELIS Research Digest has scanned the literature for possible ideas to include in disciplinary literacy frameworks that might provide teachers and educators generally with help in understanding the issues involved in disciplinary literacy. There are two areas that can be considered. First, what are the student skills or behaviours that constitute disciplinary literacy and how do they vary across disciplines? Second, what kind of teacher behaviour and classroom environments help in the development of students’ disciplinary literacy?

As indicated in the early sections, there is a growing set of guides in the USA as to what constitutes disciplinary literacy in terms of student outcomes.
as a result of the need of states to conform to the new Common Core State Standards. These guides could be used as a basis for working on similar guides that could be used in Singapore classrooms.

In the later sections, the focus was on what teachers could do to help students and on what kind of classroom environments could help. In this area, there are a number of studies that have come up with different guides but there is a lot in common across them all. Essentially, they all indicate that we must first start from where the students are. This means we need to listen to them talk and read what they write. We must then help them to learn the concepts and language of the subject. Based on principles advocated by Vygotsky (1978), we can only do this in a social setting in which students learn together with knowledgeable others – their teacher and other students.

This review found a situation very similar to that described by Howe and Abedin (2013). They reviewed the literature on classroom dialogue from the forty years beginning in 1970 using a fairly broad definition of dialogue that included written forms that were not face-to-face such as on the computer. They found that, where the subject context of a study was indicated, the most common subject was science followed by mathematics (much as was found in the preparation of this digest). They also found that studies often implied values such as the need for a shift from teacher talk to student talk but none laid out clearly what best practice their findings were being judged against. The writers suggested that the model-based assessment that was often used was suitable for estimating how closely a teacher applied the model but it did not help identify its effectiveness. That could only be done through a target-based assessment that looked at the results obtained. They suggested that research should perhaps now focus on quantitative studies to determine which forms of dialogic organization would be beneficial. It was important for teachers to know how large any benefits might be so that they could determine whether the extra effort in implementing such methods was cost effective. In their review of the article, Mercer and Dawes (2014) agreed with this position.

Howe and Abedin (2013) found that not a lot had changed over the forty years from 1970. The IRF structure still dominated the classroom. One difficulty teachers had in encouraging increased exploratory talk in class was judging the correct timing and technique for introducing the ‘expert’ view when students were unable to get there on their own. A further difficulty related to balancing the time between class discussion, which was useful for checking student thinking, and forming small groups that would increase the talking time for individual students. Moreover, they found that students had difficulties learning how to challenge each other’s views. There was also a problem of student attitude towards discussion, which some students saw as fun but not real learning. Interestingly, the research reported that teachers were not able to scaffold student learning very well as they were not able to see what the students’ misunderstandings were.

Perhaps the most important way to bring about a change towards a clearer focus on disciplinary literacy is through a focus on teacher professional learning. McConachie and Apodaca (2010) stressed the need for the whole education system to support the development of disciplinary literacy education among teachers. They suggested that district education officers needed to work with principals, who, in turn, needed to work with teachers. All, district education officers, principals and teachers, needed to learn the principles of disciplinary literacy so that they could provide the necessary support. Teachers needed to work together in Professional Learning Communities that looked at their own and others’ teaching in a non-evaluative way focusing instead on how the teaching helped students learn.

In an example of raising teacher awareness, McArthur (2012) reported on a course for pre-service teachers from different disciplines in which they were shown that not all reading was equal. Each of them chose a text from their own discipline and then paired with someone from a different discipline to discuss how they read their own text, subsequently comparing this with how they read a text from their partner’s discipline. The exercise helped them understand the importance of prior knowledge in the reading of text. Applying this to their teaching, they understood how students might need help to cope with texts from different disciplines with which they were not familiar.
Another potential source of teacher support would be a guiding framework of what disciplinary literacy entails for both students and teachers. There is probably still some way to go before a full set of frameworks for disciplinary literacy can be prepared. However, we do have models of target student behaviours, including that of Lee et al. (2013) that shows the overlap between three disciplines. (See p. 73 of this issue.) We also have a number of studies in science and mathematics. We still need to have more in the social sciences and the arts and humanities covering a wider range of subjects so that we can more satisfactorily build up a representative set of frameworks.

Another question to be answered is whether there can be one framework that covers all subjects or whether there is a need for separate ones for each subject. McConachie and Petrosky (2010) indicated that they believed it was not possible to have a single framework covering all four core academic areas. Instead, they suggested the five principles they offered (McConachie et al., 2006) could be used across the academic areas as a general framework but could be interpreted differently for each of the areas in terms of what they meant for student and teacher behaviour. Research may prove this to be the most suitable compromise.

References


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