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Doing critical disciplinary literacies in teacher education: A pedagogical framework

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Background: This article explores the possibilities for conceptualising and doing critical disciplinary literacies (CDL) in (teacher) education.

Aim: By revisiting and adapting Luke and Freebody's four resources model, we consider the critical questions that teachers and teacher educators could ask about knowledge, practice, and text and/or representation within different disciplines.

Setting: Our use of the word 'critical' in CDL is therefore underpinned by traditions of critical literacies in which power and identity are fundamental to participating in disciplinary fields.

Methods: Using two cases as illustrative examples of CDL in context, one from science education and one from geography education, we demonstrate how our CDL model reveals possibilities for doing critical literacies across the curriculum and with disciplinary content knowledge and practice.

Results: Each case illustrates the pedagogical utility of the CDL framework for: (1) relating the disciplines to students' lives and (2) demystifying the processes of producing disciplinary texts.

Conclusion: We end with a call to action for student teachers, teachers, and teacher educators to explore the pedagogical utility of our CDL model by identifying the dominant texts of their (inter/trans) disciplinary work, interrogating the privileged sign systems as well as assumptions about imagined audiences of disciplinary texts, and (re) designing text and practice by drawing on multiple sources and approaches to representing knowledge and engaging in social action.

Contribution: In this article, we build on scholarship in critical literacies, disciplinary literacies, and teacher education by adapting and applying Luke and Freebody's four resources model to different disciplinary texts and practices, with implications for pedagogy at school and higher education contexts.

Keywords: critical literacy; disciplinary literacy; content-area literacy; science literacy; geography literacy.

Introduction

In this article, we contribute to critical and disciplinary literacy scholarship by attending to two main questions, working from different disciplines: (1) given the literature on content-area literacy, (socially just) disciplinary literacies, and critical literacies, what might a model for critical disciplinary literacies (CDL) look like? And (2) how might a model for doing CDL be used to think about literacy teaching and learning in two particular disciplines? Building onto and adapting Luke and Freebody's (1999) four resources model, we provide a framework (Figure 3) for understanding and doing literacy across the curriculum in ways that are both cognitively challenging and critically conscious. We then also provide two illustrative examples, presented as cases, to demonstrate the pedagogical utility of our model in context. The research questions here also respond, in part, to the questions posed by Moje (2008:99) in the article, *Foregrounding the Disciplines in Secondary Literacy & Learning: A Call for Change*:

1. What does discussing literacy in the disciplines from which subject areas are derived mean?
2. Does literacy simply refer to the cognitive processes of decoding, comprehending, encoding, and composing informational print texts? Or is literacy in different disciplines something more complex?
3. In particular, what does it mean to engage in literate practice in disciplines or subject areas?

Given the ongoing, contemporary questions about and efforts towards education as a means to address issues of social justice and equity in (teacher) education (Banegas & Sanchez 2023;

Behizadeh 2023), decoloniality and decolonisation (Gabi et al. 2022; Govender 2023; Kato, Galamba & Monteiro 2023), as well as other work on anti-oppressive pedagogies, the need to revisit disciplinary literacies from a critical perspective has been reignited across transnational contexts. The argument for disciplinary literacies is premised on foregrounding disciplinary knowledge and practice in teaching literacy across the curriculum (Goldman et al. 2016; Moje 2008; Shanahan & Shanahan 2012). Here, the dying notion of 'every teacher is a teacher of literacy' (Fischer & Ivey 2005) might finally be buried, and in its place, a binary understanding of 'content' and 'literacy' has been ushered in (Brozo et al. 2013; Draper et al. 2010). Arguably, this binary understanding of content-area literacy as a set of generic strategies for teaching reading and writing across the curriculum sits in direct opposition with disciplinary literacies, which understands literacy as 'an emphasis on the knowledge and abilities possessed by those who create, communicate, and use knowledge within the disciplines' (Shanahan & Shanahan 2012:8). This echoes the social turn in literacy studies in which Street (1984) differentiated between an autonomous model of literacy (i.e. as technical skill in reading and writing) and an ideological model of literacy (i.e. as a social practice that informs and is informed by social, historical, economic, political, and cultural factors).

Despite the perceived differences between content-area literacy and disciplinary literacies, the critical components of how knowledge and meaning-making (literacy) are interconnected with issues of power, access, diversity, and (re) design (Janks 2010) are necessary for teaching literacy as cognitive and socio-cultural practices (La Duke, Lindner & Yanoff 2016). This critical, social justice approach to literacy understands that students should have equitable access to powerful forms of knowledge, which may allow them further access to opportunities while having their own social and cultural capital valued as part of the processes of knowledge reception, production, and interrogation (Ladson-Billings & Tate 1995; Moje 2007, 2008). But access is perhaps also not enough. Drawing on Janks' (2010) interdependence model for critical literacies exposes how disciplinary texts and meaning-making practices, as they are imagined within the Western episteme (Grosfoguel 2007), are 'positioned and they work to position us' (Janks 2017:132). That is, what content and practice is selected to create the 'subject knowledge' of any discipline is itself socially constructed and determined (positioned) by specific historical events and choices. As a result, the texts and practices within disciplines have come to be taken for granted and are likely to reproduce themselves through educational practice (positioning). Critical disciplinary literacies seek to put these texts and practices (as well as their historical and political contexts) up for interrogation.

Therefore, we take up those understandings of literacy that regard knowledge and communication as socially constructed – and which can, therefore, be deconstructed and reconstructed (Janks 2010, 2014). Without moving from disciplinary literacy to

CDL, literacy across the curriculum risks becoming an exercise in turning students into disciplinary 'insiders' without consideration for their own identities, investments, or cultural capital (La Duke et al. 2016; Luke 2004, 2018; Moje 2008) in lived context. It also maintains that those pre-determined disciplines continue to be represented as truth-claims to knowledge and practice, backgrounding or silencing indigenous, subversive, and marginalised ways of knowing and doing. The 'critical' in CDL is, therefore, one premised on the multiple and eclectic traditions of critical literacies, in which power, identity/ diversity, access, and (re)design (Janks 2010) are paramount to building critically literate teaching and learning across (trans) disciplinary confines.

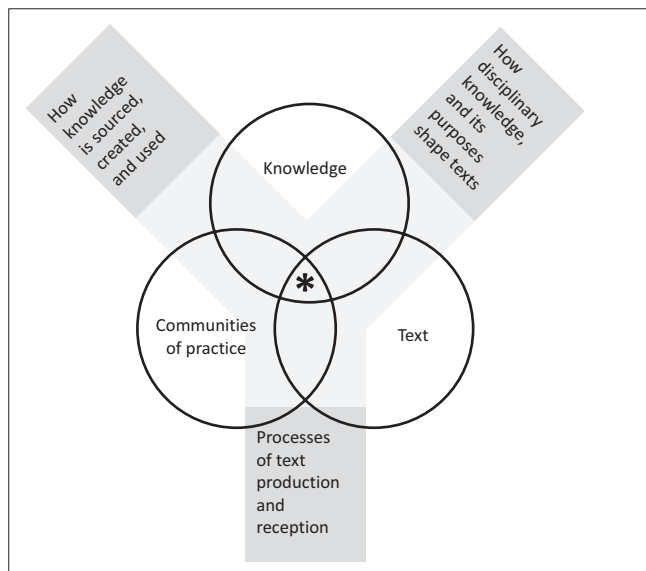## Disciplinary literacies and the critical literacy project

Moje (2008) calls for a social justice approach to literacy across the curriculum, which resonates with critical literacy's social justice agenda. This is given by the description that socially just literacy education is situated in, and instantiated with, ideology and issues of power. Significantly, Moje (2008:99) also states that such a take on literacy education is both a cognitive and socio-cultural practice, stating that 'the disciplines themselves are replete with cultural practices and can be considered discourse communities students must navigate'. Disciplines are therefore positioned and positioning (Janks 2010) insofar as the choices of disciplinary insiders construct them. Such gatekeeping of content knowledge and practice is perhaps inherent in all subject areas and education at large. However, without a critical consciousness of how and why knowledge and practice might be selected, sequenced, and presented to students (un)wittingly perpetuates how different disciplines present claims to truth. This suggests that the very structures of disciplines have social and psychological effects on teachers and students, positioning disciplinary literacy and success within the potentially narrow confines of the selected knowledge and practice.

Three issues stand out here: one, that school disciplines are communities that value particular ways of using language that students need access to. Two, that navigating discourse communities suggests becoming proficient in both the cognitive requirements of disciplinary learning as well as the sociocultural practices of knowledge production (Moje 2008, 2015; Shanahan & Shanahan 2012, 2017). And three, that discourse communities themselves are socially constructed traditions of language use, genre, and identity performance, which should be open to deconstruction and reconstruction.

There is a fine distinction to be made between disciplinary literacies in this regard and content-area literacy. While content area literacy tends to focus on literacy as a cognitive exercise, disciplinary literacy focuses on both the cognitive and the socio-cultural. Goldman et al. and the READI project (2016) discuss this at length. They argue that in order for students to become literate in the practices of their disciplines, they must move across three main kinds of text-based meaning-making: (1) *the surface level*, where basic decoding skills are developed and students can reproduce ideas and texts verbatim; (2) *the*

textbase level, where students' meaning-making is reliant on their lexical knowledge, syntactic analysis, and memory of disciplinary concepts; and (3) *the situation level*, whereby students begin to interpret whole texts using their memory of the subject matter and some inferencing strategies.

These three levels of engagement work in conjunction with the core constructs of disciplinary literacy, which Goldman et al. (2016) list as epistemology, inquiry practices,

overarching concepts, forms of information representation, and discourse and language structures. In a sense, disciplinary literacy is conceptualised as a set of relationships between content knowledge, the communities of practices that each discipline represents, and the text(-types) most prevalent and preferred by those disciplines (see Figure 1).

From this perspective, disciplinary literacy requires teachers and students to think carefully about how 'literate disciplinary practice' works at the interface of disciplinary knowledge, discipline-specific texts, and the valued activities within disciplines. If disciplinary knowledge drives what constitutes a discipline, then discipline-specific texts are the media through which that knowledge is represented. The texts of disciplines will also vary in genre (purpose) and multimodal composition (Kress 2015).

Therefore, between knowledge and text lies the question of *how* knowledge gets represented, for whom, and for what purposes (Govender 2020). Furthermore, constructing discipline-specific texts requires discipline-specific decoding/encoding practices of knowing, interpreting, analysing, arguing, evidencing, and explaining. The question raised between text and practice is, therefore, how knowledge is accessed through texts (reading), as well as how knowledge is conveyed (writing/[re]design). Finally, the question of how knowledge is identified, sourced, and used in the classroom lies between disciplinary knowledge and practice.

However, this model might be reconfigured as shown in Figure 2.

*, literate disciplinary practice.
FIGURE 1: Conceptualising disciplinary literacies.
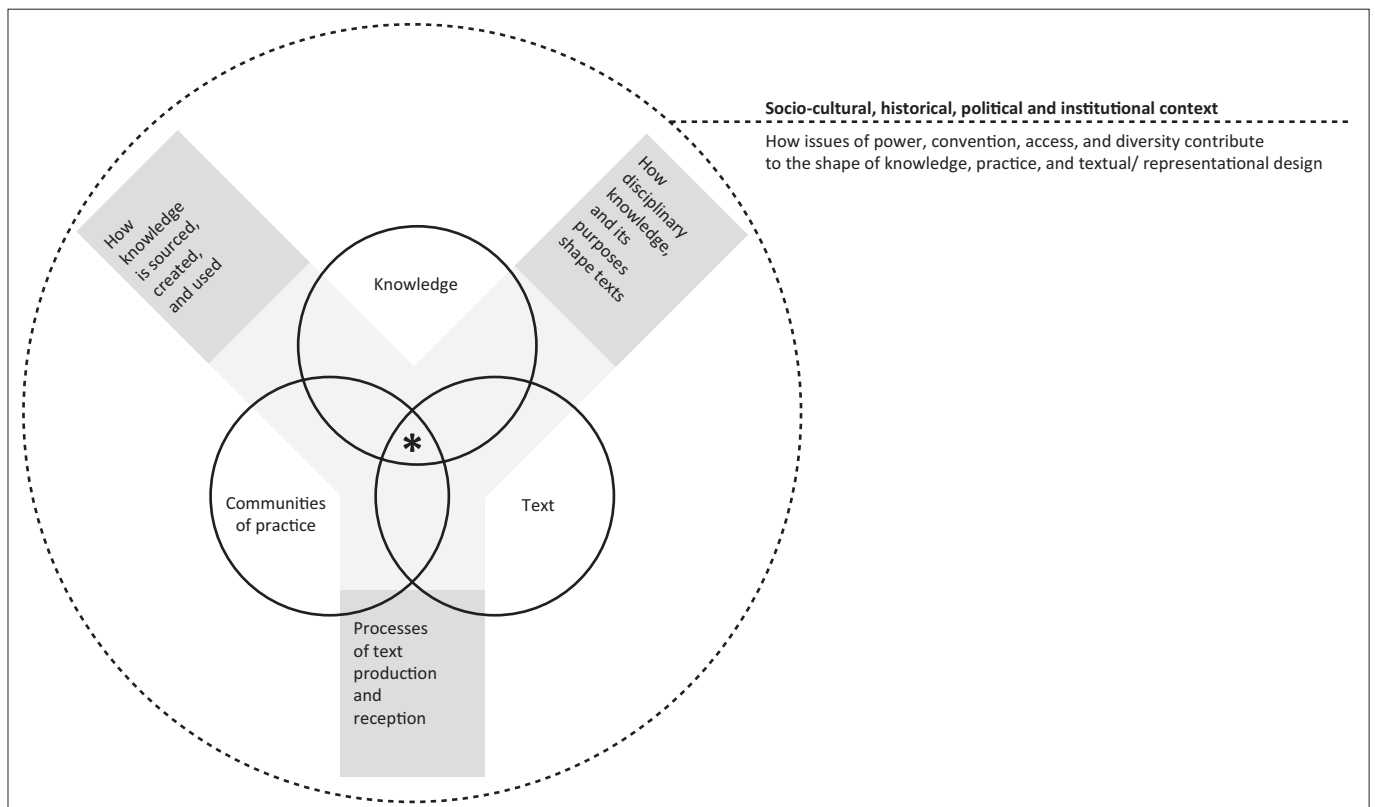
*, critically literate disciplinary practice.
FIGURE 2: Conceptualising critical disciplinary literacies.

By making the role of sociocultural, historical, political and institutional context explicit (Vasquez, Janks & Comber 2019), CDL might enable teachers and students to engage with their disciplines in more socially conscious ways (Dyches & Gunderson 2021; Moje 2015; Villanueva 2001). Moving beyond disciplinary knowledge that only 'addresses cognitive complexity by identifying that each subject presents diverse challenges' (Hillman 2014:399) requires that the disciplines themselves be recognised as socio-cultural and ideological constructions as well that enable the maintenance, resistance, or transformation of a range of social issues, including racism, cisheteronormativity, xenophobia, environmental catastrophe, and so on.

For example, how many geography classrooms use Mercator projection maps without questioning their design? Mercator maps, like most other projections, necessarily distort some aspects of its representation of the world in order to maintain other aspects of representation. Specifically, this projection maintains the relative shape of the world's continents but distorts relative size from a Eurocentric perspective (Roudometof 2017). This occurs when translating the 3D oblate spherical shape of Earth into a 2D image. However, designers' decisions about what to distort suggest that alternative choices exist. As such:

1. What social effects does this have? What stereotypes about whose social, political, or demographic issues matter are maintained or (re)produced by the distorted sizes of the continents?
2. What assumptions are (re)produced?

It would be interesting to know how many geography classrooms make serious use of Hajime Narukawa's Authagraph map, which has been heralded as the most accurate representation of the planet to date (Le Page 2018). Furthermore, it would be interesting to note whether teachers, teacher educators, or students themselves see these choices as both a broader sociocultural practice of power and a pedagogical one that shapes teaching, learning, and worldviews.

A framework: The four resources model for critical disciplinary literacies

Luke and Freebody's (1999) four resources model has been adapted as a framework for thinking about the various literacy practices that are inherent to knowing (epistemology), doing and being (practice and identity), and designing (text [de]construction) across disciplines. This provides a framework for literacy and disciplinary specialists to: (1) recognise the literacy practices, genres, and texts inherent to those disciplines, (2) design resources and pedagogies for making those literacy practices explicit, and (3) interrogate how content knowledge and disciplinary literacy practices relate to sociocultural issues of power, in sociocultural context.

Firstly, Luke and Freebody's (1999) four resources model outlines the four main roles that students need to take up in order to do critical literacy: (1) text decoder, (2) text participant, (3) text user, and (4) text analyst:

- **Text decoder:** As a 'code-breaker', the reader is interested in *textual features* and how texts are built using sounds, letters, words, phrases, sentence types, paragraphing structures and so on.
- **Text participant:** As a participant, the reader makes meaning from the codes of the text. Therefore, readers engage in developing their *cognitive competence* by interpreting the text using their prior knowledge and accessing the intended meanings of texts by considering the authors' or text designers' intentions.
- **Text user:** As a text user, the reader must consider the *social function(s)* of texts. This is connected to the genre: the purpose, intended audience, and form or structure of texts. Genres emerge from 'traditions of representations' (Govender 2020) that draw on dominating discourses. Within particular disciplines, a text user might also learn to employ those rules, regulations, and techniques for constructing texts and representing particular kinds of knowledge.
- **Text analyst:** The analyst is interested in how the components of the text, the meanings available, and the social function of the text all relate to issues of power, identity, access, and diversity in order to develop their own *social awareness* of texts and disciplinary knowledge in context. The reader asks critical questions (Janks 2010) about who is included or excluded. Whose interests are served by the text? How might this text be used to reproduce or challenge certain social norms? Furthermore, the analyst engages in practices of (re)design as a means to construct counternarratives, reveal alternative perspectives, and reimagine both knowledge and knowledge-making through critical inquiry.

By reconfiguring the questions under each role, it may be possible to use the model to read both disciplines as well as disciplinary texts (see Figure 3), thereby extending the original model for use beyond literacy scholars and practitioners.

Secondly, like Luke and Freebody's (1999) iteration, this model is non-linear and non-hierarchical. It requires that teachers and students work across disciplinary knowledge, ways of representing knowledge, and the practices necessary for participating in and/or transforming the discipline (see Figure 2) in more socially just ways.

In the following sections, Authors 2 and 3 present a 'case' from each of their disciplinary subject areas in teacher education, responding to the core research questions that underpin this article: (1) given the literature on content-area literacy, (socially just) disciplinary literacies, and critical literacies, what might a model for CDL look like? And (2) how might a model for doing CDL be used to think about literacy teaching and learning in two particular

Decoder		Participant	
Textual features		**Cognitive competence**	
What does communication look like in the discipline? What is the language and grammar of the discipline?		*What are the practices of meaning-making and knowledge production? How is disciplinary knowledge represented in texts?*	
• What sign systems are needed to access or convey disciplinary texts and knowledge? Provide examples of symbols, images, and sentence types that have particular meanings in your discipline. • What is the language (vocabulary) of the discipline? Which terms are associated with which areas of the discipline? • What modes of communication are valued in the discipline? Which modes, or combination of modes, are associated with which areas of the discipline? • What are the features of communication in this discipline? Describe how teachers and learners might be expected to speak, read, write, think, act or perform, etc.		• What definitions and explanations are given to the vocabulary of the discipline? • How is this similar/different to other disciplines? • What are the cognitive skills needed to make sense of the knowledge in this discipline? (refer to Bloom's taxonomy) How is this conveyed in language (across modes)? • What practices are necessary for participating in the discipline? How are these practices similar/different from studying the discipline? • What kinds of prior knowledge, cultural capital, or intertextual knowledge should learners have to access the content in this discipline? • How does disciplinary content knowledge relate to everyday knowledge? How do these different contexts shape how knowledge might be conveyed? • What counts as evidence in this discipline? How is evidence sourced, organised, analysed, and used to support claims?	
User		**Analyst**	
Social functions		**Social awareness**	
What purpose or social function does knowledge, and its representational forms (texts), serve in and beyond this discipline?		*Whose interests, perspectives, identities, and positions does this discipline serve? What social impact does disciplinary knowledge and practice have on individuals, local and global communities?*	
• What are the valued text types/genres in this discipline? When? Why? • What modes are valued most? When? Why? What are the affordances of particular modes, or combinations of modes, when trying to convey particular kinds of knowledge and understanding? • Who are the intended audiences? How does audience influence how knowledge can be conveyed? • What is disciplinary content knowledge typically used for? What are the real-world and school applications? What social functions do the disciplinary texts have? How does social function influence the shape texts can take? • What are the valued forms (genres) of assessment and how are these related to both disciplinary knowledge and practice?		• What assumptions does the discipline (and its participants) make about the world, identity, history, culture, etc.? • In what ways does the expression of ideas in this discipline maintain and/or challenge problematic socio-cultural norms? Provide an example. • Who benefits most from this disciplinary knowledge and/or practice? • Where does the most valued knowledge, texts, and evidence come from? Why? • Are there are alternative perspectives, sources, forms of evidence, or practices that could be included or foregrounded? • What are the criteria for assessing understanding, 'good' practice, and effective communication? Who do these criteria include or exclude? How might they be reconceptualised?	

Source: Adapted from Luke, A. & Freebody, P., 1999, 'Further notes on the four resources model', *Reading Online* 3, 1–6

FIGURE 3: Four resources model for critical disciplinary literacies.

disciplines? Each 'case' serves as an illustrative example of how the *four resources model for CDL* (Figure 3) can be applied in context.

Disciplinary area 1: The 'science-y' way of using literacy

Science education is a broad field of study, and the exposure to scientific texts, printed or verbal, is not confined to science textbooks, a science curriculum and related scientific literature. It is much bigger and broader as it employs scientific knowledge gained from everyday experiences through students' exposure to social media, newspapers, magazines, science centres, and conversations with people from different formal and/or informal social gatherings (Watts 2015). These everyday science experiences can be captured using the four CDL components (Figure 3). For instance, a young person can:

• *Decode and make meaning* of the comparative concepts. For instance, 'Why do we say that the bread has expired [*dead*] although it is already non-living [*dead*]?' or conceptualise the different patterns of bubbles which they are exposed to, such as bubbles in soapy water, bubbles when the seawater touches the body, patterns of showering bubble clouds (mammatocumulus).

• *Use and analyse* scientific texts. For example, the health and safety issues of the labourers working at the construction and/or petroleum drilling sites or scientists dealing with radioactive materials or the impact of the

coronavirus disease 2019 (COVID-19) pandemic on the lives of medically ascribed vulnerable groups.

The nature of gaining knowledge from everyday science, which (in)directly links with formal science education, has become a worldwide effort to develop a 'scientifically literate' next generation. Norris and Philips (2003) pointed out two senses of scientific literacy: fundamental and derived. The fundamental sense requires students to acquire core concepts, ideas and relationships, whereas the derived deals with the nature of science, scientific enquiry, and the involvement of science with wider societal issues – connecting the world of science to everyday life. Supporting school students to develop Norris and Philips's derived sense of scientific literacy along with fundamental knowledge is recognised by many science educators as a worthwhile goal (e.g. Fang 2013; Hassard & Dias 2009; Salehjee 2020).

Therefore, in becoming scientifically literate, there is no requirement for a person to be a science graduate and/or work in science-related professions. Instead, it requires a person who can read, write, comprehend, reason, and evaluate scientific knowledge, discoveries, and skills (Salehjee 2021). Language and literacy are fundamental to scientific learning and appreciation in the everyday lives of all children (Gee 2004; Fang et al. 2010; Osborne 2007), and developing scientific knowledge and skills to enhance scientific enquiry over time (Pearson, Moje & Greenleaf

2010). This aligns with Brickhouse's (2007) ideology of scientifically literate people who can:

- demonstrate some level of scientific understanding;
- critique written or oral science-oriented texts and/or scientists for the betterment of public life;
- draw upon scientific knowledge and skills to make personal choices for a better lifestyle, appreciate and understand scientific ideas concerning their interests;
- critically analyse written, oral and/or visual texts to make scientifically informed decisions.

These four points specifically highlight the (everyday) use of scientific texts. However, it is noticed in the literature that one factor of students' disengagement with science is their exposure to scientific texts, which focus on facts and theories (Archer, DeWitt & Dillon 2014). Moreover, it is observed that students believe they are confronted with sophisticated scientific vocabulary and a passive style of written and oral texts (Cervetti et al. 2006; Sutherland 2008). On the one hand, jargon presents science as an expert field that requires expert knowledge and unfamiliar terminology. On the other hand, passive voice removes the speaker from expression, presenting scientific concepts and phenomena (including the interpretive use of those concepts and reports on said phenomena) as timeless, unquestionable truth claims. Therefore, some students find it difficult to connect their everyday language and experiences to the specialised scientific literature they encounter within the discipline.

The four resources model of CDL (Figure 3) can guide science teachers and educators to engage students with scientific texts and support the development of future scientifically literate people. Therefore, we present some general aspects of the CDL model in the light of science (Figure 4), followed by a working example on the topic of polymers and plastics.

Critical disciplinary literacies components: Polymers and plastic

In planning and teaching, for example, the core concepts and uses of synthetic and/or natural polymers and their relationship with environmental pollution, teachers could plan their lessons by first engaging the students with reading, writing, and reasoning of science by introducing them to multiple sources of texts on ideas and/or objects that are familiar to students – for example, bringing in associated texts on plastics and leaves as examples of synthetic and natural polymers in the classroom to initiate a discussion on the types of polymers and its impact on the environment. A teacher could adopt the following steps, aligned with the four resources model for CDL, to plan a lesson on polymers and associated environmental issues.

Decoder – Textual Features: Provide a single-use plastic bag and a banana leaf to a small group of students. The students would probably regard these as two very different objects. Next, ask them to link these two objects by writing three sentences on the single-use plastic bags and the other three sentences on a banana leaf. In doing that, instruct the students to use the same ending and starting term to finish the third sentence on plastic and the first sentence on the leaf. The terms used could be synthetic, natural, water-resistant or shiny surface. Next, a teacher can ask all the small working groups to share their six sentences with the other groups and collectively, with the teacher, make a word bank of the new vocabulary learned. This activity would allow students to: (1) freely use everyday (vernacular) language, (2) access new scientific vocabulary, and (3) use the same vocabulary to link the two very different objects.

Meaning-maker – Cognitive Competence: Next, a teacher can provide some key vocabulary words taken from the textbook (such as polymers, hydrocarbons, cellulose, polyethene) and ask students to use their previously formed word bank and these critical vocabularies to identify the meaning of the words and sort them in three or four meaningful groups. This decoding can be accompanied by an experiment to test the same and different properties (such as strength, durability, water resistance, size, thickness, texture, etc.) of different single-use plastic bag strips and the strips of a banana leaf.

This strategy would allow students to understand the meaning of the texts by aligning familiar words about single-use plastics and banana leaves with key scientific vocabulary. As such, by measuring disciplinary terms with everyday language and applying these to disciplinary practice, students can work at the meeting point of formal and informal scientific meaning-making to make sense of their world.

Text User – Social Functions: Now, the texts from the textbook and other resources, such as science magazines, videos, newspapers, among others, can be provided to the students on the uses of plastic bags and their impact on the environment.

Decoder - textual features	Meaning-maker – cognitive competence
Decoding and practicing science-specific symbols, formulae, models, diagrams, figures, tables, graphs, terms, terminologies, and language.	Making meaning of interpretations and dispositions of the coded scientific texts and aligning it with prior everyday (vernacular) language and associated knowledge.
User - social functions	**Analyst - social awareness**
Using multiple sources to search for textual evidence to investigate further.	Critically analysing written, oral and/or visual texts written for varied audiences, voice certain communities of practice, scientific reasoning, written in different timeframe and its impact on local, regional, and global decision making of public and governments.
Language shapes science ideas and understanding, and the nonlanguage features of science shape scientific discourse	
Multiple sources could be pictures, practical investigation, written and verbal accounts, textbooks, newspapers, videos, posters, blogs, student chatrooms etc.	Communicating scientifically informed decisions based on the analysis gained from multiple sources of texts, including pseudoscientific news and reports.

FIGURE 4: Dimensions of critical disciplinary literacies in science.

This can be followed by asking them to write a summary of how and why texts in textbooks differ (or not) from the other sources of scientific information. Why has the media given attention to plastic pollution recently? What are microplastics? What are your opinions on using, misusing, or not using plastic bags? How convinced are you to use leaves as a natural polymer instead of plastic bags? If you are convinced, which kinds of leaves would you prefer to use instead of a plastic bag? Would using leaves unbalance the production, demand, and consumption of polymers in this way?

These probing questions and use of resources in addition to the textbook would help to embed the social functions of text in the classrooms and allow students to analyse the manipulation of the text to suit the readers (audience) and the reliability and credibility of the texts to be acceptable (or not) in the everyday lives of the students. Students, therefore, need to interrogate how a scientific question or phenomenon emerges across different texts for different audiences, to explore how such disciplinary knowledge becomes reachable to different people. Furthermore, rubbing multiple texts up against each other reveals how texts are constructed and the assumptions that the designers of scientific texts draw on to make choices about representation within and beyond the field.

Text Analyst – Social Awareness: The critical turn here would be to use the textual evidence gained from the previous steps, carry out further research, and communicate through poster and/or video presentations aligning to who (government, plastic industries, local shops, public) is responsible for controlling the increase, stabilising, or decreasing the use of plastics? What is the contribution of school science, media, and government (such as 'Go Green') in supporting global, regional, and local initiatives in banning plastic bags? Do they think the initiative of buying plastic bags instead of getting them for free in the shops helps the environment? Are these initiatives shared equally around the world? Why or Why not? What can they, as young people, do to tackle this global issue of plastic pollution?

This step is very important to promote social awareness among students and encourage them to view themselves as part of the global community in making or proposing scientifically informed decisions to protect the environment 'science-y way'. Students must, therefore, make direct connections between the text they work with, their practices of inquiry, their everyday discursive experience of coming into contact with a range of texts and the environment, and the broader social issues of their time. Acting on those social issues within the immediate contexts of learning, students reformulate the discipline so that it enables them to effect change in the classroom, their school or other educational setting, and/or their local community. This can then become an empowering practice for students to use their growing understanding to engage with the world around them.

We recommend the use of this model to practically implement the aspects of scientific literacy that go beyond the use of

scientific words/phrases taken from the science textbooks and curriculum by considering the way students participate in the global scientific community by critiquing, making day-to-day choices, and working towards better lifestyles in a scientific way (Salehjee 2021). Teachers, teacher educators, and students might then draw on the range of roles in the CDL model to create the conditions for critical inquiry and social action in contextually relevant ways.

Disciplinary subject area 2: Geography and environmental sciences (social sciences)

Geography is a diverse and multi-faceted discipline composed of human geography, physical geography, and environmental sciences (Bonnett 2008; Fouberg & Murphy 2020). For the purposes of this article, only one aspect of geography will be focussed upon – the spatial dimension. Many people argue that Geography, as a spatial discipline, is highly 'visual' (Driver 2003; Larangeira & Van Der Merwe 2016). Map work and geographic techniques (like the use of Geospatial Sciences and Geographic Information Systems – GIS) require practitioners to interpret and 'read' maps through an understanding of symbols and 'conventional signs' – so as to make meaning of the world. Maps, then, represent the meeting point of lived, imagined, and discursive space, which both not only shape the way map readers make sense of the world but also enable map-makers and users to interrogate ways of representing their world.

Although most geographic texts are both printed and verbal, most spatial information in Geography is available visually. Geography is increasingly being identified as a school discipline with the most 21st century skills necessary for students to solve the world's problems in years to come (Dolan 2020; Nagel 2008; Whalley et al. 2011). For example, reading, interpreting, and understanding maps (digital or printed) have become commonplace (Johnson, Louis & Pramono 2006). So, this section of the article explores the CDLs of geography that are required in GIS.

The four resources model for CDL (Figure 3) can guide Geography teachers and students to strengthen and develop the core of making geographic literacy more accessible. Some aspects of the model in the light of Geography are depicted in Figure 5.

Using the four resources model of CDL, I provide one exemplar teaching plan on mapwork and geographic techniques (Figure 6). Teaching Geography through the use of maps and atlases is an important component of the discipline. To effectively teach 'space and place', geography teachers need to use topographical maps, orthophoto maps (OPM), and satellite images so that pupils get a spatial sense of their environments. In a Geography Module on mapwork and geographic techniques for a second-year BEd class in the Faculty of Education at the University where I teach, I designed a course to engage student teachers on how better to teach mapwork to primary and secondary school pupils. Much criticism on how poorly mapwork teaching in school geography (Larangeira & Van Der Merwe 2016; Naxweka &

Wilmot 2019; Wilmot & Dube 2016) exists; therefore, student teachers were required to think critically about how best to teach children a spatial understanding of their local, regional, and international environments through effective integration of mapwork and geographic techniques (Mendoza 2018).

Students need to learn the 'language of mapping' to work effectively with maps. This involves understanding the symbols, colours, and notation (the code) used on maps to represent real-life landforms and features. To ascertain the student teachers' baseline knowledge and understanding of working with topographic maps, we gave them this question at our first lecture for this module:

The image below (Figure 6) is a topographical map extract of the 2528CC Pretoria map sheet in South Africa. Part of our Education Campus has been pointed out as feature A. Using your knowledge of conventional signs, name the vegetation type on the feature

Decoder - textual features	Meaning-maker - cognitive competence
Decoding and practicing geographic-specific *symbols*, formulae, models, diagrams, figures, tables, graphs, terms, terminologies, and language. Geographic jargon specific to certain sections of syllabi is unique to understanding various geographical concepts.	Making meaning of their interpretations and dispositions of the coded geographic texts and aligning it with prior everyday language; associated knowledge; and every day, common experiences. Geography requires an understanding of *place (and space)*; spatial processes; spatial distribution patterns; and human environmental interactions.
User - social functions	**Analyst - social awareness**
Using multiple sources (maps, graphs, data) to search for textual evidence to investigate further. Interpretation of the approaches, style and structure used by spoken language to shape geographic ideas and understandings and the coded language of geography shaped by geography discourses. Language shapes geographic ideas and understanding, and the non- linguistic features of geography shape scientific discourse. Multiple sources could be pictures, practical investigation, written and verbal accounts, textbooks, the Internet, newspapers, videos, posters, blogs, student chatrooms; maps and models.	Critically analysing written, oral and/or visual texts written for varied audiences, hear voices of certain communities of practice, geographic reasoning, written in different timeframes and its impact on local, regional, and global decisions. Communicating geographically informed decisions based on the analysis of the multiple sources of texts. For example: in most post-colonial countries urban planning of yesteryear has left an imprint of colonialism (and a westernised logic of what 'modern' cities looks like). How might urban planning, then, happen in ways that better represent the people and cultures (and ways of living) in that city? Are these questions teachers should be asking their Geography students?

FIGURE 5: Dimensions of critical disciplinary literacy in geography.
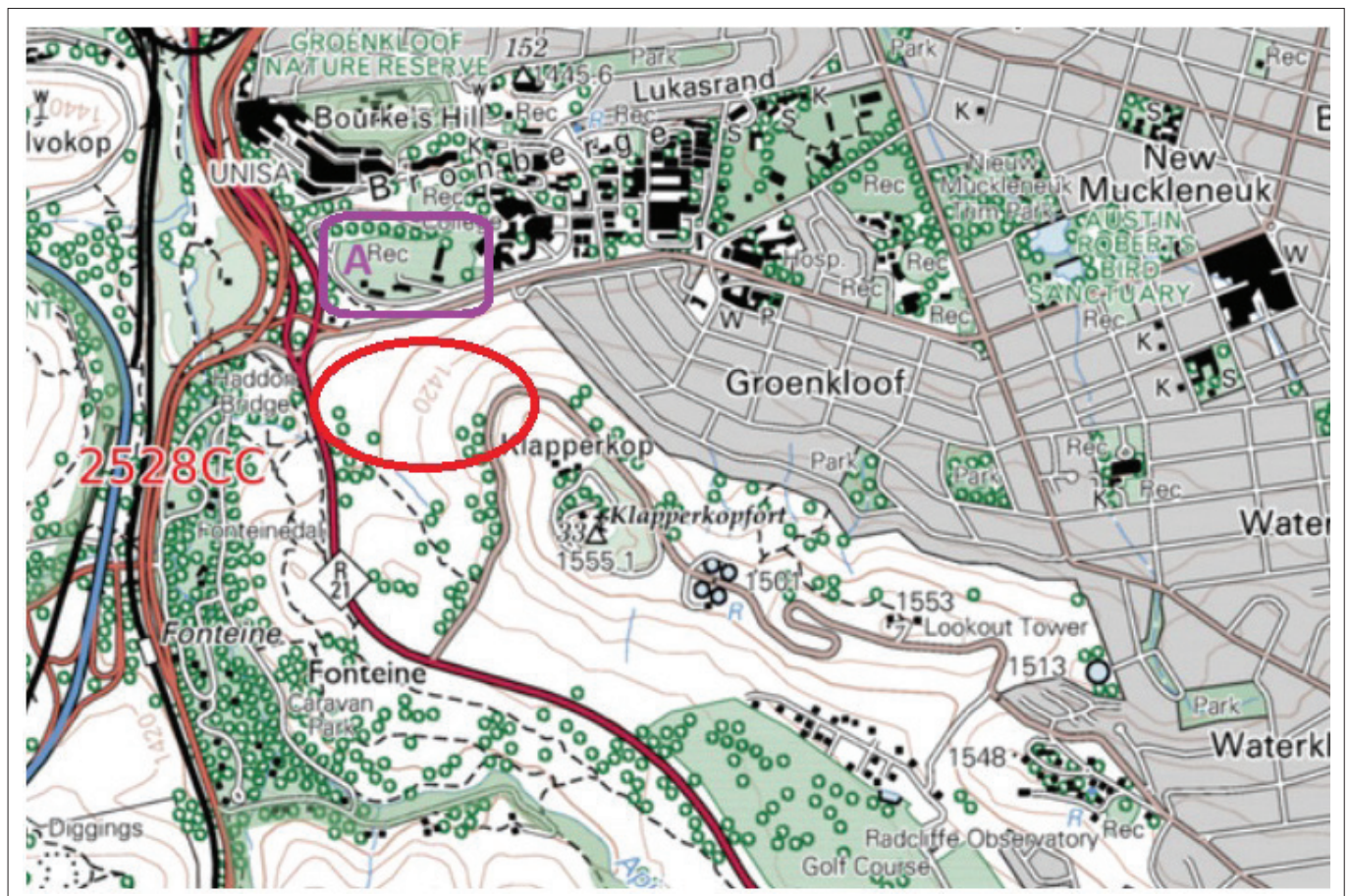
Source: Sagta.org.za, n.d., *2528CC Pretoria*, viewed n.d., from https://maps.sagta.org.za/
Note: Map made using the TopoMap Downloader from SAGTA.
FIGURE 6: Map extract of the 2528CC Pretoria map.

and/or landform on the map, which is depicted as an area by the colour white, as indicated by the red oval shape.

The question was asked because all students would have driven past this area on their journey to or from campus.

When using topographical maps, colours, shapes, and types of symbols represent various features – for example, green (vegetation), blue (water), and red and black (human-made features). Of the 159 respondents in the class, 0.662% answered correctly, saying that all 'white' on the map represents *veld* (natural grassland or endemic vegetation). Most of the other responses incorrectly identified this 'space' as 'just open land', 'contour lines', or 'undeveloped land'. It may not be explicitly explained in the conventional signs on maps, but Geography teachers need to know and teach that natural grassland exists across the landscape and is universally represented by the colour white on most maps.

Text decoder: After being taught the various types and colours associated with conventional signs, students can work with an OPM (or a true colour satellite image) of their local area. This can be displayed on a data projector to orientate and familiarise the class with the environments. Ask the students to identify the different land uses on the OPM or satellite image. This will enable students to make associations between conventional symbols and various features in reality (on the topographical map). Students can then work out how they think naturally occurring vegetation (not cultivated land, forested areas, or orchards and vineyards) should be depicted on the map – what colour and type of symbol would make the most sense, cartographically speaking?

Text participant: Having taught some basic conventions of map-making, the teacher can design an activity in which students think about why white would be a suitable colour to represent naturally occurring vegetation on a topographical map. The students could be tasked with drawing a sketch map of their local school in the suburb where it is found and thinking about what colours and symbols to use for each land use and/or feature on the landscape. By using too many colours (including one for natural grass and/or endemic vegetation), they should notice that maps become 'too busy'. Furthermore, students might explore a range of examples of maps and the codes used to construct them to help demystify how map codes are generated across different cultures and contexts (see, e.g., Breda 2022, who explores how indigenous Amazon communities use spatial and other codes to construct artefacts for navigating and sustaining their environments).

Text user: Now the topographical map sheet of the local area can be used alongside the OPM and/or satellite image so that students see the representation of various land use, landforms, and features, which are represented on the topographical map (with various colours and symbols) using conventional signs. Across different examples, students can then begin to explore how maps are constructed across different contexts for different purposes to enable different understandings of and interactions with the environment and how different forms of knowledge beyond the Western episteme give rise to culturally and contextually specific mapping codes.

Text analyst: Students might then recognise the practical reasons why naturally occurring vegetation needs to be represented as 'white on the map' to avoid making it too 'busy' and keep it visually comprehensible for the user. The other colours and symbols used to represent all other features on maps can be explored. The grey, red, black, blue, green, and brown can be related to the various categories of features they represent. The types of symbols (points, lines and polygons, or area) can also be unpacked to show various features such as specific coordinate points (like trigonometrical beacons – used to show the highest places on the landscape), or linear features (such as roads, rivers, powerlines, etc.), and features that take up more space (like area symbols, such as dams, lakes, cultivated land, etc.). Similarly, other polygons such as a dam (blue), a cadastral district and/or built-up area (grey), and a piece of cultivated land (green) where maize is grown can be shown in representative colours.

In geography, there is a need to work with multiple maps to better understand both maps and the environments they visually represent. A more holistic perspective is necessary for the map user to see the 'whole picture'. Students, therefore, not only need to access dominant colonial modes and codes for map-making but they also require access to a broad range of indigenous map-making practices and codes. Such critical access to diversity both displaces the power that colonial maps and map-making continue to have in education and places various indigenous knowledge and practices at the centre of teaching and learning. As such, a CDL model advocates for critical literacy development that enables students, teachers, and teacher educators to reimagine disciplinary content knowledge and practice beyond the bounds of predominantly Western traditions.

A call to action for (student) teachers and teacher educators

Reflect on knowledge, practice, and the use of texts in your classroom:

1. Select a text that is typical to your discipline and consider what combinations of sign systems (codes) are used.
2. Describe the genre of this text by considering its intended audience, its function in and beyond the classroom, and the decisions that go into producing a text like this. What are the assumptions about the imagined audience of this or these texts? Who is present and absent from this imagined audience?
3. Explore (source and collect) a variety of other texts that attempt to convey the same ideas to different audiences and from different perspectives. What 'new' genres and sign systems emerge? Which of these genres are students expected to (re)produce, and why? What

understandings might be demonstrated if students produce 'alternative' genres or draw on different sign systems?

4. What opportunities might these texts present for students to redesign or explore 'new' ways of presenting their understanding? How might you and your students bring everyday experiences with disciplinary knowledge into the classroom?

Consider how the different texts used and produced in your classroom resonate with out-of-school, activist, and indigenous literacies. How might students benefit from using social media to (re)design disciplinary texts, particularly where this might enable engagement with contemporary scholar-activist work? What alternative meanings might be made, and how might this relate to the decolonial turn in education? How might understanding be enhanced by making these intertextual connections that draw on students' lives?

Conclusion and implications for teaching

The framework for CDL presented here (Figure 3) adapts and builds onto Luke and Freebody's (1999) four resources model as a way to:

> [C]onceptualise more fully the notion of disciplinary literacy … as domains or cultures in which certain kinds of texts are read and written for certain purposes and thus require certain kinds of literacy practice. (Moje 2015:255)

The 'critical', therefore, lies in how knowledge, practice, and text (re)design are selected, navigated, and negotiated when students and student teachers are apprenticed into disciplinary communities of practice. Significantly, this framework contributes towards critical literacy scholarship in teacher education (Govender 2023; Johnson & Keane 2023) beyond literacy-specific education and into subject-specific, disciplinary spaces. Understanding disciplines as positioned and positioning – as social and political constructions – that frame and give value to some kinds of knowledge and practice over others is necessary for developing critical dispositions and reimagining the disciplines themselves. This also has implications for school-going students, where CDL offers a means to place both content knowledge and practice into question, promoting a critical inquiry approach to learning. For (student) teachers, our CDL model seeks to encourage critical self-reflexivity on the gate-keeping roles they or we have and their consequences.

The two discipline-specific examples help to illustrate possibilities for CDL and classroom practice. Consider how, in science education, students actively engage in relating science knowledge and meaning-making (or inquiry) to their own lived experiences with scientific phenomena. Or how demystifying the design of maps and map codes in the geography classroom reveals its social and disciplinary function in representing and being in the world. In both

examples, the possibilities for doing the 'critical' in CDL emerge from the everyday classroom activities, text selections, questions and enquiries by teachers and students alike. We, the authors, therefore offer this version of CDL as a means to interrogate the disciplines themselves, the texts that make up these curriculums, the texts produced as a result of teaching and learning, and to imagine practices that might lead towards more critically literate futures (see also Govender 2023). We also offer this framework to be revised and adapted by teachers, researchers, and students in contextually and culturally relevant ways.

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