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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.

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.

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 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 revoicing 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 inscriptional 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 inscriptional 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, corroboration, 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, corroboration, and contextualisation.

Teachers should plan assessment tasks that require students to read multiple documents that enable them to engage in the heuristics used in history of sourcing, corroboration, and contextualisation in their writing.

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 corroboration 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 corroboration 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.

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.

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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.

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.

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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