ONPAR Academic Language Resources: Developing Academic Discourse Skills in Science

One of the key features of ONPAR assessments is that they have a lower reading load than traditional assessments and feature multiple avenues of access so that language proficiency does not confound the measurement of content. While language is minimized within the assessments, the role of language in learning is an important aspect of learning content. As part of the ONPAR system, resources to support student development of academic language have been provided to help ensure that this important part of learning is not overlooked. The academic language resources that accompany ONPAR assessments are intended to support development of three language practices (1) learning and using vocabulary, (2) talking science and (3) writing science, as well as two discourse genres, argumentation and explanation. This document provides a brief overview of these topics and lists of additional resources to support independent professional learning about these topics. It is recommended that educators read the summaries of the academic language topics and select resources from the lists to further understanding of how to create opportunities to promote academic language development in the science classroom.

Learning and Using Vocabulary

Vocabulary knowledge has been shown to be one of the greatest predictors of students' academic success (August & Shanahan, 2006). Vocabulary knowledge includes everyday words used in both social and academic settings, general academic vocabulary words, content-specific vocabulary, and multiword expressions (Biber, Conrad, & Cortes, 2004; Ellis, Simpson-Vlach, & Maynard, 2008; Schmitt, 2004; Wray, 2002). The vocabulary students are familiar with and use depends on their varied experiences inside and outside of school settings.

Within the science classroom, vocabulary is an important part of learning because it is a way of knowing the world. Vocabulary is a not only a tool for identifying and naming new discoveries; words and phrases can entail complex scientific understandings. For example, how could one elegantly talk about parts of a cell such as a *nucleus*, *mitochondria*, or *chloroplast* without content-specific terminology? Phrases such as *natural selection* and *climate change* express scientifically complex ideas; ideas that cannot be memorized but must be built up through experience over time. Supporting students' vocabulary development provides them with the tools they need to express themselves as they come to understand the natural world around them in scientific ways.

In each packet of ONPAR academic language resources, there is a list of vocabulary words that correspond to a technology enhanced task, definitions, example sentences, and cards that can be printed and displayed in the classroom. It is important that students are exposed to terminology, meanings of the terms, and how to use them in context. Lists are not intended to be used for rote memorization, but to be used within the context of learning science content. Further, educators should be aware, as noted above, that some vocabulary words have concrete meanings and may be easier for students to learn, whereas other terms have meanings that should be built up over time. A term such as *chloroplast* is content-specific and can be easily depicted. Other terms such as *system* are used across science domains and may have multiple meanings or nuanced meanings within different domains. Finally, a term such as *biodiversity* is less concrete and may require several examples to help build students' understanding. The vocabulary lists provided are not intended to be comprehensive of all words that students might need to learn during a unit, but provide a foundation that educators may expand upon.

Learning and Using Vocabulary Resources

1. This video, narrated by Dr. Kevin Anderson from the Wisconsin Department of Instruction, provides background on learning vocabulary as well as strategies for students creating their own vocabulary notebooks and other extension activities to support vocabulary development. A power point and transcript are also provided. The power point was originally developed by Thersea Burzynski from CESA 10.

2. This brief from the Center for Applied Linguistics describes a classroom intervention for English Learners that was focused on vocabulary learning in science classrooms. Examples of vocabulary cards are provided in the brief.

   August, D., Artzi, L., & Mazrum, J. (2010). Improving Science and Vocabulary Learning of English Language Learners. Center for Applied Linguistics: Washington, DC.

Talking Science

Research on language in schools has shown that *talk* is a primary way to conduct day-to-day work in classroom settings (Shuy & Griffin, 1981). In spite of this, relatively little time is spent preparing educators to understand the role of talk in learning or the dynamics of classroom conversation. Early research on classroom discourse showed that the most common type of discourse structure was *initiation-response-evaluation* (IRE); a teacher initiates a question, a student answers with a word or a sentence, and then the teacher evaluates the response, letting the student know whether the answer was correct or not. While this type of discourse has been common in classrooms, it offers students little opportunity to talk or support their ideas verbally. Other research has shown that teachers tend to manage classroom talk; they choose the topic of conversation, take more turns, and hold the floor for longer periods of time (Peled-Elhanan & Blum-Kulka, 2006; Ramirez, Yuen, Ramey, & Pasta, 1991). Teachers also determine student turns, how long their turns can be, and when to close conversations. The conversational management decisions teachers make have consequences on student participation and learning. Talk is a complex professional skill for educators to develop (Michaels & O'Connor, 2012).

As a modality, talk is flexible, allowing students to jointly construct meaning in real time (Roth, 2005). Through talk, students can select from an array of possible verbal options, try out descriptions, and negotiate the best verbal representations interactively. For example, Wright (2008) shows how a group of students in a chemistry lab examine a phenomenon and describe it as *bubbling*, *fizzing*, and *sizzling* within in the same conversation. Ultimately, the group of students decide to describe the phenomenon as *bubbles* to their teacher. Later, in classroom discussion with the teacher, students come to use the word *gas* as their scientific description. As a flexible modality, students can stop and restart, agree and disagree, and revise their descriptions in a moment; these are fluid and expected moves within classroom discourse.

Recent research on classroom discourse has promoted student engagement in extended discourse. Linguists have asserted that talk provides students an opportunity to organize thinking coherently, hear how thinking sounds, listen to others' responses, and hear how others elaborate or add to thinking (Michaels & O'Connor, 2012). Thus, talk is a way that one's thought process can be shared with others and expanded through interaction. Teachers play a central role in orchestrating these discursive opportunities. Not all talk is necessarily productive; because talk is a complex skill, conversations within classrooms should be deliberately structured, and rules of classroom talk are strengthened when they are taught and reinforced through practice (see Michael and O'Connor's primer for science in the resource section for further information).

ONPAR's question prompts, provided in both the Teachers' Guides and Academic Language Resource packets, have been developed with this research in mind. In each packet of ONPAR academic language materials, there is a set of guiding questions related to various ONPAR response screens. The question prompts are intended to be used with students following an

ONPAR task. The questions are open-ended prompts that encourage students to engage in rich discussion. Most questions cannot be answered with one or two-word answers; they are structured to require explanations, descriptions, and citations of evidence with reasoning. Opportunities to engage in these types of discussions will help students think about the material covered in ONPAR tasks and review information to help reinforce and express understandings. It is recommended that after administering a task to a class that students are encouraged to debrief with their teacher and classmates to reinforce thinking through talk.

Talking Science Resources

1. This resource provides guidance on how to develop academically productive talk in classrooms. The primer provides suggestions on talk formats and talk moves.

   Michaels, S. & O'Connor, M.C., (2012). Talk Science Primer. Cambridge, MA: TERC

2. This short article focuses on features of good academic conversations, specifically with English Learners in mind. The authors focus on ways that teachers can support extended academic conversations.

   Zwiers, J. & Crawford, M. (2009) How to Start Academic Conversations. Educational Leadership, 66 (7), pp. 70-73.

3. A related video from Dr. Zwiers, is about developing oral academic language and critical thinking skills. In this video, Dr. Zwiers talks about the difference between oral output versus oral interaction and conversational skills and supporting students' abilities to meaningfully build on each other's ideas.

Writing Science

In their book *Writing Science*, Halliday and Martin (1993) explain that scientists harnessed the power of grammar to develop a highly sophisticated way of representing ideas in written form. Unfortunately, learning how to use this sophisticated, technical grammar to express understandings in writing can be difficult for students in science classrooms. Research has shown that writing science may be difficult because students have little time to practice, science assignments do not usually use process-oriented writing as they do in English Language Arts, and it is difficult for students to write when content is unfamiliar to them (Halliday & Martin, 1993; McGlynn & Kelly, 2018).

While spoken and written language can share linguistic characteristics (Tannen & Chafe, 1987), they are different modalities and, as such, have different affordances and constraints. In classroom settings, talk can be quick, interactive and somewhat informal. Talk is frequently used during learning experiences to develop consensus through small group and whole class discussions. Conversely, as a modality, writing is durable. Once something is written, it is concrete and must be erased and edited in order to be changed. Therefore, writing does not lend itself to expedient interaction the way talk does and is often done individually. Writing in schools is often treated more formally, where aspects such as spelling, grammar and punctuation are consequential. Attending to these aspects of writing take time and attention. Finally, writing is also portable and affords the opportunity for teachers to take students' answers and read them outside of classroom time. Thus, writing is a common means of assessing individual student understanding in U.S. schools. While these affordances have led to writing being used in school settings in certain ways, writing practices can be reconceived to make them more accessible and manageable for students.

One way that writing can be reconceived is to use informal forms of quick writing. For example, students can use graphic organizers to jot down their ideas; graphic organizers do not necessarily require attention to formal aspects such as spelling, grammar, and punctuation. Another way to support students' quick writing is to use statement frames. Statement frames help students start their ideas and focus on content rather than the form. Graphic organizers and statement frames can allow students to use every day, informal language, and allow them to draw pictures to annotate their ideas. Incorporating these activities regularly can provide more frequent writing opportunities for students to help them practice writing about science content.

In addition to quick writing, students should be provided with opportunities to engage in extended writing on a variety of topics. One way to support students in extended writing is to provide them with models before they start to write. Models will help students know what they are working toward so they can focus on form. In addition, sharing a grading rubric can help students know how they are being evaluated so they can identify important aspects of writing to include.

ONPAR utilizes a number of these forms of writing in its system to help build students' writing abilities. The assessments themselves provide statement frames, word banks, and graphic organizers to help students as they are learning content. The writing prompts provided in the Academic Language Resource packets have been developed to promote extended writing. In each packet of ONPAR academic language materials, there is one writing prompt related to an ONPAR graphic and is focused on a cross-cutting concept (see the resource section for a link to the cross-cutting concept resource). The writing prompts are intended to be used with students following the ONPAR End of Unit test when they at their highest point of mastery over the science content; this is purposeful so that students are familiar with the content they are being asked to write about. Within each packet, after the prompt, there is a writing rubric that can be shared with students so they better understand the goals of their writing; they are to use scientifically appropriate words and phrases, write in complete sentences, and answer all of the questions included in the prompt. Opportunities to regularly practice writing will help students think about the material covered in ONPAR tasks and reinforce and express their understandings.

Writing Science Resources

1. This resource from the Exploratorium provides several examples of different forms of writing in science classrooms. In addition, two videos of examples of writing in science classrooms are provided; each video has interactive annotations that provide insights into important moments within the classroom interactions.

2. This resource from science education researchers at the University of Colorado, Boulder provides cross-cutting concept prompts which were the basis for the ONPAR writing prompts. Teachers may find these prompts useful for developing their own writing prompts, embedded within classroom instruction.

3. This short article from the NSTA journal *Science Scope* provides useful guidance on writing within middle school science classrooms. The article is written by two middle school science teachers.

   McGlynn, K. & Kelly, J. (2019). Evolving students' writing skills. *Science Scope* 42(8) 40-43.

Discourse Genres: Argumentation and Explanation

The *Next Generation Science Standards* focuses on three dimensions of science learning: disciplinary core ideas, science and engineering practices and crosscutting concepts. Several of the practices are inherently linguistic, including argumentation and explanation. It would be difficult to engage in these practices without using language. The goal of science practices is to engage students in the work of science when learning science. That is, students should not just learn information and facts, but should be doing science as well. Argumentation and explanation are two ways that scientists use language to express their understandings and advance knowledge.

Argumentation and explanation in linguistic terms may be called *genres* or *text types*. They are forms of discourse that have recurrent linguistic patterns which make them recognizable as a type of text. Within science education, the terms argumentation and explanation are often used interchangeably, so for the purpose of this discussion, we will rely on the descriptions provided in *A Framework for K-12 Education* (2012). Explanations according to the *Framework* are "accounts that link scientific theory with specific observations or phenomena" (p. 67). Arguments, on the other hand, are described as "a process of reasoning that requires a scientist to make a justified claim about the world" (p. 71). Within the science classroom, it is important is that students learn how to make clear their logical connections between ideas (claims) and forms of evidence, and link their evidence to larger theories. Teachers may find that argumentation naturally leads to explanations.

One useful framework for supporting argumentation and explanation is called the Claim-Evidence-Reasoning Framework (CER) (McNeill & Krajcik, 2012). This framework breaks arguments and explanations into smaller moves. Students learn to make a claim, a conclusion that answers an original question, provide evidence, scientific data that supports the claim, and reasoning, a justification that links the claim and evidence. Reasoning articulates why data count as evidence, using appropriate scientific principles. The CER Framework is used widely in science settings now and is an effective tool for helping to scaffold students' development of these types of texts.

Argumentation and Explanation Resources

1. This video, provided by NSTA, discusses how to support students in writing claims, evidence and reasoning in science classrooms.

2. This template, provided on the Wisconsin Department of Instruction website, is a useful graphic organizer for helping students create their own claims, evidence and reasoning when engaged in science learning.

3. This website by Kate McNeill has a large range of argumentation resources, including student examples.

4. This article, on the Relating Research to Practice website, describes nuanced differences between argument and explanation, based on an article by Jonathan Osborne and Alexis Patterson.

   Osborne, J. F., & Patterson, A. (2011). Scientific argument and explanation: A necessary distinction? *Science Education, 95*(4), 627–638.

5. This page, from the Ambitious Science Teaching project provides a series of videos that culminate in video called Pressing for Explanations. An additional written resource is also available on their website.

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