

Academic Conversation: Deeper Learning through Interactive Language

High School Participant Packet



LANGUAGE
DEVELOPMENT
OPPORTUNITIES

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Academic Conversation: Deeper Learning through Interactive Language

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3 Contact Hours

Overview

An academic conversation goes beyond casual conversation. The goal is for the participants to reach a new understanding of a school topic through the use of specific conversational skills. Each partner must listen and speak, elaborate, clarify, challenge, paraphrase, and summarize what his/her partner says, and determine the outcome of the conversation.

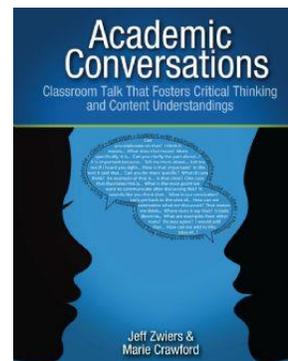
This workshop will offer participants a chance to try new ways of talking about academic topics, and build those strategies into their lessons.

Based on *Academic Conversations: Classroom Talk that Fosters Critical Thinking and Content Understandings* by Jeff Zwiers & Maria Crawford. Stenhouse, 2011.

Participant Goals

Through participating in *Fostering a Verbal Environment: Deeper Interactive Practice* participants will:

- learn and be able to train students to use a variety of
- be able to explore academic topics using a variety of
- increase achievement through the use of improved conversational skills.
- apply improved conversational skills to their writing.



Learning through

conversational skills
conversational skills.

PowerPoint Slides

What is an Academic Conversation?

An academic conversation goes beyond casual conversation. The goal is for the participants to reach a new understanding of a school topic through the use of specific conversational skills. Each partner must listen and speak, elaborate, clarify, challenge, paraphrase, and summarize what his/her partner says, and determine the outcome of the conversation.

Review the Research for ELLs

- ▶ ELLs benefit from Big 5 reading instruction, more so in word-level skills.
- ▶ Text level skills – comprehension and writing – are closely aligned with oral language development.
- ▶ Focus on systematic high quality vocabulary instruction
- ▶ **MAJOR THEME:** “The importance of intensive, interactive language development instruction for all English learners. This instruction needs to focus on developing academic language.”

August & Shanahan (2006) and Gertsen et al (2007) in Honigsfeld & Dove (2010)

Hot off the press...

Teaching Academic Content and Literacy to English Learners in Elementary and Middle School April 2014

- **Recommendation 1** Teach a set of academic vocabulary words intensively across several days using a variety of instructional activities.
- **Recommendation 2** Integrate oral and written English language instruction into content-area teaching.
- **Recommendation 3** Provide regular, structured opportunities to develop written language skills.
- **Recommendation 4** Provide small-group instructional intervention to students struggling in areas of literacy and English language development.

Academic Conversations: Getting Started

- ▶ All students have common information
 - Read a text
 - Heard a read aloud
- ▶ Practice one skill at a time, build on them
- ▶ Facilitator
 - Be as quiet as possible
 - Avoid "rescuing" – providing a word or idea for a student
 - Model the skill frames
 - In early stages, pause for progress checks on the conversation goals – which skills used, etc.
- ▶ Mini-lessons
 - Teacher model
 - Student pairs model with coaching
- ▶ Make a Conversation Poster
 - see Teaching ideas, Questions, Answers

Getting Started

- Effective conversations
 - Both partners talk
 - Critical and creative thinking
 - Welcome controversy and conflict
 - Follow norms
 - Share knowledge and skills
 - Provide choice and ownership
- Planning
 - Teach/OK moves
 - Set chunks
 - Write questions
 - How will you assess?

Conversation Norms

- ▶ We listen to each other
- ▶ We share our own ideas and explain them
- ▶ We respect another's ideas, even if they are different
- ▶ We let others finish explaining an idea without interrupting
- ▶ We take turns and share air time

Elaborate and Clarify: Questions

Questions ask for specific information. *Try these:*

- ▶ **Can you elaborate on...?**
- ▶ *What do you mean by...?*
- ▶ **Can you tell me more about...?**
- ▶ *What makes you think that?*
- ▶ **Can you clarify the part about ...?**
- ▶ **Can you be more specific?**
- ▶ *How so?*
- ▶ *How/Why is that important?*
- ▶ *I wonder if ...?*
- ▶ *I'm a little confused about the part...*

Elaborate and Clarify Frames

Level	Questions	Answers
1	What do you mean by...? Porque piensas eso? Tell me more about... Dime mas sobre...	I mean... Yo pienso.... I think that... Yo pienso que....
2	What do you mean by...? Tell me more about... <i>Can you elaborate on...?</i> <i>I wonder how/if...</i>	I mean... <i>By that I meant....</i> I think that...
3	What do you mean by...? Tell me more about... Can you elaborate on...? <i>I wonder how/if...</i> <i>What makes you think that?</i> <i>Can you be more specific?</i>	I mean... By that I meant.... I think that... <i>It's similar to when...</i>

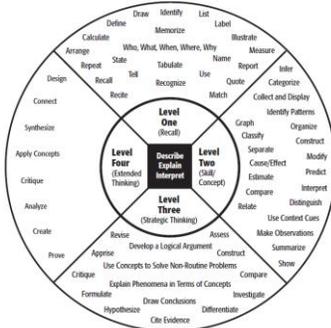
Elaborate and Clarify Frames

Grade	Questions	Answers
4	What do you mean by...? Tell me more about....? Can you elaborate on...? I wonder how/it/... What makes you think that? Can you be more specific? How does that connect to...? Why is that important?	I mean... By that I meant... I think that... It's similar to when... In other words... According to.... It's important because... I believe that...
5	What do you mean by...? Tell me more about....? Can you elaborate on...? I wonder how/it/... What makes you think that? Can you be more specific? How does that connect to...? Why is that important? I'm confused about the part... Can you clarify the part about...?	I mean... By that I meant... I think that... It's similar to when... In other words... According to... It's important because... I believe that... An analogy for this might be... More specifically, it is...because...

Leaf & Root Questions

- ◆ “Leaf” questions are “above ground”, literal comprehension knowledge level
 - Answer is in the text
- ◆ “Root” questions are “buried”, higher order thinking questions
 - Information leading to the answer is in the text, but not the exact answer

Depth of Knowledge (DOK) Levels



Costa's Three Story House

- ▶ Level 3: Apply information
 - Evaluate, judge, generalize, predict, hypothesize, imagine, speculate, forecast
- ▶ Level 2: Process information
 - Compare, contrast, sort, infer, analyze, classify, explain
- ▶ Level 1: Gather information
 - Complete, identify, recite, define, list, select, describe, observe



Support Ideas with Examples: Teaching

- ▶ The Hunt for Deep Ideas. What makes you stop & think? Write quotations on cards.
- ▶ Plan the conversation on an organizer

Idea	Example
The Red Sox are a great team.	They won the World Series eight times. (1903, 1912, 1915, 1916, 1918, 2004, 2007, 2013)
	They have 74 players in the Hall of Fame.

- ▶ Evaluate the support (quality) of examples on a continuum:



Support Ideas with Examples: Questions

- › *Can you give me an example from the text?*
- › *Can you show me where it says that?*
- › *What is a real-world example?*
- › *What is the evidence for that?*
- › *Why do you say that?*
- › *Such as?*
- › *Like what?*

Support Ideas with Examples

Level	Questions	Answers
1	Like what? Como que? Such as? Why did you say that?	The picture showed.... The story said...
2-3	Can you show me where it says that? Can you provide text-based evidence? What is a real life example?	In the text it said that... According to... For instance,... For example,....
4-5	What is an example from your life? How do you justify that? Why is that a good example? What would illustrate that? Are there any cases of that?	On one occasion,... One case showed that... An illustration of this could be... To demonstrate,... An example from my life is... Indeed,...

Send a Question: *Asteroids*

- ◆ Again, “chunk” the reading with your partner
- ◆ With DOK or Costa, each partner write three questions from different levels on one card
- ◆ You must be able to cite the answer from text.

Quiz Quiz Trade

Description	Teaching Tips for ELL
•Students write questions related to the content on cards. Must know the answer.	Level 1 students may write questions in L1.
•Students mill around the room to music.	Level 1 students partner with students who speak their own language. Level 2 may partner in L1 for their first pairing.
•When the music stops, they form a pair and ask each other their question.	
•If the answerer knows the answer, they say it. If not, the questioner explains the answer.	
•Student trade cards.	
•Music begins, students mill and find new partners.	

Chants

- Put content to a rhythm or music
- Popular & easy:
 - Cadence with call & response
 - We Will Rock You
 - Bugaloo
 - Addams Family
 - Are You Sleeping
 - Row Your Boat
 - Or any tune at all
- Samples: www.psd1.org/page/253

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Write one!

- Think of a topic
 - Tie to standards
- Think of a tune
- Write a few verses
 - Think about pairs of rhyming words
- Create movements
- Extra: **harmony and dance moves!**

Paraphrase: Teaching

- ▶ Listeners set aside their own thinking
- ▶ Listeners tell as much of what they heard as possible
- ▶ Listeners question the speaker for clarification

Paraphrase: Sounds like...

- ▶ So, you are saying that...
- ▶ Let me see if I understand you.
- ▶ In other words, ...
- ▶ What I'm hearing is...

Paraphrase Frames

Level	Questions	Answers
1	What? Que? What did you say? Que dijistes?	I said... Yo dije.... Well,... Pues,....
2-3	Can you say that again? Please repeat what you said. I can't remember what you said.	So, you are saying that... Let me see if I understand you. In other words, ... What I'm hearing is...
4-5	I'm not sure that was clear. Can you repeat that? What did you hear me say?	What I heard you say... Essentially, you think ... In a nutshell, what you're saying is...

Give One Get One

- Write 3 responses for a higher level question on a sheet of paper
- Tear each response off
- Mill around
- With a partner, share and trade one strip
- Repeat twice more
- Return to seat
- Read & share with table team

*What was Bill's response to the Northern Lights?
What do you think your response would be?*

Build on &/or Challenge a Partner's Ideas: Teaching

- Read two texts, opposing views
- Two-minute Opinion Share
 - Give the partners a controversial question.
 - Assign one partner A, one B
 - A gets 1 minute to defend her/her side of the question
 - B must challenge A's position
 - Third minute is for consensus
- Build – and use – a set of norms

Build on &/or Challenge a Partner's Ideas: Teaching

- Pose the question
- Students decide on their position
- Read/watch informational input
 - Assign one partner A, one B
 - A states and defends her/her position
 - B must agree or challenge A's position
 - Develop consensus or summary

Build on & Challenge a Partner's Ideas

Level	Questions	Answers
1	Do you agree? Piensas igual? What are your ideas? Que son tus pensamientos? Can you say more? Puedes decir mas?	I agree because... Estoy de acuerdo porque... I disagree because... No estoy de acuerdo porque... I think that... Yo pienso que....
2-3	How does that connect to...? Can you add to this idea? Can you show where the text supports that?	I would add that... I want to follow up on your idea... I respectfully disagree because... Another way to think about this is... Going back to what you said before...
4-5	How can we bring this back to the text? What might be other points of view?	Yet I wonder also if... What struck me about what you said... I want to expand on your point about...

Conversation Norms - Challenge

- We listen to each other
- We share our own ideas and explain them
- We respect another's ideas, even if they are different
- We respectfully disagree and try to see the other view
- We let others finish explaining an idea without interrupting
- We try to come to some agreement in the end
- We take turns and share air time

Opinion Continuum

Jelly beans are better than M&Ms.

Yes	No
-----	----



- Students place their own personal arrow where their opinion falls.

Synthesize Conversation Points: Questions

- ▶ What have we discussed so far?
- ▶ How can we bring this all together?
- ▶ What can we agree on?
- ▶ What are the main points?
- ▶ What was the original question?
- ▶ We can say that...
- ▶ The main point seems to be...
- ▶ How does this sound?
- ▶ We think we should...

Synthesize Frames

Level	Questions	Answers
1	What did we learn? Que aprendimos? What was important? Que era importante? What did we talk about? De que hablamos?	We said that... Decimos que... We learned... Aprendimos.... We talked about... Hablamos de...
2-3	What have we discussed so far? What can we agree upon? What main ideas can we share?	We can say that... We have discussed... The main theme/point seems to be...
4-5	How can we synthesize what we're talking about? What key idea(s) can we take away?	As a result if this conversation, we think ... The evidence seems to suggest that...

Assessment: Student Voices

- Informal formative assessments. See list on page 27 of the packet.
- Use a rubric
 - Determine the skills you are looking for from the Standards
 - Build your own rubric. (Good templates on p 192-193 in AC)
- Student Recording
 - Use Conversation Counter checklist
 - In your team, make a recording of a student conversation of Elaborate & Clarify and/or Support Ideas with Examples. Use your rubric to analyze it. See p 196 in AC for guidance.

Deepen the Practice

Students take on more responsibility to deepen the conversations:

- ▶ Whole Brain Teaching: Teach/OK
- ▶ Pairs invite singletons to join them
- ▶ Pairs change
- ▶ If one pair member won't talk, other member may join another pair
- ▶ Each pair monitors itself – point value (eventually)
 - Baseline and improvement data
- ▶ Students monitor conversations with checklists
- ▶ Recognition for great conversations

Make it...

- Make:
 - The Norms
 - Elaborate & Clarify stems
 - Support Ideas with Examples stems
- Adapt for your grade level
 - Poster or flash cards
 - Materials in the back
- Math Talk Moves:
 - www.melrosemathgradek.wikispaces.com/talk+moves
- DOK posters on Pinterest:
 - pinterest.com/pin/272186371204089828

Your turn now...

With the classroom material you brought:

- Connect with your teaching partners
- Go back to p 6 for the planning steps
- Review the S&L and ELPS work we did this morning
- Decide how you will apply one or more of these skills
 - What content area
 - What lesson
 - When
 - What assessment tool(s)
- Prepare to tell!

Try one skill at a time. Stick with it for awhile until it feels natural. There is no hurry, there's just taking the next step.

CCSS ELA Speaking & Listening Standards Grade 8

1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on *grade 8 topics, texts, and issues*, building on others' ideas and expressing their own clearly.
 - a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
 - b. Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed.
 - c. Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
 - d. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
2. Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
3. Delineate a speaker's argument and specific claims, evaluating the soundness and sufficiency of the evidence and identifying when irrelevant evidence is introduced.

CCSS ELA Speaking & Listening Standards Grade 9-10

Comprehension and Collaboration

1. Initiate and participate effectively in a range of collaborative discussions (one- on-one, in groups, and teacher-led) with diverse partners on *grades 11–12 topics, texts, and issues*, building on others’ ideas and expressing their own clearly and persuasively.
 - a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue stimulate a thoughtful, well- reasoned exchange of ideas.
 - b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
 - c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
 - d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
2. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
3. Evaluate a speaker’s point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

CCSS ELA Speaking & Listening Standards Grade 11-12

Comprehension and Collaboration

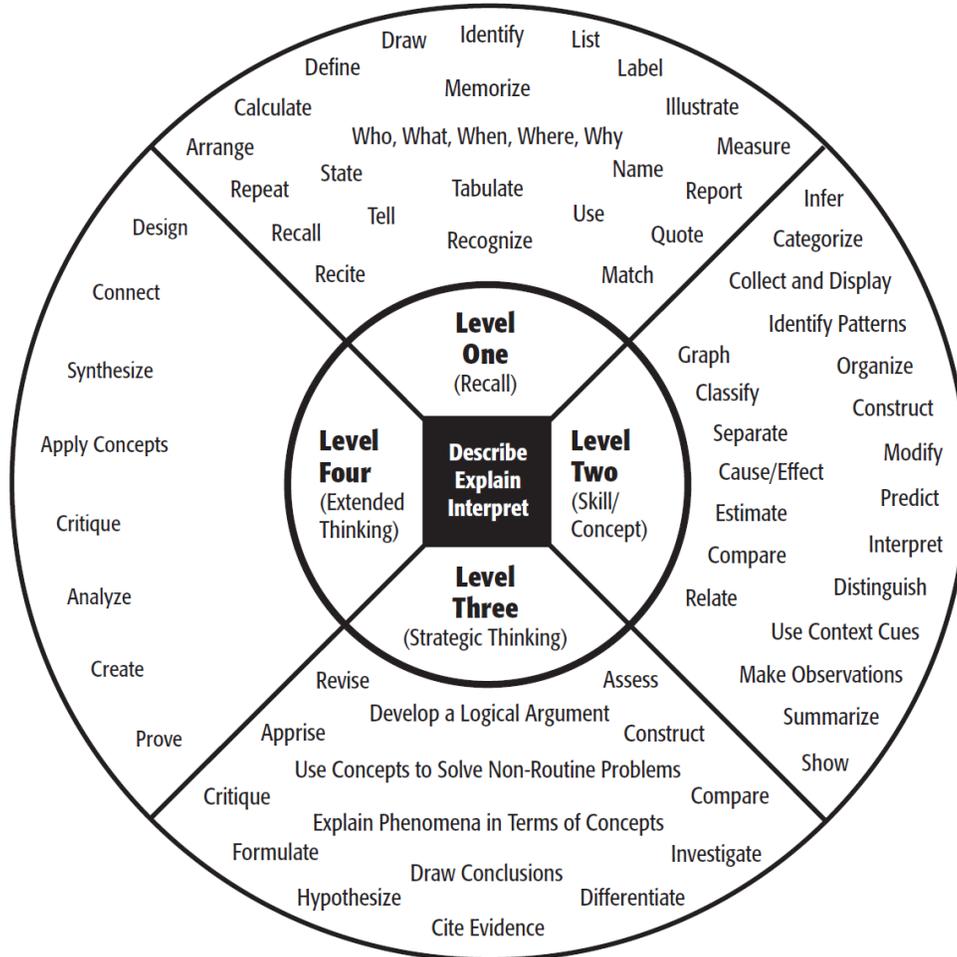
1. Initiate and participate effectively in a range of collaborative discussions (one- on-one, in groups, and teacher-led) with diverse partners on *grades 11–12 topics, texts, and issues*, building on others’ ideas and expressing their own clearly and persuasively.
 - a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue stimulate a thoughtful, well- reasoned exchange of ideas.
 - b. Work with peers to promote civil, democratic discussions and decision- making, set clear goals and deadlines, and establish individual roles as needed
 - c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
 - d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
3. Evaluate a speaker’s point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

English Language Proficiency (ELP) Standards

An ELL can...

1	construct meaning from oral presentations and literary and informational text through grade-appropriate listening, reading, and viewing
2	participate in grade-appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions
3	speak and write about grade-appropriate complex literary and informational texts and topics
4	construct grade-appropriate oral and written claims and support them with reasoning and evidence
5	conduct research and evaluate and communicate findings to answer questions or solve problems
6	analyze and critique the arguments of others orally and in writing
7	adapt language choices to purpose, task, and audience when speaking and writing
8	determine the meaning of words and phrases in oral presentations and literary and informational text
9	create clear and coherent grade-appropriate speech and text
10	make accurate use of standard English to communicate in grade-appropriate speech and writing

Depth of Knowledge (DOK) Levels



Level One Activities	Level Two Activities	Level Three Activities	Level Four Activities
<p>Recall elements and details of story structure, such as sequence of events, character, plot and setting.</p> <p>Conduct basic mathematical calculations.</p> <p>Label locations on a map.</p> <p>Represent in words or diagrams a scientific concept or relationship.</p> <p>Perform routine procedures like measuring length or using punctuation marks correctly.</p> <p>Describe the features of a place or people.</p>	<p>Identify and summarize the major events in a narrative.</p> <p>Use context cues to identify the meaning of unfamiliar words.</p> <p>Solve routine multiple-step problems.</p> <p>Describe the cause/effect of a particular event.</p> <p>Identify patterns in events or behavior.</p> <p>Formulate a routine problem given data and conditions.</p> <p>Organize, represent and interpret data.</p>	<p>Support ideas with details and examples.</p> <p>Use voice appropriate to the purpose and audience.</p> <p>Identify research questions and design investigations for a scientific problem.</p> <p>Develop a scientific model for a complex situation.</p> <p>Determine the author's purpose and describe how it affects the interpretation of a reading selection.</p> <p>Apply a concept in other contexts.</p>	<p>Conduct a project that requires specifying a problem, designing and conducting an experiment, analyzing its data, and reporting results/ solutions.</p> <p>Apply mathematical model to illuminate a problem or situation.</p> <p>Analyze and synthesize information from multiple sources.</p> <p>Describe and illustrate how common themes are found across texts from different cultures.</p> <p>Design a mathematical model to inform and solve a practical or abstract situation.</p>

Webb, Norman L. and others. "Web Alignment Tool" 24 July 2005. Wisconsin Center of Educational Research, University of Wisconsin-Madison. 2 Feb. 2006. <<http://www.wcer.wisc.edu/WAT/index.aspx>>.

DOK Question Stems

<p>DOK 1</p> <ul style="list-style-type: none"> • Can you recall _____ ? • When did _____ happen? • Who was _____ ? • How can you recognize _____ ? • What is _____ ? • How can you find the meaning of _____ ? • Can you recall _____ ? • Can you select _____ ? • How would you write _____ ? • What might you include on a list about _____ ? • Who discovered _____ ? • What is the formula for _____ ? • Can you identify _____ ? • How would you describe _____ ? 	<p>DOK 2</p> <ul style="list-style-type: none"> • Can you explain how _____ affected _____ ? • How would you apply what you learned to develop _____ ? • How would you compare _____ ? • Contrast _____ ? • How would you classify _____ ? • How are _____ alike? Different? • How would you classify the type of _____ ? • What can you say about _____ ? • How would you summarize _____ ? • How would you summarize _____ ? • What steps are needed to edit _____ ? • When would you use an outline to _____ ? • How would you estimate _____ ? • How could you organize _____ ? • What would you use to classify _____ ? • What do you notice about _____ ?
<p>DOK 3</p> <ul style="list-style-type: none"> • How is _____ related to _____ ? • What conclusions can you draw _____ ? • How would you adapt _____ to create a different _____ ? • How would you test _____ ? • Can you predict the outcome if _____ ? • What is the best answer? Why? • What conclusion can be drawn from these three texts? • What is your interpretation of this text? Support your rationale. • How would you describe the sequence of _____ ? • What facts would you select to support _____ ? • Can you elaborate on the reason _____ ? • What would happen if _____ ? • Can you formulate a theory for _____ ? • How would you test _____ ? • Can you elaborate on the reason _____ ? 	<p>DOK 4</p> <ul style="list-style-type: none"> • Write a thesis, drawing conclusions from multiple sources. • Design and conduct an experiment. Gather information to develop alternative explanations for the results of an experiment. • Write a research paper on a topic. • Apply information from one text to another text to develop a persuasive argument. • What information can you gather to support your idea about _____ ? • DOK 4 would most likely be the writing of a research paper or applying information from one text to another text to develop a persuasive argument. • DOK 4 requires time for extended thinking.

From Depth of Knowledge – Descriptors, Examples and Question Stems for Increasing Depth of Knowledge in the Classroom Developed by

Dr. Norman Webb and Flip Chart developed by Myra Collins

Costa's Levels of Questioning: English

LEVEL 1

What information is given?
Locate in the story where...
When did the event take place?
Point to the...
List the...
Name the...
Where did...?
What is...?
Who was/were...?
Illustrate the part of the story that...
Make a map of...
What is the origin of the word _____?
What events led to _____?

LEVEL 2

What would happen to you if...
Would you have done the same thing as...?
What occurs when...?
Compare and contrast _____ to _____.
What other ways could _____ be interpreted?
What is the main idea of the story (event)?
What information supports your explanation?
What was the message in this piece (event)?
Give me an example of...
Describe in your own words what _____ means.
What does _____ suggest about _____'s character?
What lines of the poem express the poet's feelings about _____?
What is the author trying to prove? What evidence does he present?

LEVEL 3

Design a _____ to show...
Predict what will happen to _____ as _____ is changed.
Write a new ending to the story (event)...
Describe the events that might occur if...
Add something new on your own that was not in the story...
Pretend you are...
What would the world be like if...?
Pretend you are a character in the story. Rewrite the episode from your point of view.
What do you think will happen to _____? Why?
What is most compelling to you in this _____? Why?
Could this story have really happened? Why or why not?
If you were there, would you...?
How would you solve this problem in your life?

Asteroids and Us (Support Ideas with Examples)

By [Bill Nye](#) | Published: February 15, 2013 – 4:00 pm

My O my, wow... the 7,000-ton meteor over the Chelyabinsk region slammed into our atmosphere at 15,000 km per hour (33,000 miles an hour). Witnesses could see the flash of light 500 kilometers away. It was probably 15-meters (50 feet) across. When these things hit the atmosphere they just blow up. It's not combustion, at least at first; it's a rock slamming into something air so hard, that it disintegrates. Its energy becomes a pressure wave, a shock. This is to say, the molecules in the air get slammed into moving faster than their natural speed (at a given temperature). They form a shock wave turning the rock's energy of motion into a wave of pressure and the energy of heat...in an instant. The pressure wave blasted windows and doors. The flying glass and falling building material injured over a thousand people— in an instant. The heat combined with atmospheric oxygen incinerated most of the rock— in a few moments. Rock hounds and scientists will no doubt scour the area for meteorites and for clues. The more we learn about these things the better, because it sure could happen again.

On top of the drama, what a remarkable phenomenon it was in Russia on the eve of the flyby of Asteroid 2012 DA14, which was discovered by astronomers funded in part by The Planetary Society <http://planetary.org>. This asteroid is somewhat larger at 45-meters, and it missed us completely, but wow is there a lesson to be learned for all of us humans.

When I was in 2nd grade, our teacher, Mrs. McGonagle told us that the reason the ancient dinosaurs went extinct was that their brains were small. This enabled mice and rabbits to take all of the dinosaurs' food, so the dinosaurs died out. To her credit, Mrs. McGonagle knew this theory was fraught with difficulties (lame). She showed us pictures in a book, shrugged her shoulders and pressed on. It seemed clear to everyone in the room that somebody like a titanosaurus would have little difficulty with mice or rabbits, except that they wouldn't make much of a hors d'oeuvre, let alone a snack or light meal. Such a dinosaur would crush such a mammal like a penny on the railroad track (paper thin— I've tried it).

So, in my lifetime a much more plausible theory came to be, when geologists looking for oil around the Gulf of Mexico with magnetometers discovered an enormous sub-ocean ring of shocked rock— a crater long about 1983. Scientists soon inferred that the ring is an impact crater. It's off the coast near Chicalub, Mexico. Looking further and farther, geologists like Walter Alvarez realized that there is a layer of the unusual element iridium buried at the same geologic depth all over the world. Iridium is atomic number 77. It's heavy; its atomic mass is 192. So when the Earth was formed from molten rock, the iridium sank to the middle. To get iridium in a nice layer near the top of the Earth's crust took an impactor— a hurtling asteroid with primordial iridium got its guts blasted worldwide. The ejecta were spread in a circle wider than the Earth's diameter. Phew...

Asteroid 2012 DA14 is not nearly as big— not even close. But there's a lesson for all of us. It's about the same size as the impactor that smacked into the atmosphere above Tunguska, Siberia in June 1908. In other words, if an asteroid the size of 2012 DA14 (about 45 meters across) were to hit the atmosphere over Paris, that would be the end of Paris as we know it.

A feature of these impacts that I still find remarkable is that at the speeds these things are moving relative to the Earth, the atmosphere acts virtually like a solid. It's akin to the stories I heard often as a kid. If you jump off a high bridge into water, you won't fare very well, because at that speed, water acts like concrete. Yikes. The same was apparently true for the Tunguska object and our air. The same will be true for the next one— unless we do something about it.

The key to doing something is to find them. The Planetary Society funded some very skilled diligent astronomers in La Sagra, Spain, who used the money we supplied them to acquire a very sophisticated high-speed camera for their telescopes. They found this object. It's through the support of our 30,000+ members around the world that these researchers came across a hurtling bit of primordial rock that could cause us tremendous harm. It's frightening, but it's also wonderfully exciting. We are the first generations of humans who can do something about an asteroid or comet

impact. We have learned enough about the cosmos and our place in space that we can understand the danger and make a plan.

Among our projects at The Planetary Society is a scheme to use a network or squadron of laser-bearing spacecraft to ablate or cook the surface of an asteroid so that we change its velocity just a little, a few millimeters per second. That way, it would cross the Earth's orbit when we're not there. Other ideas include a massive spacecraft with enough gravity to gently tug an asteroid off its course. Or, we could just smash into an object with a smasher rocket (a kinetic transfer vehicle). It's the stuff of science fiction, but it's real.

The Chelyabinsk along with Asteroid 2012 AD14, should serve as a warning. The small one wrought small havoc. The big one is going to miss— this time. But, there are about 100,000 more out there crossing the Earth's orbit, and we don't know where they are. Some day in the not too distant future we humans are going to have to do something about one of these things. At the end of the original movie "The Thing," the journalist warns us: "Keep watching the skies..." It's good advice, because our Solar System is a cosmic shooting gallery. Sooner or later, we'll be a sitting duck.

Support your ideas with examples from the text.

Describe aspects of how asteroids cause damage on Earth.

What are some of the things being done to prevent an asteroid from smashing into Earth?

How serious does Bill Nye think this threat is?

Bonus: In your opinion, how does this threat rank with other environmental or political problems?

Conversation Counter	
My Name _____	
Partner's Name _____	
Date _____	
Place a tally mark next to each talk move you complete.	
	Asked a question
	Answered a question.
	Explained your thinking.
	Asked your partner to elaborate or clarify their thinking.
	Added on to your partner's thinking.
	Supported your idea(s) with evidence.
	Respectfully agreed or disagreed with your partner's thinking.

Conversation Counter	
My Name _____	
Partner's Name _____	
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	Supported his/her idea(s) with evidence.
	Respectfully agreed or disagreed with your thinking.

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