Teaching Students to Write a Well-Supported Argument

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Can genetically modified foods help solve world hunger problems? How can we design and construct buildings that will withstand strong earthquakes? Can and should we grow kidneys in a lab for transplants? What kind of fuel is best for powering efficient cars?

These are just a few of the social-scientific questions that must be answered at a global level if we are to have a well-functioning world population and a safe, thriving environment. Being able to respond to questions of such complexity involves taking a comprehensive look at data, reviewing the evidence from multiple perspectives—examining the pros and cons as well as the claims and counterclaims—to make a claim or state a rebuttal. As educators we must also ask, Are we preparing students to answer such complex questions in ways that illustrate their abilities to wrestle with the complex factors embedded in each question?

**How Do Our Students Compare?**

There is not a cut-and-dried answer regarding student performance in the United States. But let’s consider some existing data that might help us gain insight regarding how well our students are performing scientifically. The National Assessment of Educational Progress (NAEP) is a measure of trends in academic achievement of U.S. elementary and secondary students in various subjects, including science. The NAEP science assessment measures the understanding of both scientific content knowledge and science practices.

A comparison look at data from 2009 and 2011 indicates that there is a slight increase in average scores for eighth graders, from 150 to 152. The scale at each grade ranges from 0 to 300 with a mean of 150. In both 2009 and 2011, between 93% and 98% of the eighth graders assessed were at basic or proficient levels. These are acceptable scores; however, at the advanced levels, there was no significant change between these two years, and only about 2% of eighth graders scored in this range. If we want our young people to develop the capacity to tackle complex science issues, we must provide instruction that moves them toward advanced levels of science literacy. Having only 2% of our eighth graders in the advanced category of science literacy is not good enough.

Now let’s consider international data. The Trends in International Mathematics and Science Study scores have remained relatively flat since 2007. Although there is a slight difference between the U.S. average science score at grade 8 in 2007 (520) and in 2011 (525), it is not significant. For comparison, the international average score was 500. Eighth graders in the United States are average on an international scale. Again, this is acceptable. We can do better.

The Programme for International Student Assessment, another global metric, looks at the acquisition of key knowledge and skills needed for full participation in a modern society. U.S. students are in the middle, with 17 education systems scoring higher and 27 scoring lower. Fifteen systems were not measurably different from the United States.

These data show that U.S. students have foundational skills and proficiencies at a moderate level; however, answering complex science questions like those at the opening of this article require higher level skill. Students need to be able to analyze data and information, evaluate ideas, and create solutions if we are to address the issues we face as a nation and as members of a global society. Although U.S. students are holding steady, there is clearly room to grow if they are to become the very top students on an international level and, more important, scientifically informed citizens, researchers, and practitioners. To support this growth, one final question needs to be addressed: What changes need to be made to science instruction to move U.S. students from the middle to the top in scientific knowledge and performance?

**What Do Scientists Do?**

Let’s consider first what it is that scientists actually do to formulate solutions to problems. How do they consider the pros and cons of an issue? What does it really mean to consider data, analyze
Did you notice that these two scientists were engaged in argumentation in a scientific way? The art and science of argumentation requires the higher order thinking skills of analyzing data, synthesizing ideas, creating models, and designing and postulating solutions. In addition, the results of thinking through each of these stages need to be shared in either a written or a verbal form. In essence, a person developing an argument needs to be able to share his or her critical thinking in a cohesive, coherent fashion to communicate elements of the claim being made.

In this article, we share how to teach students the art and science of argumentation. Through classroom scenarios, we view teachers supporting students in real-world research, where they engage in investigations, consider data, and convey and support evidence-based claims. To develop coherent, cohesive arguments, students are guided to include claims, evidence, warrants, and counterclaims in their conveyance of their argument.

Roger Dalton, an environmental scientist, argues that nuclear energy is clean energy compared with fossil fuels. His comments are rooted in the idea that the burning of coal, oil, and gas pours pollutants into the atmosphere, thus affecting the environment in numerous ways. “Nuclear power,” according to Dalton, “is free of carbon and can produce great amounts of energy when compared with solar and wind sources.” He adds that it’s relatively inexpensive. To combat Dalton’s claims, biologist Daniela Wayne notes that radioactive waste produced by nuclear power plants is not biodegradable and is potentially dangerous. It can stay radioactive while in storage for thousands of years. Daniela adds to her points with a compelling note, “Exposure to radiation is deadly. That’s not debatable. It’s just fact.”

Given the call to teach students to read, write, and engage in evidence-based conversations centered on science, it is with a clear mandate that teachers must support students to engage in well-grounded scientific argumentation. To address this, let’s consider two lessons that engage students in exploring, examining, and arguing from a well-studied position.

Into the Classroom: Crafting a Text-Supported Opinion

Mr. Davis’s third-grade classroom is embarking on a study of habitats and, in doing so, they are addressing the following standards:

NGSS 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

CCSS.ELA-Literacy.RI.3.2: Determine the main idea of a text; recount the key details and explain how they support the main idea.

To start, Mr. Davis’s students are listening to a read-aloud of Animal Habitats! (Press,
(2005). He begins with the first chapter entitled “A Habitat Is a Home.” Students then brainstorm characteristics of their own habitats, which Mr. Davis records on chart paper. Third grader Shalene states, “We have air to breathe.” Nate adds, “We grow vegetables in pots on my apartment balcony to eat. Corn and tomatoes.” Anthony contributes, “And we have things we can build our houses out of, like wood.” Mr. Davis praises their efforts and then puts students into groups of three so they can engage in a collaborative poster activity that relates to the habitats they are reading about in this text.

However, before they begin the poster, Mr. Davis models for his students how to state an opinion that is supported by textual evidence, adding that this is the start of creating an argument. Mr. Davis thinks aloud and holds up a copy of a text called How Do a Fish’s Gills Work? from HighlightsKids.com, which he refers to as he speaks:

*I read in this text that fish have gills. These are places on the sides of fish where oxygen can get into the fish. This is how fish breathe. You and I have lungs to breathe on land. Fish have gills so they can breathe under water. My opinion, based on my reading, is that fish have the structure of gills so that they can survive in oceans by getting oxygen from the water.*

Next, each group is given a different habitat to explore from the first text. One group is assigned the desert. Another group is assigned the forest. A third takes lakes and rivers. Other habitats include the seashore, wetlands, the Arctic tundra, cities, and grasslands. Each group is given a large piece of poster paper and an assortment of markers. For the collaborative poster activity, Mr. Davis tells each group that it must follow these steps:

1. Explore your habitat by reading the chapter in the book.
2. Identify two animals that live in your habitat. What features do these animals have that help them survive?
3. Select one of your animals and decide, as a group, what your opinion statement will be for your habitat.
4. Use this sentence frame to write your opinion statement: Our opinion, based on the ______ chapter, is that ______ have ________ so that they can survive in ______ by _____________.
5. On your poster, you should have the following items:
   a. The name of your habitat
   b. A drawing of your two animals
   c. The sentence that states the opinion of the group using the sentence frame
6. Everyone must write on the poster using the colored marker that you are given.
7. Everyone must sign his or her name on the back of the poster using his or her colored marker.

As students read aloud and discuss their chapters in groups, Mr. Davis moves around the room, listening in on their conversations and offering needed scaffolds. For example, he prompts one group to reread a particular sentence to be sure that the students have a clear understanding of the habitat. He cues another group to look again at a visual to be sure it matches the written message.

As Shalene’s group shifts into the opinion writing stage, she asks Mr. Davis why they had to write the name of the chapter in the sentence frame, complaining that the sentence was long. Mr. Davis replied,

*This is where you tell the reader that your opinion comes from your reading. This helps the reader to know that you have studied this topic and really know something about it. This is how you can share your evidence.*

Once posters are completed, students hang them on the walls (Figure 1). Mr. Davis leads the class in a gallery walk around the room to read and examine the posters. Each student records one thing he or she learned about each habitat. They conclude with a whole-class sharing of information they learned.
Into the Classroom: Crafting a Text-Supported Argument

In Mrs. Jackson’s eighth-grade science class, students are examining the topic of plastic bags in the environment. As they do so, they are addressing the following standards:

- **NGSS MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **CCSS ELA-Literacy.RST.6-8.6**: Determine the central ideas or conclusions of a text, provide an accurate summary of the text distinct from prior knowledge or opinions.
- **CCSS ELA-Literacy.RST.6-8.9**: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

To design a method to monitor and minimize human impact, Mrs. Jackson wants students to first understand a local issue: a proposed ban on plastic grocery bags. Her strategic and thoughtful method of instruction is to have students examine first the pros and then the cons of this proposal. To do this, she has students read multiple texts related to the issue. They first read an article by Jane McGrath entitled “Which Is More...

![Image of a student writing]

To the surprise of many students, this article notes reasons why plastic bags could be an environmentally friendlier choice than paper bags, citing evidence such as the greater amount of energy required to produce paper. Further, the article notes that many people reuse plastic bags for purposes such as holding sack lunches, lining trash cans, and picking up dog waste. In an article entitled *Are Plastic Grocery Bags Sacking the Environment?*, from National Geographic, John Roach noted that plastic bags are some of the most recycled materials around. Roach went on to explain some of the concerns with plastic bag use, including the ultimate contribution to ocean pollution and marine animal deaths.

Then, to help students view the issue from multiple vantage points, Mrs. Jackson asks them to use these two articles to identify the pros and cons of using plastic bags. She encourages students to refer to their notes to write from both perspectives, using the writing tool RAFT, which stands for Role, Audience, Format, and Topic (Santa & Havens, 1995). Students write from the perspective of a particular role. They write for a designated audience using a specified format and address a given topic. Mrs. Jackson assigned students to complete two RAFTs, charging students to include data from the two articles. The RAFT details for *Which Is More Environmentally Friendly: Paper or Plastic?* are as follows:

- **Role**: An employee of a plastic bag manufacturing plant
- **Audience**: The city council of your town that wants to ban plastic bags in grocery stores
- **Format**: A speech
- **Topic**: The production of plastic bags helps our economy

The RAFT details for *Are Plastic Grocery Bags Sacking the Environment?* are as follows:

- **Role**: A sea turtle
- **Audience**: A shopper in a grocery store
- **Format**: A letter
- **Topic**: I’m choking on your litter

Here’s an excerpt from the first RAFT written by eighth grader Jose:

*Hello City Council people. I have been working at the Bright Day plastic bag company for 10 years. I have a family to support. Making plastic bags helps bring jobs to our community, and it helps me get food for my family. They are cheap to make, and we don’t pollute too much when we make them. I think they are a good choice. And paper bags give off 70% more air pollution when they are made. Let’s keep plastic bags.*

Jose also wrote this RAFT:

*I am a sea turtle. Yesterday a nice person rescued me from the ocean because I had a plastic bag in my mouth. I was choking on it. It looked like food when I was swimming around. It takes 1,000 years for plastic to break down. If I or other animals die, the plastic bags are still there hurting more animals. We need to ban plastic bags.*

After students review the issue from both perspectives, Mrs. Jackson asks them to share their RAFTs in groups of three. She encourages students to add any data their peers identified was needed in their RAFTs. She also encourages them to listen to the questions their peers ask, reminding students that the questions might help them to see what information they still need to include.

After sharing and editing their RAFTs in their groups, Mrs. Jackson asks students to discuss the following question: Should plastic bags be banned from all grocery stores? Next, Mrs. Jackson asks students to develop a formal argument around the topic, given their discussion and group agreement around a position.
identifying four areas of focus: a framework for argumentation, logical arguments, Mrs. Jackson provides development of clear, well-developed, rooted in evidence. To facilitate the development of clear, well-developed, logical arguments, Mrs. Jackson chooses the topic of plastic bags versus paper bags because it is both a local and a national issue that was broached in various ways during studies in earlier grades. For instance, in second grade, students might look at plants and animals in different habitats. In fourth grade, they might look at the effects of humans on the environment. Students and their parents are concerned with protecting the environment, but they also want convenience. The plastic bag issue engaged the students in the study of new information and allowed them to draw from previous study of related topics.

What Is Involved in Developing a Well-Grounded Argument?

Argumentation is an intersection among the CCSS in Math and English Language Arts and the NGSS. All of these standards documents indicate that students need to be proficient in developing arguments rooted in evidence. To facilitate the development of clear, well-developed, logical arguments, Mrs. Jackson provides a framework for argumentation, identifying four areas of focus:

1. Claim: Write a sentence to state whether plastic bags should be banned.
2. Evidence/Data: Provide data to support your claim. Use data from every article you read.
3. Warrant/Reasoning: Explain how your evidence supports your claim. Describe how the data support your claim and explain how you determined if the data supported the claim using scientific principles such as research-based ideas related to the food chain, pollution, or habitats.
4. Counterclaim/Rebuttal: Discuss alternative explanations or ideas. Were any of these considered as you examined the research around plastic bag use? Consider alternative solutions. Why is your claim correct and why are the others incorrect?

As students begin to write, she provides scaffolded feedback as needed. Because Mrs. Jackson had discussed the meaning of claim, evidence, warrant, and counterclaim, she was confident that students would respond in the expected format. Consider Devon’s response:

I think that plastic bags aren’t so bad, and we should continue to use them. There are many reasons why. First, plastic bags are reusable. I reuse them all the time. I bring my lunch to school in one. Also, people don’t really use recycled bags that often. They don’t always remember to bring them to the store. Paper bags aren’t that good either. They are actually worse than plastic. I think we should use plastic and keep recycling it.

Upon review of Devon’s writing, Mrs. Jackson realizes that Devon needs more support to do the following:

1. Cite clear, logical evidence from his data rather than from only his own real-world observations.
2. Connect the claim to evidence in a coherent manner.
3. Develop a warrant that includes reasoning to connect the evidence to the claim. This should include reference to scientific principles.
4. Consider other possible viewpoints and then clarify why his idea was more sound.

Many of Devon’s classmates produced similar writing, so Mrs. Jackson decides that she should reteach for the purpose of clarifying the elements of an argument—the elements she expects to see in the students’ writing. She determines that the best way to support students’ understanding of the ideas she is trying to convey is by thinking aloud about another aspect of pollution: the problem of pesticides getting into groundwater. Mrs. Jackson’s purpose is to showcase the elements of a strong argument.

Mrs. Jackson addresses the question. Should we permit the use of pesticides to protect crops from insects and weeds? She shares how she conducts an Internet investigation for resources that discuss the use of various pesticides and the issue of crops dying from insect infestations. She shares the data chart she created and then shows the results of her research from different sources (Figure 2).

From this, Mrs. Jackson develops her think-aloud in which she states her claim, discusses her evidence, shares how her evidence supports the claim, and talks about the scientific principles of precipitation, percolation of rainwater into the ground, and the flow of groundwater. She discusses why pesticides might be carried through groundwater flow and considers the effects on humans. As she thinks aloud, she notes when she is making a claim, how she is choosing evidence, how she is reasoning, and when she is considering other counterclaims.

Then Mrs. Jackson asks students to share their observations with partners regarding
how she has addressed each component of her argument. To help them better construct their arguments, she gives students a guide sheet with sentence frames (Figure 3). The intent is to support the use of academic language and to guide the logical flow of the argument. As students build proficiency, Mrs. Jackson offers more language frame options, with the ultimate goal being that students begin to use this language without the sentence frame guides. Using the support of the think-aloud and the guide sheet, all students revise their writing about plastic bag use. Here’s what Devon wrote:

Plastic bags should not be banned because I think that plastic bags are a good choice and we should continue to use them. There are many reasons why. First, plastic bags are reusable. According to National Geographic, they say that the American Plastics Council is working to get people to reuse them for lunches and to pick up dog poop. Also, people don’t really use cloth bags that often. They don’t always remember to take them to the store. Furthermore, National Geographic states that plastic bags give out 94% fewer waterborne wastes than paper. Paper bags use four times as much energy to make as plastic bags. Finally, Howstuffworks.com suggests that paper bags take more energy to recycle and fill up landfills with trash. They are actually worse than plastic. While some people think that plastic bags should be banned because many marine animals eat them when they get dumped in the ocean, the evidence shows we can stop it. They can destroy the intestines of turtles and fish. That is a real problem, but I think we can stop it by helping people to understand that they can’t just drop plastic bags on the side of the road or in the ocean. In summation, if we are responsible, we can stop that problem. I conclude that we should use plastic and keep recycling it.

Although there’s clearly much to consider in terms of data analysis (How did students evaluate resources? Did they consider the degree of impact of the pro and con issues? Do students understand the connection among pollution, the ecosystem, and human impact?), a look at the structure of argument writing reveals that Devon needs more support, despite his improvements. Here’s how Mrs. Jackson analyzes Devon’s work:

- **Claim:** Plastic bags should not be banned because I think that plastic bags are a good choice and we should continue to use them.
- **Evidence:** There are many reasons why. First, plastic bags are reusable. According to National Geographic, they say that the American Plastics Council is working to get people to reuse them for lunches and to pick up dog poop. Also, people don’t really use cloth bags that often. They don’t always remember to take them to the store. Furthermore, National Geographic states that plastic bags give out 94% fewer waterborne wastes than paper. Paper bags use four times as much energy to make as plastic bags. Finally, Howstuffworks.com suggests that paper bags take more energy to recycle and fill up landfills with trash. They are actually worse than plastic.
- **Warrant:** This is missing.
- **Counterclaims:** While some people think that plastic bags should be banned because many marine animals eat them when they get dumped in the ocean, the evidence shows we can stop it. They can destroy the intestines of turtles and fish. That is a real problem, but I think we can stop it by helping people to understand that they can’t just drop plastic bags on the side of the road or in the ocean.
- **Conclusion:** In summation, if we are responsible, we can stop that problem. I conclude that we should use plastic and keep recycling it.

Mrs. Jackson uses a rubric to assess Devon’s work (Figure 4). In her analysis of
Devon's revision, she notes that he clearly documented the claim. He also discussed the research, although it could have been organized differently; it was not as logical and coherent as possible, jumping from the issue of banning plastic to the use of paper as a mediocre alternative without clarifying the connection. She determines that she needs to discuss data analyses more with the whole class.

In addition, Devon's development of a warrant is in need of scaffolding. Devon needs to share his reasons for using particular data to support a claim. He needs to clarify how human impact affects the environment and populations of marine organisms and other wildlife using scientific principles. He might have also clarified how landfills affect humans.

Mrs. Jackson did note, however, that Devon clearly addresses a counterclaim (the idea that some people worry about the effects of plastic bags on marine life) and notes a rebuttal to it as well.

Mrs. Jackson's next steps are to create a new guide sheet with prompts to support argument writing. For this particular task she offers these prompts:

**Figure 3 • Sample Guide Sheet on How to Write an Argument**

- **Claim:** (Write a sentence to state whether plastic bags should be banned).
  - Plastic bags _________ (should or should not) be banned because ____________.

- **Evidence/Data:** (Provide data to support your claim. Use the data from all articles you read).
  - According to ________________ (cite your evidence) plastic bags ________________.
  - Furthermore ________________ states ________________ (cite your evidence).
  - Finally, ________________ suggests that ________________.

- **Warrant/Reasoning:** (Explain how your evidence supports your claim. Describe how the data support your claims and explain how you determined if the data supported the claim using science principles such as research-based ideas related to the food chain, pollution, or habitats.)
  - Because ________________ (the food chain, pollution, the habitat, or any other term that fits) is ________________, we must choose to use ________________.
  - Scientists know that ________________, therefore ________________.

- **Counterclaim/Rebuttal:** (Discuss alternative explanations and/or ideas). Were any of these considered as you examined the research around plastic bag use? Consider alternative solutions. Why is your claim correct and why are the others incorrect?)
  - Although some people believe _________, the evidence shows that ________________.
  - This means that ________________.

- **Final Conclusion:** (State your claim to emphasize your position).
  - In summation, ________________ because ________________. I therefore conclude that ________________.

Mrs. Jackson did note, however, that Devon clearly addresses a counterclaim (the idea that some people worry about the effects of plastic bags on marine life) and notes a rebuttal to it as well.

Mrs. Jackson's next steps are to create a new guide sheet with prompts to support argument writing. For this particular task she offers these prompts:

Write an argument that answers this question: Should plastic bags be banned in grocery stores?

- **Claim:** Write a sentence to state whether you believe plastic bags should be banned.
- **Evidence:** Provide evidence to support your claim. Use data from the articles you have read and cite your data. Present your data in logical terms—think about the order of the data you are sharing.

- **Warrant:** Explain how your evidence supports your claim. Discuss any scientific principles that relate to your claim. These might include human impact on the environment, use of landfills, the food chain, effects on the ecosystem, and so forth.

- **Counterclaim:** Discuss alternative views. State if any of these are addressed in your review of the research. Write a rebuttal to the counterclaim, and state why your claim is the better option.

- **Conclusion:** Restate your claim as the best option given the research and the data.
What Else Can Teachers Do to Support Argument Writing?

Mrs. Jackson engaged students in data collection to address a relevant, real-world issue. She used meaningful formative assessment to analyze student work to identify areas of need and then determined a plan to address those needs. She offered scaffolds through her think-aloud and her guide sheets. Is there more that might support students as they work toward creating strong, evidence-based arguments? We believe there is more that can be done. Here are a few ideas.

• Teach close reading:
  † Students will need to know how to read complex texts and how to annotate so that they can easily refer to data.
  † The use of text-dependent questions will help students learn to respond to questions and create questions as they gather and analyze evidence.
• Provide sentence frames:
  † The author states, ________.
  † The author supports his or her claim with ________.
  † The data reveal ________.
  † As suggested by the data, ________.
  † As indicated by the evidence, ________.

<table>
<thead>
<tr>
<th>Elements of an Argumentation Paper</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Claim</strong></td>
<td></td>
</tr>
<tr>
<td>A statement that responds to an issue or problem with a position</td>
<td>A clear, relevant, and logical claim is established</td>
</tr>
<tr>
<td><strong>Evidence</strong></td>
<td></td>
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<tr>
<td>Scientific data that support the claim; data should be substantial, relevant, and clear</td>
<td>Provides evidence in the form of scientific data that are substantial, relevant, and clear</td>
</tr>
<tr>
<td><strong>Warrant</strong></td>
<td></td>
</tr>
<tr>
<td>Reasoning that connects the evidence to the claim; used to clarify why and how the evidence supports the claim</td>
<td>Provides a warrant that clarifies why and how the evidence supports the claim</td>
</tr>
<tr>
<td><strong>Counterclaim</strong></td>
<td></td>
</tr>
<tr>
<td>An acknowledgment that there are other positions; should include why counterclaims are not sufficient and why the claim is the best position</td>
<td>Addresses (a) counterclaim(s) that establishes why other positions are not sufficient and why the claim is the best position</td>
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<tr>
<td><strong>Composing Technique</strong></td>
<td></td>
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<tr>
<td>Combines well-documented data, evidence, warrants, and counterclaims in a coherent, written text format; includes appropriate academic language</td>
<td>Combines well-documented data, evidence, warrants, and counterclaims in a coherent, written text format; includes appropriate academic language</td>
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The alternative claim suggests ________; however, ____________.

This claim is supported by the following data: ____________.

- Provide opportunities for student to verbally debate ideas, such as engaging them in Socratic seminars.
- Have students read pros and cons of issues.
- Have students regularly write analyses of lab data.
- Teach students to cite references. Consider APA in addition to, or as an alternate to, MLA for science writing.

Most important, give students opportunities to consider issues and to develop logical, research-based arguments. Not only will students be considering some of the complex problems that affect the planet, but they will also be growing empowered by having a voice that is backed by evidence and logical, clear thinking.

It is with this voice that students will have a chance to be heard and a chance to contribute meaningfully to our global community. Although we have shared science examples, these same instructional ideas apply to teaching students to investigate topics in social studies. As students study past societies and cultures, similar instruction enables them to understand, problem-solve issues, and argue solutions to improve the world today and tomorrow.

References


Literature Cited

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