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Using Socioscientific Issues in Primary Classrooms

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Abstract

In this article, we provide three examples of the use of socioscientific issues (SSI) in a 5th-grade classroom. Taken from Earth science (beach sand replacement), life science (the Canadian seal hunt), and physical science (speed limits), the examples show how teachers can embed scientific content in controversial social issues that engage younger students in constructive sociomoral discourse. Each example includes a preliminary learning activity as well as a description of the SSI scenario and its results. The potential of SSI to inspire preservice elementary science methods students to teach more science and create their own modules is also discussed.

Introduction

The theoretical companion piece that was published in the previous issue of this journal (21[2]) suggests that socioscientific issues (SSI) have considerable potential to improve science education in elementary school classrooms. But what does SSI actually look like in practice? This article examines SSI in action from the perspective of a 5th-grade teacher and elementary methods instructors in Tampa, Florida. The examples are not meant to be precise lesson plans; rather, they will show how SSI can be practically applied, helping readers to understand the underlying theory. We hope that after reading both of these articles, teachers and teacher educators will be inspired to design or adapt their own SSI modules and give them a try. The social context that makes an SSI module relevant to the students will vary from classroom to classroom. This article should help teachers and teacher educators understand SSI better and go on to construct modules that will resonate with their own students.

One of the things that makes teaching with SSI so interesting is that science content which may seem boring or irrelevant to students can be taken and set in a provocative social context that brings it to life. The following examples, implemented by the first author, who is actively involved in SSI development and research, cover topics from Earth science, biology, and physics woven into social issues to bring them alive for both teacher and students.

A 5th-Grade Teacher's Perspective

If the 5th graders in my elementary science classes ruled the world, all females would have matching Vera Bradley bags. We would all don the latest styles from Hollister and Abercrombie, and not one of us would be out of style. Ever. We would all be masters of the Nintendo Wii handset, but they would always be better than me. Somehow, in between all the pop culture nuances and interminable fun, they would find time to save the world. They would consider use of crushed glass and plastics as aggregates to solve beach erosion, and they would manage to preserve the Canadian harp seal population without endangering the fishing industry or indigenous communities.

As a fifth-year teacher, I have seen my share of sheer silliness in the classroom, but immersed within the seemingly nonsensical are nuggets of realism that reveal that these students who are between 10 and 12 years of age actually feel the weight of the world and the need to bear responsibility for its future. My tenure teaching science at Roosevelt Elementary in Tampa, Florida, has afforded me the opportunity to pursue leading-edge instruction methodologies with the goal of helping students apply the scientific principles learned in my classroom to the world in which they subsist.

As an educator—moreover a science educator—it is imperative to continually seek out and implement new methods of pedagogical instruction in order to promote social growth and scientific understanding of students. The teaching world is filled with an abundance of new methods muddled with past approaches that have been renamed but still present the "same old stuff." A recent developmental approach that has shown great promise both in improving science comprehension and, more importantly, incorporating social dilemmas in order to make students better individuals is the use of socioscientific issues (SSI) in the classroom. Through SSI, teachers present students with social or moral dilemmas that implore them to utilize critical thinking skills in order to analyze and synthesize scientific information to defend a particular position. This strategy exposes students to real-world scenarios to help bolster social development while simultaneously enhancing science knowledge.

I recently completed a postgraduate science education course that explored the use of SSI in secondary classrooms. During the course of instruction, I came to believe that with modest adjustments in approach, this curricula could be utilized at the elementary level as a way to increase critical thinking skills and enhance overall student learning. Moreover, I felt that infusing primary science curriculum with SSI would also empower students to consider how science-based issues reflect, in part, moral principles and elements of virtue that encompass their own lives as well as the physical and social world around them. I considered SSI particularly applicable to the Earth, life, and physical science disciplines as they are "breathing" disciplines. Though they have yielded important scientific discoveries, a multitude of unsolved problems and many areas of active research still remains.

As SSI involves employing the fundamentals of sociomoral discourse, argumentation, debate, and discussion, it is imperative that students have a solid comprehension of the elementary science concepts being discussed prior to implementing SSI techniques. To that end, I decided to incorporate a hands-on activity into each lesson that would address each scientific concept prior to initiating the SSI exercise.

SSI in a Methods Class

One of the biggest challenges of teaching a science methods course for preservice elementary teachers is convincing the students that science is a worthwhile topic for them to teach. After repeatedly surveying students and reading hundreds of science autobiographies, it becomes clear that many students have had unpleasant experiences with science education, and one of the most common complaints is that science lessons seemed to be pointless memorization of information that had no relevance to their lives. In our science methods classes, we do plenty of hands-on, inquiry-based activities to model better ways of teaching science, and, although these activities move content and provide practice for science process skills, they do not always show undergraduates the importance of science to society.

That is where SSI can be so helpful. SSI topics at an undergraduate level can convince preservice teachers that science can be interesting and worthwhile, stirring their emotions and highlighting the nature and practice of science. Modeling elementary level SSI units and convincing teachers that their future students can feel the same way is the next step, which is why Tom Dolans's experience with 5th graders is so important. We have selected three SSI units—one from Earth science, one from life science, and one from physical science. The results of these units can certainly be adapted directly into other primary school classrooms, but they can also be used to convince preservice and inservice teachers that SSI has a place in elementary school classrooms.

SSI and Earth Science

Hands-on Activity – Erosion Central

Materials:

- Aluminum pie pans
- Play sand
- Parsley
- Monopoly hotels
- Water
- Measuring cups
- Digital camera
- Computer presentation hardware
- SMART board (optional)

Goal: Students will understand the concept of mechanical erosion, the difference between erosion and weathering, and the idea that both erosion and weathering can occur concurrently.

Procedure: The purpose of this activity is to provide students with a visually stimulating, hands-on learning experience that will impart the concept of *mechanical erosion*—the displacement of solids by wind, water, ice, or natural disasters such as earthquakes and shoreline erosion. Specifically, the lesson should address the difference between erosion and weathering and confirm that both processes can occur concurrently.

For this outdoor instructional activity on erosion, students are given a disposable aluminum pie pan, two cups of clean playground sand, one Monopoly hotel, parsley, and two cups of water. Students will be instructed to use the sand to construct the landform (i.e., a physical feature such as a plain, mountain, hill, or valley) of their choice in the aluminum pie pan, so long as they feel it will hold up in a natural disaster. They will add parsley to the landform to signify trees and place the Monopoly hotel in what they feel is a secure location. Students are then instructed to add two cups of water to the pie pan. To simulate wave action, the students will lift the pan several inches three times in both directions.

Have the students snap digital photographs before adding the water, after adding the water, and after each set of wave actions. Following the lesson, assemble one or two sets of pictures (i.e., via computer presentation or hard copies) to show students the erosion progression over time. If possible, plug the laptop into a classroom SMART Board, which combines the simplicity of the whiteboard with the power of the laptop computer in order to better engage students in the lesson. If using the SMART Board, write notes on the pictures with digital ink and save the work generated so that later it can be shared with students for test preparation. When flipping through the pictures, point out that adding water simulates weathering through the breakage of sand pieces, and performing the wave motion triggers erosion by causing the sand to travel further from the original landform. Use pertinent ideas to reinforce the concepts of erosion and weathering.

SSI Activity – The Walking on Broken Glass Debate

Goal: Students will apply what they have learned about erosion and weathering to a debate regarding beach erosion on a local Florida beach. The aim would be for students to utilize argumentation and invoke sociomoral discourse to reflect cognitively on both their scientific knowledge and personal beliefs and to determine the most just solution regarding how to protect and restore the beach.

Procedure: Provide the students with two articles that provide ample detail surrounding the background of beach erosion. After students have read and processed each article, initiate discussion to ensure all students understand the concept. Present the following scenario:

- Recent weather patterns have had a devastating effect on the beach of the local community.
- This particular beach has experienced *critical erosion*, a level of erosion which has threatened development, recreational, cultural, and environmental interests.
- While some of this erosion is due to natural forces and imprudent coastal development, a significant amount of the coastal erosion is directly attributable to the construction and maintenance of navigation inlets. These inlets are artificially deepened to accommodate commercial and recreational vessels, and they are protected by jetties to prevent sand from filling them in.
- Earlier this year, the county spent millions of dollars replacing beach sand only to have it erode just as it has in the past.
- Faced with constant erosion, county officials are exploring using recycled glass—crushed into tiny grains and mixed with regular sand—to help fill gaps in the local beach.

Pose a Moral Question: Should the county continue to purchase beach sand to fix the beaches or use crushed glass as a new alternative? Divide the students into groups and assign each group one of the two positions: (1) those in favor of replacing eroded beach with sand and (2) those in favor of replacing it with crushed glass. Allow each group ten minutes of discussion time to derive a basic argument based on the group they represent. Open debate follows, allowing students to present their arguments and rebut points made by other groups, with the idea that students will eventually recognize that everyone in the discussion must strive toward the best solution to the issue at hand.

Results: This SSI lesson was implemented by chance in my classroom following the completion of the erosion hands-on activity. As I was reviewing the results of the experiment, one student applied the concept of erosion to an article he had recently read in the local paper regarding beach erosion and the use of crushed glass as an alternative. The crushed glass alternative was under review by the local government to determine its viability. As the scenario helped the students relate erosion to their personal experiences, I felt it appropriate to expand upon it and employ it an SSI exercise during the following class. I presented students with articles about the topic and had them discuss it within their individual groups. They were then randomly assigned a group and given a particular viewpoint to defend. I introduced added complexity by having various groups represent the Environmental Protection Agency (EPA), local residents, the World Wildlife Federation (WWF), and local children.

As each group had a specific viewpoint to defend as well as a specific group to represent, the debate was rather animated and produced several dynamic arguments. One such argument centered on sea turtles and the impact the glass may have on them and their ability to lay their eggs. Some students expressed concern that the deviation in shape of the sand versus the glass might adversely affect the sea turtle nests. Another topic students spent much time debating was the type of glass that would be recycled in order to create the sand alternative. One student asked how the government could ensure that if the crushed glass was made from glass containers that once housed toxic substances, there would be no adverse affect on the local community and beach environment. I believe the debate became most personalized when students asked questions, including "Well, what happens if I bury someone in the sand?" and "What happens if it gets in my eyes?" These questions allowed students to enter into more purposeful dialogue regarding the legal ramifications for the county if someone were to get hurt on the beach because of the glass. It was a great lesson that pushed students to move beyond the scientific concept of erosion and think critically and apply that concept to more personalized levels. It was also interesting to consider my role as teacher in this exercise. Though I was required to research information regarding erosion and use questioning to provide a directed framework for the debate, it was ultimately the students who were instilling knowledge within themselves by discrediting their student counterparts and collectively forming new perspectives and solutions.

SSI and Life Science

Hands-On Activity – The Black Bear Necessities

Goal: Students will understand a food chain, a food web, an energy pyramid, and the interdependence of organisms in an ecosystem.

Materials:
- 1 Black Bear Necessities Lesson Plan
- Game pieces (dependent upon the number of students in class)
- Large open field
- Envelopes (dependent upon the number of students in class)

Procedure: Students will participate in the Black Bear Necessities Game. The game is designed to teach students about food chains, food webs, limiting factors, interdependence, and natural resources. Before this activity can begin, some basic preparation work must be completed. Each student who participates must have a "den" where each student (i.e., bear) will house his or her food during the game. Envelopes will represent each bear's den.

Food pieces must also be created on different color cards. The number of food pieces used is dependent upon the number of students in the class. To determine the necessary number of pieces for an individual class, refer to Table 1. Locate the column for the correct number of students. Prepare the indicated number of cards for each category, labeling each with the codes shown in parenthesis. For example, for a class of 10 to 15 students, prepare two Nuts cards labeled "N-24," where N stands for nuts and 24 stands for pounds. Prepare eight Nuts cards labeled "N-12," where N stands for nuts and 12 stands for pounds, and so on down the column.

Table 1. Number of Food Pieces to Use Based on the Number of Students in the Class

Number of Students	10 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45
Nuts (N-24)	2	3	3	4	5	6	7
Nuts (N-12)	8	13	17	21	25	29	33
Berries (B-20)	2	3	3	4	5	6	7
Berries (B-10)	8	13	17	21	25	29	33
Insects (I-12)	2	3	3	4	5	6	7
Insects (I-6)	8	13	17	21	25	9	33
Meat (M-8)	2	3	3	4	5	6	7
Meat (M-4)	8	13	17	21	25	29	33
Plants (P-20)	2	3	3	4	5	6	7
Plants (P-10)	8	13	17	21	25	29	33

Students are to become bears during this activity. Their goal will be to collect enough food to survive for ten days. In a large open area or an area with some sparse foliage, spread the game pieces around. Have students leave their "dens" on the periphery of the open area. Since bears are foragers, they walk to get their food. As bears walk on all fours foraging for food, students must walk on all fours for this activity.

Just as in nature, some bears have special needs. For this game, select one student to be a blind bear who was blinded during a fight with another bear. Blindfold this student. Select another student to be an injured bear with a broken leg. Have this student use three appendages to walk instead of four. Finally, select one student to be a mother bear who must find food for herself and her two cubs.

When the instructor says "Go!," students will walk to a piece of food and bring it back to their dens. A student may only pick up one piece of food at a time. Stealing from another den is not permitted. The game ends when all food pieces have been picked up and placed in the bears' dens.

Return to the classroom and have students sort and group their game pieces by color. Have the students calculate the total amount of food they collected in kilograms (kg) or pounds. On the board in class, list the three special bears (i.e., blind, hurt, and the mother) and how much food each collected. Inform the class that an adult bear eats approximately 36 kg (80 pounds) of food in ten days. Any adult bear that failed to find 36 kg of food has died. Point out that the mother bear must collect 18 kg (40 pounds) of food for each baby. So for one baby, the mother bear must collect 36 kg (80 pounds) for herself and 18 kg (40 pounds) for her baby. If there are two babies, then the mother must collect 36 kg (80 pounds) for herself and 36 kg (80 pounds) for her two babies. A mother bear will always feed herself first, so the cubs will die if only 36 kg were collected. Point out that based on the food provided, only a certain number of bears can survive as a sustained population. Use pertinent ideas to address the concepts of a food chain, a food web, an energy pyramid, and the interdependence of organisms in an ecosystem.

SSI Activity – The Canadian Harp Seal Debate

Goal: Students will apply what they have learned about a food chain, a food web, an energy pyramid, and the interdependence of organisms in an ecosystem to a debate regarding the Canadian harp seal. The aim would be for students to utilize argumentation and invoke sociomoral discourse to reflect cognitively on both their scientific knowledge and personal beliefs and to determine the most just solution regarding how to address the harp seal population in Canada.

Provide the students with two articles that contain ample details surrounding the background of the Canadian harp seal. After students have read and processed each article, initiate discussion to ensure that all students understand the role of the harp seal in Canadian society. Touch on the following points:

- In Eastern Canada, newborn harp seals can no longer be killed for their pelts, although they typically lose their white coats and their protected status before they are two weeks old.
- For centuries, the indigenous Inuit peoples have depended on seal blubber, meat, and fur for fuel, food, and clothing. Many also have made a living through the trade of seal products.
- The seal pup hunt also provides economic relief from the region's decline in employment during winter months. In many cases, it made up a third of a fisherman's yearly income.
- Some Canadian fishers view the harp seal as a competitor as adult harp seals consume over 3 kg (7 pounds) of fish every day, or 1.13 metric tons of fish every year. This is an important factor to communities that depend on fishing, although as the Canadian Department of Fisheries and Oceans itself admits, "Seals eat cod, but seals also eat other fish that prey on cod."
- Animal rights groups view the seal hunt as pure barbarism. Some conservation groups fear that at current harvesting levels, the harp seal will become endangered.

Pose a Moral Question: Should the seal hunt be reinstated? Divide the students into four groups: (1) People for the Ethical Treatment of Animals (PETA), (2) government officials, (3) Canadian fishers, and (4) the Inuit. Give each group ten minutes of discussion time to derive a basic argument based on the group they represent. Following the discussions, have each group present a brief summary of their position and recommendation. Following the presentations, open debate follows during which students can rebut points made by other groups, with the idea that students will eventually recognize that everyone in the discussion must strive toward the best solution to the issue at hand.

Results: As each group had a vested interest in determining the harp seal's ultimate purpose, a lively debate ensued regarding animal rights, human rights, human growth and prosperity, government, and law. Some students started out with purely emotive arguments (e.g., hunting is being mean to seals), but the discourse soon led to additional assertions from ecological (e.g., reinstating the hunt may endanger the seal population), economical (e.g., fish population supported the local community), and cultural (e.g., sealing and fishing are a way of life for indigenous peoples) perspectives.

The students assisted one another in forming better arguments and incorporated the topics previously introduced during the hands-on activity. Using the concepts of food chains and energy pyramids, one group of students requested that the energy pyramid be drawn on the SMART Board so they could reference it during the debate. I complied with their request and filled in the animals on the different levels, with the top level being sharks, followed by harp seals, then cod, and krill on the bottom. One student then said, "If we kill the harp seal to reduce its numbers, then, theoretically, the shark population will decrease as a result of less food being available." Another student in that group added to that by saying, "Well if the cod levels do increase, then the krill numbers might decrease as a result of too many predators." A third student chimed in and added, "If the krill is lessened, that's not only going to impact this food chain because krill is an essential part of many food chains. This hunt affects more than this one chain. It affects the food web." This dialogue served as a significant eye-opener to my students as they realized if one group's numbers increase or decrease on the food chain, then other groups are affected. Following the conversation, the room became somewhat quiet as students pondered the ramifications of these proposed human alterations to the environment. It was a great moment for me as a teacher.

Students were thinking critically and utilizing analysis, synthesis, and evaluative skills throughout the debate. As the debate continued, their dialogue was deliberative in that they showed evidence of intuitive, emotive, and rationalistic reasoning. *Intuitive reasoning* emerged initially as the students were arguing specifically with regards to the scenario context I had originally provided. *Care-based* or *emotive reasoning* then came into play as each group became progressively passionate about the causes of the groups they were chosen to represent. *Rationalistic reasoning* became the primary form of reasoning when the students realized they were taking into account each group's reason-based consideration, ultimately leading to joint construction of collective knowledge. After *cognitive reflection* on the personal beliefs of each group, the students agreed to allow limited hunting of the harp seal for the purpose of sustaining both the fishing and indigenous communities. As previous preservation efforts had already lessened the ecological threat of seal endangerment, they also agreed to allow PETA to monitor the number of seals hunted and the government to regulate the hunting methods of seals and establish humane trapping standards. The debate really compelled the groups to work together to build a case for their interests, which led to the synthesis of ideas. At the end of class, my students were pleading to complete additional SSI in class.

Tom's results and the enthusiasm of his students for this SSI scenario show that science content that might seem boring or even too advanced for elementary students can end up being part of a very engaging SSI unit. Effective SSI scenarios need not be local. Although the beach unit was a familiar one for his Florida students, the harp seal hunt was not. Nonetheless, with the right background materials and guidance, his 5th-grade students were drawn in to the Arctic scenario. This SSI harnesses the considerable imagination that children can bring to a topic, and it resulted in a classroom full of enthusiastic learners.

SSI and Physical Science

Hands-On Activity – Slip 'N Slide

Goal: Students will understand the concepts of friction, momentum, velocity, and mass.

Materials:

- 1 Slip 'N Slide
- 1 hose
- 1 stopwatch
- 1 recorder (parent possibly)
- Bathing suits
- Shirts (optional)
- Soap
- Goggles
- Towels

Procedure: Students will participate in the Slip 'N Slide game. The game is designed as a practical application of the concepts of friction, momentum, velocity, and mass. A Slip 'N Slide will be set up in a safe, open area prior to the start of the game. Before the game starts, ask questions and probe students' understanding regarding the concept of friction. Following the review, request that a student slide down the Slip 'N Slide without the water turned on. (The student should promptly refuse knowing that it would hurt him or her.) Probe the students once again regarding their understanding of friction. Explain that as the school prohibits friction-causing injuries, the students must therefore reduce the effect of friction on them. Spray water on the Slip 'N Slide (and the students). Students will then line up and run a distance of 5 meters before proceeding head first down the Slip 'N Slide track, which is approximately 6.1 meters in length. Record each student's length of time on the water track. Have a parent record each student's time in order to later calculate the velocity of each student. Each student will slide on the Slip 'N Slide three times with the water running. After each child has taken three turns, apply dish soap to the Slip 'N Slide. (This is used to further demonstrate the reduction of friction.) Goggles will be worn, and students will again take three turns down the slide with the soap added. A parent can record each student's time. After all of the students have taken six turns down the slide, they will change back into their school clothes and return to the classroom. Supply students with their recorded times and have them complete the activity sheets for homework (see Appendices A and B).

The following day, students will bring their answers to class. Graph each of the student's data on the computer. As the results are reviewed, point out that sometimes objects that are smaller can generate more momentum as momentum incorporates two principles: (1) mass and (2) velocity. Use pertinent ideas to address the concepts of friction, momentum, velocity, and mass.

SSI Activity – Speed Limit Reduction

Goal: Students will apply what they have learned about friction, momentum, velocity, and mass to a debate regarding the current speed limit and whether it should be decreased or increased. The aim would be for students to utilize argumentation and invoke sociomoral discourse to reflect cognitively on both their scientific knowledge and personal beliefs and to determine the most just solution regarding how to implement a speed limit that will minimize accidents.

Materials:

- Article packet (containing four articles—two for keeping the speed limit and two for reducing the limit)
- Highlighters

Procedure: Place students in groups of four for this activity and present the following situation:

> A recent series of children being struck by cars and trucks has prompted local parents to petition the local government to find a solution. After several grueling weeks of deliberation, the local government has put forth a bill to the community in which the speed limits on all roads will be reduced by half in order to safeguard children. A town meeting has been called for members of the community to debate this proposed legal action and decide if it is a course that will be pursued and implemented.

Have each group read the articles pertaining to speed and its effects, and have them highlight important information within each article. After all students have finished reading the articles, each group will individually discuss the effects of lowering the speed limit. Then, place students into new groups that represent different segments of society. Students will use the information in the articles and the knowledge gained in the hands-on experiment to formulate arguments for their particular social segment. Four students will serve as the governing body. The other three social segments will be local business leaders, parents, and truck drivers. In this case, the parent group will advocate for speed limit reduction, and the local business leaders and truck drivers will oppose the proposed reduction. Groups will debate the facts and try to persuade the members of the governing council to vote their way.

The Slip 'N Slide hands-on portion of this scenario has already been implemented (much to the delight of the students and parents), and the SSI portion will be introduced next year. The development of this unit helps show how SSI scenarios can be purposefully developed in many different scientific contexts.

Summary

Though the implementation of SSI into primary classrooms is a novel idea for many, the experiences described here demonstrate that SSI can be used to enhance scientific literacy in the 5th grade. Students benefited from argumentation, and SSI provided a successful framework for increasing their science content knowledge. The primary students involved in our efforts showed an affinity for classroom discussions, which ultimately enhanced their own reasoning and argumentation skills. While participating in these SSI activities, students began to show signs of a collective social conscience as indicated by their concerns for social justice issues. We believe that further use of SSI strategies will positively impact student learning because they offer a multidimensional approach to learning science concepts, and they contain the added element of real-world application of such concepts to larger societal ideals.

SSI show great promise not just in getting primary teachers and their students interested in science content, but in showing them the importance of science to society and helping them become better critical thinkers and citizens. These are just a few examples of how the application of SSI theory can be used to create effective and engaging interdisciplinary science lessons in primary school classrooms. As other teachers design and adapt modules for their own locales and students, there will be many more.

Appendix A

Name: ______________________________

Date: ______________________________

Slip 'N Slide

Mass Conversion (Round answer to the nearest hundredths.)

Your Weight (lbs.)	×	0.464	=	Your Mass (kg)
______________	×	0.464	=	____________

Time Trials (Round time to the nearest tenth of a second.)

Without Soap Trials

Trial	Time
1	
2	
3	

With Soap Trials

Trial	Time
4	
5	
6	

Appendix B

Velocity Calculation (Round answers to the nearest hundredths.)

Trial	Distance (m)	÷	Time (sec)	=	Velocity (m/sec)
1	6.1 m	÷		=	
2	6.1 m	÷		=	
3	6.1 m	÷		=	
4	6.1 m	÷		=	
5	6.1 m	÷		=	
6	6.1 m	÷		=	

Momentum Calculation (Round answers to the nearest hundredths.)

Trial	Mass (kg)	×	Velocity (m/sec)	=	Momentum (kg m/sec)
1		×		=	
2		×		=	
3		×		=	
4		×		=	
5		×		=	
6		×		=	

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