Correlation of the Middle School Science Olympiad Events to the Tennessee Science Curriculum Standards

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Abstract—Teachers are always looking for resources that will help them organize content information in an interactive, student-centered, inquiry-based environment. One resource that is often overlooked is the events that are part of the Science Olympiad Tournaments. This article is a 12-year correlation (2002–2014) of Science Olympiad middle school events to the Tennessee Science Curriculum Standards adopted in 2007 and implemented from 2009 to 2018. In 2015, Science Olympiad celebrated its 31st anniversary for middle and high school tournaments, and Tennessee celebrated its 30th anniversary with Science Olympiad. Regional, state and national tournaments consist of 23 events in each division, B for middle and C for high school. This manuscript will focus on Division B middle school events. It will show that all middle school events can be used to teach one or more of the Tennessee Science Curriculum middle school science standards. Since each state's science standards are specific for that state, this could serve as a model for all states. The events can also be used as classroom inquiry-based, constructivist approaches in many science content areas. Only limited information has been published showing minimum correlation of Science Olympiad events to middle school state science standards. This publication should help teachers in Tennessee specifically, and other states in general, find alternative activities to teach their students the science content standards in an engaging format. It could also prepare them for a competitive environment, similar to "sports teams," with medals, trophies and regional, state and national recognition.

Introduction

After fifteen years of being involved with Science Olympiad as an event coordinator, assistant director and regional director in Middle Tennessee, it became apparent that Science Olympiad was the best of "Science, Technology, Engineering and Math" (STEM) competitions for children of all ages. School administrators, curriculum specialists and teachers agree that national and state standards are necessary resources when organizing the content for science classes. An excellent resource that is often overlooked is the events that are part of the Science Olympiad Tournaments. The events provide an interactive, student-centered, inquiry-based environment. This article will focus on a 12-year (2002–2014) correlation of the Division B (middle school) Science Olympiad events to the Tennessee Science Curriculum Standards (TSCS) (embedded inquiry, embedded technology and engineering and the specific content standards 1–12) for middle school students, grades 6–8. With the implementation of the new Tennessee Academic Science Standards (TASS) in the 2018–2019 school year, the previous standards implemented in the 2009–2010 school year are being archived, and are not currently available on the Tennessee Department of Education (TDE) home page (TN Department of Education, 2010). However, the standards can be found on the University of Tennessee website (The University of Tennessee at Knoxville, 2018).

Science Olympiad is a national organization that oversees local, regional and state tournaments in all 50 states. Their mission is to improve the quality of K–12 science education in the United States. Science Olympiad has correlated the events to the National Science Education Standards (NSES) (National Research Council (NRC), 1996) for 2008–2013, balanced among three broad areas: science concepts and knowledge, science processes and inquiry skills, and science application and technology. Each school year, a list of short descriptions for the events can be found on their website (Science Olympiad, 2018). The events also encompass all eight content standards distributed under the five National Science Education Standards categories: (1) life, personal and social science, (2) earth and space science, (3) physical science and chemistry, (4) technology and engineering and (5) inquiry and nature of science. Table 1 shows the correlation of these events to the TSCS.

Since state standards are customized, states may have different content in each grade level. Although some state Olympiad websites show correlations of their standards to the events (e.g., Georgia (Georgia Science Olympiad, 2006) and North Carolina (North Carolina Science Olympiad, 2011)), this manuscript will present the correlation of the middle school Science Olympiad events to the Tennessee Science Curriculum Standards over a 12-year period. This will cover most of the Science Olympiad events, since the events are on a rotation pattern. Correlation of the TSCS to the events could give teachers the opportunity to change the way science is taught. Table 2 shows the Tennessee Department of Education (TDE) Science Curriculum Standards approved November 2, 2007, and used 2009–2010 to 2017–2018 for grades K–8. It can be seen that content standards 1–5 are life science, standards 6–8 are earth and space sciences, and standards 9–12 are for physical science.

TABLE 1. Science Olympiad Division B (Grades 6–9) frequent events with TSCS numbers, GLEs, and NSES.

Event	TSCS #	Grade	GLE	NSES Alignment
1. Dynamic Planet/Oceanography	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Earth and Space
		7	0707. Inq. .1,.2,.3,.4,.5	
		8	0807. Inq. .1,.2,.3,.4,.5	
	7	7	0707.7.1,.2,.3	
2. Experimental Design	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Science as Inquiry
		7	0707. Inq. .1,.2,.3,.4,.5	
		8	0807. Inq. .1,.2,.3,.4,.5	
	9	8	0807.9.3	
3. Meteorology/Weather or Not	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Earth and Space Science
		7	0707. Inq. .1,.2,.3,.4,.5	
		8	0807. Inq. .1,.2,.3,.4,.5	
	8	6	0607.8.3,.4	
4. Metric Mastery/Estimation	Inq	6	0607. Inq. .3	Science as Inquiry
	T/E	6	0607. T/E.2	
5. Mission Possible	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Science and Technology
	T/E	6	0607. T/E.2	
	10	6	0607.10.2	
6. Reach for the Stars/Solar System	EI	6	0607. Inq. .3	Earth and Space Science
	6	6	0607.6.1,.2,.3,.4,.5,.6,.7	
	8	6	0607.8.2,.3	
7. Road Scholar	Inq	7	0707. Inq. .2	Unifying Concepts and Processes
	T/E	7	0707.T/E.2	
8. Rocks and Minerals	Inq	7	0707. Inq. .2	Earth and Space Science
	T/E	7	0707.T/E.2	
	7	7	0707.7.1,.2	
9. Science Crime Busters	Inq	7	0707. Inq. .1,.2	Science as Inquiry
	Inq	8	0807. Inq. .1,.2	
	9	8	0807.9.3	
10. Water Quality	Inq	6	0607. Inq. .2,.3	Unifying Concepts and Processes
	T/E	6	0607.T/E.3	
11. Wright Stuff	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Science and Technology
	T/E	6	0607.T/E.2	
	10	6	0607.10.2,.3	
12. Write It/Do It	Inq	6	0607. Inq. .1,.2,.3,.4,.5	Science and Technology
	Inq	7	0707. Inq ..1,.2,.3,.4,.5	
	Inq	8	0807. Inq. .1,.2,.3,.4,.5	

Inq-Embedded Inquiry; T/E-Embedded Technology & Engineering; 1-Cells; 2-Interdependence; 3-Flow of Matter & Energy; 4-Heredity; 5-Biodiversity & Change; 6-The Universe; 7-The Earth; 8-The Atmosphere; 9-Matter; 10-Energy; 11-Motion; 12-Forces in Nature; NSES-National Science Education Standard

It shows that not all 12 content standards are covered at each grade level, especially at the middle school level (grades 6–8). However, the embedded inquiry and embedded technology and engineering standards are included for all grades K–8.

Materials and Methods

In Tennessee, a board of directors was established in October 2002 to help regional tournament directors and coaches do a better job of advancing Science Olympiad. For years, the Tennessee Science Olympiad Board of Directors (Tennessee Science Olympiad, 2011) thought that participation in the Science Olympiad tournaments would increase if the teachers were shown how to correlate the TSCS standards to the events. This would enable them to use some of these activities as part of their science classes. As a starting point, the Science Olympiad Event History for 1994–2007 (Tennessee Science Olympiad, 2006) was modified. The Science Olympiad Coaches Manual and Rules for Division B (grades 6–9) for each year between 2002 and 2014 were used to construct the event table (Table 3). The "Description" sections were studied to complete the alphabetized listing of events. Some of the events were combined if the name changed slightly from year to year, but the description wording was essentially the same. A few examples are: Don't Bug Me and Entomology; Dynamic Planet and Oceanography; Life Science Process Skills and Bio-Process Lab; Reach for the Stars and Solar System; and Metric Estimation and Metric Mastery. The "Competition" sections and the TSCS were studied to match events to grades 6–8, since most middle schools in Tennessee do not include 9th grade.

TABLE 2. Tennessee Department of Education (TDE) grades K–8 science curriculum standards, by grade, for academic years 2009–2010 to 2017–2018.

		Life Sciences				
Embedded Inquiry	Embedded Technology and Engineering	1-Cells	2-Interdependence	3-Flow of Matter and Energy	4-Heredity	5-Biodiversity and Change
K	K	K	K	K	K	K
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	*	6	*	*	*
7	7	7	*	7	7	*
8	8	*	*	*	*	8

*no standard at this grade

Also, the 9–12 grade science standards are subject-specific and not appropriate for middle schools.

Results and Discussion

Table 3 shows the correlation of the Tennessee Science Curriculum Standards for the events over a 12-year period (2002–2014). It can be seen that all 12 content science standards can be addressed with many of the events. Many of the events involve using the standards associated with the scientific inquiry and embedded technology and engineering, as well as content specific standards. Table 1 shows the corresponding Grade Level Expectations (GLEs) for 12 events that have repeatedly occurred at least 10 times over the last 12 years. This could be used by curriculum specialists and teachers for the teams in the schools to help correlate the content required to the Science Olympiad events. Thereby, coaches (teachers) would be able to incorporate some of these "national well-established" events into their curriculum. This would not only help all middle school students learn the content in an interactive engaging manner, but it would also help Tennessee middle school teams better prepare for regional, state, and national tournaments.

The State Board of Education adopted revised Tennessee Academic Standards for Science in October 2016, and they were implemented in the 2018–2019 school year (TN Department of Education, 2018). The revised academic science standards were developed utilizing recommendations found in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council of the National Academies, 2011). These standards were based on three dimensions of science instruction: Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), and Disciplinary Core Ideas (DCIs). An example is given below to show how the GLEs (i.e. 0607–0807. Inquiry .1, .2, .3, .4, .5) in Table 1 can be used for teaching the Scientific Inquiry, using the Experimental Design event. The Scientific Method is part of the new standards, under "Science and Engineering Practices (SEPs), included in the introductory chapter of science textbooks (McGraw-Hill School Education, Glencoe Tennessee Integrated Science, 2019). The description in the 2014 Science Olympiad Division B Rules Manual states: This event will determine a team's ability to design, conduct and report the findings of an experiment actually conducted on site (Science Olympiad, Inc., 2014). Each of the 14 sections can score a specific number of points. Zero points will be given for no response or an inappropriate response. The amount of points awarded will depend upon completeness of the response. Table 4 shows the rubric for this event, along with a graded response from one of the event coordinators' assignment of the points, based on a detailed rubric. For the 2019 tournaments, an Experimental Design Checklist will be part of the event rules, which will increase consistency of the points assigned. An example that has been used for this event is as follows: "Determine the Effect of Different Amounts of Barium Chloride on the Change in Temperature of the Mixtures." Each team was provided the following materials: five plastic cups, thermometer, spoon, barium chloride, timer, water, 50-mL graduated cylinder. Students must complete this event in less than 50 minutes. The scenario is not given in advance. Therefore, the teacher would need to give the students several questions, so that they could practice developing the 14 steps to be able to earn credit in each area. This allows students to use what they are learning in their science classes. The preparation of these events also helps students and teachers develop a deeper content knowledge. Examples of scenarios are given on the Science Olympiad website.

With the implementation of new Tennessee Academic Science Standards in the 2018–2019 school year, correlation of Science Olympiad events to the TSCS will serve as a bridge between the previous standards and the new standards. From 2014 to 2016, the Science Olympiad website showed the alignment of Division B and C to the NGSS (Next Generation Science Standards, 2013). For example, their Experimental Design description, "Given a set of objects, students will design, conduct, analyze, and write up an experiment" correlates to the NGSS "Science and Engineering Practices 1–8." In 2015, Science Olympiad showed alignment to NGSS, Math and English Language standards for 15 events in Division A Elementary Science Olympiad (ESO).

TABLE 2. Extended.

Earth & Space Sciences			Physical Sciences			
6-The Universe	7-The Earth	8-The Atmosphere	9-Matter	10-Energy	11-Motion	12-Forces in Nature
K	K	K	K	K	K	*
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	*	6	*	6	*	6
*	7	*	*	*	7	*
*	*	*	8	*	*	8

The Science Olympiad tournaments also serve as professional development for middle school teachers by allowing them to collaborate with college and university professors and preservice teachers. As students prepare for the tournaments, they learn to build teams, dig deeper into content knowledge, do research by looking for information to help them through websites and individuals. Regional tournaments give the students an opportunity to visit college campuses and (for some) get them thinking about attending college in the future as an option to what they do after high school.

Conclusions

Although a few teachers have used Science Olympiad events to aid in the teaching of specific physical science concepts (Doney, 2008 and Thomas, 2000), this is the first time a complete summary for 12 years is presented. The article by P. Doney (2008), "An Eggciting Alternative to a Science Olympiad," discussed an activity where students prepare a device to protect a raw egg from breaking when it was dropped from a given height on a specific circular target. The winner was the one whose egg dropped closest to the target and the egg did not break. This activity involved understanding several concepts, including Newton's first and second laws of motion, friction and gravitational forces, potential and kinetic energy, and science inquiry. This activity was similar to the Science Olympiad event "Egg Drop", which correlates to state standards 10 (energy) and 11 (motion) for both 6th and 7th grade. The article by J. A. Thomas (2000), "Springtime flights of Fancy," involved students building rockets using 2-L plastic bottles. This activity involved understanding gravity and Newton's laws of motion, scientific inquiry and engineering. The "Competition sections" for the Science Olympiad events "Bottle Rocket" and "Experimental Design" were the basis for this activity. The teachers could use several TSCS: 8 (the atmosphere), 10 (energy), 11 (motion), and 12 (forces in nature), as well as embedded inquiry, embedded technology and engineering, when teaching physics and astronomy to 6th, 7th and 8th grade students.

Over the 12-year period, some events are rotated in and out, yet several events were present at least 10 to 12 years. The listing is given in Table 1 and include Dynamic Planet, Experimental Design, Rocks and Minerals, and Write It/Do It. The skills needed to be successful in these events require not only basic science content knowledge, but require students to use many process skills (such as observing, inferring, measuring, communicating, classifying, predicting and experimenting) needed to be successful in science classes and life. Although this is not a complete correlation, it can serve as a guide and a starting point for anyone who wants to see the correlation of the middle school Science Olympiad events to the Tennessee Science Curriculum Standards.

The next challenge is to correlate the new Tennessee Academic Science Standards to the Elementary Science Olympiad events for grades 3–6. If more students competed at the elementary level, this would help the Tennessee Science Olympiad Board of Directors expand tournaments at this level. It has been observed that when young children participate in the Elementary Science Olympiad Competitive Tournaments, an increase in the participation at the middle and high school levels have occurred in Chattanooga, Murfreesboro and Lebanon, TN (Science Olympiad, 2018). These findings will be discussed in the manuscript in progress, "The History of Science Olympiad in Tennessee." A deeper understanding of science concepts will ultimately help students develop their process skills and ability to work in teams using an interactive hands-on/minds-on approach at the middle school, high school and college level.

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TABLE 3. Science Olympiad Division B (Grades 6–9) event history by year, correlated to TSCS standards and grade.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TSCS #	Grade
Anatomy						X	X	X	X	X	X	X	X	1	7
Amphibians & Reptiles							X	X						5	8
Awesome Aquifer				X	X	X				X	X			7	7
Balloon Launch Glider						X	X							11	7
Balloon Race	X	X			X	X								Inq	6–8
Battery Buggy	X								X	X				11	6–8
Boomilever												X	X	Inq, 11	7
Bottle Rocket	X	X	X	X	X					X	X			11	6–8
Bridge Building	X	X	X	X	X									11	6–8
Can't Judge A Powder (By Its Color)	X	X	X	X	X				X	X			X	9	8
Compute This				X	X			X	X	X	X			5, 6, 7	6–8
Crave the Wave							X	X						11	7
Disease Detective					X	X	X	X	X	X	X	X	X	5	8
Don't Bug Me/Entomology					X	X							X	5	8
Dynamic Planet	X	X	X	X	X			X	X	X	X	X	X	7,8	6,7
Ecology						X	X	X	X	X				2, 3, 5	6–8
Egg Drop (Naked/Rotor)	X	X	X	X								X	X	10, 11	6,7
Elevated Bridge								X	X					Inq, 11	7
Environmental Chemistry								X						3, 7, 5, 9	7,8
Experimental Design	X	X	X	X	X			X	X	X	X	X	X	1, 5, 8, 12	6–8
Feathered Frenzy	X	X												5	8
Food Science					X	X	X				X	X		9	8
Forestry			X	X							X	X		5	8
Fossils		X	X	X				X	X	X				5	8
Helicopter												X	X	10	6
Heredity					X	X						X	X	4,5	7,8
Junkyard Challenge									X	X				Inq	6–8
Life Science Process Skills (Bio-Process Lab)	X	X	X	X			X	X	X					Inq	7,8
Keep the Heat											X	X		Inq, T/E	6–8
Meteorology		X	X	X	X	X	X	X	X	X	X	X	X	8	6
Metric Estimation (Mastery)	X	X	X			X						X	X	11, 9, 12	7,8
Microbe Mission										X	X			2	6
Mission Possible	X	X	X	X	X	X					X	X		10,12	6,8
Mousetrap Vehicle											X	X		Inq	6–8
Mystery Architecture	X	X			X		X							Inq	6–8
Oceanography						X	X							6, 8, 3, 7	6,7
Optics										X	X			Inq, 11, 12	6,7
Ornithology									X	X				5, 2	6,8
Pentathlon	X							X	X					Inq	6–8
Physical Science Lab								X	X					9,10,11,12	6–8
Picture This		X	X											1–12	6–8
Reach for the Stars	X	X	X	X			X	X			X	X	X	6,8	6
Road Scholar	X	X	X	X	X	X	X	X	X	X	X	X	X	7	7
Robo-Billards		X	X	X			X							11	7
Robo-Cross							X						X	11, 12	6
Rocks and Minerals	X				X	X	X				X	X	X	7	7
Science Crime Busters	X	X	X	X		X	X	X	X	X	X	X	X	4, 5, 9	7,8
Science of Fitness	X	X	X	X	X									1,3	7
Science Word						X	X							1–12	6–8
Scrambler							X	X						10,11	6,7
Shock Value									X	X		X	X	12	6,8
Simple Machines						X	X						X	11	7
Solar System					X	X			X	X			X	6,10,11,12	6–8

TABLE 3. Continued.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TSCS #	Grade
Sounds of Music				X	X							X	X	Inq	6–8
Storm the Castle			X	X	X	X				X	X			Inq, 11	7
Tower Building (Towers)						X	X			X	X			Inq	6–8
Trajectory							X	X	X					Inq, 11	7
Water Quality	X	X	X	X	X						X	X	X	1,2,3,5,7	6–8
Weather or Not	X													6, 8	6
Wheeled Vehicle			X		X	X							X	10	6
Wright Stuff	X	X	X	X				X	X					10	6
Write It/Do It	X	X	X	X		X	X	X	X	X	X	X	X	Inq	6–8

Inq-Embedded Inquiry; T/E-Embedded Technology & Engineering; 1-Cells; 2-Interdependence; 3-Flow of Matter & Energy; 4-Heredity; 5-Biodiversity & Change; 6-The Universe; 7-The Earth; 8-The Atmosphere; 9-Matter; 10-Energy; 11-Motion; 12-Forces in Nature; TSCS #-Tennessee Science Curriculum Standards

TABLE 4. Science Olympiad experimental design scoring rubric.

Scoring Category	Possible Points	Earned Points
A. Statement of Problem: Experimental Question	4	2
B. Hypothesis: Including prior knowledge that contributed to hypothesis	8	1
C. Variables: Constants (Controlled Variables) Factors that are purposefully kept the same	8	8
Independent Variable: Factor being manipulated	6	6
Dependent Variable: Factor being measured which responds	6	6
D. Experimental Control (where applicable): Standard of Comparison	4	0
E. Materials	6	6
F. Procedure: Including Diagrams	12	8
G. Qualitative Observations During Experiment & Summary of Results	8	0
H. Quantitative Data; Including Data Table	12	10
I. Graph(s)	12	10
J. Statistics: Average (mean), median, mode, range, or drawn in line of best fit	4	4
K. Analysis of Results: Interpretation	8	8
L. Possible Experimental Errors including identified human errors	6	5
M. Conclusion: Include why your results did or did not support the hypothesis	8	8
N. Recommendation for Further Experimentation Based on Your Data & Practical Applications	8	8

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