Design of a student-led organizational partnership to host an annual statewide Science Olympiad K–12 outreach tournament

Daniel Naveed Tavakol1,2 and Karen Emmons3

1Department of Biomedical Engineering, University of Virginia, Charlottesville, Virginia; 2Engineering Student Council, University of Virginia, Charlottesville, Virginia; and 3Virginia Science Olympiad, Fairfax, Virginia

Submitted 19 February 2019; accepted in final form 16 July 2019

Tavakol DN, Emmons K. Design of a student-led organizational partnership to host an annual statewide Science Olympiad K–12 outreach tournament. Adv Physiol Educ 43: 401–407, 2019; doi: 10.1152/advan.00027.2019.—Since fall 2015, the University of Virginia’s (UVA) Engineering Student Council (ESC) has partnered with the nonprofit Virginia Science Olympiad (VASO) organization to host a Science Olympiad (SciOly) state tournament in Charlottesville, Virginia, each spring. This annual tournament brings over 2,000 middle and high school students, teachers, and parents to the UVA campus, and teams of 15–17 people from roughly 90 schools across Virginia participate in 46 different events (23 middle school, Division B; 23 high school, Division C) relating to the science, technology, engineering, and mathematics (STEM) fields throughout the day-long competition. The national SciOly organization sets the events and rules to comply with national education standards, and the VASO board coordinates the teams and tournaments within the state. By collaborating with VASO, UVA ESC was able to plan a large-scale SciOly tournament at UVA in approximately 10 mo with the support of the UVA School of Engineering and Applied Science. Since this event was planned and executed solely by undergraduates in cooperation with the nonprofit organization, there were institutional hurdles that were overcome through the months of planning. The Virginia SciOly state tournament has continued to be held at UVA with the support and cooperation of the UVA ESC and VASO, and bringing this tournament to UVA has allowed for increased excitement for participating K–12 students and a mitigated burden to the VASO organizers in planning the state competition. This paper aims to provide a resource for other universities to support STEM activities in K–12 outreach organizations, like SciOly, in the future.

K–12; outreach; Science Olympiad; STEM

INTRODUCTION

Science Olympiad (SciOly) is one of the nation’s largest K–12 nonprofit organizations that helps introduce students from elementary, middle, and high schools to a number of different fields within Science, Technology, Engineering, and Mathematics (STEM). SciOly as a national organization has been instrumental in introducing students from all ages to “events” in all areas of STEM, ranging from “study,” “hands-on laboratory,” and “building” engineering design events. Schools choose to sponsor one or more teams, and students of all years can come together to compete in all events offered in a single year. With the support of one or more faculty supervisors, students can spend up to 1 academic yr preparing for their events, which culminates to competing in these events at the regional, state, and national levels. K–12 students of all age groups are able to participate, with elementary (Division A), middle (Division B), and high (Division C) schools being split up based on age groups; for the culminating state tournaments described in this paper, only Division B and C schools participate. Hereafter, K–12 refers to the middle and high school divisions of SciOly, for the purpose of this paper.

Although events change from year to year, many of these remain unchanged, albeit with topic variations; an example list of events from the high schools (Division C) in 2018–2019 is shown in Table 1 (3). For example, for a high school that is sponsoring one team of 15 students, there may be up to 23 events, where students will form pairs within the team to compete in 3–4 specific events (per student) of the 23 total events. During the school year, students have the opportunity to compete in practice tournaments, they will compete in a regional competition (between schools in similar geographical areas), and eventually some teams may move on to the state and national competitions (one or two schools participating from each state). The tournament structure is comparable to a high school swim meet, where students of all years may compete in different categories (freestyle, breaststroke, etc.), and the overall team’s ranking is determined by a compiled metric of each team member’s performance in each of his/her events. The impact of this organization has been widespread, as many student participants end up pursuing careers in STEM (3). More recently, state programs, including the Virginia Science Olympiad (VASO), have been attempting to introduce deprived schools and students from lower socioeconomic backgrounds to SciOly, with hopes to increase the diversity of student participants who are underrepresented minorities in STEM.

For the Commonwealth of Virginia, the SciOly program was established in 2001 by Fairfax County Public Schools and grew to a point where an independent VASO Board of Directors was formed to enlist schools to participate, expand the program outside of Fairfax county, and run each of the tournaments (6). A major benefit to these tournaments is that students are able to work in pairs to learn more about a niche field that may interest them, exposing K–12 students to areas of science outside of the standard school curriculum, and giving students an opportunity to participate in extracurricular academic activities. In Virginia, adequate facilities were getting more difficult...
to book, and rental costs were rising rapidly. The precedent for most of the Virginia regional and state tournaments before 2016 was asking a participating high school and faculty sponsor, who already had the burden of coaching a competing team, to organize and host the entire Virginia state tournament. Not only was this a large burden for each host school and faculty sponsor, but it also required all participating coaches and teams to contribute large numbers of judges and volunteers to run the tournament (6).

To address this need, and in hopes to help promote STEM outreach in K–12 students in schools across the Commonwealth of Virginia, a collaboration between authors D. N. Tavakol, as a representative of the University of Virginia’s (UVA) Engineering Student Council (ESC), and K. Emmons, as a representative of VASO, led to an 8-mo plan to bring close to 1,200 students from middle and high schools across the state to Virginia’s flagship university. UVA’s ESC is an undergraduate organization that aims to promote student life and support for students at the School of Engineering and Applied Science (SEAS), build relationships between faculty and students, and promote STEM outreach in the city of Charlottesville and in Virginia as a whole, among other roles (1, 4). As an organization, ESC was interested in helping to give Virginia students an opportunity to visit the University in an atypical format, allowing them a chance to meet current students, and offer tours to learn about the UVA SEAS. At the same time, students

Table 1. Example events listing for the 2018–2019 high school (Division C) SciOly season

| Event Name          | Type of Event | Description                                                                                           | Spaces                        |
|---------------------|---------------|-------------------------------------------------------------------------------------------------------|-------------------------------|
| Anatomy and Physiology | Study         | Anatomy and physiology of three rotating human body systems, specifically cardiovascular, lymphatic, and excretory systems for 2019 | Classroom with stations       |
| Designer Genes      | Study         | Genetics and molecular biology in reference to inheritance                                            | Classroom                     |
| Disease Detectives  | Study         | Epidemiology and the study of diseases, how they spread, and their impact in society over time, with specific years gaining specific diseases of interest | Classroom                     |
| Herpetology         | Study         | Identification and biological understanding of amphibians and reptiles                                | Classroom with stations       |
| Water Quality       | Study         | Water quality of estuarine and marine bodies, identification of marine organisms, nutrient and aquatic chemistry, and treatment of water | Classroom                     |
| Astronomy           | Study         | The study, math, and physics regarding various astrological phenomena, specifically stellar evolution and starburst galaxies in 2019 | Classroom                     |
| Dynamic Planet      | Study         | Glacier history, morphology, evolution, and geology                                                  | Classroom                     |
| Fossils             | Study         | Identification of fossilized animals and plants, and the study of paleontology                       | Classroom with stations       |
| Geologic Mapping    | Study         | Study of geological structure, geographical history, and map reading                                  | Classroom                     |
| Chemistry Laboratory| Laboratory     | Study of various topics in chemistry and select laboratory experiments relating to these topics       | Laboratory space              |
| Circuit Laboratory  | Laboratory     | Study of direct current (DC) fields and analyses, and their applications toward laboratory circuit design | Classroom with stations       |
| Forensics           | Laboratory     | Identification of polymers, powders, and solutions, and examination of blood, hair, and fingerprints for forensic interpretation to solve crime | Laboratory space              |
| Protein Modeling    | Laboratory     | Design of select protein models before competition to understand how structure determines function    | Classroom                     |
| Sounds of Music     | Build          | Design of an instrument before competition, performance of the instrument, and study of the physics of sound | Classroom                     |
| Thermodynamics      | Laboratory     | Design of an insulating device before competition, and study of the chemistry and physics of thermodynamics | Classroom                     |
| Boomerlevers        | Build          | Design of a boomerlevers to support a given load                                                      | Multipurpose room             |
| Mission Possible    | Build          | Design of a Rube Goldberg machine to complete a certain number of suggested tasks                     | Large lecture hall or gymnasium|
| Mousetrap Vehicle   | Build          | Building a vehicle using mousetraps to maximize speed, directionality, and timing                    | Gymnasium                     |
| Wright Stuff        | Build          | Design of an airplane to minimize mass and maximize flight time                                       | Gymnasium                     |
| Codebusters         | Laboratory     | Decoding and encoding messages using ciphers                                                        | Computer laboratory           |
| Experimental Design | Laboratory     | Design an experiment using the limited and provided materials to test a central hypothesis           | Laboratory space              |
| Fermi Questions     | Laboratory     | Analytically answering questions relating to size, quantity, and shape of random topics               | Classroom                     |
| Write it Do it      | Laboratory     | Instruction and building of a construct oblivious to one of two partners                              | Multiple classrooms           |
who may not necessarily have the resources to visit UVA may have been more likely to see UVA when organized by their individual middle and high schools.

In August 2015, a plan was initiated to host the 2016 spring Virginia State SciOly tournament at UVA, and members of the UVA ESC with support of the UVA SEAS and VASO organized and held the tournament successfully in April 2016. For undergraduate student volunteers, this tournament provided a unique opportunity to get excited about STEM outside of the classroom environment, with many students continuing to volunteer with VASO in future years. This paper describes the approach to planning a collaborative nonprofit/university statewide outreach event, its successes and obstacles, and the intended impact of this tournament on K–12 SciOly participants in Virginia and student volunteers at UVA SEAS (Fig. 1).

**METHODS**

**Organizational partnership.** As then Vice President of UVA’s ESC, D. N. Tavakol reached out to K. Emmons, VASO State Director, in May 2015, to start talking about bridging the outreach capabilities of UVA SEAS and VASO. To date, many students at universities around Virginia, including UVA, helped volunteer at the various SciOly competitions throughout the year. Similarly, other universities, including the Virginia Polytechnic State University (Virginia Tech) and Randolph-Macon College, have previously hosted one competition each for the culminating state tournament in Virginia. Unfortunately, these tournaments have not sustained repeated iterations with VASO due to mismatched expectations, changing staff roles, and the effort required by the tournament planning. By being initiated by SciOly alumni students (UVA ESC) at a university where student self-governance is promoted throughout the undergraduate culture (UVA SEAS), the hope was that effective planning and commitment could lead to renewal of the tournament at UVA for future iterations (1, 4, 5). As a flagship university that is relatively spatially centered in Virginia, it appeared as an effective and attractive location for the annual state tournament for SciOly participants.

**Administrative support.** Although UVA ESC and VASO initiated the collaborative project, having the support of the Associate Dean of Undergraduate Programs of UVA SEAS allowed us to surpass many hurdles in space reservations and liability restrictions. With the Dean’s approval, we were able to work more closely with the UVA Office of Student Life and University Registrar to ensure we had enough space for the tournament day. No financial support was asked from the administration to plan or execute this large-scale event.

**Safety.** For the tournament, VASO listed UVA as an insured venue for security and safety of the student participants and volunteers. VASO also had a “never alone” policy in assigning judges and volunteers, so no student is left alone in a room with just one adult. VASO also committed to having all volunteer contact information and set up a twitter account with text notifications for all teachers and school contacts on the day of the tournament. Finally, all events with any risks required strict safety

---

Fig. 1. Organizational relationship and roles split between the University of Virginia (UVA) Engineering Student Council (ESC), UVA School of Engineering and Applied Science (SEAS), and Virginia Science Olympiad (VASO). SciOly, Science Olympiad.
guidelines to be adhered to, with first aid kits in the laboratory events for emergencies.

Middle and high school student participants. Student teams were recruited by each individual school’s program, with between 15 and 17 students participating from each registered middle and high school (total of 91 schools; total of over 2,000 students) in Virginia. Students ranged from around age 10 yr (grade 5) through 18 yr (grade 12), with one or more faculty sponsors per school. Participating schools came from throughout Virginia, with the following counties represented: Fairfax, Loudoun, Arlington, Montgomery, Albemarle, Powhatan, Henrico, Madison, James City, Staunton City, Charlottesville City, Fairfax City, and Alexandria City.

Event descriptions and needs. VASO simultaneously recruits and coordinates with high school teachers, faculty at Virginia colleges, and other SciOly volunteers to create the exams and rubrics for each of the 23 events in any given year; they are also charged with finding volunteers to administer and grade the exams and judge the engineering design events at the actual state competition (~2–3 examiners per event). In many of these cases, former SciOly alumni volunteer to help run the events on the day of the tournament. Although many events are similar from year to year, space and event requirements were different for each iteration of the SciOly state tournaments. Therefore, to coordinate the 46 events for both the middle and high school divisions, the UVA ESC tournament director (D. N. Tavakol) met with the VASO state director (K. Emmons) to constantly adjust the space and event needs for each of the 46 events. For example, laboratory-based events (Chemistry Laboratory and Experimental Design) required spaces for Bunsen burners, sinks, and chemical hoods, among other things, which was coordinated through the UVA Department of Chemistry many months before the tournament. For certain engineering events, a large gymnasium-like space was needed to store the large devices or allow each student to compete his/her designed flying helicopters.

UVA ESC organizing committee. Starting officially in September 2016, an organizing committee was made up of 5–8 of the roughly 30 undergraduate UVA ESC board members, led by the UVA ESC tournament director. The organizing committee was charged with distributing the responsibilities of planning the tournament’s logistics, including coordinating space reservations, finding food vendors, recruiting student logistical volunteers, and addressing all of the minor issues that arose in the planning to host over 2,000 students, their coaches, and their parents for the tournament.

Volunteer responsibilities. Student volunteers were charged with helping set up event spaces, guide the student participants around, coordinate with the VASO event volunteers, and promote opportunities for exploring UVA SEAS throughout the tournament day. Set up entailed putting signs up throughout the engineering school, taping off regions that were restricted, and placing a number of “welcome packets” containing maps and relevant information about UVA around the engineering school. Student volunteers also assisted with coordinating with VASO volunteers, to help set up a volunteer break room and a headquarters for VASO board members. The majority of student volunteers on the UVA ESC side of logistical preparations were involved in guiding participating students and their parents throughout the campus. Volunteers were stationed at each major corner of the engineering school, throughout the connecting roads to the gymnasium areas, and toward the main student center on campus. One of the most important tasks, however, was having volunteers show plots of the campus to prospective students and host student life panels throughout the day. At every hour, from 10:00 AM until 4:00 PM, one of our UVA SEAS engineering guides (E-Guides) gave an extensive tour of the engineering school to any prospective students who had a free block of time during the SciOly tournament. In addition, we had student volunteers from the Society of Women Engineers host a question-and-answer session for prospective students alongside our Dean of Undergraduate Education at UVA SEAS.

These planned events helped introduce visiting students to UVA SEAS alongside their main intention to visiting the university.

Volunteer recruiting. As the only required outreach events for the engineering council, all UVA ESC board members (~30) were asked to commit 4 h on the day of the competition. Committee members at-large from ESC were also suggested to volunteer for the competition, which yielded roughly enough student volunteers for 2-h shifts. The organizing committee also reached out to the Trigon Engineering Society and Alpha Omega Epsilon groups, which contributed some volunteers throughout the tournament day. Volunteers were provided with bagels (morning) or pizza (noon/afternoon), as well as a VASO tee-shirt for helping with the tournament.

Planning time line. Organizing a large-scale, statewide SciOly tournament required over 100 student volunteers, in addition to the countless VASO volunteers, and approximately 10 mo of planning to host the roughly 2,000 middle and high school students, teachers, and parents at UVA in Charlottesville, Virginia. Over the course of 1 yr, ~700 volunteers from VASO help as test writers, event judges, or supervising adults for the regional and state tournaments, which would commit roughly 7,500 h of service in any given season. This section is divided into the months leading up to the event, from date selection to postevent analysis (Table 2). In the years following the first tournament (spring 2016), a new UVA ESC organizing committee has led the continuation of the Virginia State SciOly tournament in the spring of 2017, 2018, and 2019.

DISCUSSION

Impact on K–12 student participants. SciOly held its first nationwide tournament in 1985 at Michigan State University and, since then, has allowed for over 7,798 teams (in 2017) to participate in the regional, state, or national competitions (3). In Virginia, 2,070 students participated in one of the competitions in 2017–2018, with 913 from middle schools (Division B) and 1,157 from high schools (Division C) (7). By the state tournament, where each qualifying school was allowed to send only one team, there were a total of 859 participating students, with 446 from Division B and 413 from Division C. Demographical student data in the SciOly program, pulled from data in 2015–2016, is shown in Table 3. It is of particular interest that the ratio of male-to-female participants is similar, with a relatively equal number of male and female participants in the program overall.

A benefit of hosting a SciOly tournament like this at a university like UVA is the wide exposure of the campus and college atmosphere that students feel when they come to participate in the competition. As a student, it can be extremely eye opening to see the sheer size of a college campus and STEM facilities, and, for many students, these tournaments are the first times they visit a university environment. Many students opted to take a tour of the university or engineering school, but, regardless, there were students who still benefitted from getting the chance to compete alongside undergraduate volunteers in college laboratories.

Impact on Virginia state SciOly nonprofit organization. VASO struggles not only to find tournament locations with adequate classroom, laboratory, and technical spaces, but also venues able to accommodate large numbers of attendees as well. UVA has such facilities, and partnering with ESC provides VASO access to the impressive campus facilities at the affordable student-discounted rate. However, the use of the UVA facilities is merely a small part of the benefits of the VASO partnership with the UVA ESC.
The greatest benefit has been in maintaining a strong connection with the alumni of the nationwide SciOly program. While VASO has long kept a list of alumni interested in working with the organization after their high school graduation, actually having a tournament on a campus with many alumni both cements that connection and expands it. SciOly alumni are often part of greater campus STEM organizations, such as STEM honor societies, that then get involved in the program. SciOly is thus able to access an increasing number of STEM-oriented students through the friendships and connections of the SciOly alumni. Actually having the tournament on the campus makes it easy for the college students to participate in all facets of the VASO tournament: judging, test writing, and coordinating logistics. College students at UVA, and indeed around the state and country, have become empowered to take on increasing responsibility in SciOly. This partnership with UVA ESC and greater UVA community has freed much of the burden from coaches and teams to provide tournament-day judges and volunteers.

Working with college students is energizing for VASO-provided judges and volunteers. This connection provides experienced judges with a view to what is new in STEM on college campuses, while also exposing college student volunteers to post-college STEM connections. This partnership with college students moves even beyond their time in college. Many college students continue to volunteer for groups like SciOly to maintain their STEM connections.
SciOly or move on to coach their own teams after their graduation. High school seniors become college student judges and organizers who move on in their professional lives to mentoring students to compete.

The VASO partnership with ESC is shaping the way VASO moves forward in expanding its tournament locations, focusing anew on VASO student alumni communities.

Impact on undergraduate volunteers and UVA SEAS. For the engineering school and UVA ESC, this partnership formed a sustainable and manageable opportunity to expose K–12 students to the UVA community without excessive difficulty for student participants. For UVA SEAS, this was an easy and cooperative opportunity to bring students who may or may not have already planned to visit the campus at another date. Our UVA ESC was particularly excited, as it gave our volunteers alternative opportunities to interact with middle and high school participants, seeing the value in K–12 outreach as a way to introduce topics of STEM to students at a young age. It provided an opportunity to reach out to the entire commonwealth of Virginia, rather than solely targeting the surrounding city of Charlottesville.

Undergraduate volunteers also gained a fervent excitement for scientific outreach (2). Through these tournaments, students started from volunteering on the logistical side of the tournament to writing tests and running individual events in future years. Although some student volunteers participated in some form of SciOly when they were in high school, many students found the joy for outreach through volunteering year after year at our tournaments. Anecdotally, we learned that our college students were enthusiastic about giving back to the community, and the busyness and adrenaline that filled the campus each spring reinforced that drive to continue to host the state tournaments.

**Future directions.** Since 2017, the position of tournament director has been the responsibility of the UVA ESC Vice President. Although events change from year to year, there has been a good precedent of resources that can allow the planning of a statewide SciOly tournament without as many obstacles as there were in the first iteration (2015–2016). The VASO state tournament has been held at UVA for the past 4 yr, including the most recent in April 2019. Improvements in management of volunteers and spatial distribution of events, home bases, and gymnasium spaces always remains a challenge, but, with ample planning, we believe this collaborative tournament has potential to continue for years to come. In addition, UVA ESC and VASO aim to further engage faculty and staff across UVA’s campus; through anecdotal evidence, we believe that there are anticipated benefits to both academics and K–12 students in such partnerships (2). In future iterations, it may be useful to track both K–12 participants in their matriculation to UVA and number of returning UVA student volunteers over time. As there is a large annual turnover of UVA ESC volunteers, the VASO partnership would be crucial in implementing these changes long term.

In Virginia, the continuity of the described state tournament has encouraged other universities around the state to start hosting their own tournaments. Students from the neighboring Virginia Tech motivated themselves to host an optional practice tournament (“Invitational”), to rally SciOly alumni at Virginia Tech to engage young SciOly participants with another level of scientific rigor. Nationwide, a number of SciOly alumni and undergraduate students from universities around the country have led a new wave of tournaments, engaging with their state nonprofit organizations and providing opportunities of STEM outreach to K–12 students through SciOly. In fact, students from Cornell University hosted the SciOly national tournament in May 2019, where each state advances teams to represent them on the national field. This new wave of alumni and university involvement has been widespread in SciOly, leading a new and comprehensive STEM outreach network throughout the country.

**Conclusion.** SciOly programs in middle and high schools have continuously risen to providing opportunities for students of all backgrounds to explore their interests in the STEM fields, with the VASO state organization growing to support over 90 total schools (2017–2018 season; middle and high schools) from Virginia each year. Through an extensive planning time line, UVA’s ESC and SEAS were able to partner with VASO to organize and support the Virginia State SciOly tournament first in the spring of 2016, and every year since then. Although this model relies on extensive undergraduate student support and communication with the VASO nonprofit organization, we believe that partnerships like the one presented can give rise to a number of benefits for K–12 student participants, nonprofit partner organizations, and ultimately university outreach groups across the country.

**ACKNOWLEDGMENTS**

The execution of this outreach tournament at the University of Virginia (UVA) was only possible with the unwavering encouragement of the UVA School of Engineering, Engineering Student Council, and the support of Dean George Cahen. In particular, there was extensive support by other executive board members and organizing committee members, including Jonathan Bugg, Christina Kim, Alexander Lord, Frances Morales, Nicholas Mikalauskas, Jessie Rivera, Mary-Michael Robertson, Casey Russell, Maya Singh, and all of

---

**Table 3. Demographics for student participants (Division B and C from 2015 to 2016; self-reported via Virginia Science Olympiad)**

| Demographic                  | Percentage |
|------------------------------|------------|
| **Sex**                      |            |
| Male                         | 52         |
| Female                       | 48         |
| **Ethnicity**                |            |
| Asian                        | 61         |
| White                        | 26         |
| Hispanic                     | 4          |
| Black or African American    | 3          |
| Other                        | 6          |
| **Participation History**    |            |
| 1 yr                         | 50         |
| 2 yr                         | 25         |
| 3 yr                         | 14         |
| 4+ yr                        | 11         |
| **Needs-based school-fee discounting** |           |
| Standard fee                 | 78         |
| 25% reduction                | 6          |
| 50% reduction                | 7          |

See Ref. 6. There were 1,737 total respondents to the 2015–2016 survey (Division B and C students). Four respondents chose not to answer the sex question (n = 1,735 students); 143 chose not to answer the ethnicity question (n = 1,594 students). *Based on percentage of free and reduced lunch population within 91 total schools. Thresholds are <33% (standard fee), 33–40% (25% reduction), and >40% (50% reduction).
the volunteers from 2015 until the present day. Thank you to Allison Jensen for manuscript comments and early support in this project, and special thanks to Kristi Weniger, Jann Cassady, and Allison Sarfati from James Madison High School for supporting and encouraging this project from the beginning. Finally, the Virginia Science Olympiad Board of Directors was extremely helpful in coordinating these tournaments year after year, with special thanks to Emily Owens for taking the lead in directing the community contacts in recent years.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

D.N.T. and K.E. conceived and designed research; D.N.T. performed experiments; D.N.T. analyzed data; D.N.T. interpreted results of experiments; D.N.T. prepared figures; D.N.T. and K.E. drafted manuscript; D.N.T. and K.E. edited and revised manuscript; D.N.T. and K.E. approved final version of manuscript.

REFERENCES

1. Engineering Student Council, University of Virginia. Service and Outreach (Online). https://www.uvaesc.com/service-committee [17 Feb 2019].
2. Pickering, M, Ryan, E, Conroy, K, Gravel, B, Portsmore M. The benefit of outreach to engineering students (Abstract). Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition, Salt Lake City, UT, 2004, session 1692, p. 1–12.
3. Science Olympiad. Science Olympiad Mission (Online). https://www.soinc.org/about/mission [17 Feb 2019].
4. Tavakol DN, Broshkevitch CJ, Guilford WH, Peirce SM. Design and implementation of a student-taught course on research in regenerative medicine. Adv Physiol Educ 42: 360–367, 2018. doi:10.1152/advan.00157.2017.
5. University of Virginia. Student-Self Governance (Online). https://www.virginia.edu/life/selfgovernance [17 Feb 2019].
6. Virginia Science Olympiad. VASO Mission (Online). https://virginiaso.org/mission.php [17 Feb 2019].
7. Virginia Science Olympiad. Virginia Science Olympiad: Facts at a Glance (2017–2018 School Year) (Online). https://virginiaso.org/pdf/Statistics2018.pdf [17 Feb 2019].