

This is a partial list. Citing these activities does not take away from the many activities in SD in K-12 not listed here and the continuing support of others in the SDS.

Main events and achievements of Pre-College in the SDS during 2018

Efforts in 2018 continue to center around increasing ST/SD pre-college education outreach in conjunction with SDS conferences where there was an interest by conference leaders to make this happen. Email addresses were shared (with permission) with all pre-college educator survey respondents (about 55) to allow them to communicate with each other on ST/SD topics. Beta version of *Splash!* released. Efforts are increasing to spread the word (via other conferences & workshops) about SD in pre-college education. DynamiQuest was resurrected.

- *Splash!* version 1 (for beta testing) was made available at the Creative Learning Exchange's Systems Thinking and Dynamic Modeling conference in Wellesley, MA, June 30-July 2, 2018. Funding for this software needs only \$3200 to meet the version 1 development goal. Ninad Jagdish (BTN) did 2 parallel sessions for teachers (and some students), explaining how to use the app.
- *Splash!* cards were produced by the CLE to support "getting started" with *Splash!*
- The Creative Learning Exchange's Systems Thinking and Dynamic Modeling conference was held at the Babson Conference Center in Wellesley, MA, June 30-July 2, 2018.
- In May 2018 an email was sent to all of those educators who responded to the Pre-College ST/SD Survey sent out in December 2016 to gain permission to send all the respondents' emails to the group so they could collaborate on ST/SD topics. Some respondents sent additional names of people who should be on the list.
- Pre-College SIG was established within the SDS. There were about 40 SDS advocates who supported this request.
- The SDS funded a "Strengthening the Field" request in order to support outreach to pre-college teachers in Reykjavík and to support bringing Anne LaVigne to the ISDC conference to provide both a presentation and workshop specifically designed for Reykjavík middle school teachers, and to make an important connection between SDS and Reykjavík teachers for work beyond the conference activities.
- A flyer was created to send to pre-college teachers in Reykjavík encouraging them to register for Education Day at ISDC. The SDS graciously allowed a significant reduction in the registration fee to encourage teachers to attend.
- Spreading the SD modeling word to other (non-SD) organizations:
 - Lecture and 4-hour workshop for K-12 teachers in Seoul, South Korea. (See Dr. Chang-Kwon (Benjamin) Chung below.)
 - Keynote presentation on "Understanding the Dynamic Behavior of Systems: A Different Way to Think" was presented at the New Hampshire Math & Science Pre-College Teachers Conference in April 2018. A 1.5 hour workshop entitled "Systems Models Everyone Can Build" was also provided at the same workshop. (See D. Fisher below.)

- Parallel presentation entitled “Systems Models Everyone Can Do” was given at the National Science Teachers Conference in Atlanta, Georgia in March 2018. (See D. Fisher below.)
- Regularly share the use of (my) simulations to address scientific practices, system dynamics, and biology to the *College Board’s* Advanced Placement Biology Teacher Community, [Patreon.com/jondarkow](https://www.patreon.com/jondarkow), Twitter @jondarkow, the National Association of Biology Teachers (NABT) Facebook group, and the National AP Biology Teachers Facebook group. (See Jon Darkow below.)
- DynamiQuest was held at WPI in March 2018.
- Efforts continue to increase research article publications about use of SD in pre-college education.
 - Fisher, D. M. (2018). [Reflections on teaching system dynamics modeling to secondary school students for over 20 years](https://doi.org/10.3390/systems602012). *Systems Journal Special Edition: Theory and Practice of System Dynamics Modelling*, 6(12). Available at: <http://www.mdpi.com/2079-8954/6/2/12/htm>.

Main aims for 2019

It continues to be a priority to provide pre-college ST/SD outreach instruction for those educators who are interested. A research project focusing on assessment for researchers who plan to do research on deeper learning at secondary and tertiary educational level will begin. Efforts have begun and will continue to be exerted to increase pre-college presence at ISDC 2019. Infecting other learning communities with SD will continue. Publication of research articles dealing with SD infused learning continues to be a focus. Enhancing *Splash!* with in-app (for purchase) lessons will begin.

- A committee of five professors has been formed to study the issue of assessment needed to capture learning from SD student experiences. The focus of the group will be secondary school and undergraduate education. The professors on the committee are: Edward Gallaher, Martin Schaffernicht, Juliette Rooney-Varga, Saras Chung, and Diana Fisher. Diana Fisher is chairing the committee.
- Efforts will begin in September to reach out to teacher leaders in the Albuquerque school system to try to generate interest in attending ISDC 2019.
- Efforts have already begun to invite those pre-college educators who have been using SD within their classes/schools as presenters for Education Day ISDC 2019.
- Efforts will be initiated to obtain some (Albuquerque) corporate sponsorship to support follow-up instruction in Albuquerque for those pre-college educators who attend ISDC 2019.
- Continue to infect other pre-college educational conferences with ST/SD approach.
 - Plans are underway to submit a proposal for the ICTMA 19 (International Community of Teachers of Mathematical Modeling and Applications) being held in Hong Kong in July 2019.
 - A proposal has been submitted to present at the National Science Teachers Conference in St. Louis, Missouri in March 2019.
 - A paper entitled “Algebra Students Build Stock/Flow Models to Study Non-linear Dynamic Feedback System Problems” is in the final stage for consideration to be published in the Springer Book Series: International Perspectives on the Teaching and Learning of Mathematical Modelling: *Mathematical Modelling Education and Sense Making*

- Efforts will begin to connect with the AERA (American Educational Research Association) Systems Thinking SIG.
- Efforts will begin to connect to the CSTA (Computer Science Teachers Association) to establish a mutually beneficial effort to enhance the appropriate use of technology in education. Initial outreach to ISTE (International Society for Technology in Education) will also be made.
- Get article on assessment published in a research journal focused on secondary and tertiary education.
- Continue to enhance *Splash!* (build in learning modules). Additional features for the software will require additional funding support.
- Continue to work with WPI as home base for DynamiQuest.
- Locating a funding source to support continued ST/SD training for teachers in Chile who were part of the initial initiative to spread ST/SD to pre-college education there.

Support, cooperation, resources needed & potential obstacles/issues.

It remains essential that the leaders in the SDS support the education efforts to spread SD to pre-college environment. To that end, permission to establish the Pre-College Education SIG was another step showing that the SDS values these efforts. There will always be a financial burden associated with supporting the pre-college education efforts and we all hope to find ways to optimize the use of any financial support that the SDS provides.

- We will request a repeat of the special registration fee for teachers allowing them to attend Education Day and workshops at the ISDC 2019 in Albuquerque.
- Assistance in funding continued SD training presence in those locations where initial pre-college SD workshops have been provided is an issue and will probably require trying to locate corporate sponsorship in each of the ISDC's locations for the first year after the initial training. Options to utilize online support and distance learning may provide some direction. A train-the-trainer approach is the goal. Essentially each location should become self sufficient within three years after the initial training.
- Assistance in funding the continued presence of experienced pre-college practitioners at the ISDC will be needed. The reduced registration fee is a significant step in that direction.
- Efforts to connect to SD researchers who want to conduct experiments in pre-college classrooms to be able to increase the published research about how ST/SD activities impact pre-college student learning will continue.
- Conversations about the development of videos that explain the SD approach to pre-college administrators and teachers have started. The videos may help SD professionals gain entry to pre-college schools. Funding this effort is a question that needs to be addressed.
- An additional \$3200 is still needed to finish paying the expenses for the version 1 development of *Splash!*

2 major goals for the Society (as a whole) to achieve over the next 3 years:

Our goals remain the same as last year.

- Consistent and visible support for the pre-college pipeline of SD education.
- Create an easy, efficient system to match system dynamicists with teachers who need support while implementing systems thinking and dynamic modeling with students and to record examples of these in a database to inspire others who are interested.

Some snapshot recent activities involving ST/SD with pre-college students:

Creative Learning Exchange (Massachusetts, USA):

- Released beta-testing version1 *Splash!* App at the CLE conference in June 2018.
- Developed (for purchase) a set of 42 cards to help people “get started” with *Splash!*
- DynamiQueST was held at WPI in March, 16 2018. Next year it will be held again at WPI in March 2019.
- Hosted the 13th biennial Systems Thinking and Dynamic Modeling Conference for K-12 education June 30-July 2, 2018.
- Full-day preconference ST/SD instruction for novices in association with the CLE June ST/SD conference.

Waters Foundation (Arizona, USA):

- Providing workshops and webinars in systems thinking for pre-college educators
 - Provided a 2-day workshop in Milwaukee, Wisconsin in March 2018 entitled “Systems Thinking Institute.” There were close to 200 individuals working in education, community organizations and businesses in attendance.
 - Provided a 1-hour webinar in April 2018 entitled “Systems Thinking and Math Discourse.”
 - Provided a 1-day workshop in Tucson, Arizona in May 2018 entitled “Systems Thinking Approach to School-Based Challenges.”
 - Provided a 1-day workshop in Tucson, Arizona in June 2018 entitled “The Habit-Forming Workshop to Becoming a Systems Thinker.”
 - Provided a “Systems for Teaching Science Symposium” in July 2018 in Oracle, Arizona.
 - Will provide a 3-day workshop in Renton, Washington in July entitled “Improving Student Success with Systems Thinking.”
- Ongoing ST classroom and organization work within school districts in California, Arizona, Kentucky, Alabama, Wisconsin
- New work emerging in Washington, Indiana, Tennessee, New York
- Other work and grant partnerships primarily focusing on leadership development and ST approaches to organizational improvement with companies, universities, associations and non-profits:
 - Center for Enhancing Early Learning Outcomes–Washington, D.C.; National Governor’s Association– Washington, DC; National Association for the Education of Young Children NAEYC– Washington, D.C.; AZ Dept of Education– Phoenix; Puget Sound Education Service District– Washington; United Way of Tucson and Southern Arizona; Equity Residential– Chicago; Penn State Health and College of Medicine– Hershey, PA; Kentucky Valley Education Cooperative KVEC– Hazard, KY; WK Kellogg Foundation– MI; Hewlett Foundation– CA; Battelle for Kids– Ohio; Engage Winona– MN
- We have expanded our Leadership Team to 8 members, and we have 18 Associates.

- We have a new website, and in the Fall expect to launch our Thinking Tools Studio which will include online courses, coaching and a gallery of visual applications and sample work from sites we have worked with worldwide. Our new Guidebook and Habits cards are now for sale on Amazon and are doing very well.

Innovation Academy Charter School (IACS)(Massachusetts, USA):

IACS remains the entity the closest to a lab school for ST/SD in K-12 we have in the US. This charter school has four part-time systems mentors, including Alan Ticotsky and Rob Quaden, authors of the *Shape of Change*, to help the staff integrate SD into the classrooms. Multiple teachers at IACS actively use SD in their classrooms consistently.

Rob Quaden (teaches a first year integrated (algebra and geometry) math class)

- I gave an introduction to “bathtub dynamics”. Students given flow graphs and construct graphs of stocks. Flows are constant but do include steps. Hope to include flows for exponential & quadratic next year.
- Students have been introduced to Stella Online and build simple linear models (with step function) to answer math questions. Students are given modeling homework since Stella Online is web-based.
- Have included questions on tests related to the model work mentioned above. Students are given a story scenario and asked to a) draw a behavior over time graph, b) use algebra to determine the answer, c) draw a stock/flow map to illustrate the problem.
- Want to include a systems project as one of the options of projects students can select each year.
- Using the principles from Senge’s Fifth Discipline, I continue to promote Team Problem Solving (an application of systems thinking).
- I help facilitate professional development for systems concept with the administrator and other systems colleagues in the school.

Alan Ticotsky

- Along with support from our administrator (Greg Orpen) and the other systems colleagues at the school, IACS is a core participant at DynamiQuest, where students display their CLDs and stock/flow models for the community and family to see at WPI.
- Members of the IACS faculty will facilitate a climate summit simulation using MIT materials.
- IACS staff have worked with Peter Senge and Mette Miriam Boell on initiatives to bring “compassionate systems” into the school curricula. Some faculty have participated in meetings at MIT and in The Hague.
- Systems thinking and system dynamics remain key design elements in the charter of our school. Most teachers integrate systems tools and principles into their curriculum and new examples are developed each year across the grades 5 – 12 spectrum.

Chris DiCarlo

- Have taught modified Atwood’s machines with modeling this year.
- As a class we built a two-stock (velocity and displacement) model with mass and net force used to calculate an acceleration. Their task was to take that general model and make it work for any modified Atwood’s Machine. The results indicate that, with modeling, students are more likely to ask why they are getting different results, which gives us a change to dig into the subtleties of the system. Students, with modeling, are much less

accepting of an incorrect result. When their graph is different, they initiate a conversation with either me or their classmates about why.

- As a class we build wind resistance into our general displacement-velocity model and use it to model the flight of a paper rocket. Then we use that model to test our conceptual understanding of different scenarios.
- Offer a one-week computer modeling session at WPI each summer for pre-college students focusing on environmental systems.

Diana Fisher (Oregon, USA):

- Worked with the CLE *Splash!* design team to help guide *Splash!* feature development to optimize its use in pre-college education.
- Worked with Ed Gallaher and an Anatomy and Physiology teacher at Franklin High School to introduce SD modeling into the study of human physiology. The focus was using the drug models and the study of homeostasis (Calcium, Glucose/Insulin, and maintaining Red Blood Cell count).
- Gave keynote presentation on “Understanding the Dynamic Behavior of Systems: A Different Way to Think” was presented at the New Hampshire Math & Science Pre-College Teachers Conference in April 2018. A 1.5 hour workshop entitled “Systems Models Everyone Can Build” was also provided at the same workshop. (See D. Fisher below.)
- Presented parallel session entitled “Systems Models Everyone Can Do” was given at the National Science Teachers Conference in Atlanta, Georgia in March 2018. (See D. Fisher below.)
- Published article in Systems Journal:
 - Fisher, D. M. (2018). Reflections on teaching system dynamics modeling to secondary school students for over 20 years. *Systems Journal Special Edition: Theory and Practice of System Dynamics Modelling*, 6(12). Available at: <http://www.mdpi.com/2079-8954/6/2/12/htm>.
- Submitted article for ICTMA Journal (in second stage of review process):
 - A paper entitled “Algebra Students Build Stock/Flow Models to Study Non-linear Dynamic Feedback System Problems” is in the final stage for consideration to be published in the Springer Book Series: International Perspectives on the Teaching and Learning of Mathematical Modelling: *Mathematical Modelling Education and Sense Making*
- Worked with SDS to provide content for newspaper advertisement and the creation of a flyer for pre-college educators to support recruitment of pre-college educators to attend Education Day presentations and workshop activities at the ISDC in Reykjavík.
- Presented a workshop at the CLE Systems Thinking and Dynamic Modeling Conference in June 2018 in Wellesley, Massachusetts.
- Will be one of 5 people speaking at a “Systems in Pre-College Education” meeting at the ISDC 2018. Will also present a poster highlighting 19 of my secondary school student models at the ISDC. Will provide 2 workshops, one for undergraduate SD professors and the other for novice SD pre-college teachers on using SD modeling in instruction.
- Will chair a committee to study assessment of ‘different’ learning provided by use of SD modeling at secondary and tertiary educational levels.
- Will continue work with Anatomy and Physiology teacher in collaboration with Ed Gallaher again this year.

- Will work with a mathematics teacher at Wilson High School in Portland, Oregon to infuse SD modeling into his secondary school algebra classes, starting in the fall.
- Continue to teach some teachers SD modeling via my three online SD modeling courses.
- Plan to collaborate with Peter Galbraith (long-time member of ICTMA and also a previous member of SDS) in preparation to submit a proposal to the ICTMA conference in Hong Kong in July 2019.
- Have invited John Darkow to present his work at ISDC 2019. Have invited a group of pre-college educators from IACS to present ST/SD work at their school at ISDC 2019.

Jon Darkow (Ohio, USA): (I have invited Jon to present at ISDC 2019)

- The main goal of mine in 2017 was to build simulations to teach scientific practices and systems dynamics within the context of the biological sciences.
- The main scientific practices I focused on was using quantitative reasoning to support claims using evidence from running simulation runs. To use quantitative reasoning students strategically collected data. Students incrementally perturbed parameters of the simulation, controlled experimental simulation runs, eliminated confounding variables to test hypotheses, and ran simulation runs multiple times to increase sample size. Many of the simulations have random operations to help students appreciate the importance of large sample sizes in experimentation.
- I produced a variety of activity sheets to help my students (and others) guide scientific inquiry with the simulations. These required students to use descriptive and inferential statistics to support conclusions. Also, the activity sheets are used to help students explore the intended learning outcome of the models and help elucidate common misconceptions in the biology content.
- Each year I have been building and publishing online system dynamics biology simulations for my students and others. Currently, I have 41 different online biology simulations shared at jondarkow.com. These simulations have been run nearly a half million times by users in 132 different countries.
- Another teaching technique of my simulations I used extensively in my classroom was recreating the dynamics of the behavior of the system. Students drew diagrams of the scientific model under a variety of different parameters. For example, students would illustrate how the lactase enzyme would catalyze chemical reactions at 0, 20, 40, 60, and 80 degrees Celsius. Students would use the behavior over time graphs generated by the simulation runs in conjunction with the induced fit model of enzyme kinetics to illustrate the behavior of the enzyme in the five different temperatures.
- I regularly share the use of my simulations to address scientific practices, system dynamics, and biology to the *College Board's* Advanced Placement Biology Teacher Community, [Patreon.com/jondarkow](https://patreon.com/jondarkow), Twitter @jondarkow, the National Association of Biology Teachers (NABT) Facebook group, and the National AP Biology Teachers Facebook group.
- In St. Louis, Missouri I presented at the 2017 NABT National Conference on using simulations and systems models to teach the scientific practices.
- My own students built system dynamics models of:
 - Exponential and logistic growth.
 - Natural selection
 - Accumulations of carbon in the atmosphere
 - Positive feedback in climate systems
 - Negative feedback in physiological systems

- In the upcoming school year, I will extend my classroom integration of systems thinking and system dynamics modeling and extend my dissemination of how I use system dynamic modeling with my students.
 - I will be giving two presentations at the 2018 NABT National Conference in San Diego, California. One presentation will be on simulations and scientific practices. The other workshop will show teachers how to build systems dynamics models.
 - I hope to publish my first paper on using simulations in the classroom.
 - Use systems thinking to understand the interdependencies and complexities of wicked problems, like climate change, wind turbine development, and algal blooms.
 - Continued use of simulations to teach scientific practices, systems dynamics principles (especially accumulations, feedback, nonlinearity, and interdependencies), and biology content (especially evolution, growth, equilibrium and disequilibrium, and climate change.)
- Developed numerous SD simulations for biology to use with his students. These simulations are published via ise systems and available for use at: <https://exchange.iseesystems.com/>

○ Lactase Enzyme Simulation with Data Analysis	○ Transformation Simulation
○ Lactase with Variable Sample Sizes	○ Diffusion of a Spherical Cell
○ Lac Operon with Monod Bump	○ Steady State in Freshwater Ecosystems
○ Photosynthesis Model	○ Evolving Bits
○ Photosynthesis with Variable Sample Sizes	○ Growth Factors, Cyclins, and Cancer
○ Evolution and Natural Selection	○ HPV and Adaptive Immune Response
○ Information Processing and Neurophysiology Model	○ Evolution
○ Population Dynamics of White Footed Mouse	○ Tryptophan Operon: A Repressible System
○ Evolution of LAP Allele in Mussels	○ Circadian Clock in the Mouse
○ Cellular Respiration Accounting Model	○ Tick Tock: The Biological Clock and Circadian Rhythm
○ Recombination and Gene Linkage	○ Pattern with Recessive Single Band
○ White-Eyed Genetics	○ Phenology of the Karner Blue Butterfly
○ Water Potential and Osmosis	○ Testing Unknown Enzymes
○ Apterous Genetics	○ Logistic Growth Model and the Butterfly Effect
○ Extinction Vortex	○ Neurophysiology and Neurotoxicity
- My students assess tipping points, feedback loops, and evolving populations by manipulating and perturbing these systems models. My students build simple models of ecosystems to explore the dynamics of accumulations and sustainability. Students construct oscillating hormone models to examine how negative feedback loops can lead to robust homeostatic interactions. Students change models of natural selection to examine how selection and genetic drift affect population dynamics. When my students reflect upon lessons centered on systems models the language they use to describe the interactions is more precise and thorough. Computational modeling has enriched how my students learn science.

Julie Walker (Molalla, Oregon) (Took 1st introductory course in SD modeling in summer 2017)

- Used systems modeling for 2-weeks in my Science and Technology class, introducing the concepts of systems.
- Used systems modeling for 1-week in my Environmental Science class introducing population dynamics.
- I hope to include more lessons next year in biology.
- I am meeting with the math department over the summer so they will have some examples of science and math working together.

Julia Brodsky (Bethesda, Maryland) Using systems thinking in grade 4

- Introduced system thinking in 4th grade science class this year (Green Acres School, Bethesda, Maryland). The class was popular not only among the students but among the parents as well. Activities included space mission planning , spacecraft design, board game design, robotics, Rube Goldberg machines, discussions on astrobiology, comparison and construction of biomes, etc. The emphasis was on big picture, interconnections, emerging patterns, and simple modeling.

A partial list of active advocates internationally:

Chang-Kwon (Benjamin) Chung (Seoul, South Korea):

- I gave one of the keynote presentations at the CLE Systems Thinking and Dynamic Modeling Conference entitled "The Upcoming and Upheaval in Education and Opportunity in K-12 SD/ST education - Focused on Korean Case" in July 2018.
- Recently I am working with Gyeonggi-do Yulgok Training Institute of Education which is one of 6 official training center of Gyeonggi Provincial Office of Education (Gyeonggi Province, or Gyeonggi-do, has the biggest population in Korea and is far bigger than Seoul.)
 - I am scheduled to give a lecture and workshop during the K-12 teachers' professional development program which is a 2-day-long workshop on 16 August 2018. My slot is 4-hours block time starting with Hamlet modeling.
 - I am invited to give a 6-hour presentation for the 2-day professional development (October 18 and 25) program for about 25-30 K-12 teachers entitled "Systems Thinking with games for "Thoroughly Reading a Book Initiative"" (specially for elementary teachers) hosted by Gyeonggi-do Yulgok Training Institute of Education. All K-12 teachers in Korea have to get the credit of a professional development program which is provided by the official training center of each Provincial Office of Education like Gyeonggi-do Yulgok Training Center. The Gyeonggi-do Yulgok Training Center covers 140,000 teachers in Gyeonggi Province.
- I will run the World Climate Simulation for 100 grade 6 GIFTED elementary students who are selected from various schools in Korea. This activity will run on August 31, 2018. The GIFTED, **G**lobal **I**nstitute **F**or **T**alented **E**Ducation, is located in KAIST, Daejeon, the South Korea's fifth-largest metropolis which is similar to Boston. KAIST (Korea Advanced Institute of Science & Technology) is regarded as MIT in Korea.
- The Systems Thinking Group of teachers' learning organization is one of the groups of Good People for Happy Education convened at Gyeonggi-do Yulgok Training Center monthly. Even though the meeting place is in the Gyeonggi-do Yulgok Training Center because of the host who is one member of Gyeonggi-do Yulgok Training Center, the learning organization is organized voluntarily. The total enrolment is 147 until now and my Systems Thinking Group started with six teachers.

Chris Browne (Australia) Australian National University

- Teaching undergraduate honors projects running in ST/SD thinking, some with primary school-age students.

Martin Schaffernicht (Santiago, Chile):

- Working to try to find funding to support a second level of training for the K-12 educators in Santiago, Chile that was initiated last year with funds from the SDS Strengthening-the-Field initiative.
- Will be on a committee to study assessment of 'different' learning provided by use of SD modeling at secondary and tertiary educational levels.
- Working to make initial contact with AERA conference. Deadline for conference submissions has passed for this year but will be followed up next year.
- Working with school leaders in 3 schools to get them ready for next year's activities with the CLE and Anne LaVigne. They are very interested in addiction problems, so we're working on that from a systemic perspective.

Emre Göktepe (Izmir, Turkey) Systems Thinking Project

- Provided support (not financial) to assist Öxlem Orçun (supervisor of kindergarten classes in Izmir, Turkey) to present at ISDC 2018 in Reykjavík, Iceland. She presented the sequence of the "Singing Frogs" activity used with ages 4, 5, and 6.
- Works with other pre-college teachers in Turkey to help support ST work in primary school.