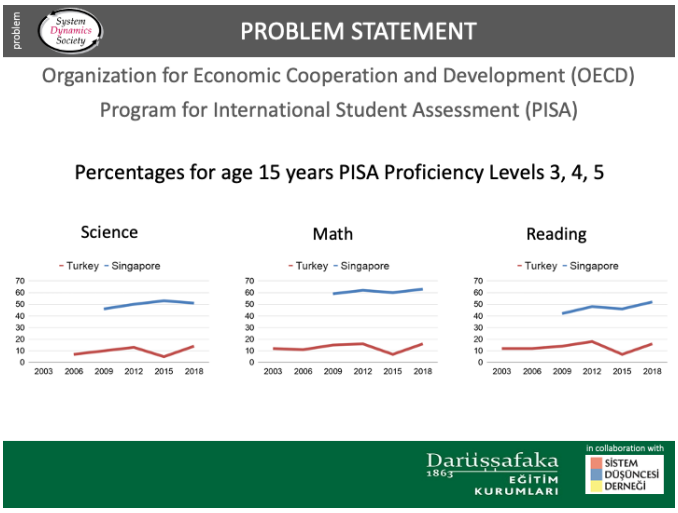
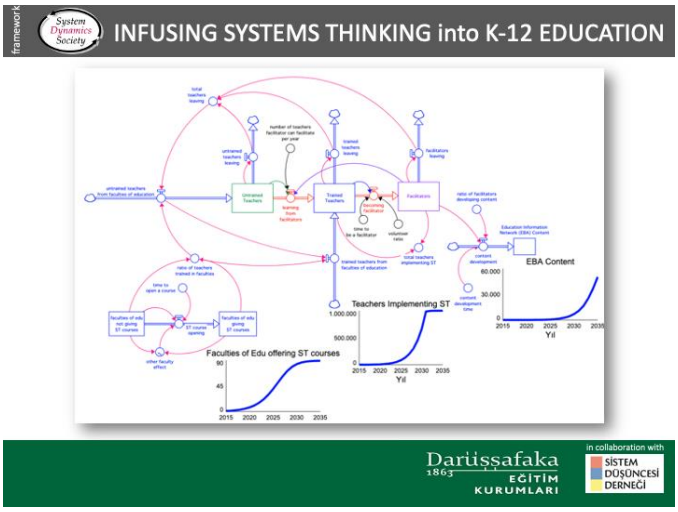
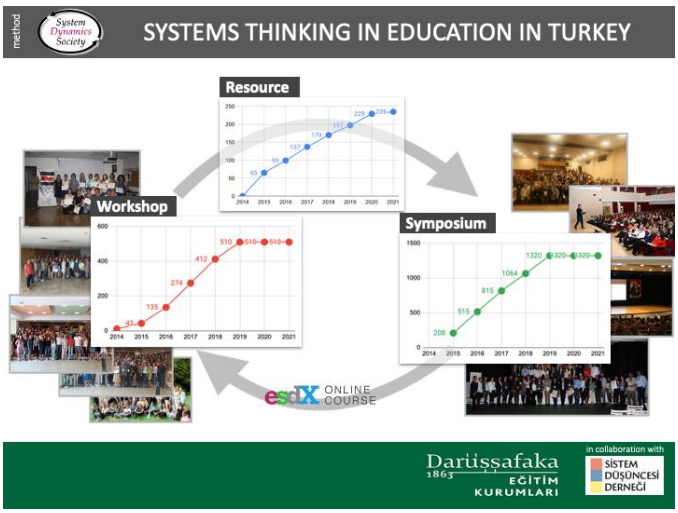
The Changing Language of Education with System Thinking



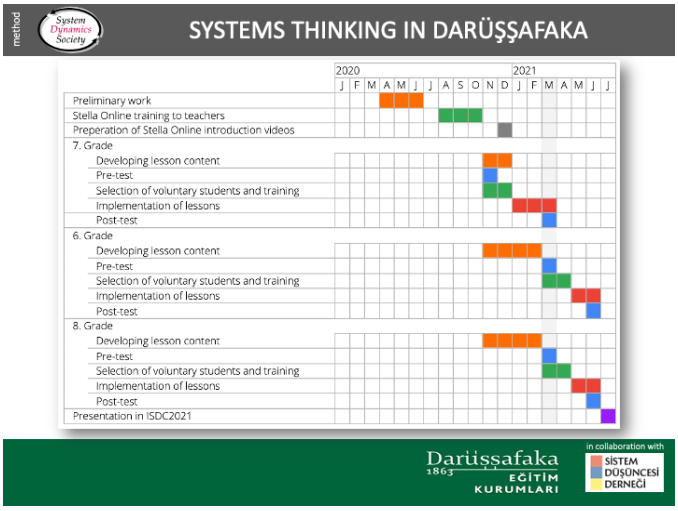
The Program for International Student Assessment (PISA) is an international assessment that measures 15-year-old students' reading, mathematics, and scientific literacy every three years. These graphs show results of Turkey and Singapore for questions assessing higher order thinking skills, namely; level 3, 4 and 5 questions. It is easily seen that Turkish students' reults are systematically lower, much lower than Singaporean students' results. As many studies found that higher order thinking is not an aptitude, it is not an inborn characteristic, it is a skill, it is a learned ability. These graphs, even if they create some frustration at first, actually shows clearly that there is huge potential for Turkey in terms of developing higher order thinking skills. We see this problem as an oppurtunity.



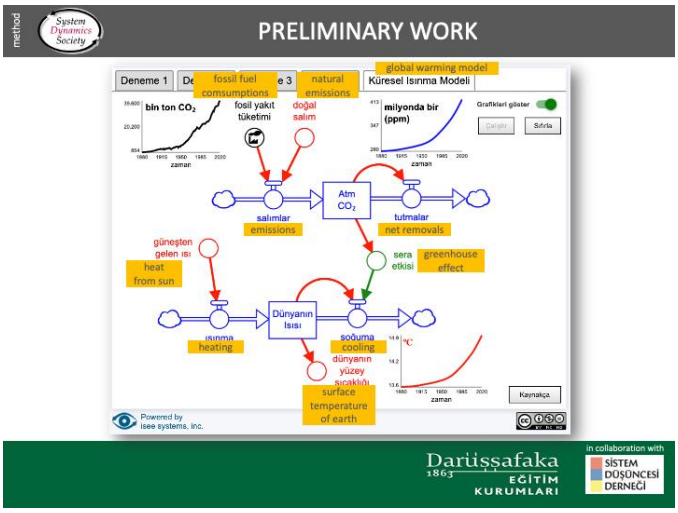
Systems Thinking Association is working for the infusion of Systems Thinking approach into the people of Turkey starting from K-12 education by incorporating this approach into the curriculum of K-12 education in schools and faculties of education. This is our strategic model showing how we plan to infuse it. We focus on 3 major areas: In-service Teacher Training, Courses in Education Faculties and Content Development. These are all interconnected. The long-term goal, a truely sustainable solution is Education Faculties delivering Systems Thinking courses in the second year of university education. By this early introduction, it would be possible to use the Systems Thinking approach in these courses.



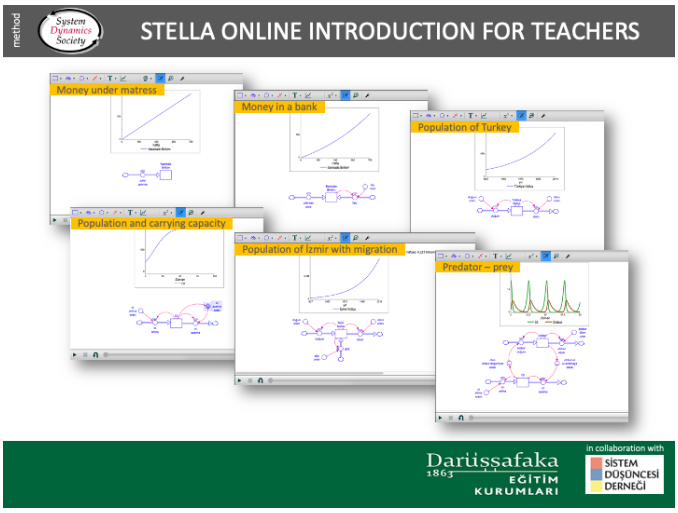
For this to be achieved, high quality, easy to use, easy to understand content is needed. This content development can be done by in-service teachers designing, implementing and updating various lesson plans and activities with Systems Thinking tools. We offer free workshops for untrained teachers and consultancy on implementation for trained teachers. We host symposiums where opportunities for experience sharing are created. In this way, the number of facilitators who can take charge of delivering workshops and developing content gradually increases. This study focuses on the perceptions of trained teachers using the Systems Thinking Approach in in-class applications.



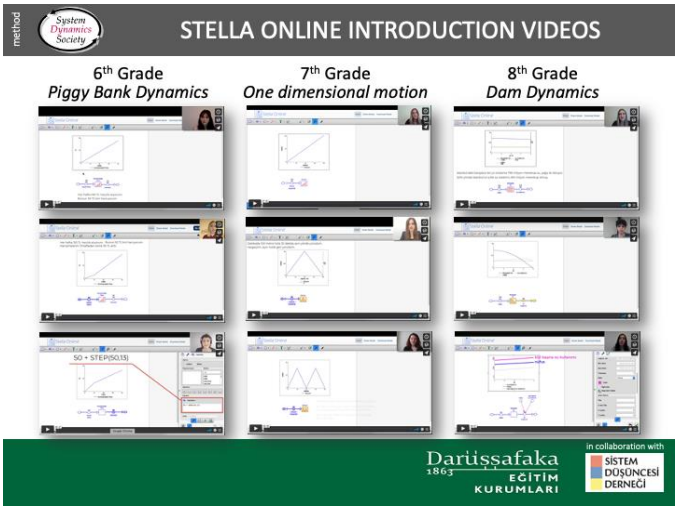
Darüşşafaka, Turkey's first non-governmental educational organization provides quality education to underprivileged students whose mothers or fathers are deceased. It is guided by the mission of Changing Lives through Education, and since 1863 it has provided a modern education for thousands of students at Darüşşafaka Schools. It also provides a scholarship for students who continue their education at the university. First introduction of systems thinking with the organization is attandance of middle school academic coordinator to one the trainings of ST association in 2018. In time, as appropriate conditions, like management's willingness and existence of voluntary teachers developed, this project is planned and implemented.



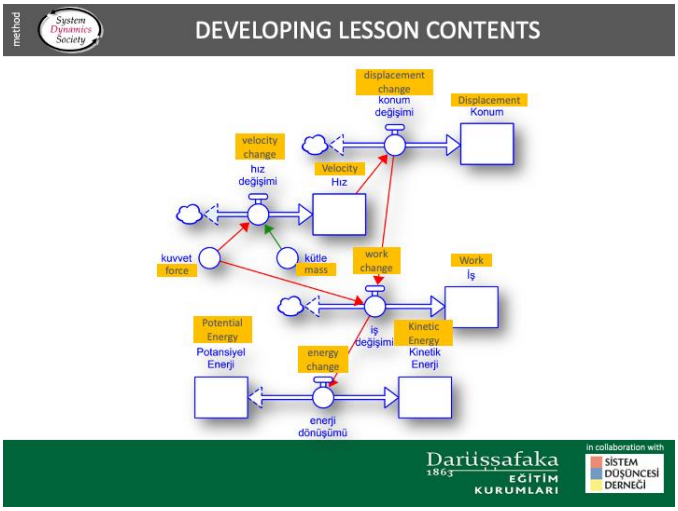
First trials of systems thinking was done in the second term of 2019-2020 school year in 8th Grade Science Lessons. While teaching sustainability concept, behaviour over time graph was used to analyze how fishing activities in a region can affect aquatic life in that region. Later; in the lesson where power plants were dicussed with regard to inputs and outputs of their processes, effects of such fossil burning systems on World Climate is studied using a simple "Global Warming Model"



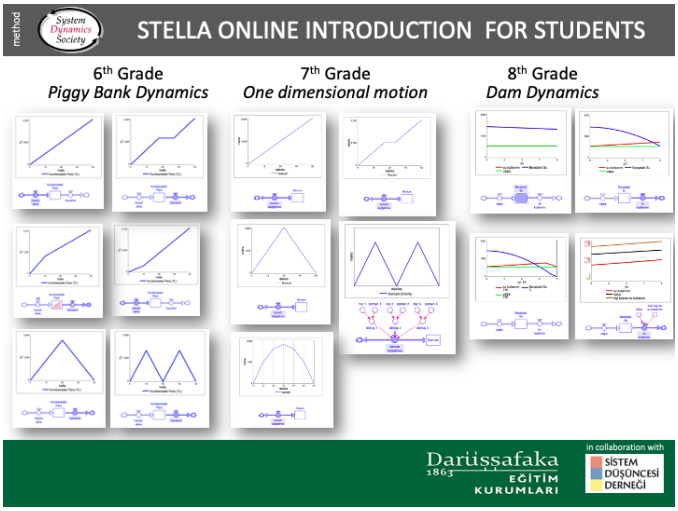
Then the project has started with volunteer teachers. Twelve Science and Math teachers of middle school of Darüşşafaka Schools are trained for 8 weeks, from August 20th, 2020 to October 8th, 2020. Each session is organized as a hands on activity that lasted about 30 minutes. Free version of Stella Online software is used for building system dynamics models. Models build and discussed progressively from simple stock-flow diagram to a 2-stock predator-prey system.



After completion of introduction of system dynamics modeling using free version of Stella Online, 5-minute videos are prepared. Scripts, written by facilitators from ST Association, are discussed with teachers. Updated versions are read and recoreded by the teachers. The videos were based on Stela Online introduction lessons for the students. Doing this, in the short run, helped teachers to review the concepts one more time and to make a virtual practice of the lessons they soon will be delivering. In the long run, these videos become valuable resources for anyone intereseted in introduction to system dynamics modeling as they are openly published on the web site of the ST Association.



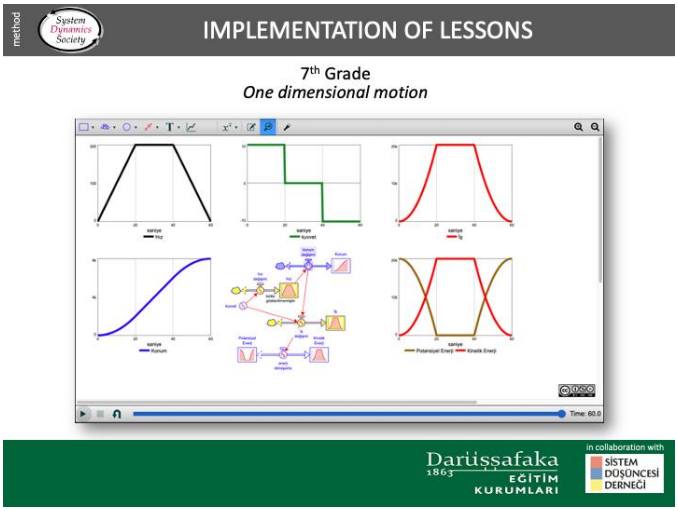
Then lessons are developed. Compulsory curricculum of Ministery of National Education is browsed and subjects are selected basing on timeliness and appropriateness of such a beginning course. For 7th grade, one dimensional motion in sience curriculum is selected. Model is constructed in paralell with the curriculum: First concept of work is introduced: The upper part of the model from the work stock. Then, lesson notes for transformation of energy between Potential and Kinetic Energy stocks is prepared. Holistic view of newtonian physics, made possible by usng the model, can be easily be seen here. Causalities are very clear. Student can see that force is not product of acceleration and mass as F = m . a implicitly implies but acceleration is direclly proportional to force and indirectly proportional to mass, that is a = F / m



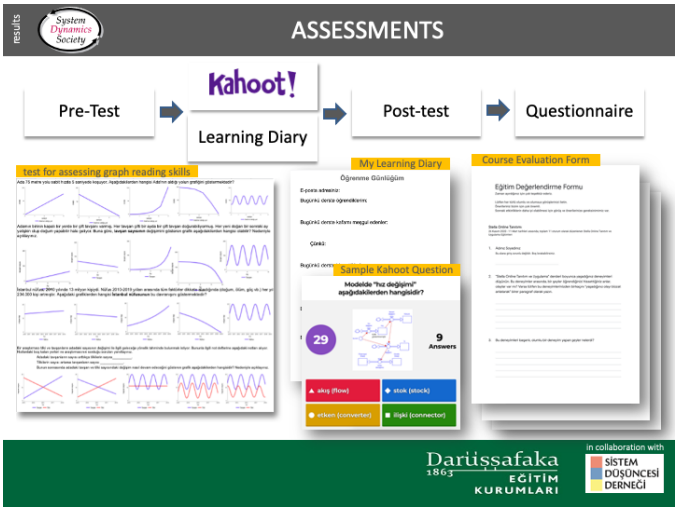
Presentation are made to a total of 110 (38+30+42) students from 3 grades that are known to be academically better than other classes. The reason for prefering academically better students is the experimental nature of the study. By selectin aacademically better students variation caused by level of students are aimed to be decreased. By this way a better initial design of lessons could be made. After that, lessons will be adapted for all students.

Presentations are made by science and math teachers and included exponential behaviour to show the unexpected results of nonlinear systems and attract attention of students. A paper folding activity followed by estimating thickness of continous folding and result of doubling rice grains on each

square of a chess board is used. Presentation is finalized by showing system dynamics models of a climate system and body weight metabolism and indicating systems thinking as a tool for understanding many disciplines (from physics to literature) with a common language. After the presentation, an online survey is conducted resulting a total of 59 (32+16+11) students enlisted. Three or four 60-minute Stella Online Introduction sessions are held weekly with these students.



This is from the last lesson of one dimentional motion for 7th graders. You can see how a rich collection of graphs can be produced from a relatively simple model of displacement, velocity, work and energy stocks. By using this model with 5 graphs showing 6 variables in these graphs, it is possible, easy and very effective to explain the concepts of physics by showing relations between and effects of these relations on behaviour.



Multiple assessments are done before, during and after the courses.

A pre-test, port-test questionaire is prepared for assessing graph reading and interpreting skills of students before and after the course. Comparison of results will show the effect the course on graph reading and interpreting skills. Currently pre-test of 308 (102+113+93) students are completed. Post-tests will be done in March and April.

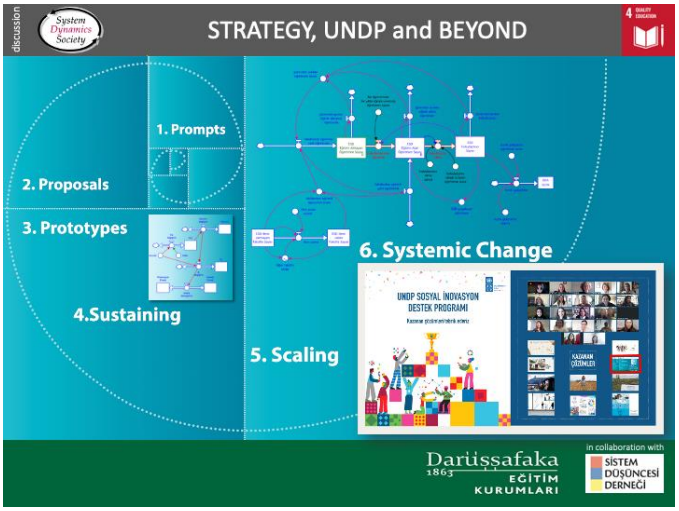
Most of the lessons are completed with a short Kahoot session having 5 questions. These questions are used for prompt evaluation of the lesson and an oppurtunşty to see misunderstood points and giving feedback to students to correct these misunderstandings.

After completion of each lesson, a Learning Diary is filled by students and teachers. Diaries included questions like what did I learn today? What occupied my mind? Because ... How did I feel today? The

reasıns for my feelings are... How can I use things that I learned today?

An quesionare, basing on Critical Incident Technique, is prepared to learn overall perception of the course of the students and teachers. Aim of the questionaire is to collect events during the course that makes an either positive or negative contribution to learning.

A comprehensive report with related statistics will be prepared after all courses are commpleted by the end of April.



This experimental work done in Darüşşafaka Middle Schools along with previous work and experience of ST Association combined into a long term project. The project is selected by The Sustainable Development Goals (SDG)Accelerator Lab under the United Nations Development Programme Turkey Office within the context of Social Innovation Support Program as one of the 10 projects to be supported from 422 applications. This long term project, in line with ST Association's strategy has two major steps after prototyping: Sustainability will be achived by infusing systems thinking into Faculties of Education of universities in Turkey. By this way, it will be possible to train each teacher to be a systems thinker. Next step will be scaling via Ministry of National Education in Turkey. Briefly; with UNDP support we are planning to collaborate with two instutitions: first Faculties of Educations, next Ministry of National Education.

We think that, in the future, this experience might have a chance of international deployment.