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2nd International JSXGraph Conference

Book of Abstracts

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UNIVERSITÄT BAYREUTH

CMLDT

2nd International JSXGraph Conference 2021

University of Bayreuth
Center for Mobile Learning with Digital Technology
95440 Bayreuth
Germany

Conference

The 2nd International JSXGraph Conference took place from 5th until 7th of October 2021. The online format encouraged fruitful discussion and collaboration among users from all over the world. The schedule respected the location and the timezone of the speakers. The conference was organized by Carsten Miller and Alfred Wassermann from the University of Bayreuth, Germany.

Conference topics

- Usage of JSXGraph
  - for learning / teaching
  - e-Learning environments: moodle, ilias, STACK
  - dynamic visualizations
- Best practices
- Tools
- Presentation of new JSXGraph developments

Website

The abstracts of the talks at the 2nd International JSXGraph Conference are also available on the JSXGraph website:

https://jsxgraph.org/conf2021

Videos

Most of the recorded videos of the talks can be found on JSXGraph's YouTube Channel:

https://www.youtube.com/@jsxgraph4224

Playlist "2nd International JSXGraph Conference"

https://www.youtube.com/playlist?list=PLr10cPSXxWJfghbJlR0SIP8oEoTkNNmuL

Talks at the 2nd International JSXGraph Conference

JSXGraph Integration in MyOpenMath

David Flenner
david.flenner@gmail.com

This session is designed for instructors of mathematics at any level, but particularly those who may instruct online courses. During the session, I will demonstrate the capabilities of a JSXGraph extension library I created for MyOpenMath – which is an open-source online homework platform for mathematics. The library allows instructors to create homework questions that integrate JSX constructions. These constructions have the ability to be graded automatically by the system in a variety of methods and thus provides an easy way to create interactive homework and test questions by instructors.

JSXGraph integration within Eleda, a NoCode pedagogical authoring tool

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KDetude EdTech company
Paris
France
https://kdetude.com

During this JSXGraph conference, we would like to talk about how we have implemented JSXGraph into our product, and how it could participate to democratise pedagogical activity design. Then we could design in real time few simple pedagogical activities using JSXGraph components.

1. Product context

Nowadays, creating and adapting pedagogical activities in STEM is a difficult task for teachers. The reason for this is that there are no easy to use authoring tools to create interactive and randomised activities. Therefore, teachers are coerced into reusing existing resources as they are, without being able to adapt them to their learners' needs.

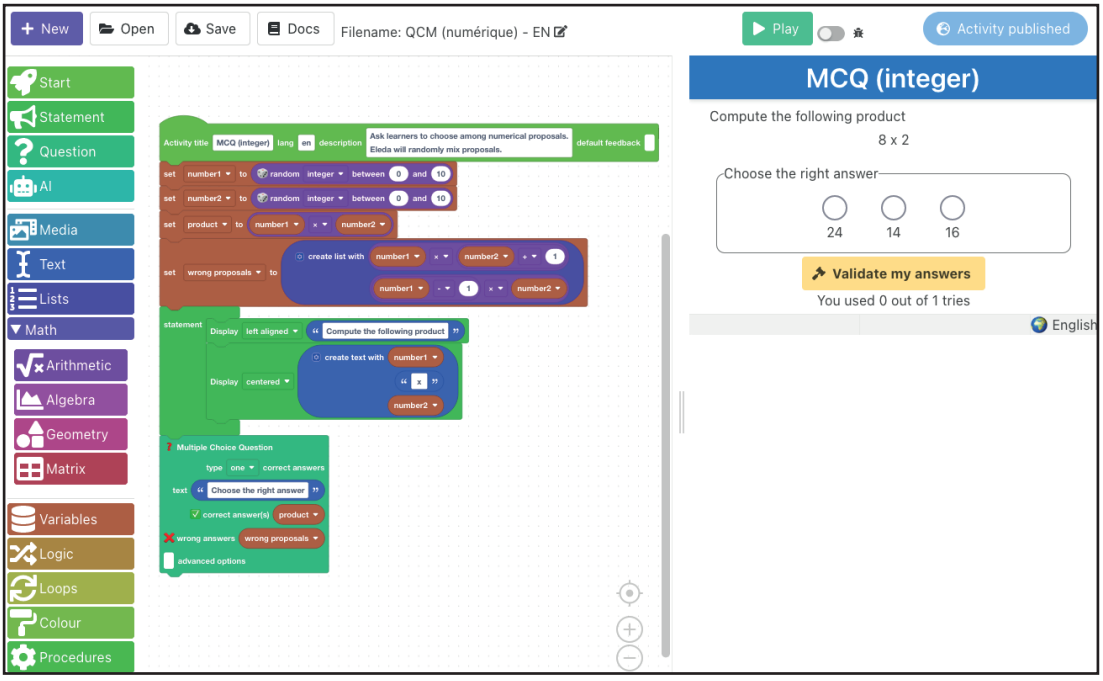
With regard to learners, resources available today are mainly based on a deductive approach: theory is presented first, and then, learners are asked to apply it. The issue is that a scientific mindset require learning to follow the opposite approach. As Galileo and Marie Curie Skłodowska have proven experimentation precede theory. We deeply convinced that learners should experiment and train to induct theory, as scientists do.

Based on these observations, our company KDetude, strives to bring computational thinking to teachers' creativity to make learners succeed. To achieve this, KDetude is developing Eleda (Experiment, Learn with Dynamic Activities),

a unique educative STEM ecosystem. It offers schools' and teachers' communities the ability to make randomised, and multilingual STEM activities with building blocks, as known as NoCode approach. As such, learners can train without limits, and develop their critical thinking and scientific mindset. Eleda wants to make teachers the "makers" of their online pedagogical activities.

Our solution Eleda offers:

- A new generation of authoring tool for teachers: just as the Scratch building blocks system does, we want to offer teachers the opportunity to easily design randomised activities through blocks. Computational thinking and Makers spirit fuel all domains and education is being following suit. In the end, one activity made by a teacher can generate an infinite number of problems to solve, allowing their learners to experiment endlessly with STEM.



(The authoring User Interface (on the left side the building blocks, on the right side the result)

- A new generation of pedagogical activities: learners receive smart and tailor-made feedback to figure out why they have not succeeded. Thus, learners experiment until they understand underlying concepts and become comfortable with them.
- A “makers” multilingual community: an open community to share, adapt, reuse activities among “makers”.

2. Our objectives and criterias to choose a JavaScript library for interactive geometry

In our early stage development, we have planned to implement an interactive geometry library to serve essential teachers’ needs in geometry pedagogical activities design. Several Javascript libraries are available on the market, but to keep geometry based activities design as simple as possible through blocks, geometry library has to be easily convertible into block instructions. Building block system follows a procedural approach, where each block has to represent an instruction, and blocks are executed ones after the others, therefore the library chosen has to be compliant with this approach.

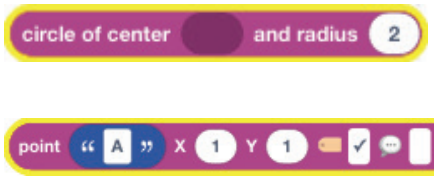
Thus, the geometry interactive library has to follow simple rules to be integrable into blocks :

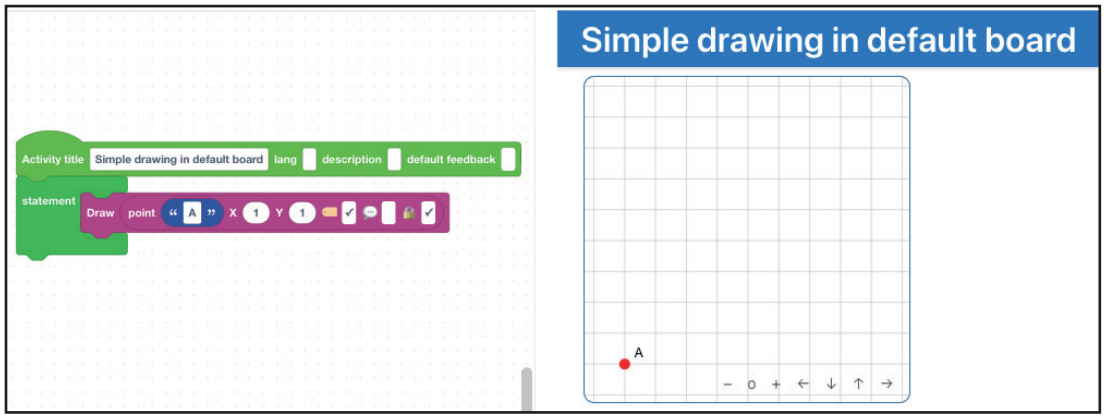
- Library should accept procedural code approach. We need to draw element one by one as we plug block one by one.
- Library should allow producing geometric figures and graphics as well.
- Library should be European and respectful of GDPR rules.
- Library should be MITor equivalent license based to be compliant with the rest of our commercial products.

JSXGraph check all these criteria and we have decided to use it as our main interactive geometry library.

3. JSXGraph implementation

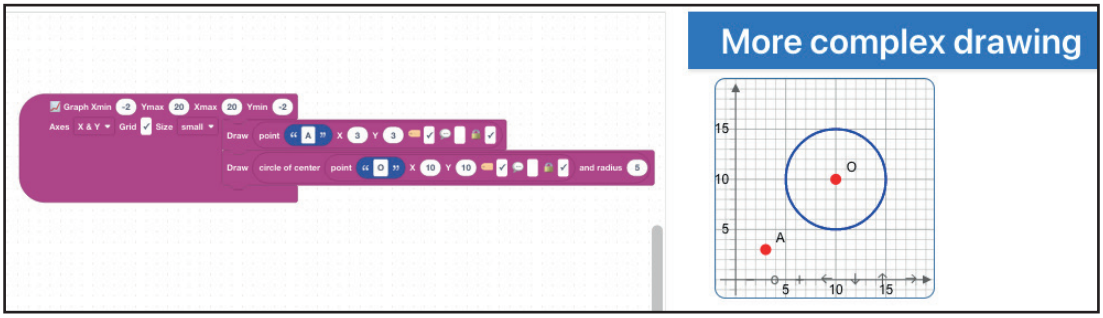
- In a first stage, we have implemented through blocks, basic geometric elements, as points and lines then we have drawn them in a default JSXboard. In order to respect our initial goal to make it simple for teachers, we keep the idea of a default board for drawing figures and graphics.





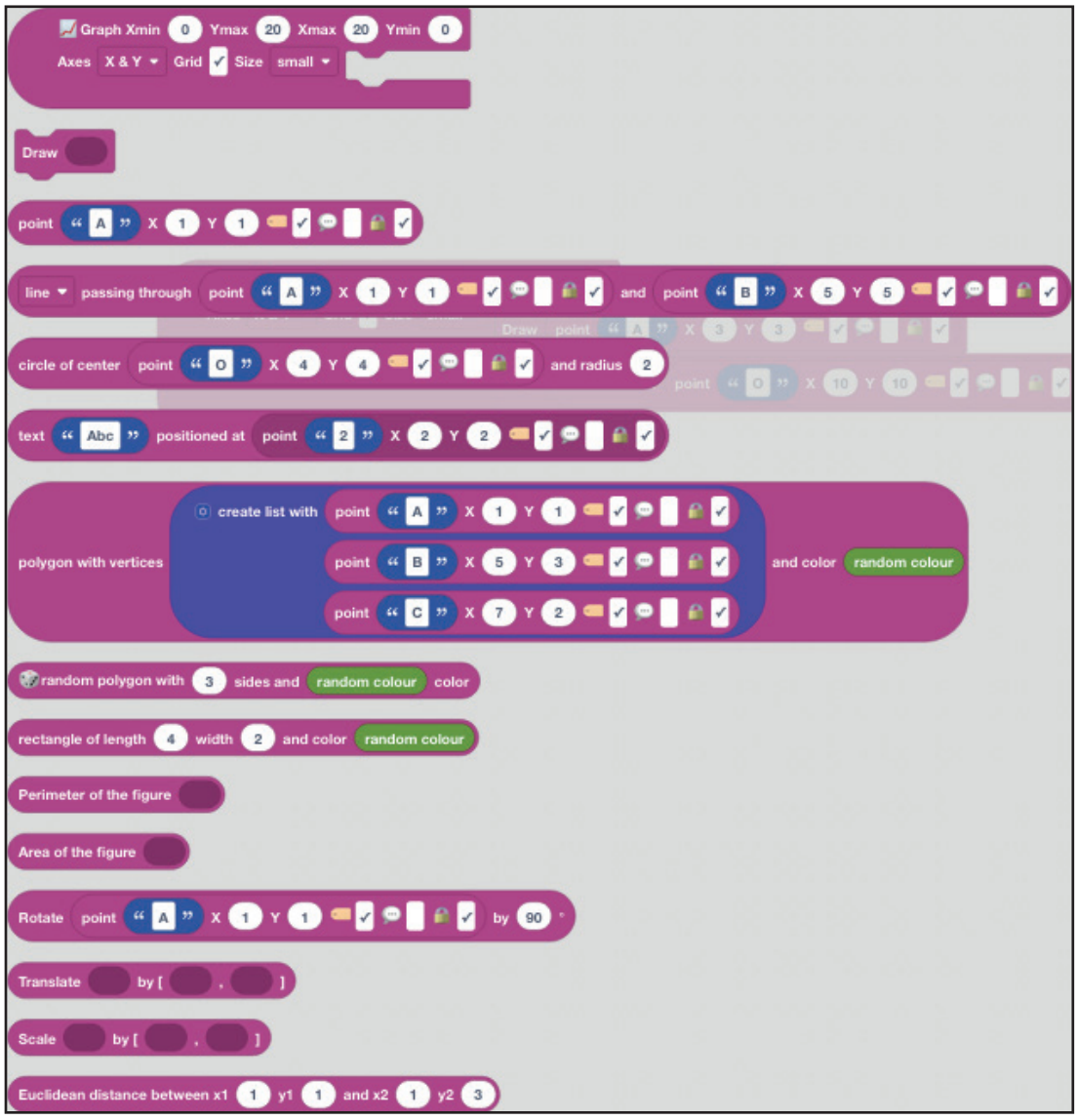
(three blocks that represent basics geometrical objects and a elementary activity which draw a point in a default Board)

- In a second step, we have improved the JSXGraph related Blocks to implement more complex drawings in the same board. To achieve that, we have implemented a board block with few principal settings.



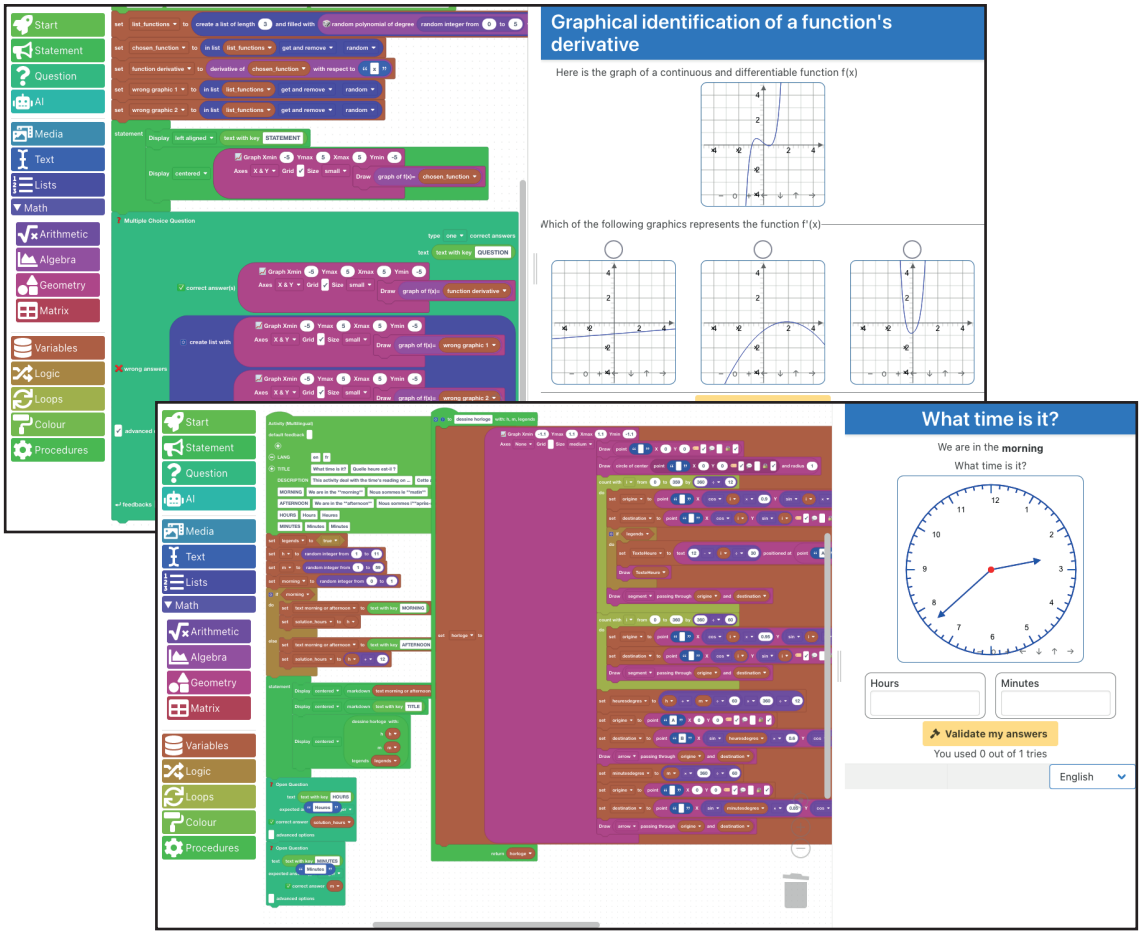
(A board block named Graph, with its geometrical elements nested)

- In the third step, we have implemented additional JSXGraph elements. We have also added to the JSXGraph related blocks several general geometry blocks to compute for instance area and perimeter of a figure or compute Euclidean distance between two points.



Finally, to test and stress our JSXgraph Blocks system implementation we have developed complex activities that carry out many JSXGraph elements mixed with other kind of blocks. One of these examples is the “What time is it?” activity which targets primary school learners to train them to read time on a clock. Another relevant example is the “Graphical identification of a function’s

derivative” which targets secondary school learners and train them to recognise derivative properties through graphics.



3. Further developments

Eleda public beta stage has been opened since September 2021. During this public beta, we count on teachers’ feedback to improve and add features in our application. The final goal is not to replicate all JSXGraph features into blocks, but curate essential functions that could help designers to implement STEM activities in a simple way. To achieve that, we hope designers and teachers will be keen to share their insights and needs in order to democratise interactive geometry activity design through blocks.

Visualizations with JSXGraph in the LMS MUMIE

Andreas Maurischat
Integral Learning
Germany

The LMS MUMIE is an E-Learning Platform for developing online courses like the Online Mathematics Bridging Course OMB+. It provides a large toolbox for automatically corrected questions, and can be embedded into your local LMS via plugins. Newly, we are using JSXGraph for interactive visualizations which are synchronized with text, and for graphical questions which the user has to solve by interacting with the graphics. We are going to present examples of such interactive visualizations and graphical questions, and also indicate how one can easily develop their own visualizations and questions in the LMS Mumie if one is familiar with writing LaTeX.

STACK + JSXGraph

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The presesentation consists of two parts. We start by describing the use of STACK in Aalto University basic math courses, in some cases combined with JSXGraph. In the second part, a 20 min video by Miko Karjalainen, we show how to combine STACK with JSXGraph by using the different bind_point commands.

Workshop – Advanced JSXGraph I&II

Alfred Wassermann
Universität Bayreuth

https://jsxgraph.org/conf2021/pdfs/advanced_I.pdf
https://jsxgraph.org/conf2021/pdfs/advanced_II.pdf

Using JSXGraph in Numbas

Christian Lawson-Perfect
Newcastle University
United Kingdom

The first half of this talk is a demonstration of software aimed at lecturers and teachers, and the second half is a technical discussion which will be of interest to developers.
Numbas (https://www.numbas.org.uk) is an open-source e-assessment system designed for mathematical subjects.
There has been an extension for integrating JSXGraph diagrams in Numbas since 2011: https://github.com/numbas/numbas-extension-jsxgraph
I will demonstrate some applications of JSXGraph in Numbas questions, and share some of my successes and difficulties in using JSXGraph.

Using interactive JSXGraphs in STACK tasks on probability theory and statistics

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In the project “OER.Stochastik.NRW”, digital tasks, interactive applications, and learning videos from the field of probability theory and statistics are being jointly developed as Open Educational Resources at three German universities. The software combination of STACK and JSXGraph proves to be fruitful for the creation of modern and interactive digital mathematics tasks. Especially in probability theory and statistics, the application of mathematics can be brought to life.

In our talk, we are going to show several sample tasks that are representative of different approaches on how to use JSXGraph within STACK questions. First, we show you a task where students are supposed to draw an empirical distribution function by placing points into a coordinate system. This is representative of tasks where students construct a solution actively instead of just changing sliders or moving objects. Then, we present our approach on using JSXGraph in the feedback of STACK tasks. Here we show two STACK questions representing two different concepts of implementation. The first is to allow students to change their initial answer by performing changes in a graphic that appears in the specific feedback. For this concept, we show a sample task on regression lines where the parameters of the line can be changed by using sliders. The second approach is to allow students to conduct a random experiment based on a probability mass function that they constructed previously. The advantage is that it enables the students to see the mistakes they made when they see

that their solution can be empirically disproved. They disprove the correctness of their answer by themselves instead of getting the correct solution from the computer. Our sample task is about the random experiment where an unfair dice is thrown.
The developed tasks will be used on a large scale for the first time in the winter semester of 2021/2022 and subsequently evaluated.

Algebra as a geometric modeling language

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86159 Augsburg

The Felix web application allows to model geometric situations with algebraic equations and inequalities. Furthermore, it allows to maximize or minimize certain quantities when calculating the configuration of objects. The talk will give a short overview of the system and the didactical ideas behind it. Moreover, some ideas for further development are discussed.

JSXGraph and 3D graphics

Juha-Matti Huusko
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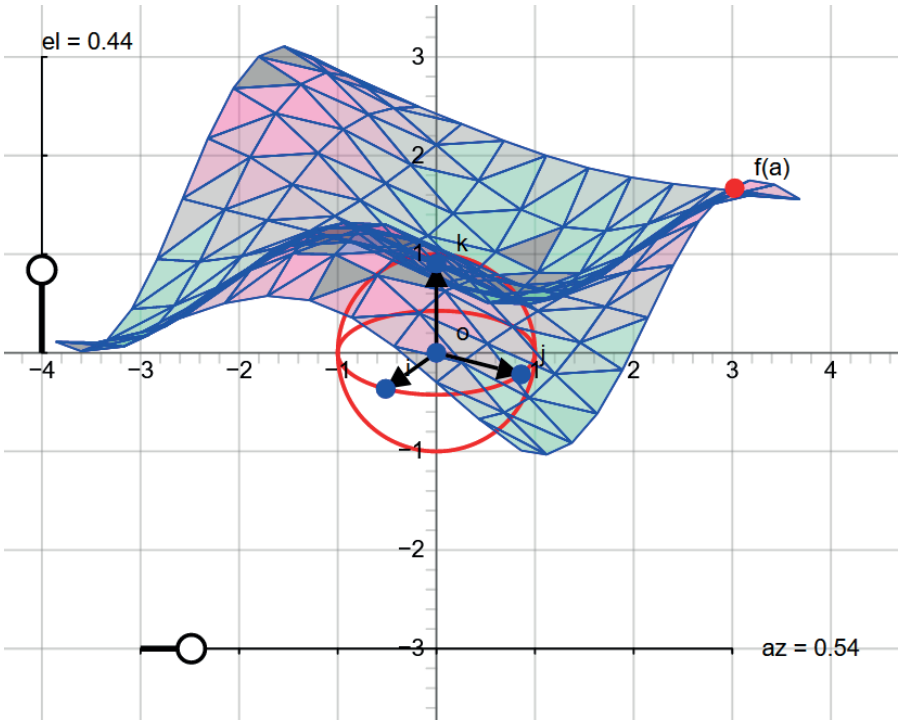
As the talk may be contain many technicalities, the intended audience are university teachers and developers.

In general, how can 3D graphics be added in a down-to-earth fashion? How to do it efficiently? Could JSXGraph some day handle 3D points natively?

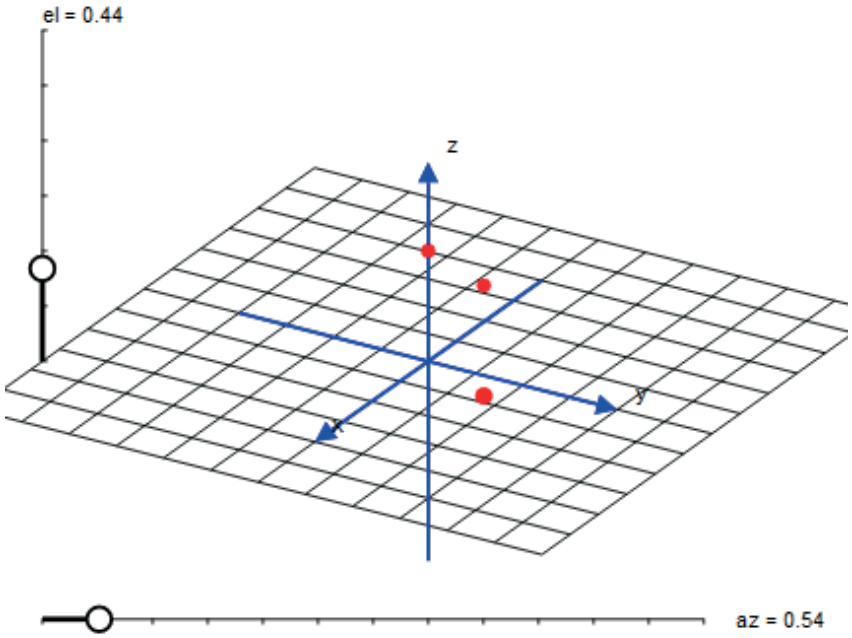
Let us use JSXGraph to visualize 3D objects: points, lines, planes, solids and surfaces. To rotate the object, we add sliders for the Azimuth (az) and Elevation (el).



First, let us consider the surface $z = f(x, y)$.

The user can give a formula of $f(x, y)$. We can then calculate $z_{jk} = f(x_j, y_k)$ for each rectangular lattice point (x_j, y_k) in $[-L, L]^2$.

The points $p_{jk} = (x_j, y_k, z_{jk})$ can be projected to a plane and visualized in the computer. The triangles $p_{jk}, p_{j(k\pm1)}, p_{j(k\pm1)}$ can be drawn to produce a surface. For rotations of the surface, the example code uses rotation matrices.



Second, let us consider the geometric objects.

JSXGraph supports generic projective mappings which allow us to slant the xy plane. When we add the z axis, we obtain a visualization of $\mathbb{R}^3$.

A rectangular grid in the xy plane becomes a slant grid. A magnetized point $p_{xy} = (x, y, 0)$ snaps to the slant grid and moves as the Azimuth is adjusted. A magnetized point $p_z = (0, 0, z)$ can be moved on the z axis. The 3D point $p = p_{xy} + p_z$ can be adjusted easily with the mouse.

To handle the code by pressing buttons, a JSXGraph editor was coded in PHP.

Moodle Formulas Combining JSXGraph and Correction of Student's Misconceptions in Physics

Alona Vered, M.Sc.
HEMDA Schwartz-Reisman Science Education Center
Tel Aviv-Jaffo

This workshop will demonstrate some examples of graphic questions with randomly generated parameters directed on qualitative analysis and understanding rather than computation training.

The main goals are helping students to overcome frequent difficulties and repair typical misconceptions such as: description of graphically depicted motion, translation real motion into it's graph representation, distinction between different types of graphs, and more.

Implementation of this kind of training encourages self-learning and can be more effective than teacher's lecture and explanation. Withal the teacher keeps control on students' progress and can give help if needed.

Some preliminary knowledge of the Moodle Formulas is advisable.

JSXGraph solutions in theoretical mechanics courses for on-line education

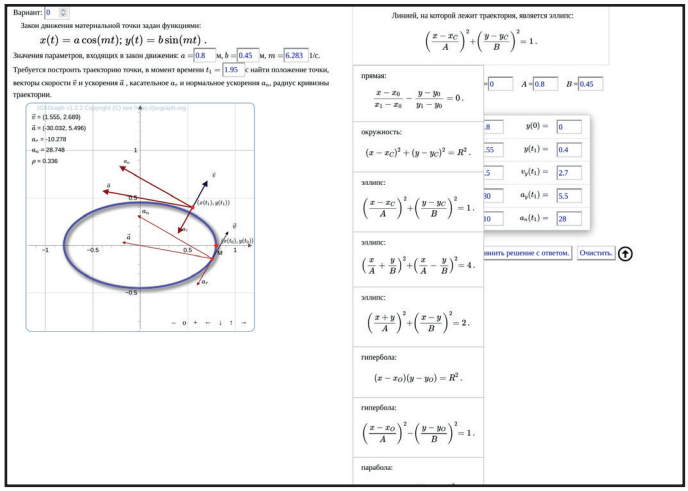
Evgeny Bord

630008, Russia Novosibirsk 113 Leningradskaya Street

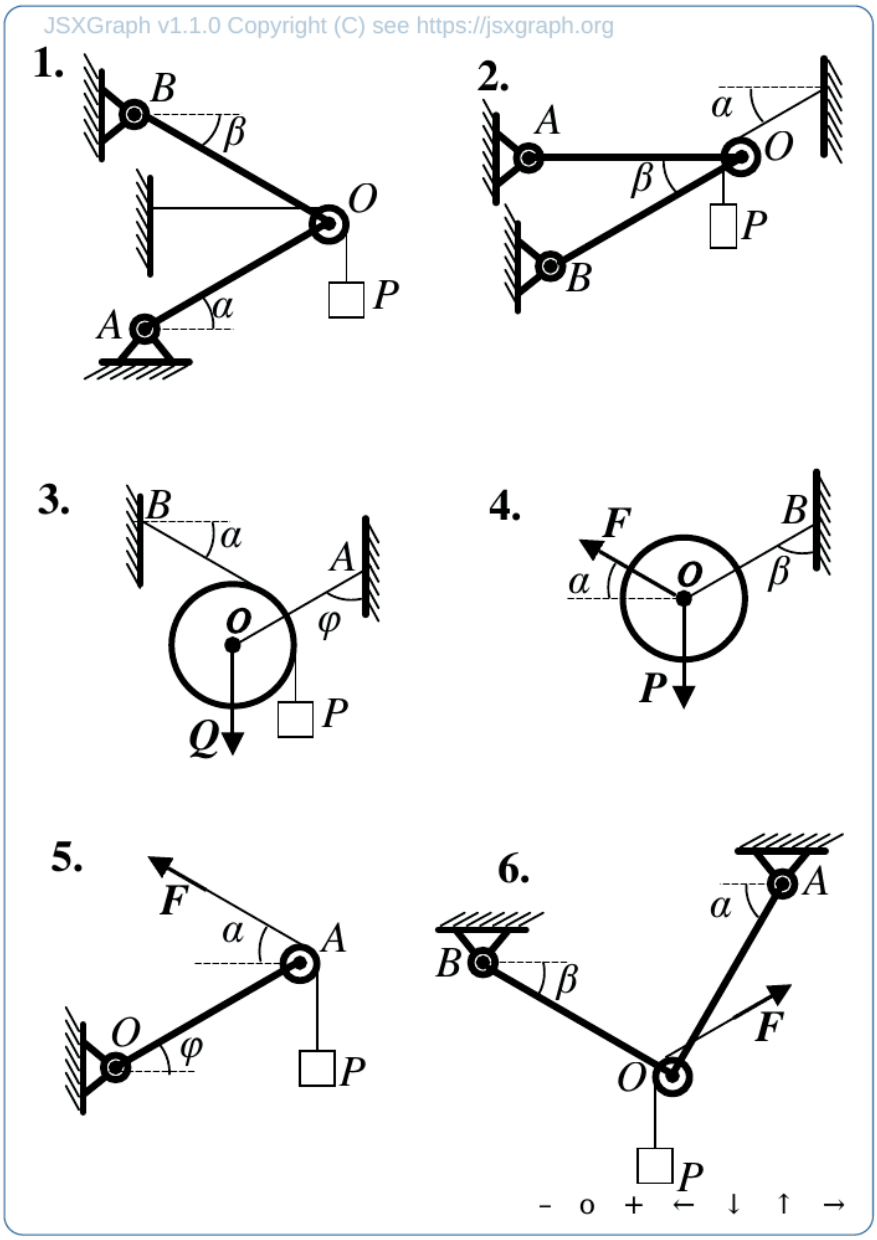
Recent one and half year actualize problem on support education process out from campus with absence of blackboard and tools for control on students activity. This challenge seems more complex by circumstens by mobile communications usual for students community. Lose of traditional auditorial dialogue pose the problem of students motivation for education efforts in individual practice for solving academician tasks. On other hand this problem were exist for a lot of time and not issued from the choice between auditorial or distant form of education process. In russian enginereing education this problem seems to be common for courses on mathematics, physics, chemistry, theoretical, applied, enginering mechanics and other courses with essential containing of formal mathematical way of solution.

In this circumstance the JSXGraph package occures to be great, full admitabel and extremely usefull by this talk author point of view. Much more better one time see, than thousand times listen for comparison between dispaying of tangential line on function graphics and epsilon-delta definition of function derivative.

On figure 1 presents some workspace of the browser in application developed with JSXGraph to regular students task in theme of material point kinematic. JSXGraph used for construction of material point trajectory, visualization of velocity and acceleration,



tangential and normal components of acceleration. Visualization suggests to compare by students their solutions with right answer. This option serve two aims. First one is self-control of the solution by student, and another one is reducing of formal difficultes in finding the equation of trajectory. In application were using formal differentiation of arrow functions, object ‘conic’ from JSX library, MathJax processing for \LaTeX , notation in ’text’ objects construction.



Technological background based on application of SVG format for internal representation of graphics images used in JSXGraph also essentially reduce problems with reaccomplish graphical materials prepared earlier for publishing in hard copy. On figure 2 represents an instance of those transfer.

System of objects in theoretical mechanics must include geometrical and analytical description with essential restriction by rigid body hypotises and inertial attributes for points and bodys. Common place in theoretical mechanics tasks is mix consideration by objects as alone free body, as connection and as part of outer system. This duality is one of essential difficulty for students in theoretical mechanics studying. JSXGraph in actual provide all necessary tools for modeling mechanical process in plane geometry, and accompanying study process. Lightweight package for interpretation operations on set, generation of function for interaction mechanical objects and visualisation of mutual properties of bodys and connections seems to be potentially conveniet addition to JSXGraph for theoretical mechanics.

MecLib – Dynamic and Interactive Graphics in STACK questions without JS

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STACK is a Moodle question type which comes with built-in support of JSXGraph, a JavaScript library for interactive and dynamic graphics. It is possible to evaluate properties of interactively modified graphics from within STACK and to provide automatic feedback. Authors of STACK questions usually handle HTML, LaTeX and Maxima (the CAS engine used in STACK). MecLib has been developed as a Maxima interface to a pre-defined set of high-level JSXGraph objects. This reduces the complexity of authoring by avoiding the need to even touch Javascript.

MecLib is a JSXGraph block with question-independent content, which is just copied to the question text. All content of the graphics is controlled by a Maxima list of lists in the question variables along with the usual math content like randomization and model answer generation.

The initial driver of the development was the need for asynchroneous interactive learning material for teaching Engineering Mechanics. Starting as an intermediate step towards an interactive editor for free body diagrams, it has evolved into a helpful tool for illustrating STACK questions, be it dynamic and interactive or not, just because of simplicity, portability and consistent design.

Randomized physics questions with JSXGraph and Formulas

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STEM subjects, and physics in particular, pose many challenges for high school students. Among those are routine tasks as variably handling multiple math concept at the same time and switching between multiple representations like diagrams, sketches, formulas and tables. At the advent of the corona pandemic, I took the leap and started creating online questions with randomized parameters for repeated individual practice and assessment using Moodle's Formulas question type and JSXGraph. In this session, I will present several such questions, discuss their didactic merits, and point out central pieces of their implementation.

eXpert project: JSXGraph in Moodle questions (Formulas and STACK)

Marc Bernat Martínez Alemany
bernatg4@gmail.com

During the pandemic, the impact of e-learning became particularly important. In the field of remote teaching, there is a notable lack of high-quality, research-based learning material. eXpert is an Erasmus+ project coordinated by Maribor University (Slovenia), which have created advanced interactive i-Textbooks including questions with JSXGraph. One of the main aims of the project is ...

- Community-driven use and improvements of i-textbooks (similar to Wikipedia).
- Possibility to include some topics from interactive textbooks in LMS and to construct personalized learning paths

In this talk we are presenting some JSXGraph animations that will be included in i-textbooks and Moodle using STACk and Formulas question type.