

GEOGEBRA 3.2 – THE NEW SPREADSHEET VIEW

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The release 3.2 of GeoGebra will add another – third – view for mathematical objects: the Spreadsheet View. In this paper we will introduce the new view, present some examples and discuss the opportunities the new Spreadsheet View will offer for teaching and learning of mathematics.

GEOGEBRA 3.2

GeoGebra (www.geogebra.org) is free, multi-platform, open-source dynamic mathematics software (DMS) with rapidly growing worldwide popularity. The basic idea of the software is to join interactive geometry, algebra and calculus, which other packages treat separately, into a single easy-to-use system for learning and teaching mathematics from primary school through university level.

So far, GeoGebra's user interface allows numeric algebraic (e.g. coordinates of points, equations) and graphical (e.g. points, lines, conic sections, function graphs) representations of mathematical objects. While coordinates and equations are displayed in the *Algebra View* on the left hand side of the GeoGebra window, their graphical representations can be seen in the *Graphics View* on the right hand side.

The upcoming version 3.2 (available this summer) will add a third view to GeoGebra: the *Spreadsheet View*. Now, various kinds of mathematical objects – not only numbers – can be entered into spreadsheet cells. As usual in GeoGebra, all representations of the same object are linked dynamically and automatically adapt to changes made to any of the representations, no matter how they were initially created. The new *Spreadsheet View* of GeoGebra now enables users to connect statistical reasoning with other areas of mathematics.

The Spreadsheet View

In GeoGebra's *Spreadsheet View* every cell has a specific name that allows you to directly address each cell using algebraic expressions and commands. If possible, GeoGebra immediately displays the graphical representation of an object you enter into a spreadsheet cell in the *Graphics View* as well. Thereby, the name of the object matches the name of the spreadsheet cell used to initially create it (e.g. C5). Spreadsheet objects are defined as *auxiliary objects* and by default hidden in the *Algebra View*, as the symbolic representation (e.g. numeric value, equation) is already visible in the *Spreadsheet View*.

EXAMPLES

The following sections present different uses of the *Spreadsheet View* of GeoGebra 3.2 and provide several basic examples ready for classroom use in secondary schools. For details on how to create these examples in GeoGebra, please see Hohenwarter & Hohenwarter 2009.

Record to Spreadsheet Feature

In this example we record the coordinates of the point $A(a, 2a)$, which depend on a slider a , into the spreadsheet and display its trace when the value of slider a is being changed (see Figure 1).

With this model, the students can explore the number pattern in column B , which is created by the y -coordinates of different positions of point A . The teacher may encourage her students to make a prediction about a function graph that runs through all different positions of point A . Then, students may enter the corresponding function equation (e.g. $f(x) = 2x$) into the input bar in order to check the correctness of their prediction. By changing the y -coordinate of point A (to e.g. $2a - 2$) you may easily create a new problem to investigate.

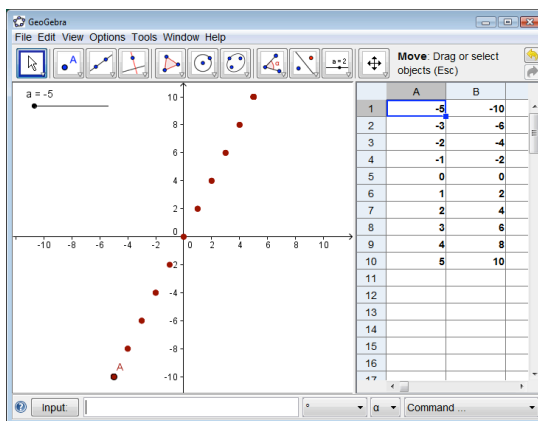


Figure 1:
Record to Spreadsheet Feature

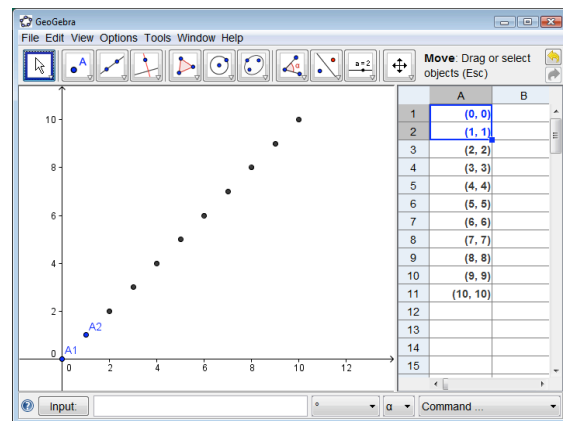


Figure 2:
Relative Copy and Linear Equations

Relative Copy and Linear Equations

After creating the points $A1(0, 0)$ and $A2(1, 1)$ in the corresponding cells of the *Spreadsheet View*, we use relative copy to create a sequence of points which is displayed immediately in the *Graphics View* (see Figure 2).

Students may explore this sequence of points in a similar way as described in the previous example. Furthermore, changing the coordinates of the initial points $A1$ or $A2$, either by editing them in the *Spreadsheet View* or by dragging the points in the *Graphics View*, dynamically updates the entire point sequence and thus, creates a new problem for the students.

Investigating Number Patterns

In this example we investigate how the surface of a cube changes when the length of its edges e is modified.

In the beginning of this investigation setting, students use paper-and-pencil to do calculations and record their results in the spreadsheet. After selecting a couple of their favourite edge lengths – preferably different ones than their neighbours – they need to calculate the surface of the corresponding cubes. Afterwards, the students enter edge lengths and surface values in the columns A and B of GeoGebra's *Spreadsheet View* and use them to plot corresponding points in the *Graphics View*. Thereby, the edge lengths provide the x -coordinates while the surface values create the y -coordinates of the points.

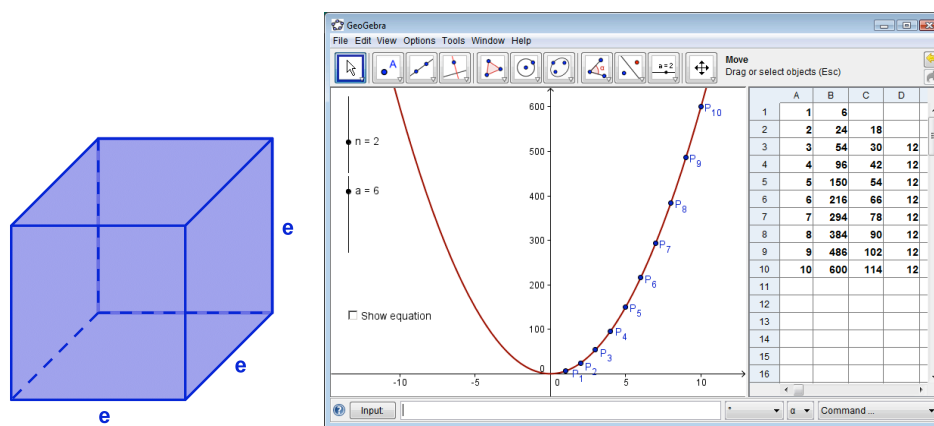


Figure 3: Investigating Number Pattern

To investigate the number pattern entered in column B the students may compute the difference of two successive surface values (in column C) and look for a pattern among the resulting values. Subsequently, they may also compute the difference of two successive differences (in column D) finding that the second order differences are constant. This allows students to come up with a conjecture about the degree of the polynomial function that runs through all points plotted in the *Graphics View* and to come up with a formula to the surface of a cube for a given edge length e . Plotting function graphs as explained in the previous examples allows to check the conjecture.

A similar problem is the investigation of sequences of differences – and determination of the constant values – for polynomials like $a x^n$ or even $a x^n + b$.

Scatter Plots and Best-Fit Lines

In this example we investigate a data set that was manually entered into the *Spreadsheet View* and plotted as points in the *Graphics View*. Using a best-fit line we will approximate these data points and investigate the effect of outliers on this regression line.

This model allows the teacher to demonstrate how outliers impact the best-fit line of a data set by dragging one of the points with the mouse in the *Graphics View* or by changing the data values of one of the points in the *Spreadsheet View* (see Figure 4).

In order to investigate real life data in such a model – like data collected in a physics experiment for example – you can easily copy and paste the data from any spreadsheet software into GeoGebra’s *Spreadsheet View*.

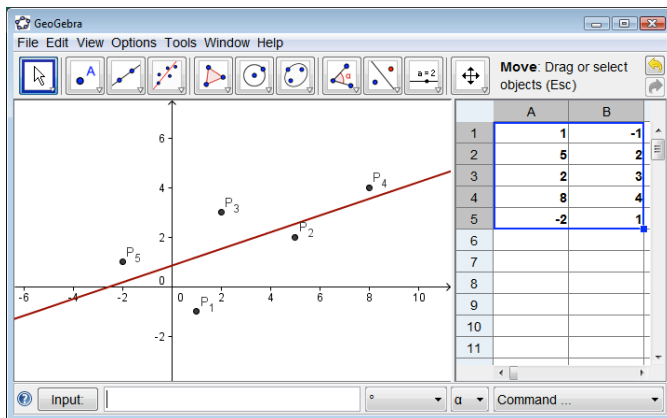


Figure 4:
Scatter Plots and Best-Fit Lines

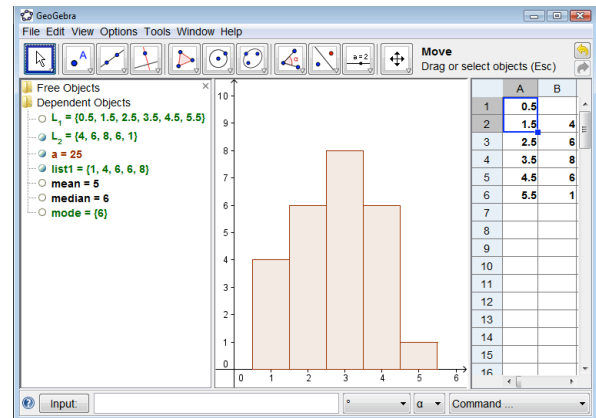


Figure 5:
Exploring Basic Statistics Commands

Exploring Basic Statistics Commands

Yesterday, you gave a mathematics quiz to the 25 students of your 1st period math class. After the quiz, you asked your students to rate the difficulty of the quiz on a scale from 1 (‘very easy’) to 5 (‘very difficult’).

- 4 of your students rated the quiz ‘very easy’ (1)
- 6 students rated the quiz ‘easy’ (2)
- 6 other students rated the quiz ‘difficult’ (4)
- 1 student rated the quiz ‘very difficult’ (5)
- The rest of the students thought the difficulty of the quiz was ‘ok’ (3).

In this example we represent the collected data using a histogram and encourage students to predict the mean, median and mode of the data set. After sorting the list of frequencies from least to greatest, students may also use the commands *Mean*, *Median* and *Mode* to verify their assumptions and interpret the data. (see Figure 5)

CONCLUSION

These examples demonstrate some mathematical concepts that can be investigated using GeoGebra 3.2, which only scratch the surface of possibilities that the new *Spreadsheet View* of GeoGebra offers for the teaching and learning of mathematics. Of course, a lot of other interesting applications can and will be investigated using this new feature of the software in the future. In order to determine the effectiveness and usefulness of such technology-enhanced models, classroom testing and research studies need to be conducted with the goal of creating and sharing high quality and ready to use interactive models that foster teaching and learning of mathematical concepts.

References

Hohenwarter, J., & Hohenwarter, M. (2009). *GeoGebra Special Topics Workshops: Spreadsheet View & Basic Statistics Concepts*. Retrieved on April 30, 2009 from http://www.geogebra.org/workshop/en/09_GeoGebra_Spreadsheet_Statistics.zip