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CPD Module 2 Didactics of Mathematics

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## 1. The GeoGebra Home page: geogebra.org

The GeoGebra Home page gives the overview of what you can do with GeoGebra. It's too much to list.

Go to www.geogebra.org. The screen below appears, if the language is set to 'Dutch'.



Do you want to use GeoGebra in another language? You can. Scroll to the very bottom of the page and set your language.



Task: On the home page, call up the following screenshots in English and French:



Scroll to 'Community materiaal' OR 'Math Resources' OR 'Ressources de la Communauté' (in French on the screenshot above). Click on 'Verken het allemaal' OR 'Explore all' OR 'Explorer tout'. Here you can find material that other teachers made and share with the community. If you scroll down, you will find the 'Help Centre' at the bottom left.

Ge@Gebra			
Info	Gebruiksvoorwaarden	Grafische rekenmachine	Download onze apps hier:
Partners	Privacy	Rekenmachine suite	GET IT ON
Hulpcentrum	Licentie	Community materiaal	App Store Google Play

If you then click 'Leer GeoGebra' OR 'Learn GeoGebra', it will take you to a page that takes you to all the initiation manuals. You can reset the language at the top.



GeoGebra is very dynamic and constantly evolving therefore the screenshots in this course may be out of date from 2025 onwards. They were all taken in August 2024. Nearly all of them are in Dutch. We have enriched the screenshots with indications that support the text. In the different languages, the location of text and figures in GeoGebra is the same. We hope that this means readers will not find the Dutch language a problem.

# 2. De GeoGebra community.

Join the GeoGebra community by signing up and creating an account. After all, with an account you can create online materials, upload and organise your own GeoGebra files in GeoGebra books, assign materials to your students and share or publish your materials.

<u>Assignment</u>: Go to <u>www.geogebra.org</u>. Sign in using the button at the top right of the GeoGebra Website screen.

https://www.geogebra.org									
GeøGebra	Didactisch materiaal	Rekenmachines 👻	Q Zoek	Sluit je aan bij een les Aanmelden					

Als je aangemeld bent, verandert de bovenstaande balk op de openingspagina van GeoGebra:

Once logged in, the bar above on the home page of GeoGebra will change to:

GeoGebra	Didactisch materiaal 👻	Rekenmachines 👻	Q Zoek	Sluit je aan bij een les

You can read more about creating a GeoGebra account via <u>this link</u>. At the top right, you can change the language English (US)  $\sim$  Q

# 3. Calculator Suite

Calculator Suite is a bundle of several apps. You will find Suite under calculators. Suite is a powerful and intuitive graphical calculator.



Click on 'Calculators' and 'Calculator suite'.

The Suite screen that opens is minimalist: a title bar, a vertical bar with a few icons **(Algebra, Tools, Table)** and one drawing window. You can make the drawing window bigger and smaller by moving the vertical line next to the icons.

Click the Algebra icon and an input field and (an icon of) a virtual keyboard appear.



In the input field, you can type an algebraic expression e.g.  $x^2 + 2x$ . GeoGebra recognises this input as a function. In the drawing window, the associated function appears and in the input field the function gets a name.





<u>Task</u>: Try it out very briefly. Type an expression in the input field. You notice that three dots appear next to the function. Clicking on these shows what else GeoGebra can do with the function.



With the virtual keyboard, you can smoothly type very diverse algebraic entries with root forms, fractions, built-in functions or mathematical operators. This keyboard becomes an icon when you click the little cross on the right.

123	f(x) A	BC #8	7					•••
x	У	π	е	7	8	9	×	÷
<sup>2</sup>	<b>"</b>	√:::		4	5	6	+	-
<	>		=	1	2	3	=	$\overline{\mathbf{X}}$
ans	,	(	)	0	•	<	>	←

Tip: If you want to work with fractions, type the edit character '/' in the input field. GeoGebra creates a fraction where you can enter the numerator and denominator (so you don't have to type parentheses).

Clicking the *Algebra* icon again closes the algebra window, the graph remains unless you delete the input field.

Click the **Tools** icon and a selection of buttons will appear, arranged by category: basic tools, edit, media, measure.... and if you scroll down, you will find *MORE*. Clicking on this will reveal all available tools.

Click on the *Table* icon and a function value table will appear.

## 3.1. An intelligent inputfield: sliders and operations.

Type  $ax^2 + bx + c$  in the input field. As you noticed above, GeoGebra turns this algebraic expression into an expression. Moreover, the graph appears in the drawing window. GeoGebra also automatically creates sliders for the parameters a, b and c. In the screenshot below, you can vary all three parameters between -5 and 5. By clicking on the little arrow next to the line segment, you make the parameter 'walk' and see the effect on the graph.

Clicking on the three dots shows even *MORE* additional possibilities. The screenshot below shows the options for the entered function.



The option *Special Points* calculates the points of intersection with the axes and the extrema of the function. The option *Table of values* creates a table in the *Table* window. You notice that the *Table* window then opens.

## 3.2. Operations via commands and built-in functions

## Oplossen(f = 0).

In the input field you can enter commands to perform additional operations. For example, you calculate the exact value of any zero values with the command Oplossen(f = 0) (Solve(f = 0)).



If you click on the three dots at the top right of the keyboard, a context menu opens with a list of all built-in functions and commands, arranged by category. If you select a command, the appropriate syntax appears.

					Fur © Alled © Tekeg © Takeg © Takeg	Toon Or totles comman tkunde bbra st cica n za cica n za	line Help do's analyse trix ss le maten g gebra	Sluiten	Charasan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan Chaissan	<vero <vero <vero <stel ien&gt; ) inbele <vory nes&gt; )</vory </stel </vero </vero </vero 	gelijking: <u>S</u> seliking seliking seliking seliking seliking seliking	· ) ·, <variab amotorvo -, <variab< th=""><th>ała≻ ) jen&gt;, <lijs galjkingar ala&gt;, <lijsi< th=""><th>t van ⊳, «Lijst mət</th><th>00000000000000000000000000000000000000</th><th>toon On thousane graduated social parameters parameters analogical and analogical analog</th><th>Mysierde 20 20 21 21 21 21 21 21 21 21 21 21 21 21 21</th><th>-</th><th></th></lijsi<></lijs </th></variab<></variab 	ała≻ ) jen>, <lijs galjkingar ala&gt;, <lijsi< th=""><th>t van ⊳, «Lijst mət</th><th>00000000000000000000000000000000000000</th><th>toon On thousane graduated social parameters parameters analogical and analogical analog</th><th>Mysierde 20 20 21 21 21 21 21 21 21 21 21 21 21 21 21</th><th>-</th><th></th></lijsi<></lijs 	t van ⊳, «Lijst mət	00000000000000000000000000000000000000	toon On thousane graduated social parameters parameters analogical and analogical analog	Mysierde 20 20 21 21 21 21 21 21 21 21 21 21 21 21 21	-	
123	f(x) A	BC #8	h-1						123	) f(	x) Al	BC #8	7						
x	у	π	е	7	8	9	×	+	x		У	π	e	7	8	9	×	÷	
$\square^2$	0"	√0		4	5	6	+	-	13 <sup>2</sup>	2	$\square^{\rm H}$	√⊡		4	5	6	+	-	
<	>		0	1	2	3	=	$\otimes$	<		>	o	00	1	2	3	-	$\bigotimes$	
	· · · · ·															-			

Clicking **Toon Online Help** (**Show Online Help**) links you to a wiki page with additional explanations with examples of a command and its possible syntaxes.

## 3.3. GeoGebra Calculator Suite on the smartphone

The app on the smartphone looks largely the same with the same features. As a result, Suite also presents itself as a graphical calculator for students and teachers.



The app has an additional option for the use with tests and exams. Using the menu button at the top left of the screen (the 3 horizontal lines), you can access exam mode. This is a secure full-screen mode in which you can use the app as a graphing calculator during written tests and exams.



Full details on usage and security can be found via the opening page **geogebra.org**. Explore 'Maths calculators & apps', scroll down to 'GeoGebra on tests' and click on 'Learn more about exam Modus'. You can also follow <u>this link</u> taking you to a Dutch page. At the top right, you can set the language.

## 4. Resources

GeoGebra offers resources. These are arranged by mathematical topic.

Geo	Gebra Resources - Calculators	Q Search	Join Lesson
25	Number Sense	Algebra	Geometry
	Understanding numbers, their relationships	Using symbols to solve equations and	Studying shapes, sizes and spatial
	and numerical reasoning	express patterns	relationships in mathematics
<b>e</b>	Measurement	Operations	Probability and Statistics
	Quantifying and comparing attributes like	Performing mathematical operations like	Analysing uncertainty and likelihood of
	length, weight and volume	addition, subtraction, division	events and outcomes

Many sample applets and worksheets are very thoughtfully designed. You can search for specific material via the 'Search' function. By typing e.g. 'Flink', you will find material from the Austrian FLINK project. Worksheets or applets in another language can be interesting. Adapting found didactic material is an interesting skill to learn. Besides creating a worksheet, adapting an existing one is covered further in this document.

# 5. GeoGebra book

## 5.1. Creating a GeoGebra book

<u>Task:</u> Go to your profile page by clicking on the icon indicating your name.



Scroll down and ignore Description, Target Group, Tags and Visibility. Click 'Save'.

GeøGebra		Gilberte Verbeeck
	Book created successfully.	
← Edit Book: Function	าร	
Content Title Page		View Book
Chapters	This Book does not contain any resources yet.	
Add Chapter	Add Activity	

5.2. Create an activity (eigen werkblad) and add it to your Geogebra book Add an activity (werkblad) to your book by clicking 'Add activity' and then 'New activity'.

GeøGebra	G Gliberte Verbeeck Help		
GeoGatorabooek werd met succes aargemaakt C Bewerk dit GeoGebraboek: Functies Infoud Telejusjios Hoofdstukken Utt GeoGebraboek bevet nog geen materiaal (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	GesGabrabeek bekijien	Add Activity to Book Search Graph the Line Bare Paela 19 May 500 Brood Mithous Marche	X Mggu Activity

#### Give it the title 'Grafh of f(x) = ax'.

← Geo	Gebra		
Grafiek	van f(x)=	ax	
Invoegen van i	tem		
Tekst	Þ	Video	
GeoGebra	applet 💼	Afbeelding	
Notitieblo	k 🛃	PDF-bestand	
? Vraag	0	Web	
Opslaan en slu	uiten Annuleer		
Zichtbaarheid	Delen via link	v	0
	Je maakt het mater Merk op dat een ke toegevoegd wordt	iaal "Publiek" zichtbaar als volgt: sluit dit scherm, klik re opie van een werkblad of boek geen hogere zichtbaarhe aan een publieke bericht.	chtsboven op het icoon : en selecteer vervolgens id kan hebben dan het origineel. Ook is 'Privé' ge

**Insert a text box**: Create a text box by clicking the 'Text' button (see screenshot above 'Tekst'). The screen in the screenshot below opens.

Tekst	D 🛊
Kop (optie)	
Typ je tekst	
	Klaar Annuleer

You need the buttons highlighted in green to bold a text, use the maths editor or choose a GG-icon.

= Tekst			ē 🛊
Font size \$ B <i>I</i> 77 [CODE] I * = [a	U ∓ × <sup>2</sup> × <sub>2</sub> <u>A*</u> ≡	≝ ≝ ≝ ¦≣ 60	
A Typ je tekst Ty			
			Klaar Annuleer

Enter the following text in the text box. You can copy this text as much as possible from this document.

- Type **ax** as input and create the graph of the function f(x) = ax.
- GeoGebra hereby creates a slider for a
- Click MORE at the bottom and select the Slope button under Measure  $\swarrow$ . Click on the graph of f
- Experiment with the slider of *a* .



Click 'Done' ('Klaar').

**Insert applet**: Click 'add element' ('voeg een item toe') at the bottom and click 'GeoGebra' ('GeoGebra applet'). You can choose from existing applets created by others. These appear on the right-hand side of the window. However, you are going to create your own applet, click 'Create applet'.

	GeoGobra applet invoegen	×
+ VOEG EEN ITEM TOE	Zeck nezr applets Usionfen asolot	splitia of typ were of
	Marcane make	<u>^</u>
Tekst sluiten Annule Video	10 ar 1200	**
GeoGebra applet a link S Afbeelding		
Notitieblok	Proof Whout Word	4 1
Vraag of toegevoegd Web Web		descreent wigens Relevante Annuker

You have a choice of options. Click on 'Graphs' ('Grafieken').

GeoGebra applet inv	begen		×
Zoek naar applets Uploaden applet Maak een applet	Selecteer a.u.b. d Applet	e Wiskunde Ap	sp voor het nieuwe
	N	<b>X</b> =	Maskande
	3D- Daintemeethaale	Rekonbilad	Waarschijnijkhokisreich
	Monitoeblok		

Click 'Done' ('Klaar') and then on the triangle below the applet so you can adjust the advanced settings (Geavanceerde instellingen).

Maak een applet	
	5
+ <u>3V</u> - 3	
1	tersleep een bestand naar hier om te uploaden, of Vervang applet
-2 -2 - 0 1 2 2	700 x 500 Bewerk applet
	Geavance     erde instellingen
	Klaar Annuleer
Klur Andre	

We adjust these settings so that students can create their own objects in this applet during class. To do this, choose 'Suite' and tick the boxes according to the screenshot below. Click 'Done' ('Klaar').

<ul> <li>Geavanceerde instellingen</li> </ul>					
Breedte 700 Hoogte 500	Wijzig de schaal 1				
Bewaar de verhouding hoogte-breedte	_				
Rechtsklikken en bewerken met toetsenbord toelaten	Toon de menubalk				
Inschakelen van het verslepen van labels     Toon knoppenbalk					
Toon knop voor het resetten van de constructie					
Verslepen en zoomen toestaan	Toon opmaakwerkbalk				
GeoGebra App Suite 🗸					
	Kiaar Annuleer				

Add multiple-choice question: Click 'Add element' at the bottom. Click on 'Question' ('Vraag').

+ VOEG EEN ITEM TOE	? Vrang 🖻 🕯 Kop (opte)
Tekst sluiten Annule Video	A Vesg J
GeoGebra applet via link	Open vraag Meerkeutevraag
Notitieblok maakt het maar als ve Merk op dat eerste pie van een werkblad of boe	Duilt de juite antwoorden aan (optie)           Jx
Vraag of toegevoegd t aan een publieke bericht. Web	Naar Annuleer

Complete the following: If a is positive then the graph of f is (Als a positief is dan is de grafiek van f)

?	Vraag		(h)	Û
Кор	optie)			
<u>A</u> fx	Als 🖻 positief is dan is de grafiek van ʃ			
Ope	n vraag Meerkeuzevraag			
<u>A</u> fx	Duid de juiste antwoorden aan (optie)			
		Klaar	Annul	<u>eer</u>

Choose 'Multiple choice' ('meerkeuzevraag'). Fill in the following first option: 'increasing' ('stijgend').

?	Vraag					Û
Kop (	optie)					
<u>A</u> fx	Als @positief is dan is de grafiek van 📝					
Ope	n vraag <mark>Meerkeuzevraag</mark>					
	stijgend	A	ſx	Û		
Voeg	een antwoord toe			Klaar	Annul	<u>eer</u>

Click 'Add Answer' ('Voeg een antwoord toe') and enter: 'decreasing' ('dalend'). Tick the correct answer. Finish again by clicking 'Done'.

?	Vraag					ĥł	Û
Kop (	optie)						
<u>A</u> fx	Als (a) positief is dan is de grafiek van						
Ope	n vraag Meerkeuzevraag						
	stijgend	A	ſx	1			
	dalend	A	ſx	Û			
Voeg	een antwoord toe				Klaar	Annu	leer

Add open question: Click on 'Add element' at the bottom. Click on 'Question'.

Enter the following: 'What do we call the graph of this function f?' ('Hoe noemen we de grafiek van deze functie f?

Choose 'Open question' ('open vraag'). Fill in the answer: 'a line' ('een rechte'). Finish again by clicking 'done'.

?	Vraag		hi	Û
Kop (d	optie)			
<u>A</u> fx	Hoe noemen we de grafiek van deze functie			
Oper	<mark>) vraa</mark> g Meerkeuzevraag			
<u>A</u> fx	een rechte			
		Klaar	Annul	eer

Save Activity: Click 'Save and Close' ('Opslaan en sluiten').

Hoe noemen we de grafiek van deze functie f?	
A cen rechte fx	
+ VOEG EEN ITEM TOE	

#### Test the activity ('werkblad'): by clicking on it



Optional if you have time to spare: add an open question with multiple correct answers.

Edit the activity you just saved by clicking on the pen.

GeøGebra			Gilberte Verbeeck
← Bewerk dit GeoGeb	orab	oek: Functies	GeoGebraboek bekijken
Hoofdstukken Vaeg een nieuw hoofdstuk toe	1	Grafiek van f(x)=ax ≥5 jui 2024 - 4602 Cliniere Vintuois ∰ Dir wertwals in inte openbaar.	
	Werk	olad toevoegen	

Click on 'Add element' at the bottom. Click on 'Question'. Enter 'Optional' ('Facultatief') in the header. This indicates that this question is optional for students. This is a form of differentiation. Fast learners can learn or practise something extra that is not strictly necessary according to the curriculum.

?	Vraag		(h)	١
Facult	atief			
<u>A</u> fx	Vraag			
Ope	n vraag Meerkeuzevraag			
<u>A</u> fx	Duid de juiste antwoorden aan (optie)			
		Klaar A	nnule	<u>eer</u>

Complete the following question: 'What happens to the line if a changes from 2 to 5?' ('Wat gebeurt er met de rechte als a verandert van 2 naar 5?')

Choose 'Open question'. Fill in the possible answers:

- 1) The slope increases. OR
- 2) The line becomes steeper. OR
- 3) From 2 to 4, the slope doubles....

If you doubt your answer, seek help from the teacher. Vul de volgende vraag in:

<u>A</u> fx	Wat gebeurt er met de rechte als 📧 verandert van 2 naar 5?
Ope	en vraag Meerkeuzevraag
<u>A</u> fx	<ol> <li>De hellingsgraad vergroot. OF</li> <li>De rechte wordt steiler. OF</li> <li>Van 2 naar 4 verdubbelt de helling</li> <li>Als je twijfelt aan je antwoord, roep de hulp van de leraar in.</li> <li>The gradient increases. OR</li> <li>The straight line becomes steeper. OR</li> <li>From 2 to 4, the slope doubles</li> <li>If you doubt your answer, seek help from the teacher.</li> <li>Augmenter l'angle de la pente. OU</li> <li>La ligne droite devient plus raide. OU</li> <li>De 2 à 4, la pente double</li> <li>Si tu as des doutes sur ta réponse, demande de l'aide à ton professeur.</li> </ol>
	Klaar Annuleer

## 5.3. Adding an existing worksheet to your Geogebra book

Go to the opening page of GeoGebra. From your profile page, do so by clicking on the icon referring to your name and then on GeoGebra.



The screenshot below shows the top of the page. Clicking here will take you to applets intended mainly for primary and lower secondary schools. If you click on Algebra, for example, you can choose from 142 applets arranged by subject and with an indication of the grade for which it is suitable.



If you scroll down you will find the screenshot below.



Click on 'Explore more'.

A lot of topics appear. By clicking further, you can refine the topic and find a suitable applet. In the example below, we choose '**Functions**' and then '**Quadratic**'.



Check how the applet 'Transforming graphs of a quadratic function (1)' works



We are going to add this worksheet to the GeoGebra book.

To do so, click on the 3 dots (MORE) and select the **Details** option.



The following screen appears. Press the button 'Add to Book'.

<ul> <li>Transforming Graphs of Quadratic Functions</li> <li>(1)</li> </ul>	<u>Make a Cop</u>	l )
Transforming Graphs of Quadratic Functions (1) Sketch the graph of $\mathbf{y}$ $y = -4 (x + 3)^2 + 4$ Correct III View Activity		
+ Add to Book Dow	nload Share	

You now enter a dialogue box in which the books you created appear. Choose the book Functions, to which you want to add this file.

### 5.4. Modifying an existing activity

You can also choose to add a modified version of an existing activity to your book. Then select the Copy Activity (Werkblad kopiëren) option.

verken: $f(x) = a(x - p)^{2} + q$	
Auteur: chris cambré	
	Voeg toe aan favorieten
$f(x) = (x - 4)^2 + 2$	7 Ø Open met GeoGebra App
symmetrieas	5 Kopieer dit GeoGebraboek
	4 Werkblad kopiëren
	2 - O Details

Make the preferred changes and save the modified version in your own account. Then you can add this customised version to your book.

#### 5.5. Create a lesson

Click the 3 vertical dots next to the GeoGebra book you want to use in your lesson. Click the **Assign** (*Toewijzen*) button.



You can choose between a GeoGebra lesson or Google Classroom.



Google Classroom is an application from Google in which you can create class groups for the classes you teach. Within this application, you can monitor student progress. It is a tool within which you can integrate GeoGebra. We won't go into detail. You can find more explanation at: <u>https://sites.google.com/view/classroom-workspace/</u>

Clicking on 'GeoGebra lesson' produces the following screen

/e les	
rk van je leerlingen in	
	-
te antwoorden bekijker	ו
	<b>/e les</b> erk van je leerlingen in 

Clicking Create (bottom right) automatically brings you into the Classroom (Klaslokaal). GeoGebra generates a code that gives your students access to the GeoGebra book. They can now use it.



How you can work with this in your lesson you will read in the next section.

## 6. GeoGebra Classroom

## 6.1. How a lesson proceeds

### 6.1.1. Learner joins a lesson

### Method 1: Learners enter a given code to join.

Display the opening page of the lesson with the code to the lesson.



Give the following instruction to your learners

- Go to <u>www.geogebra.org</u> and click on 'Join Lesson' ('Sluit aan bij een les'). GeoGebra Resources - Calculators - Q Search

Join Lesson ) Sign in

- In the dialogue box, enter the *lesson code* (*lescode*) for your GeoGebra lesson page.

GeøGebra	GeøGebra
Neem deel aan Klaslokaal	Neem deel aan Klaslokaal
Vul je lescode in, neem deel aan GeoGebra Klaslokaal en ervaar live interactie met wiskunde tools	Vul je lescode in, neem deel aan GeoGebra Klaslokaal en ervaar live interactie met wiskunde tools
Lescode	YPNX CJWM
Aansluiten	Aansluiten

- Enter your *name* and continue without Signing in. You are now in class!

GeøGe	bra
Welco	me!
Join the less	sson Functies your account to save and continue your work
anyume.	Sign in
Gilberte Ve	rbeeck
	Continue without Signing in

Learners can participate without a GeoGebra account. But they can only leave a lesson and continue working later if they joined the lesson from an account. Indeed, work can only be saved in their own account.

#### Method 2: The teacher provides the learners with the link

After creating a lesson, you got the following screen:

Klaslokaal		⑦ ♥ YPNX CJWM :
	Functies         Sluit je aan bij de les op www.geogebra.org/classroom/ypnxcjwm         of door de code in te geven op www.geogebra.org/classroom         YPNX CJWM	
		💥 VERBERG NAMEN

Clicking on the share icon with the code at the top right \_\_\_\_\_, will take you to the screen below. You can share the link with learners and add co-teachers via e-mail addresses.

Deel de	les met leerlingen		
https://	www.geogebra.org/classroom/wzdfnkrp		LINK KOPIËREN
<b>Voeg m</b> Medelera	edeleraars toe - met een bestaand GeoGebra a aars kunnen de vorderingen van alle leerlingen in de le	ccount is volgen	
Voeg m Medelera Typ een	edeleraars toe - met een bestaand GeoGebra a aars kunnen de vorderingen van alle leerlingen in de k n e-mailadres of een GeoGebra gebruikersna	ccount is volgen am	TOEVOEGEN

You can provide via email, the online learning platform, whatsapp... each learner with the link to join the lesson. In this option, learners themselves do not have to enter a Lesson code but they do have to enter their name.

#### 6.1.2. The learner follows the lesson.

Give your students the following instruction:

You will find tasks in the lesson. This may be in the form of:

- a do-applet in which you have to make your own construction, deduce connections ...;
- multiple-choice questions in which you have to tick all the correct answers;
- open questions in which you have to formulate an answer yourself.

#### **Do-Applet**

In an applet, you can use commands or buttons to create a construction. This construction can then help answer additional questions in the lesson. Below is a screenshot in an applet where you are asked to draw a cube (teken een kubus).



#### **Multiple-choice question**

For a multiple-choice question, tick the square with the correct answer. Below is a screenshot with a question about the number of faces of a cube (aantal zijvlakken van een kubus).

Hoeveel zijvlakken heeft een kubus?
Controleer je antwoord hier
<ul> <li>5</li> <li>6</li> <li>7</li> <li>8</li> </ul>
✓ CONTROLEER JE ANTWOORD

#### **Open-ended question**

In an open question, you formulate the correct answer. An example here concerns the angle sum in a regular polygon (hoekensom in een regelmatige n-hoek). After constructing a triangle, quadrangle, pentagon... in an applet and calculating the angle sum each time, you are asked to find a general formula for the angle sum in a regular polygon. If you did not find it, you are given the next open-ended question: 'Explain why you calculate the angle sum in a regular *n*-polygon with the formula  $180^{\circ} \cdot (n-2)$ 

Verklaar waarom je de hoekensom in een regelmatige n-hoek berekent met de formule  $180^\circ$ . (n-2)Typ je antwoord hier...

The prescribed answer to an open-ended question may differ from what you wrote down yourself. If you are in doubt whether your answer is correct, ask your teacher to assess it.

## 6.1.3. Progress of a lesson

At the top of the lesson's teacher screen you will find the *Lesson Overview* page (*Klasoverzicht* of *Lesoverzicht*).



In the Lesson overview you can track how many students are participating in your lesson and how many tasks they have already worked on. The images update every 2 seconds. In the screen above, no students are participating yet. In the screen below, 14 learners are taking part.

=	Ge@Gebra	Klaslokaal		0	F32K CUZY	
Klasover	zicht		UA GGKI	aslokaal	-	
vragen		s and a second	uit je aan bij de klas op www.geog of door de code in te geven op F32K	ebra.org/classroom//32kcuzy ( www.geogebra.org/classroom CUZY	· A	
		14 leerling(en) in de le	·S	II PAUZE	Sterberg NAMEN	
		Opgave 1	Opgave 4	Opgave 3	Opgave 3	
		Lore	Robine	Stefanie	Patrick	
		4 van de 4	4 Van de 4 :	5 Vari de 4	s van de 4	

In this overview, you will find an overview of the tasks for each activity. If you click on a task, you can follow the progress of all learners on the task in real time. Clicking on one of the thumbnails shows you the learners' applet in full size.

#### **Progress in constructions**

The screenshot below shows the constructions of students Lore, Robine, Stefanie and Patrick.



You can hide learners' names. To do so, click the *HIDE NAMES* button in the top right corner. This allows you to show all learners' work in a class discussion. Class climate is important for this. For example, a learner should not feel embarrassed for a wrong answer. By hiding names you avoid any problems of this nature. By selecting the *DISPLAY NAMES* button you show the learners' names again.





The pause button allows you to pause the lesson. Learners can only continue working on tasks when you click the *REPEAT* button.

#### Answers to questions

Go to the **Overview page** again. Select a multiple-choice question. When learners answer a question or change their answers, you immediately see the class results in a bar chart. Learner answers to openended questions also change immediately in real time and can be shown anonymously to anyone.

## 6.2. How to create a lesson

You can, even if you are not the author, turn any public online activity or book into a lesson. As briefly described in <u>Creating a Lesson</u>, you do this by clicking the **ASSIGN** button in the material you want to share. You can build the lesson clearly by creating a book where you spread the applets and questions over several activities. When following the lesson, students follow the lesson activity by activity, following the structure of the book. For the teacher, the tasks are numbered across the different activities. In the Lesson Overview, you can oversee tasks activity by activity.

In <u>Creating Lessons</u>, we also mentioned *Google Classroom*, a learning environment in which you can create classes in advance. If you check the option Google Classroom in the Assign button, you combine the advantages of both applications: Learners do not have to log in individually each time via the Lesson code and they can submit assignment work in Google Classroom.

We repeat and complement some things that are interesting if you are creating lessons

#### Applets

When you save a GeoGebra file in GG Suite, you create an activity. You'll find it on your GeoGebra profile page. You can edit an activity and add other elements to it (text, questions, etc). You can copy an activity from another author. Then you can make your own version of it. For example, you can also translate an activity into another language. An applet is only useful within Classroom if a learner can do more with it than just look at it. When creating or uploading an applet in an activity, you can define the applet's usage options and appearance in the *Advanced Settings*.

- Move the mouse pointer over the applet and click the *Edit* pen icon.
- Under the applet, click the triangle and open the *Advanced settings*.
- In the left-hand column you determine the user options in the drawing window.
- In the right-hand column, you determine which extras are shown next to the drawing window. If you show the *input bar* and *button bar*, a user can use commands and buttons to create additional objects in the applet.
- At the bottom, you decide whether the applet appears in GeoGebra Classic or Suite or in one of the apps. This way, you can let learners work in the GeoGebra interface they are used to.

▼ Geavanceer	de instellingen	
Breedte 700	Hoogte 500	Wijzig de schaal 1
🗆 Bewaar de ve	rhouding hoogte-breedte	
Rechtsklikken toelaten	, zoomen en bewerken met toetsenbord	Toon de menubalk
Inschakelen v	an het verslepen van labels	Toon knoppenbalk
Toon knop vo	oor het resetten van de constructie	Toon invoerbalk
Verslepen en	zoomen toestaan	Toon opmaakwerkbalk
GeoGebra App	GeoGebra Klassiek	
	Suite Grafische rekenmachine Meetkunde	Klaar <u>Annuleer</u>
	3D Rekenmachine	
	GeoGebra Klassiek	
+ VOEG EE	CAS rekenmachine	

In a lesson, you can have learners start in a blank window, instruct them to manipulate existing objects or create additional objects in an applet with the initial situation prepared.

#### Step-by-step plan

In a text box, you can have a learner follow a step-by-step plan. Some interesting buttons:

- Click the letter symbol <u>A</u> to open the formatting window.
- Click the buttons icon to insert a GeoGebra button icon in the text.
- In a table, you can nicely align step numbers, button icons and descriptions.

Tekst		2
Font size 🛊 B I	U icoon van GeoGebraknop invoegen \Xi 🗏 🗄 🗄 🔁	
🦅 [CODE] 🖽 🎽 🛓	🛛 🔀 [BBCODE]	
A Typ je tekst		
ſx		
		Klaar <u>Annuleer</u>

#### **Questions**

You can create multiple-choice and open-ended questions. The learner gets three answer probabilities. His answer to a multiple-choice question is immediately evaluated.

De omtrekshoek in C op de cirkelboog AMB is				
Select all that apply				
A 🗌 Gelijk aan de middelpuntshoek op dezelfde cirkelboog.				
B 🔳 De helft van de middelpuntshoek op dezelfde cirkelboog.	✓ CORRECT			
C 🗌 Het dubbel van de middelpuntshoek op dezelfde cirkelboog.				
Well-done! Your answer is correct				

For open questions, a formula editor is available in the answer field. The answer to an open question is not evaluated. However, as a teacher you can formulate a model answer that a student can compare with his own answer.

## 6.3. Organising and editing lessons

On your profile page, lessons form a separate category for easy retrieval.



You can organise your created lessons into folders. To do this, click the 3 dots (More) by the lesson's thumbnail image and select *Move to (Verplaats naar)*.



If you select *View original*, the lesson's source file opens. You can create a new lesson from it for a new class group. You can also modify the source file. The changes also appear in the lesson(s) of the already created lessons. This allows you to fix errors, add a problem or a activity with the solution(s) of your lesson.

An example of an activity (werkblad) with a step-by-step plan, a start file and an accompanying question can be found at <u>https://www.geogebra.org/m/t39b8ugj</u>. In this activity, learners follow a step-by-step plan, investigate the relationship between a perimeter angle and a midpoint angle on the same arc and answer a multiple-choice question.



# 7. The new GeoGebra math solver

GeoGebra developed a new math solver. Like other solvers, it works out mathematical expressions and solves equations. But the interesting thing about this GG solver is that it shows multiple solution methods and you can zoom in on the intermediate steps in detail. Access Math Solver via <u>GeoGebra</u> <u>Wiskunde oplosser - stapsgewijze oplosser van problemen</u>. Again you can change the language on the bottom of the page.



## 7.1. Example 1 – quadratic equation

To solve the quadratic equation  $x^2 - x - 6 = 0$ , enter this equation in the 'Enter your problem' ('Voer je probleem in') field. Click solve and you will get the screen below.



Clicking on 'solving steps' ('stappenplan') will give you the steps leading to the solution.

← Oplossingen Los de vergelijking op: Stappenplan			
$x^2 - x - 6 = 0$			
$x^2 - x - 6 = 0$ Ontbind de veelterm in factoren	~		
(x - 3)(x + 2) = 0 Deel op in mogelijke gevallen en stel elke factor gelijk aan 0	~		
x - 3 = 0 of $x + 2 = 0Los elke vergelijking op$	~		
Oplossing $x = -2, x = 3$			

## 7.2. Example 2 - making the denominator root-free

The solver makes a denominator root-free of an entered expression and simplifies the form. In the input field, enter the fraction as shown in the screenshot below.

GeoGeb oplosse	ora W er	/isl	kui	nde	9			(	A	315 <sup>2</sup> X <sup>2</sup>
Krijg stap-voor-stap u en krik je probleemopl $\underbrace{\left(\frac{2-\sqrt{3}}{1+\sqrt{3}}\right)}$	itleg over algeb lossende vaardi	ra en an gheden	ndere wi op! ≡	skundige	e problem Oplosse	nen,		-		
	123	f(x) A	BC #8							
	x	У	Ζ		7	8	9	×	÷	
		"	√:::	₩	4	5	6	+	-	
	<	>	≤	2	1	2	3	=	$\propto$	
	(	)	#	-	0		<	>	←	

Click on 'Solve' ('oplossen') and the solution appears.

## Oplossingen

Vereenvoudig de uitdrukking	Stappenplan →
$\frac{2-\sqrt{3}}{1+\sqrt{3}}$	Oefenen
$\checkmark$	
$-rac{5-3\sqrt{3}}{2}$	

Clicking on 'Solving steps' ('Stappenplan') and 'Explain how' ('Leg uit hoe'), you can visualise different steps in the solution with explanations of the steps.

← Oplossingen Vereenvoudig de uitdrukking: Stappenplan	<ul> <li>← Stappenplan</li> <li>Vereenvoudig de uitdrukking: Details</li> </ul>
$\frac{2-\sqrt{3}}{1+\sqrt{3}}$	$\frac{2-\sqrt{3}}{1+\sqrt{3}}$
$\frac{2-\sqrt{3}}{1+\sqrt{3}}$ $\checkmark \text{ Maak de noemer wortelvrij}$ $\frac{(2-\sqrt{3})(1-\sqrt{3})}{-2}$	$\frac{2-\sqrt{3}}{1+\sqrt{3}}$ $\checkmark$ Vermenigvuldig met de factor die de noemer wortelvrij maakt $\frac{2-\sqrt{3}}{1+\sqrt{3}} \cdot \frac{1-\sqrt{3}}{1-\sqrt{3}}$
Leg uit hoe $\rightarrow$	$\frac{2-\sqrt{3}}{1+\sqrt{3}} \cdot \frac{1-\sqrt{3}}{1-\sqrt{3}}$ Vermenigvuldig de breuken $\frac{2-\sqrt{3}}{1-\sqrt{3}}$ en $\frac{1-\sqrt{3}}{1-\sqrt{3}}$
$\frac{(2-\sqrt{3})(1-\sqrt{3})}{-2}$ Noteer het minteken in $\frac{(2-\sqrt{3})(1-\sqrt{3})}{-2}$ voor deze breuk	$\frac{(2-\sqrt{3})(1-\sqrt{3})}{(1+\sqrt{3})(1-\sqrt{3})}$ Vereenvoudig de noemer
$-\frac{(2-\sqrt{3})(1-\sqrt{3})}{2}$	← Terug naar de hoofdstappen