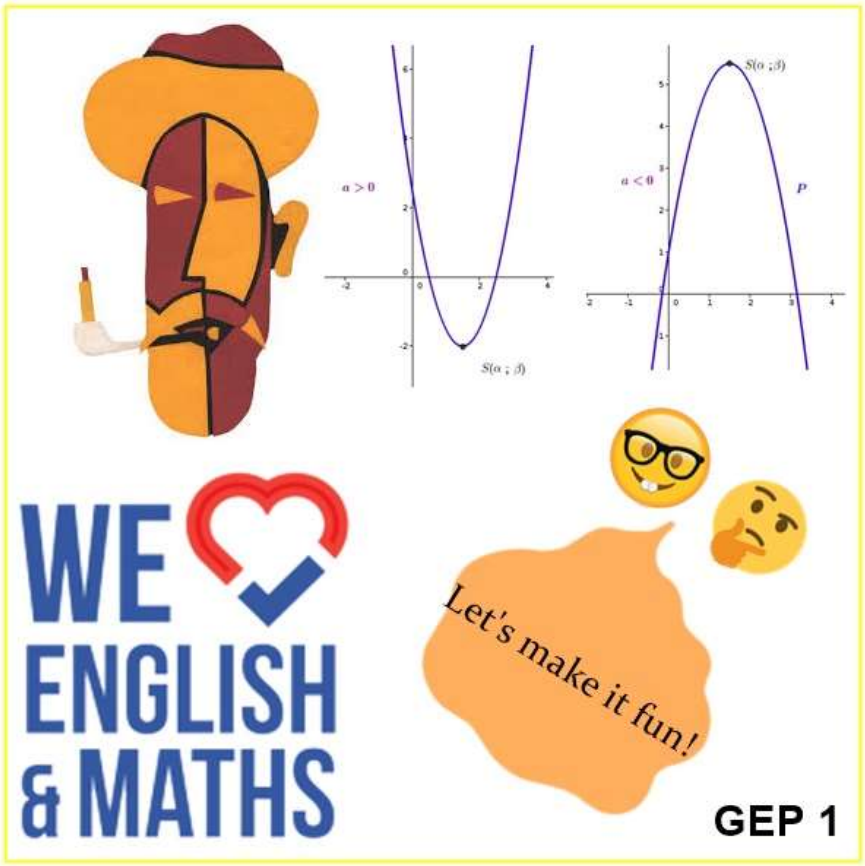
Making the quadratic function approachable



Institut Ramon Casas i Carbó
Patricia Tena Zaforas i Andrea Esteve Recatalà
Generació Plurilingüe (GEP)
Year 1 - 2018-2019

GEP 1		Task 1 : Input & Cooperative /Collaborative learning in CLIL
Title of the lesson or topic		Quadratic function – The parabola
Course / year / age		4th ESO from 15 or16-year-old teenagers
Timing		6 sessions in total. 3 sessions in January and 3 sessions in March
Collaboration with …..		Andrea Esteve Recatalà & Patricia Tena Zaforas
Short description of the session/s		**In the first three sessions, the goal is to know the parabola in real life.**
SESSION 1	**Activity 1**	Description of the activity: This is the presentation of the quadratic function from the mathematical point of view using visual aids. In order to do so, in the slide, an image of this would be shown as an example. (See slide 2 at 17 from the ppt document) 1. Type of input: spoken and visual input. 2. Type of questions: "Explicit questions" such as: How to write a function?, also "Implicit questions" such as: Can you write a function? Give us an example (teachers write in board and comment with students). Explicit questions are "What is the classic way of writing a function? or "Could you think further"? and "Referential questions" such as: "Do you remember the lineal function from last year (3rd ESO)?". This would imply to make connections with the first and second stage of Bloom's taxonomy (remember and understand). 3. Collaborative and cooperative activities: There are neither collaborative nor cooperative activities since it is the Maths teacher who is in charge of giving all the input. 4. Materials used: PowerPoint presentation, projector, computer, and both English and Maths teacher's involvement. 5. Timing: 20 minutes.

	Activity 2	Description of the activity: This is a brainstorming activity among the students where and when they see a parabola: in a public fountain, in a building, in a basketball throw, etc. 1. Type of input: spoken and visual input. 2. Type of questions: "Implicit questions" such as: "Do you think that these are parables?. Why?". To make reference to the second stage of Bloom's taxonomy (understand) the Google search or Google scholar can be used for the students to find out some information without solving out the activity itself. This solution of the activity would be done by the teachers. 3. Collaborative and cooperative activities: There is no cooperative activity. However, it is collaborative because everyone participates and expresses their own ideas and thoughts. 4. Materials used: PowerPoint presentation, projector, computer, time needed for previous preparation of the flashcards, flashcards themselves and both English and Maths teacher's involvement. 5. Timing: 10 minutes.
	Activity 3	Description of the activity: This activity will be mainly based on a flashcard game. Therefore, it consists of a quiz with flashcards related to the parabola. The teacher will give the students a bunch of images (Sagrada Familia in Barcelona, Oceanográfico in Valencia, etc.) and they need to discern whether this is a parabola or not. This would be done in sets of 4 grouped by the "day-and-month dynamic". This technique consists of the group organisation in which they cannot speak and they need to manage themselves in a line. In that case, they need to find the order based on the day and month of their birth. Once they are all organised, they need to say the day and month out loud. They are meant to be able to do it correctly without using the language, just by gestures. 1. Type of input: visual input and hands-on 2. Type of questions: Referential question as "To be or not to be a parabola" 3. Collaborative and cooperative activities: There is a collaborative activity because the students play with one another. 4. Materials used: 17 flashcards of which 13 represent a parabola and 4 are a similar figure. However, it cannot be defined as a parabola. For instance, one reason why it is not a parabola is that it does not have vertex. 5. Timing: 15 minutes Students are provided a handout (that is also shown in the PowerPoint presentation). Teacher uses this scaffolding technique so that the student knows exactly how to express what they are willing to say. Otherwise, they might panic and this is precisely what this scaffolding dynamics prevents.

SESSION 2	**Activity 4**	Description of the activity: This activity runs as follows: ● Presentation of an expert mime in throwing balls of juggling that he will make a demonstration trying to draw parabolas in the air. ● In the same groups of activity 3 (4 people): o Each students make three juggling balls with balloons and rice. o The teacher conducts the activity, stress the importance that all the balls have the same weight (125 g). o The teachers explain the Anglo-Saxon system of weights and measures. o But we don't' have scale or meter. We have empty water bottles and funnels. They have to think that with each pack of half a kilo of rice they can make 4 balls and therefore they must distribute each package in 4 bottles. o With the balloon somewhat swollen students should introduce the neck of the bottle at the end of the balloon so that when turning it the rice falls into the balloon. Let the excess air escape and cut out the excess balloon. Place other pieces of balloon that close the opening. o Imitate the mime to draw parabolas in the air. The language being used while imitating the mime or the mime itself is: "Look at me", "Is this a parabola?", "Here's the ball", "Is the ball properly made", "Are you sure you've got all the right measures?", "Did you get the same result as the expected one?", "Do you think you can do more on your own"?. They are going to have a video explaining this in the big screen. o Students take pictures of each other when the partner manages to draw a parable with the juggling balls (or even a video). The compulsory thing to be done is the picture because we need evidence to use it in the Geogebra program used afterwards. o The teachers will assign roles being the following one: one person (material finder) responsible for finding the material the group needs, another student (problem manager) maintains contact with the other groups in the face of difficulties, another one (group coordinator) coordinates that the whole group advances more or less at the same time and if someone needs help to move forward, ask the group for collaboration, The last one (Tidier) coordinates that the group returns the material that is left over and everything is clean and collected. 1. Type of input: visual input and hands-on 2. Type of questions: Implicit questions" such as: "Can I do a parabola with juggling balls? Why?" 3. Collaborative and cooperative activities: There is a collaborative and cooperative activity because the students do the juggling balls together and them they need your partner for to take some pictures (or non-compulsory videos). 4. Materials used: Bottles, rice and balloons (see slides 15 and 16 for amount). 5. Timing: 50 minutes.

SESSION 3	**Activity 5**	Description of the activity: This activity is based on the tool called "AnswerGarden". It consists of a website in which anonymously students answers a particular question. The more repeated answer it gets, the bigger it gets. The students would just need to type in the reply and see it on the screen with the rest of answers from the other classmates. Thus, the more recurrent ones would stand out being all in the big screen. Which words come to mind when we talk about the quadratic function? We hope that they write a parabola (as the most prominent) but also: function, second degree, vertex, axis of symmetry, minimum, axis of x, axis of y, etc. 1. Type of input: visual input 2. Type of questions: Referential question 3. Collaborative and cooperative activities: There is a collaborative activity because among all the students we will create the image AnswerGarden 4. Materials used: Projector and computers 5. Timing: 10 minutes.
	Activity 6	Description of the activity: This activity will be mainly based on pictures that students have taken themselves about juggling. Students will insert the pictures they have taken while juggling the parables in the "Geogebra" math computer program. With the help of the Geogebra computer program, the students will identify the remarkable points of the parabola: vertex, cut point with the axis of the abscissa and the ordinate, etc. They will be able to verify that although they have done the same (a parabola with balls of juggling) the function of second degree that results are different. Students will share their work in the cloud. 1. Type of input: Visual input 2. Type of questions: In this case, questions would be made by students when they are not following the instructions for the Geogebra or they would probably be addressed from the teacher to ask for clarification. The questions that we might predict are: What's the function of your parabola? Is the coefficient of incognita positive or negative? Why do you think is that? How have you come to this conclusion? 3. Collaborative and cooperative activities: This is an individual task. 4. Materials used: Pictures that they are shown in last session, computers and Geogebra program. 5. Timing: 40 minutes.

In terms of academic content, what are the students learning and what are they learning to do?	Tackling the academic content (leaving language aside), the purpose from this standpoint is that they acquire the knowledge on the quadratic function in 4TH ESO through the parabola. Besides, they are also supposed to use ICT tools in order to construct this parabola and be able to represent its function. Thus, the mathematical, digital and social and personal competence are present throughout the three GEP sessions. **Competences and key contents** (see explanation numbers in annex): ● Mathematical competences: 1, 4, 6, 8, 9, 11 and 12. o Key contents: 1, 4, 6, 7, 8, 9 and 12 ● Digital competences: 1, 2 and 5 o Key contents: 1, 3, 8, 9 and 10 ● Personal and social competences: 1, 2, 3 and 4 o Key contents: 1, 2, 5, 8, 10, 14, 15, 17, 19 and 20.
In terms of language, what are the students practicing or learning to do?	In terms of language, they are basically learning how to acquire the competence of communication. However, grammatically speaking, they are putting into practice the grammar of the textbook unit being "The conditionals and the time clauses". The patterns they might use are the succeeding ones: "What would it happen if this had _____?", "What would have happened if this had been _____"?. "Do you wish you had focused on _____"?. In that way, it is the teachers who are in charge of making them use these structures although it is a Maths-content based project. Moreover, apart from the grammar and the communicative competence acquired, lexicon is dealt previously in the English class as such so that they do not have problems while conducting these three sessions of Maths "IN ENGLISH". It is a way of preventing it from being a handicap.
In what way is this lesson plan a good example of what we learnt in the GEP course session?	In this task, we have reflected some of the knowledge acquired in our GEP sessions. Instances of this are the following resources and different approaches dealt. These are the succeeding ones: "Answergarden" website, the types of input, Bloom's taxonomy, useful techniques for grouping students, flashcards (materials employed), types of dynamics for class management, among others. We need to say that although It is not explicitly stated, we are taking into consideration all the multiple intelligences that we can have in a class. Therefore, it is thought for being accessible for everyone. Furthermore, it is worth saying that we thought about doing a "Dictogloss". However, as the students need to be ready familiar with the concept, we will do it in the Task 2 part.
Other important information	See annexes to relate to competences and key contents.

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Self assessment Checklist

Task 1 : Input & Cooperative /Collaborative learning in CLIL	YES/NO
1. Students are presented with **multimodal** and **varied** input (spoken, written, visual, hands-on…)	Yes
2. The input presented is used to **help** learners **understand** ideas and **construct** meaning	Yes
3. The input is presented at the right **cognitive level** and the right **language level**, i.e. it is neither too challenging in terms of content nor too difficult in terms of language.	Yes
4. Students are **helped** in some way to **understand,** i.e. input is made comprehensible	Yes
5. Students are **helped** in some way to **process** the input presented, i.e. activities or questions make students think and construct meaning.	Yes
6. The input and activities presented cater to **multiple intelligences**	Yes
7. Students are presented with **good questions** (explicit, implicit and referential) that help them process input and that challenge them not only to understand, but to think, create...	Yes
8. A variety of **collaborative learning strategies** are used throughout the session.	Yes
9. At least one of the activities presented requires **cooperation** among students.	Yes
10. Students are **explicitly taught** how to work in groups (or pairs).	Yes
11. Students are **explicitly guided** to succeed in group/pair work **discussions** and **interactions**. Clear **support** to guide their interactions is provided.	Yes
12. At least one **ICT tool** is used to promote **digital collaborative learning**.	Yes

ANNEX

Mathematical, Digital and Social and Personal competences. Key contents.

COMPETENCIES IN THE MATHEMATICAL REALM

DIMENSIONS	Problem resolution	**Competence 1.** Translate a problem to mathematical language or to a mathematical representation using variable, symbols, diagrams and suitable models.
		Competence 4. Generate questions of mathematical brink and pose problems.
	Reasoning and Checking	**Competence 6.** Employ the mathematical reasoning in non-mathematical surroundings.
	CONNEXIONS	**Competence 7.** Use the existent relations that between the diverse parts of the mathematical elements to analyses situations and reasoning.
		Competence 8. Identify the mathematicians involved in following and academic situations and look for situations that can relate.
	Communication and representation	**Competence 9**. Represent a concept or mathematical relation in some ways and use the change of representation as a strategy of mathematical work.

KEY CONTENTS IN MATHS

1. Sense of the numeral and of the operations.
4. Language and algebraic calculation.
6. Representation of functions: graphic, tables and formulas.
7. Analysis of the change and type of functions.
8. Space sense and representation of three-dimensional figures.
9. Geometrical figures, characteristic, properties and processes of building.
12. Metric relations and calculation of measures in figures.

COMPETENCIES IN THE DIGITAL FIELD

DIMENSIONS	**Instruments and applications**	**Competence 1.** Select, configure and program digital devices as the tasks to carry out.
		Competence 2. Use the applications of edition of texts, multimedia presentations and treatment of numerical data for the production of digital documents.
	Treatment of the information and organization of the surroundings of work and learning	**Competence 5**. Build nine personal knowledge by means of strategies of treatment of the information with the support of digital applications.

KEY CONTENTS OF THE DIGITAL FIELD

1. Basic functionalities of the devices.
3. Storage of data and backups.
8. Systems of projection.
9. Tools of edition of documents of text, presentatior
numerical data.
10. Audiovisual language: fixed image, sound and vi

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PERSONAL AND SOCIAL COMPETENCIES

DIMENSIONS	**Auto-knowledge**	**Competence 1.** Take consciousness of a same and involve in the process of personal growth .
	Learn how to learn	**Competence 2**. Know and put in practical strategies and habits that take part in the own learning.
		Competence 3. Develop skills and attitudes that allow to face the challenges of the learning along the life.
	Participation	**Competence 4**. Take part to the classroom, to the centre and to the surroundings of reflexive and responsible way.

KEY CONTENTS ON PERSONAL AND SOCIAL DIMENSION

Autoknowledge	1. Feeling and physical capacities. 2. Cognitive capacities. 3. Feelings capacities. 4. Healthy habits. 5. Personal grown of attitude.

Learn how to learn	6. Learning habits. 7. Learning planning. 8. Organisation of knowledge. 9. Consolidation and retaking of knowledge 10. Learning transfer 11. Features on the nowadays society. 12. Lifelong learning 13. Attitudes and habits in the social and professional world. 14. Group work. 15. Dynamics on the grouping. 16. Digital tools for collaborative tasks.

Participation	17. Habits and attitudes in the participation. 18. Spaces for participating. 19. Resources and techniques for participating. 20. Digital resources for participation.

ANNEX

ACTIVITY 3: FLASHCARDS WHICH ARE ACTUAL PARABOLES

Grouping: In groups of 4, it is two students against two more.

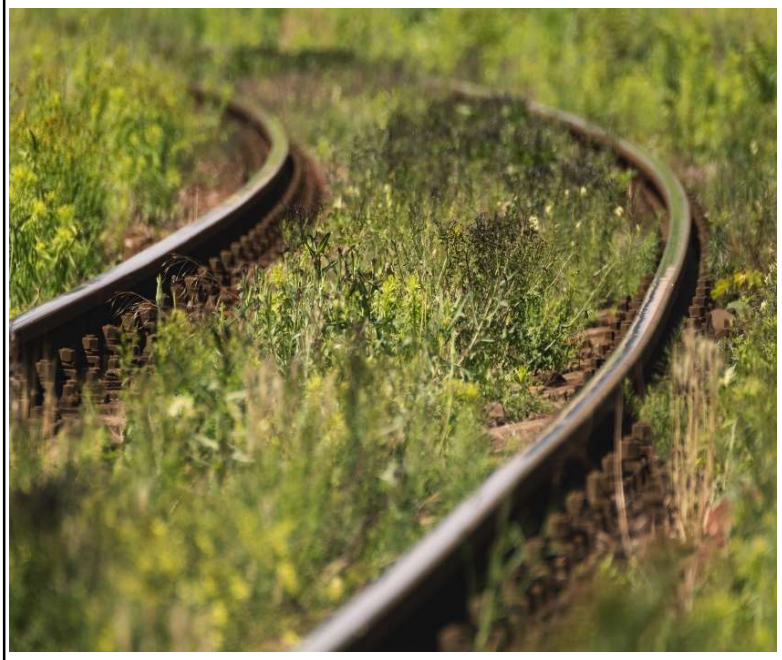
We need 24 Flashcards, 18 are parables and 6 are not.

Each flashcard is put upside down in a deck of cards. One couple takes a card and says if they consider it is a parabola or not. If it is not and they get it right, the couple of students keep it and they get a point. If it is not a parabola and they do not get it right, they lose their cards that they have been collecting (Present Perfect Continuous) so far and they are shuffled once again. In any case and in any moment, the couple can abandon the game.

Links from the images in the flashcards

https://ca.wikipedia.org/wiki/Fitxer:ParabolicWaterTrajectory.jpg
https://aquadocinc.com/product/airmax-ecoseries-arch-premium-nozzle/
https://de.wikipedia.org/wiki/Datei:Langwiesbridge.jpg
https://www.livescience.com/50411-quadratic-equations.html
https://es.m.wikipedia.org/wiki/Archivo:Font_M%C3%A0gica_de_Montju%C3%AFc_10_(2009-05-24).JPG
https://blog.sagradafamilia.org/en/divulgation/the-pediment-of-the-passion-facade-jesus-victory-over-death/
https://en.wikipedia.org/wiki/L%27Oceanogr%C3%A0fic
https://en.wikipedia.org/wiki/L%27Oceanogr%C3%A0fic#/media/File:L%27Oceanografic,_Valencia,_Spain_2_-_Jan_07-cropped.jpg
https://community.eeducation.at/course/view.php?id=116&lang=en
https://es.m.wikipedia.org/wiki/Archivo:St_Louis_Gateway_Arch.jpg
https://es.wikipedia.org/wiki/Archivo:Superman_El_ultimo_escape_-_SIx_Flags_Mexico.jpg
https://es.m.wikipedia.org/wiki/Archivo:Sagrada_Familia_looking_up_at_ceiling.jpg
https://www.flickr.com/photos/7455207@N05/4611419343
https://www.flickr.com/photos/7455207@N05/with/4611419343/
https://ca.wikipedia.org/wiki/Fonts_de_Barcelona#/media/File:Font_de_Portaferrissa_BCN.JPG
https://ca.wikipedia.org/wiki/Fitxer:Can_Cort%C3%A8s_(Palau-solit%C3%A0_i_Plegamans)_1.jpg
https://commons.wikimedia.org/wiki/File:Fuente_de_Cibeles._La_Granja._03.jpg

The Spacek Falcon 9 rocket launches the Dragon to the International Space Station,
Cape Canaveral Air Force Station, Florida, June 29, 2018



Railway tracks

Tester

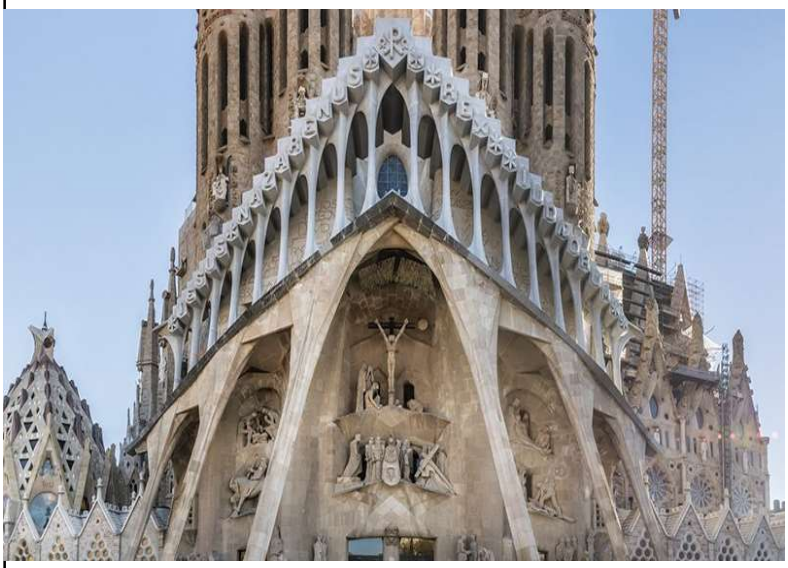
Hercules fountain at Island's garden,
Royal palace, Aranjuez, Madrid, Spain

Fontain in Adeladiem Australia

Langwies viaduct on the RhB Arosa line,
Switzerland

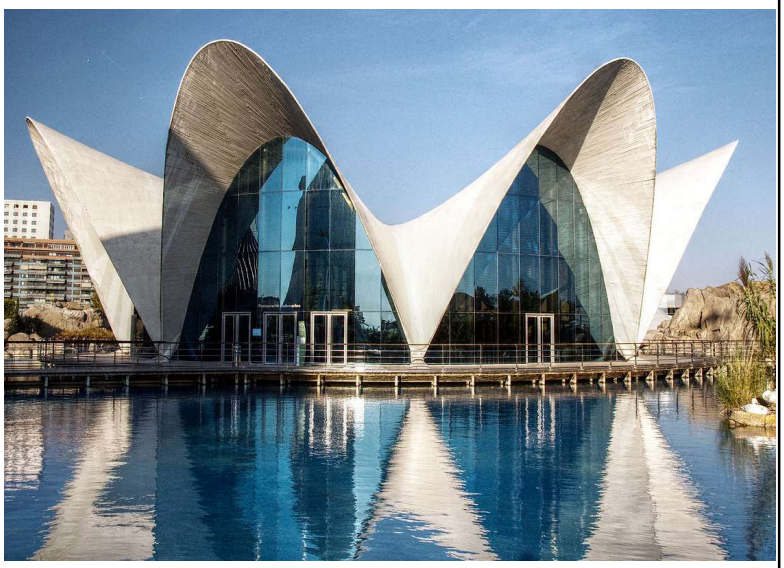
Monte Carlo Casino in Monte Carlo, Monaco, Cote de Azul, France

Montjuïc Light Fountain, Barcelona



The pediment of the Passion facade: Jesus' victory over death, Sagrada Família, Barcelona

Entrance to the marine complex "Oceanogràfic", Valencia



The underwater restaurant, "Oceanogràfic", Valencia

The Gateway Arch, part of the Jefferson National Expansion Memorial in St. Louis, Missouri, framing the courthouse where the Dred Scott decision was read.

Superman El Último Escape,
roller coaster at Six Flags park, México

Sagrada Familia interior, looking up at ceiling from near the centre of the nave, Barcelona

La Pedrera or Casa Milà interior, Barcelona

Double rainbow at Savonlinna, Finland

McDonald's logo

Portaferrissa Fountain (1680), Barcelona

Can Cortès, Palau-solità i Plegamans, Barcelona

Cibeles Fountain, La Granja de San Ildefonso, Segovia, Spain

ANNEX

PRESENTATION PPT IN CLASS

The quadratic function

The parabole

Mathematics Symbols

+	plus
−	minus
×	multiplied by
÷	divided by
±	plus or minus

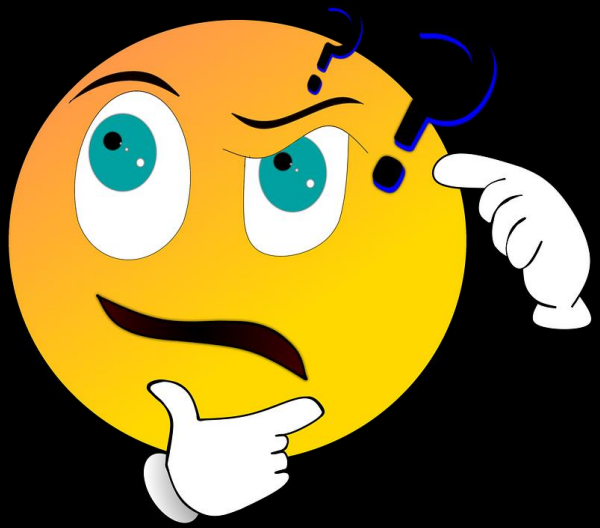
=	is equal to
≠	is not equal to
≈	is similar to
≅	is congruent to
∞	infinity

⇔	is equivalent to
⇒	implies
θ	theta
∅	empty set
Δ	triangle or delta

Activity 1

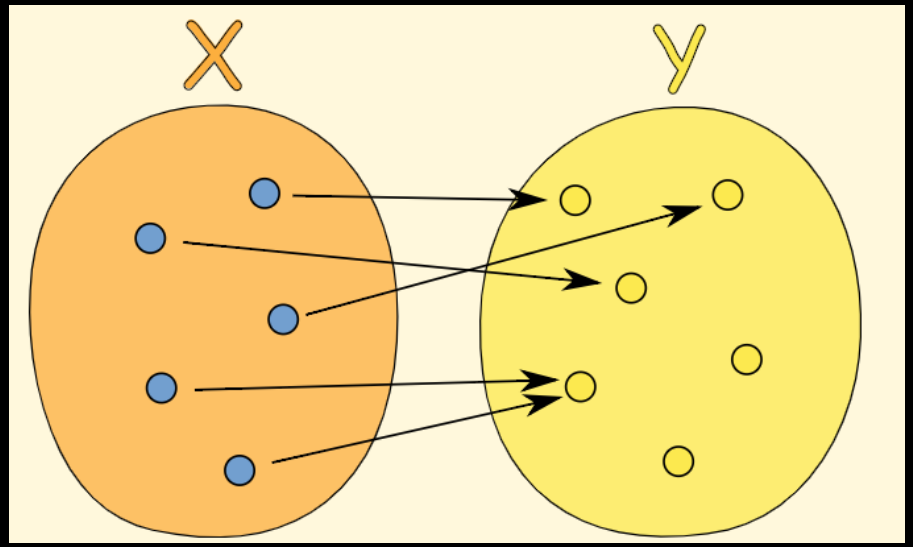
What is a function?

We hope that is not your face..



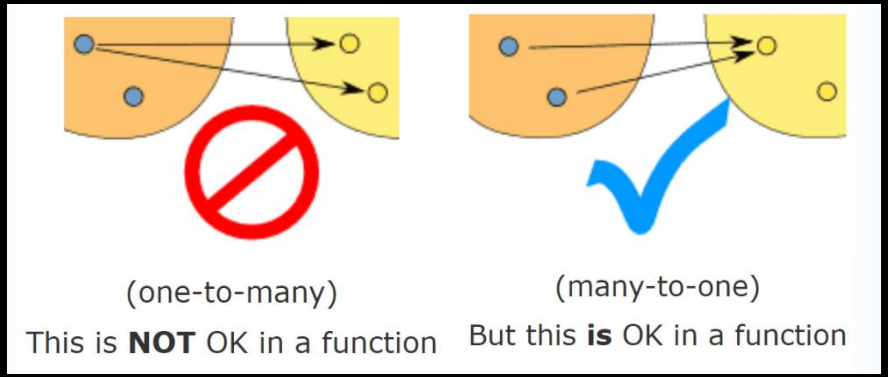
Do you think that’s all?
NO WAY!

A function relates an input to an output, only an output.



"One-to-many" is **not** allowed,

but "many-to-one" **is** allowed:



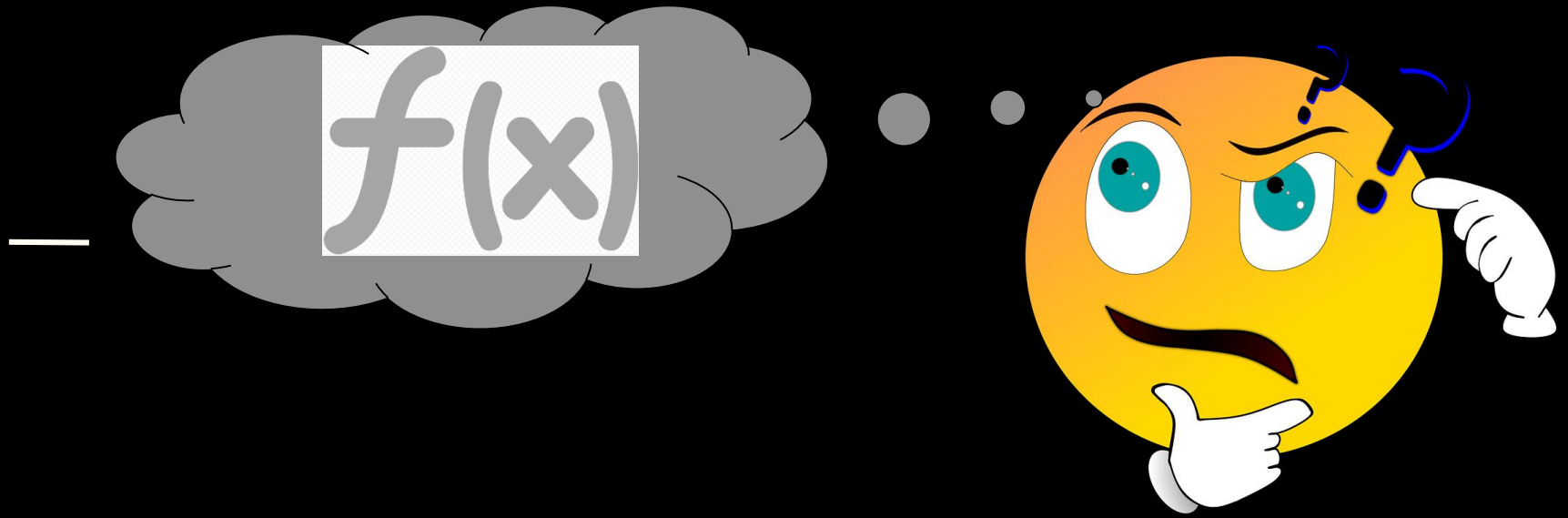
(one-to-many)

This is **NOT** OK in a function

(many-to-one)

But this **is** OK in a function

Do you remember last course?

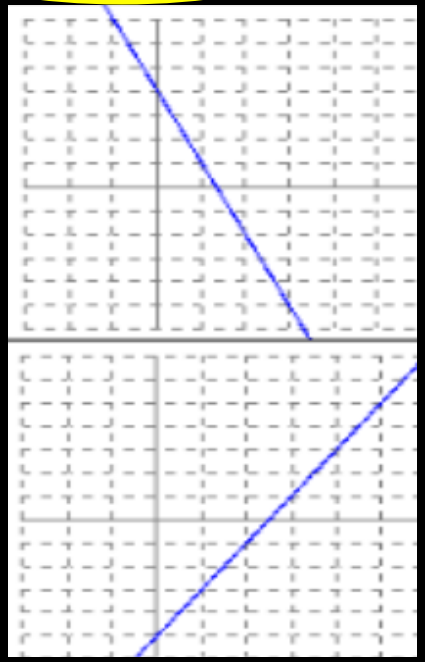


The classic way of writing a function is: **f(x) =**

In 3rd course you has seen the lineal function e.g.

f(x) -3x + 4

f(x) 2x – 5

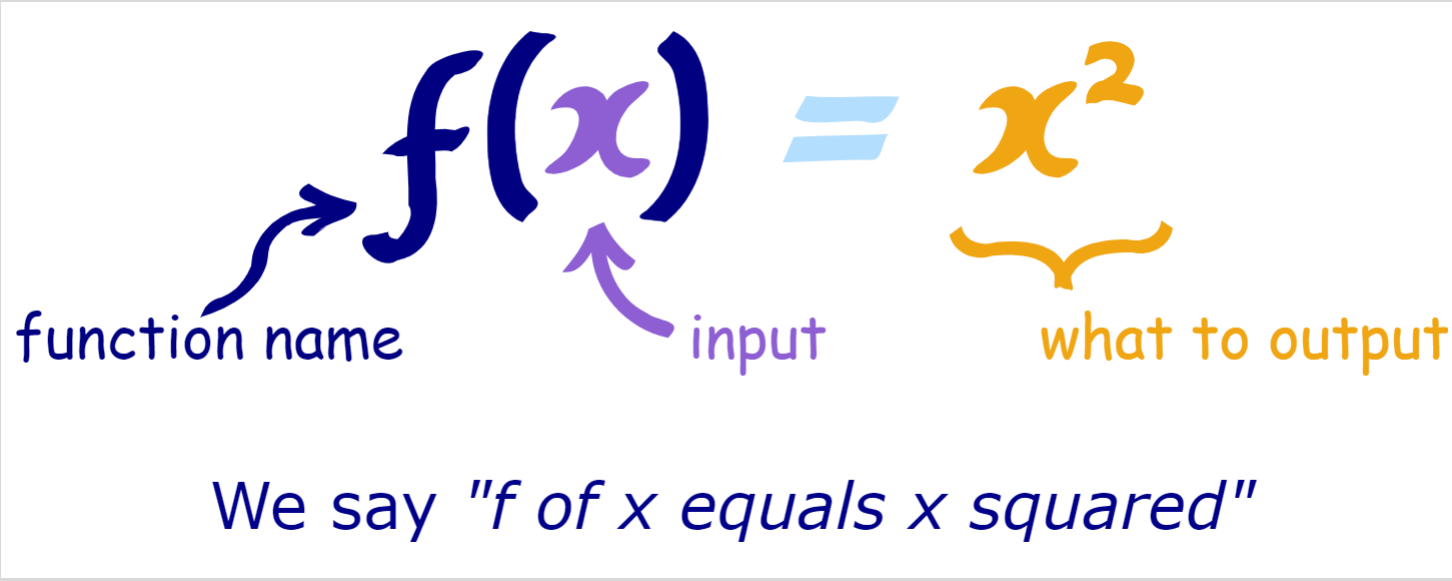


Now, you will learn the quadratic function

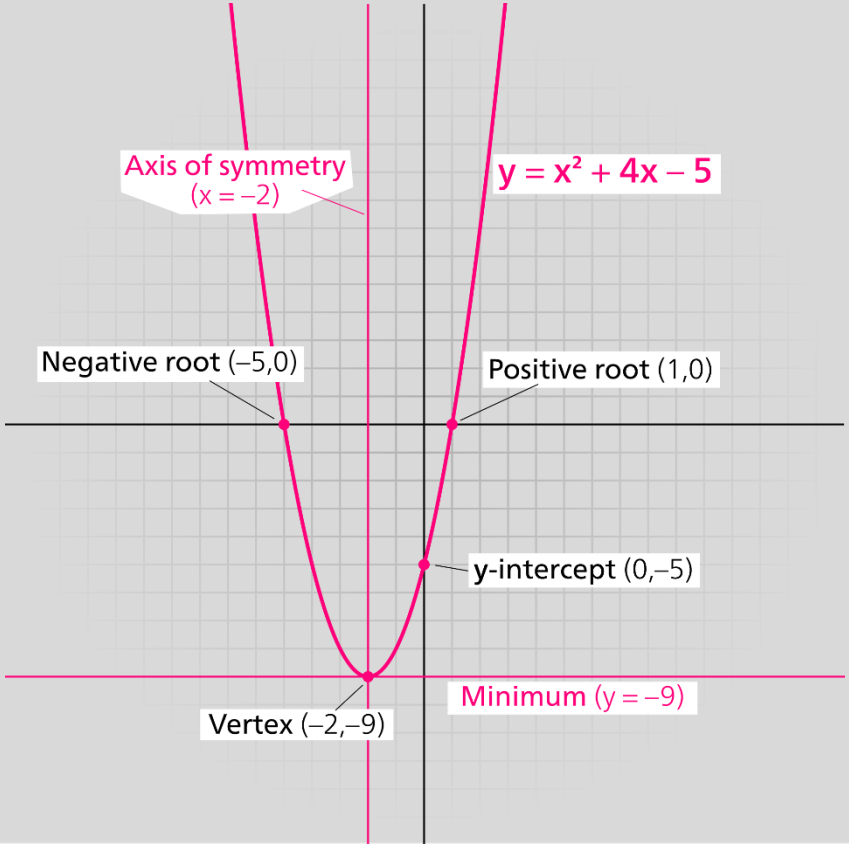
x^2

(squaring)

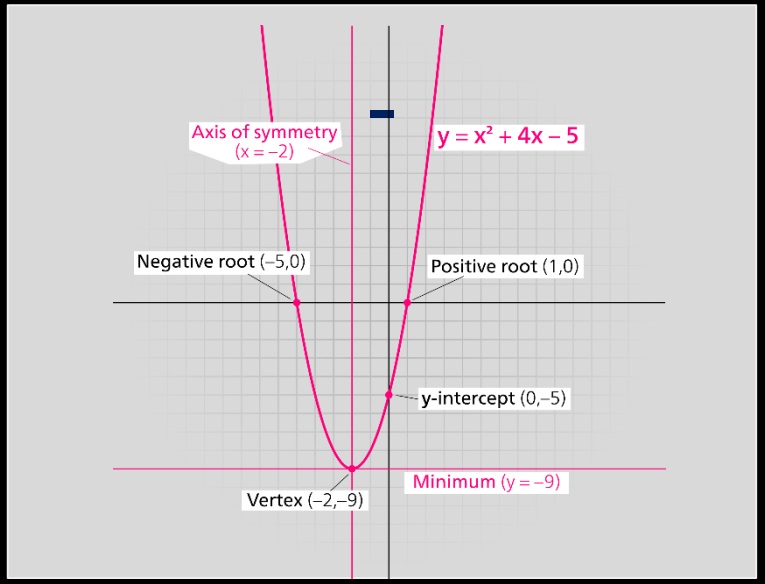
We say…


f(x) = x²
function name
input
what to output
We say "f of x equals x squared"

The graph of quadratic function is a **parabola**



Main characteristics of the parabola that form the quadratic function:

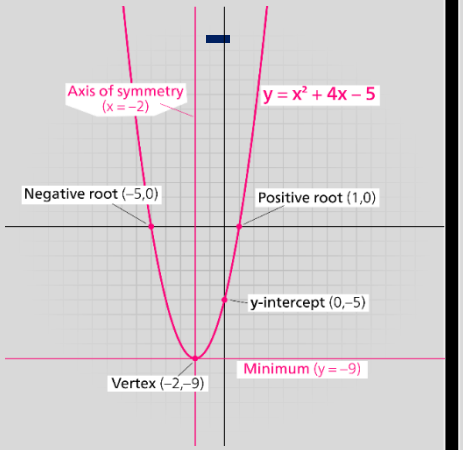


- The vertex is a single point

- The branches are never parallel

- They are always vertical

Properties of the quadratic function:



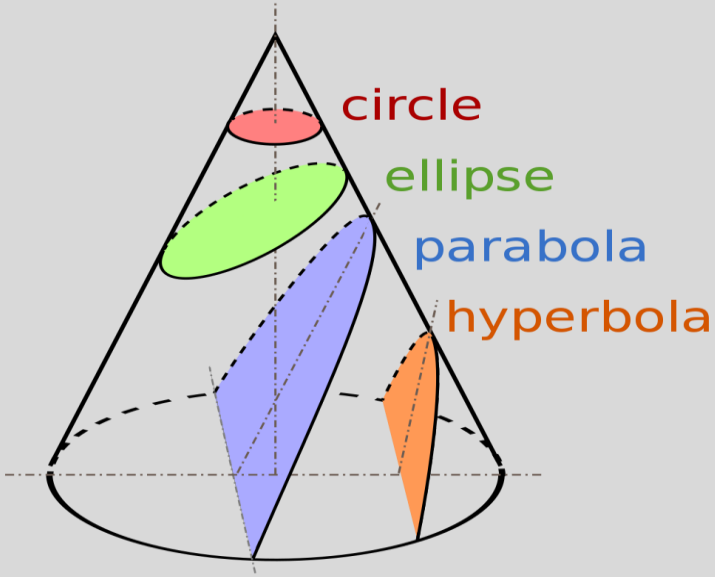
- A function is **quadratic** if it has this algebraic expression:

$$\mathbf{f(x) = ax^2 + bx + c}$$

(a, b, c ϵR, a$\neq$0), with a polynomial of degree 2.

- Its graph is a **parabola**, with a relative extremum in a point called **vertex of the parabola**.
- The **vertex** has x = **-b/2a** as abscissa, and the parabola has a **symmetry axis** in **x = -b/2a**.

A parabola is a section of the conus



So, are these parables?

When is it a parabola and when is it not?

This is a parabola because…

- **It has a maximum, only a maximum point (a minimum is also possible).**
- **The branches are not parallel.**
- **It has a vertical axis of symmetry.**
- **It is concave (the branches are not straight lines).**

Vocabulary discussion. Is it a parabola?

Could you think about it?

I think this is a parabola because…

I think this is not a parabola because…

I agree with you / I don’t agree because

This picture doesn’t accomplish the condictions to be a parabola because…

Vocabulary discussion. Is it a parabola?

Are the glasses paraboles?

Why or why not?

Vocabulary discussion. Is it a parabola?

Are the eyebrows paraboles?

Vocabulary discussion.

Is it a parabola?

Useful Debate Vocabulary

"I'm listening to the other side."

- I see your point, but I think...
- Yes, I understand, but my opinion is that...
- That's all very interesting, but the problem is that...
- I'm afraid I can't quite agree with your point.
- I think I've got your point, now let me respond to it.
- I can see what you're saying. Here's my reply...

"I need to say something now."

- I'm sorry to interrupt, but ...
- Excuse me, but that's not quite correct.
- Sorry, I just have to disagree with your point.
- Let me just respond to that, please.
- Forgive me for interrupting, but I must respond to that.
- Hold on a moment, that's not correct.

"You haven't replied yet."

- I said that... but you haven't replied to my point.
- I'd like to focus on two points that the other side has failed to address.
- I want to call your attention to an important point that you have not addressed yet.
- I must stress again that ...

"Well, I think that..."

- My position is the following...
- Here's the main point I want to raise...
- I'd like to deal with two points here. The first is...
- Let me just restate my position.
- Just to be clear, here is what I mean...

"So finally, we..."

- To sum up...
- I pointed out that...
- To recap the main points...
- Let me summarize my position in this debate.
- In summary, I want to point out that...

(Source: These phrases are from Debate and Discussion by David Moser)

Activity 2

Where are there parables?

Let's think for a while where or when we have seen parables

ACTIVITY 3

FLASHCARDS GAME

In groups of 4, it is two students against two more.

We need 17 Flashcards, 13 are parables and 4 are not.

Each flashcards are put upside down in a deck of cards. One couple takes a card and says if they consider it is a parabola or not. If it is not and they get it right, the couple of students keep it and they get a point. If it is not a parabola and they do not get it right, they lose their cards that they have been collecting (Present Perfect Continuous) so far and they are shuffled once again. In any case and in any moment, the couple can abandon the game.

The game finishes when they all abandon or when the time is up (which is 3 minutes).

ACTIVITY 4

We make and play with juggling balls

Activity 5

AnswerGarden

Do you remember the properties and the characteristics of the quadratic function?

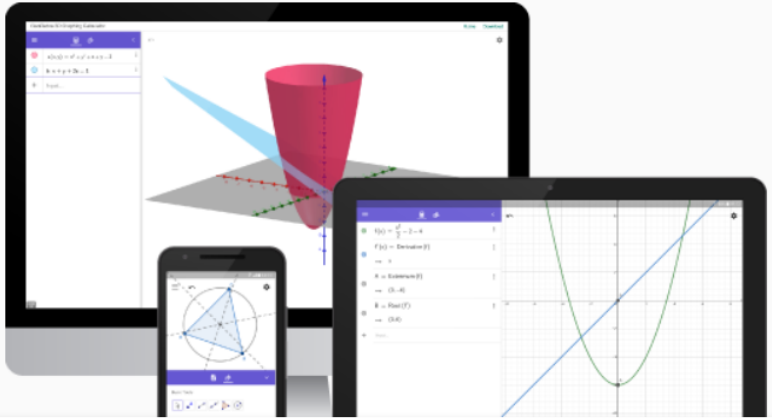
Let’s go…

Activity 6 - Geogebra

GeoGebra Math Apps

Get our free online math tools for graphing, geometry, 3D, and more!

START GRAPHING | CLASSROOM RESOURCES



New Math Apps

- Graphing Calculator
- Geometry
- 3D Graphing
- Augmented Reality

Classic Apps

- GeoGebra Classic
- Spreadsheet
- Probability
- CAS

Offline Apps

- App Store
- Google Play
- Microsoft Store
- App Downloads

GEP 1	Task 2: Reading, writing and Assessment in CLIL
Title of the lesson or topic	Let's deepen on the quadratic function!
Author	4th ESO. Students from 15 to 16 years old.
Course / year / age	Continuing with the 3 previously implemented sessions, three sessions will be made in March.
Number of sessions	3 sessions
Collaboration with...	Patricia Tena Zaforas and Andrea Esteve Recatalà.
Main objectives of the sessions	The aims of this second part of GEP 1 in TASK 2 are the succeeding ones: 1. To make sure the students understand what a quadratic function is. 2. To be able to identify the features of quadratic function (Domain, Range, and Concavity). 3. To know how to calculate and draw symmetry axis, vertex, x-intercepts and y-intercept of a quadratic function. 4. To identify quadratic functions used in real life. 5. To solve a problem word on their own and compare the result with their peers.

	6. To state their opinion in English. 7. To manage Mathematical vocabulary about functions. 8. To foster the specific vocabulary for the chess game. 9. To be able to recognise the minimal-pair sounds /ɜː/ and /ɛə/. 10. To foster the "h-sound" aspiration and identify meaning changes. (Minimal-Pairs).
Short description of the sessions	The sessions aim at creating a full view of what a quadratic function means, having a huge support from the teachers involved. We acknowledge that the students might find the quadratic function and its features quite tough. However, with this session, our objective is making it so approachable and fun for the students so that they remember it as something to be understood and applied relatively easy. In order to do that, several dynamics covered in GEP sessions ranging from "Grouping" to "Assessment" through giving "Input" will be implemented. Sessions will be definitely carried out in English as a vehicular language. Therefore, some language support is undeniably needed. The sessions and the activities are fully explained below.

S E S S I O N 1	**Activity 1**	**Type of activity**: Time: 30 minutes This is a Crossword activity in which the content teacher prepares a text related to the quadratic function whereas the English teacher makes sure the language content is appropriate and creates the crossword itself. This activity would be done in four groups of three students. Students need to work collaboratively to solve the crossword. Regarding group forming, they will be made in chess pieces. Students will be provided with language support dealing with a "Vocabulary chess set". Then, to form those groups, three equal pieces of four types will be employed. Students must resolve the Crossword about features of the quadratic function (axis of symmetry, vertex). The following image shows the crossword used. It needs to be stated that in the "Annex" section, the answers for it are shown. In this first activity, apart from the following table being given, the teachers provide the students with language support. The following quizlet will be used for teaching the vocabulary below. This vocabulary is needed to follow the class. The link for the quizlet is the following one: https://vocabulariodeingles.blogspot.com/2015/02/vocabulario-del-ajedrez-en-ingles.html

Vocabulary employed which has been taken from this resource:

CHESS VOCABULARY	
Alfil	Bishop
Caballo	Knight
Juego de ajedrez	Chess set
Peón	Pawn
Piezas de ajedrez	Chess pieces
Reina	Queen chess
Rey	King
Tablero de ajedrez	Chessboard
Torre	Castle/rook

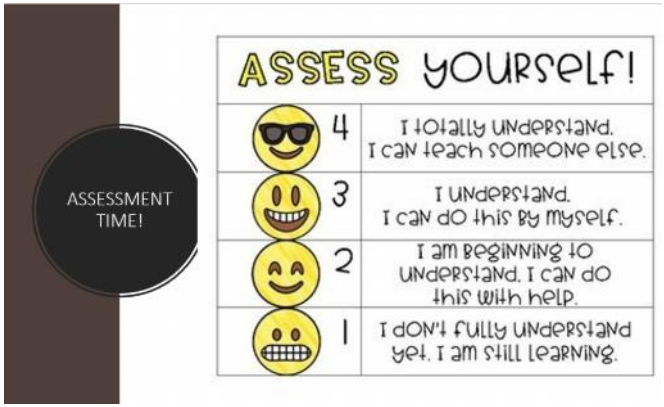
Materials used: Quizlet, Text with the descriptions, Crossword, Language support (shown on paper, printed).

These sentences will also be shown on the screen:

How can I say it?

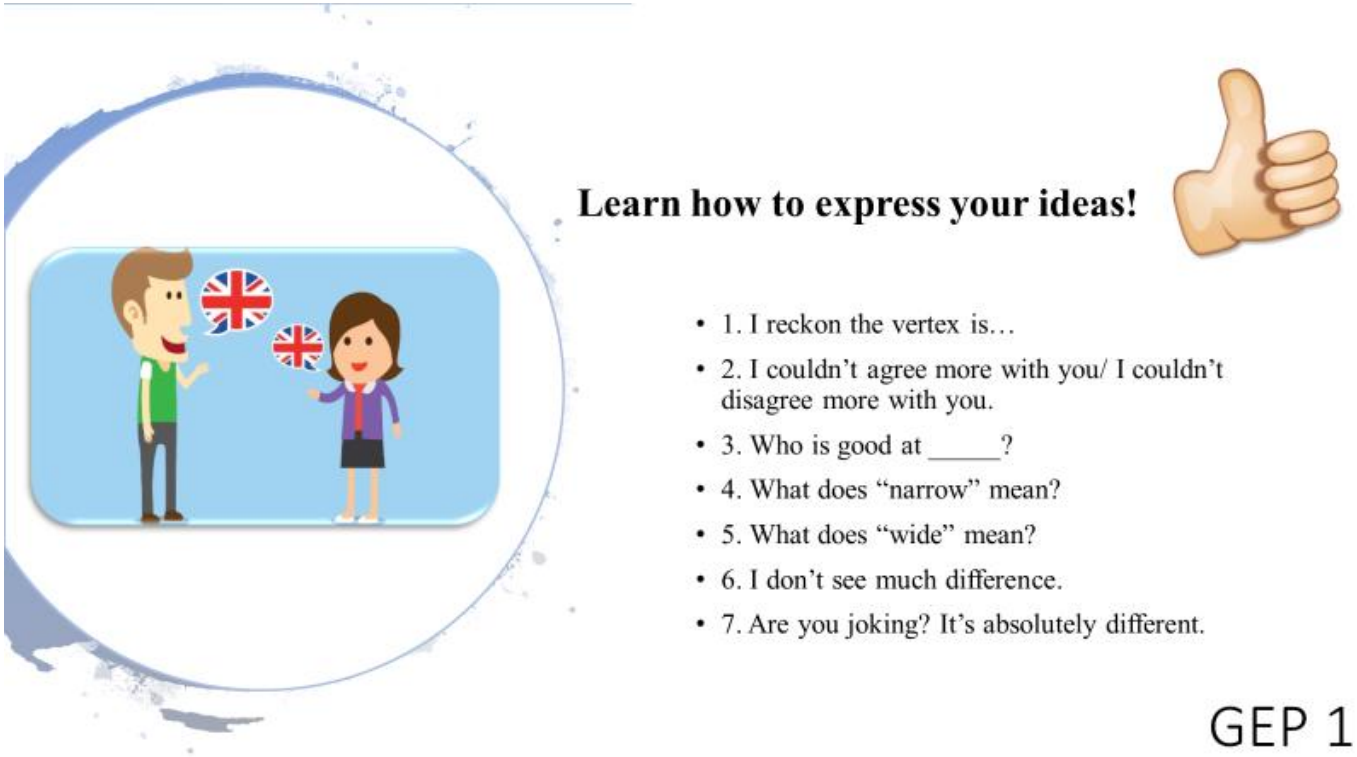
It must be...	It can't be...
It is related to...	It might be...
I couldn't agree more with that.	The word I don't understand is...
Can you help me with this one?	I am lost. What's going on?

Assessment rubric:

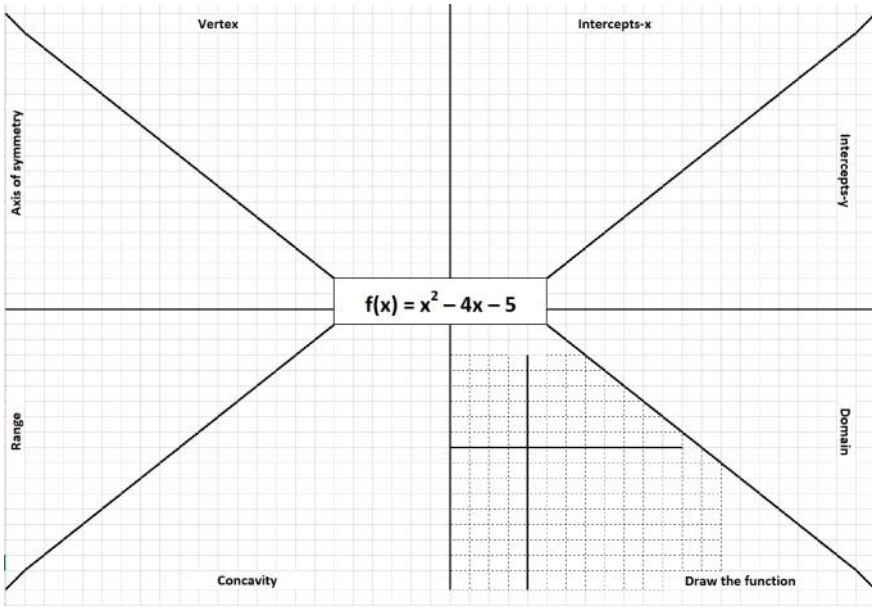


	Activity 2	**<u>Type of activity:</u>** Time: 30 minutes This activity embraces the technique of the "Placemat". The content teacher prepares the text with a function in the middle and the features of quadratic function around. The students must solve the features of quadratic function. The groups will be done with the technique of "real objects" being, in this particular case, chess pieces. From the maths perspective, the function which has been selected for all the students is the one below. Thus, it has been extracted from the link associated to it. $f(x) = x^2 - 4x - 5$ http://matematica.cubaeduca.cu/media/matematica.cubaeduca.cu/medias/interactividades/piu/53Func_cuad/co/Funciones_cuadraticas_3.html Once the students have the placemat in front of themselves, they have to identify the part of the function being the ones indicated as follows. They are: 1. Axis of symmetry 2. Vertex 3. X-intercepts 4. Y-intercepts 5. Draw the graph 6. Domain: $x \in \mathbb{R}$ 7. Range: $\{y \in \mathbb{R} : y \geq -9\}$ 8. Concavity: 

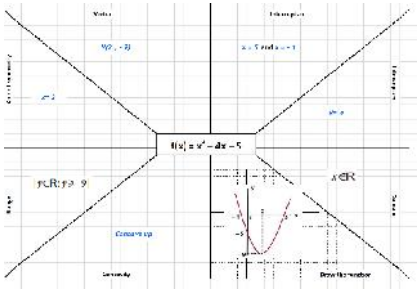
Language support:



This is the placemat that will be employed:



These are the solutions for the placement above:



SESSION 3	**Activity 3**	**Type of activity:** Time: 60 minutes The students need to draw a quadratic function themselves. At first, they will need to do it individually. Then, in groups of four students, they need to compare the answers and decide which is correct. Students discover that when the coefficient of x squared is negative the drawing of the function will remain with the branches down (concave down) and when it is positive upwards (concave up). They also discover that when this coefficient is a very small number the parabola is very wide, whereas when the coefficient is a large number the parabola is very narrow. ***1. $f(x) = 2x^2$*** Axis of symmetry: _____ Vertex: _____ y-intercepts: _____ x-intercepts: _____ Draw the graphic: Domain: _____ Range: _____ Concavity: _____

2. $f(x) = -2x^2$

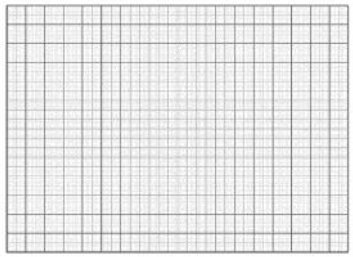
Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

x-intercepts: _____

Draw the graphic:



Domain: _____ Range: _____ Concavity: _____

Why the graph 1 and 2 have a different concavity?

3. $f(x) = 2x^2 - 5x - 12$

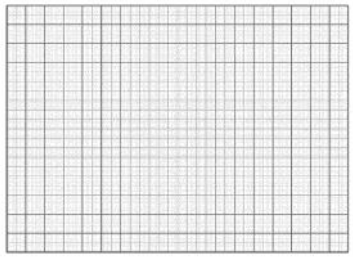
Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

x-intercepts: _____

Draw the graphic:



Domain: _____ Range: _____ Concavity: _____

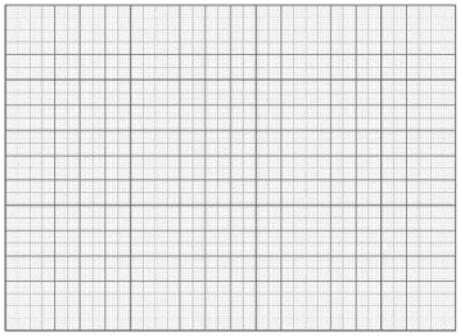
4. $f(x) = \frac{1}{3}x^2 + 3x + 6$

Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

x-intercepts: _____



Draw the graphic:

Domain: _____ Range: _____ Concavity: _____

Observe the absolute value of ***a*** in parabola 3 and 4, and indicate that it depends on whether the parabola is wider or narrower.

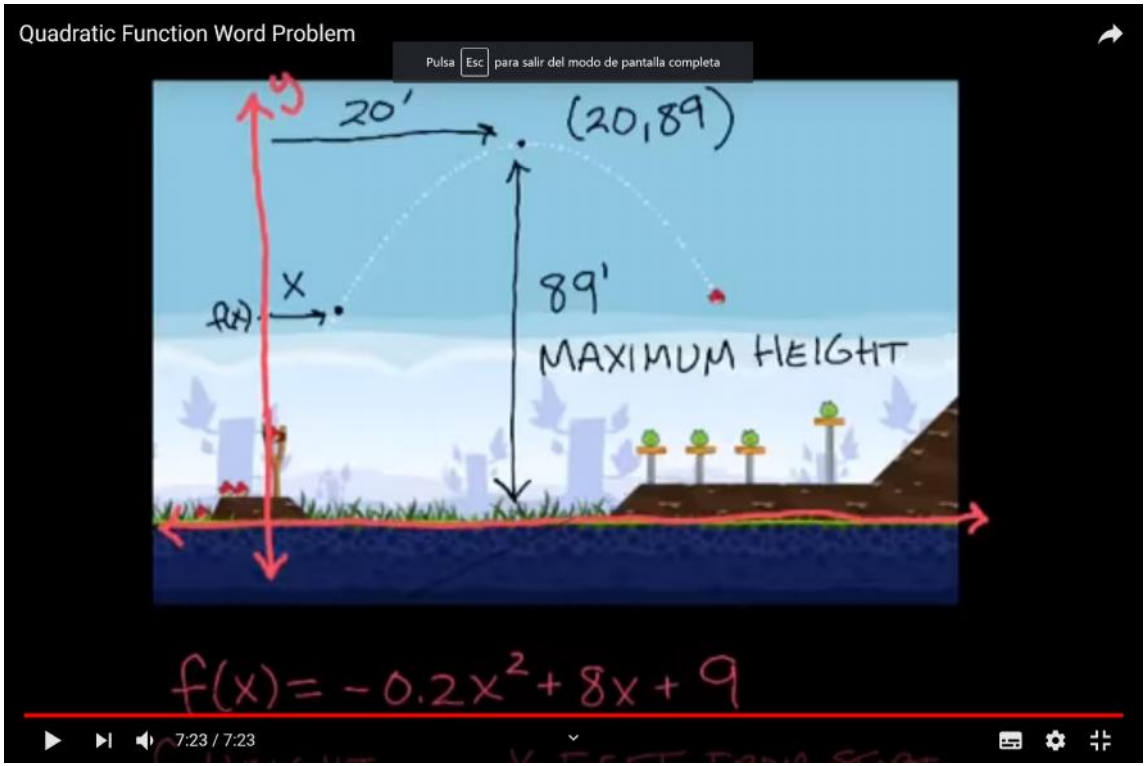
How can you express yourself in English?

- Let's think ON the concavity.
- How can the concavity be?
- Why is this concavity and not another? Because this function is… or has…
- Can you help me with this?
- I don't really get it. How can I do this?
- Spin it!
- Now, it's my turn to write on that.
- I can't remember the name of this part of the function. Do you?
- It started with…
- Oh! I need extra help with this.

GEP 1

S E S S I O N 3	**Activity 4**	**Type of activity:** Time: 15 minutes In this activity, students need to understand the usage of the quadratic function. In order to do that, they are driven through the concept of "Problem words" and they are shown a video related to the well-known video game "Angry birds". Angry Birds is a casual puzzle video game inspired primarily by a sketch of stylised wingless birds. Since that time, over 12 million copies of the game have been purchased. The students are so familiar with it that it is a way of make the quadratic function appealing and close to their own world. They might remember just by looking at the image shown below.  Image taken from: https://www.amazon.es/Rovio-Entertainment-Corporation-Angry-Classic/dp/B004SBQGHS

This image shows the result that the students are supposed to get to:



The link of the video runs as follows: https://www.youtube.com/watch?v=F--p_CeKJNQ

While they are listening and watching the video, they need to do the "Note-taking" technique.

	Activity 5	**Type of activity:** Time: 15 minutes In this activity, the students need to distinguish sounds. For that, a question will be displayed on the screen. Is it the same saying "Angry birds" than "ANGRY BEAR"?. Students need to group themselves into two groups. The ones that think they are the same will be placed by the "Queue ordering" technique following the one who was quicker to reply. So, two lines would be formed and the line itself will be ordered by the quickest student to answer to the slowest one. Then, a table will be displayed with several Minimal Pairs and the teacher needs to make "Group 1" pronounce out loud (with previous debate about the words pronunciation) the words in column 1. The group 2 pronounces the one in Group 2. The group who gets more right answers will get an extra positive. 

https://pixers.es/cuadros-en-lienzo/ilustracion-del-vector-del-oso-comiendo-miel-47785528

Minimal Pairs

Two words with sounds that differ in only one element.

batter	barter
cut	cat
bit	beat
pin	bin
not	note
ban	van
cheap	jeep
den	then
hard	heart
thin	thing

jot	yacht
cheese	she's
hack	hag
go	woe
especially	specially
seep	sheep
sin	thin
said	zed
cab	cap
thing	think

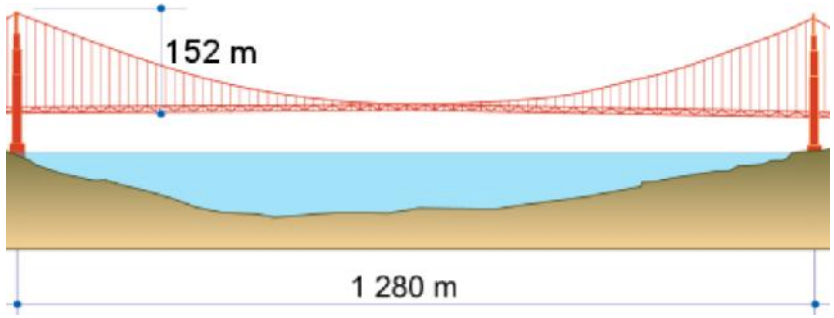
1

	Activity 6	**Golden Gate activity – Parables in engineering** Time: 20 minutes To solve problem words of quadratic function. 1st Individually: answer the questions. 2nd In groups of four students, compare the answers and you decide which is the correct in your group. Grouping: taking a chess piece from a bag (to reinforce the learned vocabulary). Matching pieces form a group. At the end, the teachers project the solutions in the projector.  **<u>Parables in engineering</u>** A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical towers. The bridge with the longest span in the world is the Akashi-Kaikyo in Japan with a stretch of nearly 2000 m. *The Akashi-Kaikyo Bridge in Japan, world's longest main span* *https://en.wikipedia.org/wiki/Suspension_bridge*

The Golden Gate in San Francisco (USA) is one of the best known suspension bridges.

Below you have an image of this bridge and an outline with the approximate measurements. You should know that the visible height of the towers that hold the cables is 227 m.

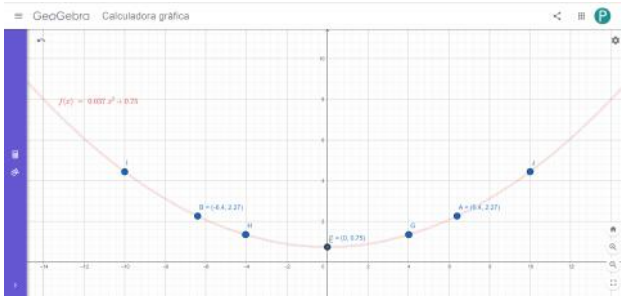
https://commons.wikimedia.org/wiki/File:Golden_Gate_Bridge_as_seen_from_Battery_East.jpg

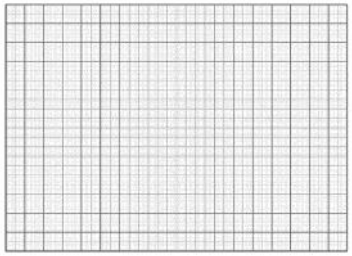


https://commons.wikimedia.org/wiki/File:Golden-Gate-Bridge.svg

6.1. Students need to overlay in a scheme of the bridge some axes of coordinates so that the axis of the abscissas corresponds to the line of the ground, and the axis of the ordinates, to the axis of symmetry of the parabola that forms the cable. Graduate the axes in meters, according to the measurements of the bridge (each box = 100 m). Mark the point of the vertex and the ends of the towers in format (x, y). The teacher will help the student understand all the vocabulary that they do not are aware of. Therefore, they will not have any problem while understanding the meaning of the instructions given to solve the activity.

To project the teachers at the end:





https://www.geogebra.org/graphing/vgceakse

6.2. Indicates whether or not the following quadratic functions may or may not be the function that corresponds to the parabola that forms the Golden Gate. Explain why or why not.

a) $f(x) = \frac{-7}{1}x^2 + 227$ *Solution: This function cannot be because the coefficient of x^2 is negative and therefore would concave down.*

b) $f(x) = \frac{3}{1}x^2 + 75$ *Solution: This function is because the coefficient of x^2 is positive, the independent term is 75 (y-intercept) and also if we substitute a point known as (640, 227) the equality is true.*

c) $f(x) = 1280x^2 + 227$ *Solution: This function cannot be because a coefficient of x^2 so big would give us a very narrow parabola, also if we substitute a point known as (640, 227) the equality would not be true.*

6.3. A car is 400 m from the centre of the bridge. How high is the cable at this point? Mark it on the graph.

Solution: Substituting x for 400, $f(x) = y = \frac{3}{1} \cdot 400^2 + 75; y = 134.2m$

6.4. Imagine that we want to increase the space between the towers to 2000 m as the Japan Akashi-Kaikyo Bridge. If we do not want to vary the equation of the parabola that corresponds to the main cables that support the platform, what height should the towers have? Mark the point on the graph.

Solution: Substituting x for 1000, $f(x) = y = \frac{3}{1} \cdot 1000^2 + 75; y = 445m$

In order to carry out this activity, some language support has been designed for guiding the students. It runs as follows:

How can you express yourself in English?

Does anyone remember how the axis of symmetry is calculated? With a fraction…

It's a negative coefficient of… over a multiplication of another coefficient

Also in negative? Yes, also or even if the denominator is not negative
In the denominator, the coefficient must be multiplied by …

Does anyone remember how the vertex is calculated?

Who has a steady hand to draw the parable?

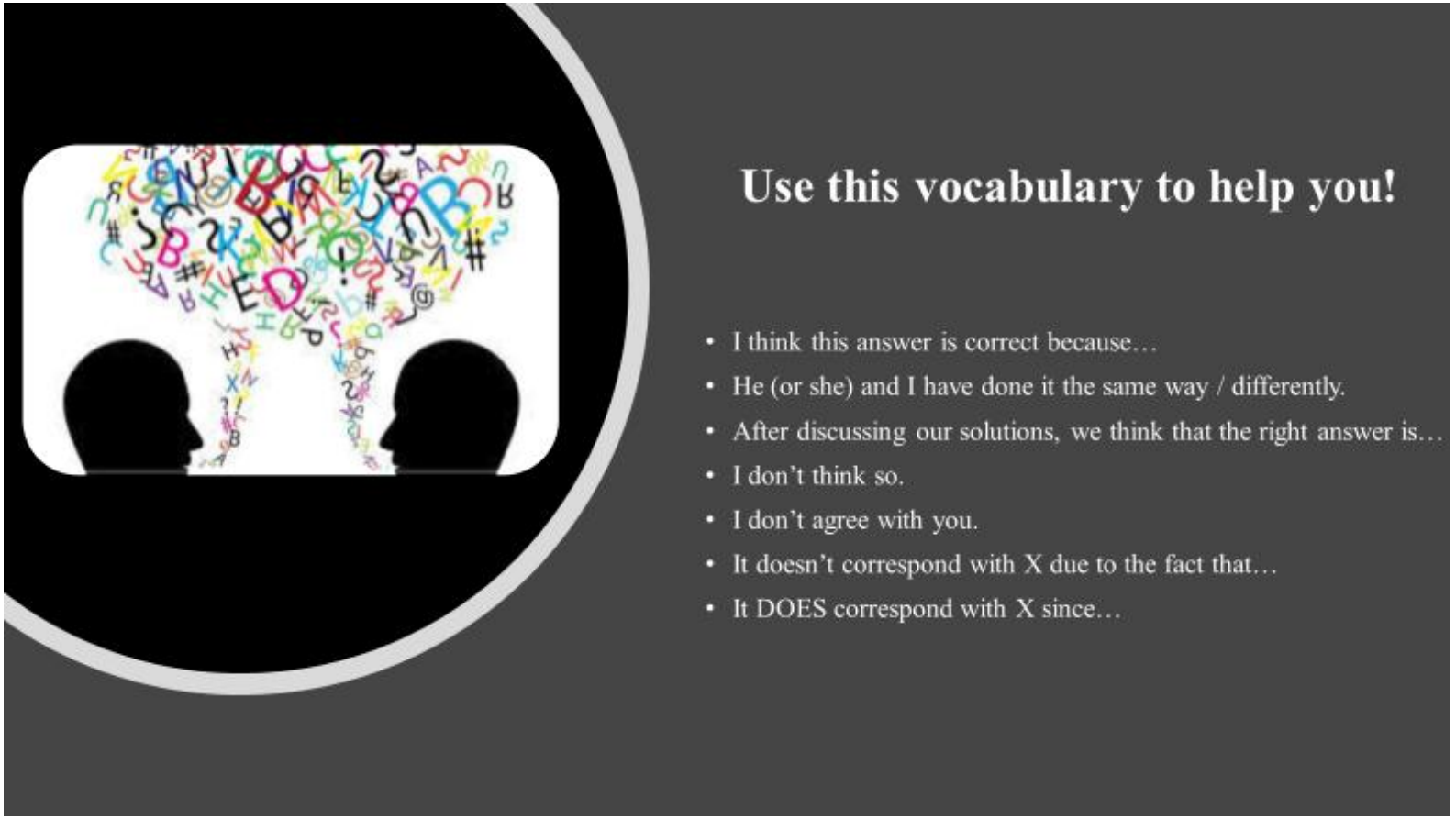
Do you have a handy calculator?

Do you want to calculate the formula to know intercepts-x meanwhile?

I do not remember the formula at all.

It is the equation of the second degree, which starts negative b plus minus square root.

GEP 1


Use this vocabulary to help you!
• I think this answer is correct because…
• He (or she) and I have done it the same way / differently.
• After discussing our solutions, we think that the right answer is…
• I don't think so.
• I don't agree with you.
• It doesn't correspond with X due to the fact that…
• It DOES correspond with X since…

Support yourself here!

Mine is concave up or concave down and yours the other way. Why? Because…

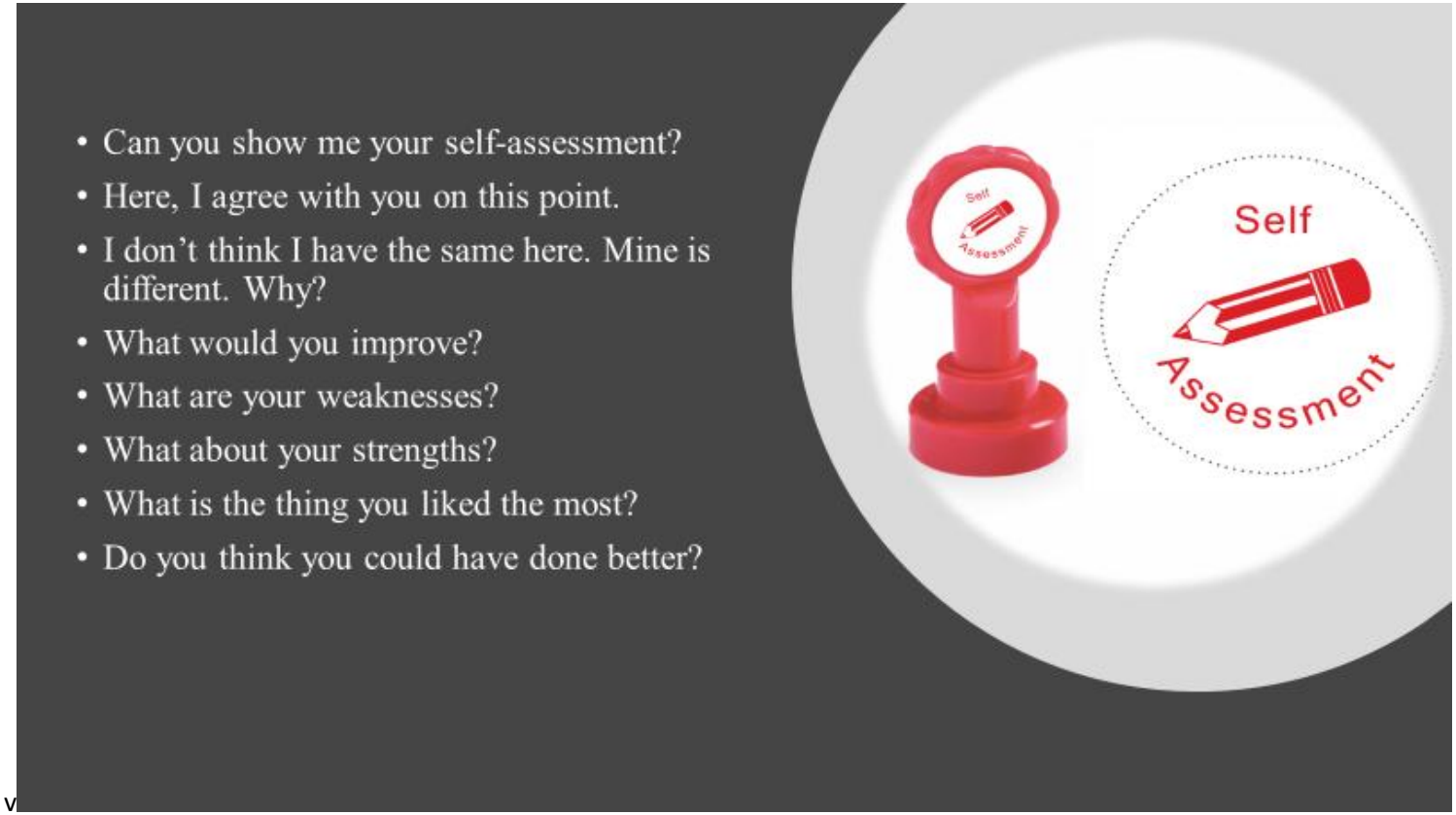
Why did you put the vertex here? I get here.

How is it that you get the intercepts-y here? Because it is the number of the function without unknown… in this case it is negative or positive

I don't agree with you at all or I agree with you totally.

	Activity 7	**Self-assessment: Can-do statements** Time: 10 minutes First the students answer individually. After, they compare their answers. Adapted from Kay Bentley **Self-assessment (Circle the answer)** **Can-do statements** I have understood about: 10% 25% 50% 75% 90% 100% of the sessions I can explain what Quadratic Function is to another student True or False? I can differentiate the parables in real life. How many? 4 / 3 / 2 / 1 / 0 I can define Domain, Range, and Concavity. Near always / often / sometimes What I have learnt about axis of symmetry is _____ What I have learnt about vertex is _____ What I have learnt about y-intercept is_____ What I have learnt about x-intercepts is _____ What I want to improve is _____ What I need to find out is _____

Language support:



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In terms of academic content, what are the students learning and what are they learning to do?	Regarding academic content, the students are learning exactly: - What a quadratic function is. - The features of quadratic function. - How to draw and interpret a parabola. - How to use the quadratic function in real life.
In terms of language, what are the students practicing or learning to do?	In terms of language, as we have claimed in the "short description of the sessions" item, the language starting point is relatively low. Therefore, having a proper scaffolding of "How to express their opinion" throughout the whole range of session would be ideal. Students will be provided with cards as language support and they might be forced to use them through the lessons. The language content will be covering simple verb tenses and probability, no probability, and deduction modal verbs (might, can't, must). Moreover, students will be learning specific mathematical vocabulary and usual vocabulary regarding terms of chess. Eventually, students will also learn about pronunciation, particularly minimal pairs.
In what way is this lesson plan a good example of what we learnt in the GEP course session?	This lesson plan is accurate regarding our sessions in GEP since it responds to the content we have been driven through. It has been designed to not leave the student alone in the learning process. They are guided throughout the whole lesson plan. They are given the right support to read and understand the text. As the topic of this plan is basically mathematical, the reading they need to do is mainly mathematical-content related. Then, the tasks that have been prepared have been designed taking into consideration before, during, and after activities.

	The chief idea was not abandoning the student. Thus, the materials are mainly visuals or hands-on activities to help comprehension. Following with the idea of no letting the students on their own (favouring the student's autonomy though), the collaboration with the figures of the teachers-students and students-students are key. This has been also promoted in this lesson plan. Concerning GEP dynamics, the teachers are supposed to predict the language the students need to both understand the language and the content taught. Therefore, the tasks are fully supported with language needed while learning Maths. Eventually, our particular lesson plan states types of assessment for self-assessment and teacher-assessment. It is used both as a starting point, as formative assessment and summative assessment. The tools employed are the ones taught in our GEP sessions. They are rubrics (with emojis), digital app (Quizlet) and "Can-do statements".
Other important information	No more details to be further explained.

Self-assessment checklist

Task 2 : Reading, writing in CLIL and Assessment	YES/NO
1**. Support** is provided to help students read and understand texts.	Yes
2**. Before-, during- and after-**reading activities are prepared.	Yes
3. The materials use **visuals** to support comprehension.	Yes
4. The writing process takes place in **joint collaboration** with the teacher (modelling)	Yes
5**. Support** is provided to help students write (the students are provided with language patterns, language frames, vocabulary banks…)	Yes
6. The teacher uses different strategies to help students **throughout the process** of reading and writing	Yes
7. The teacher has **previously predicted the language** the students will need when carrying out the different tasks successfully and, therefore, is aware of the **content-obligatory language.**	Yes
8. At least the teacher uses 1 type of **assessment** (self-assessment, teacher assessment or co- assessment)	Yes
9. At least teacher used 1 type of **designed assessment tool** during the sessions (rubric, digital app, checklist, personal dossier...)	Yes

ANNEX ACTIVITY 1 – CROSSWORD

Solution of crossword is:

Crossword of the quadratic function - Students

The game's goal is to fill the white squares with letters, forming words, by solving clues, which lead to the answers. The answer words are placed in the grid from left to right (across) and from top to bottom (down).

Definitions:

ACROSS

3 On the graph of a quadratic function $f(x) = ax^2 + bx + c$ is (0, c)

5 Is the set of all real values of *y*

7 Is any function with a degree of 2.

8 Is the place where the graph of function turns; hence, it is also called the turning point. To find with $\left(\frac{-b}{2a},\ f\left(\frac{-b}{2a}\right)\right)$

9 Divide the graph of quadratic function into mirror images. Is always a vertical line of the form $x = n$, where n is a real number. To find with $x = \frac{-b}{2a}$

10 Is the set of all real *values of* x, in a Quadratic function always is all real numbers. $Dom\ f(x) = \mathbb{R}$

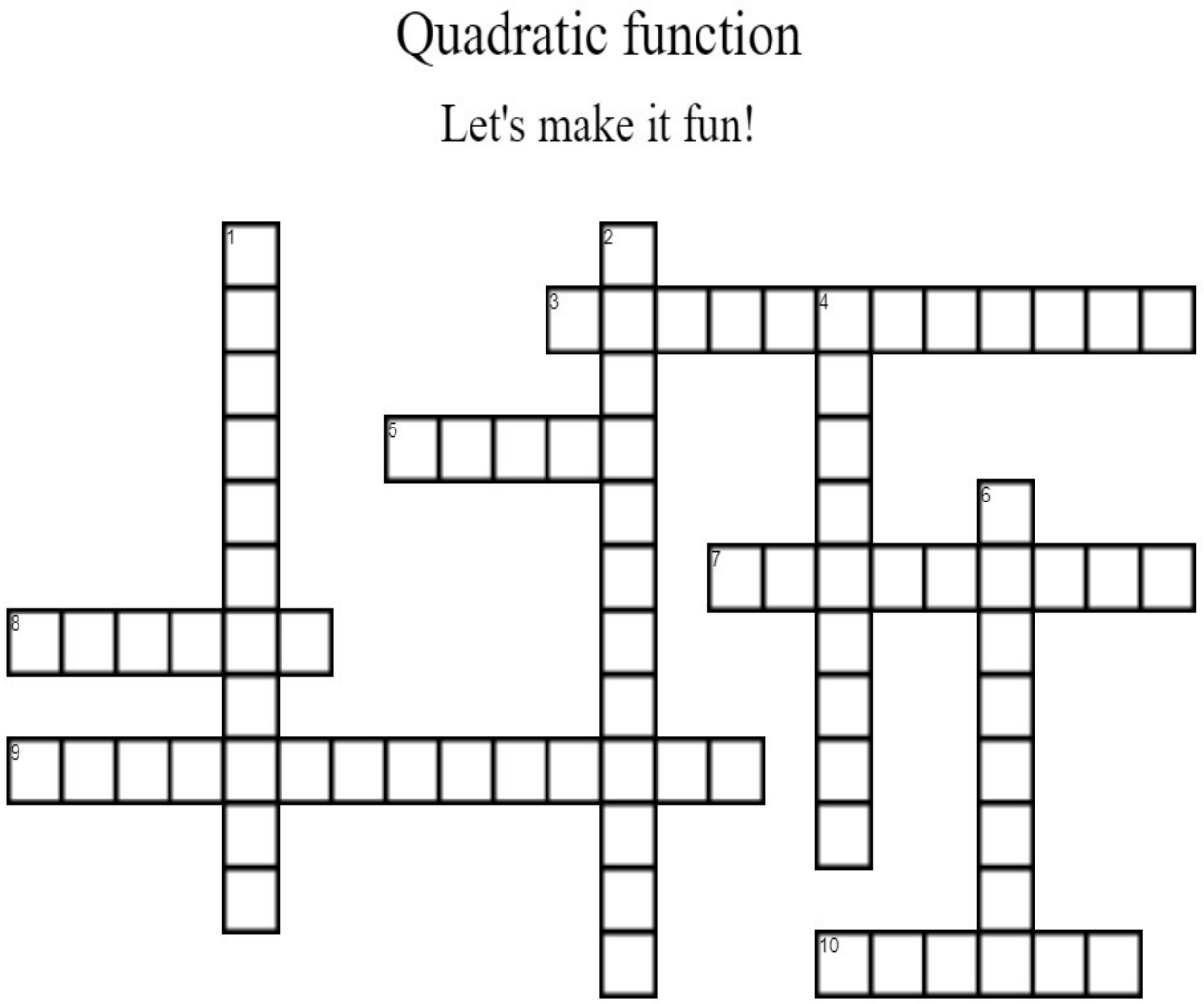
DOWN

1 If ***a*** is positive in $f(x) = ax^2 + bx + c$, with ***a*** not equal to 0. The graph has a minimum.

2 On the graph of a quadratic function $f(x) = ax^2 + bx + c$ are found by solving the corresponding quadratic equation in one variable, with expression: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

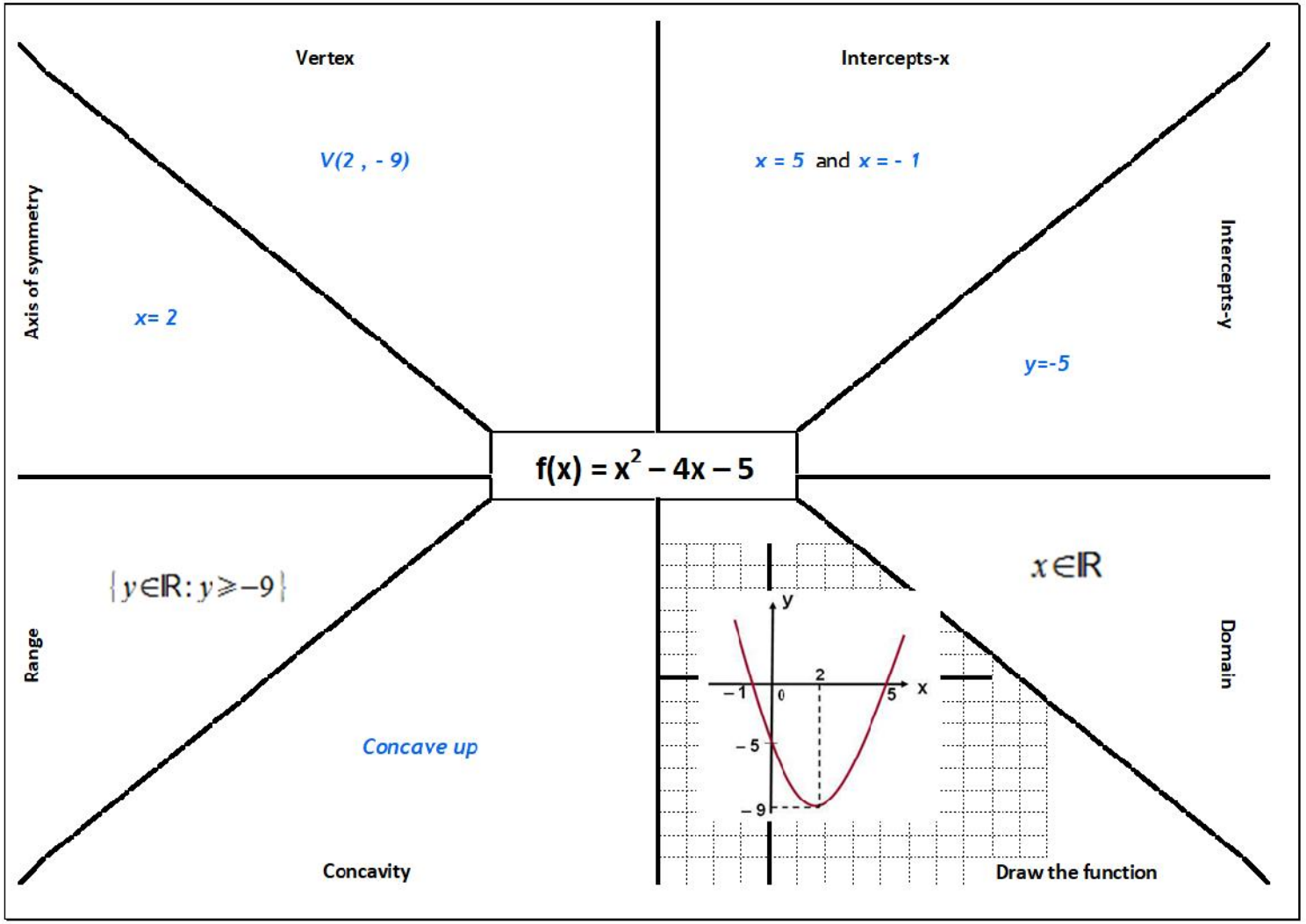
4 If ***a*** is positive in $f(x) = ax^2 + bx + c$, with ***a*** not equal to 0. The graph has a minimum

6 The graph of the function $ax^2 + bx + c = 0$



ANNEX PLACEMATE

This is the solution at placemat that will be employed:



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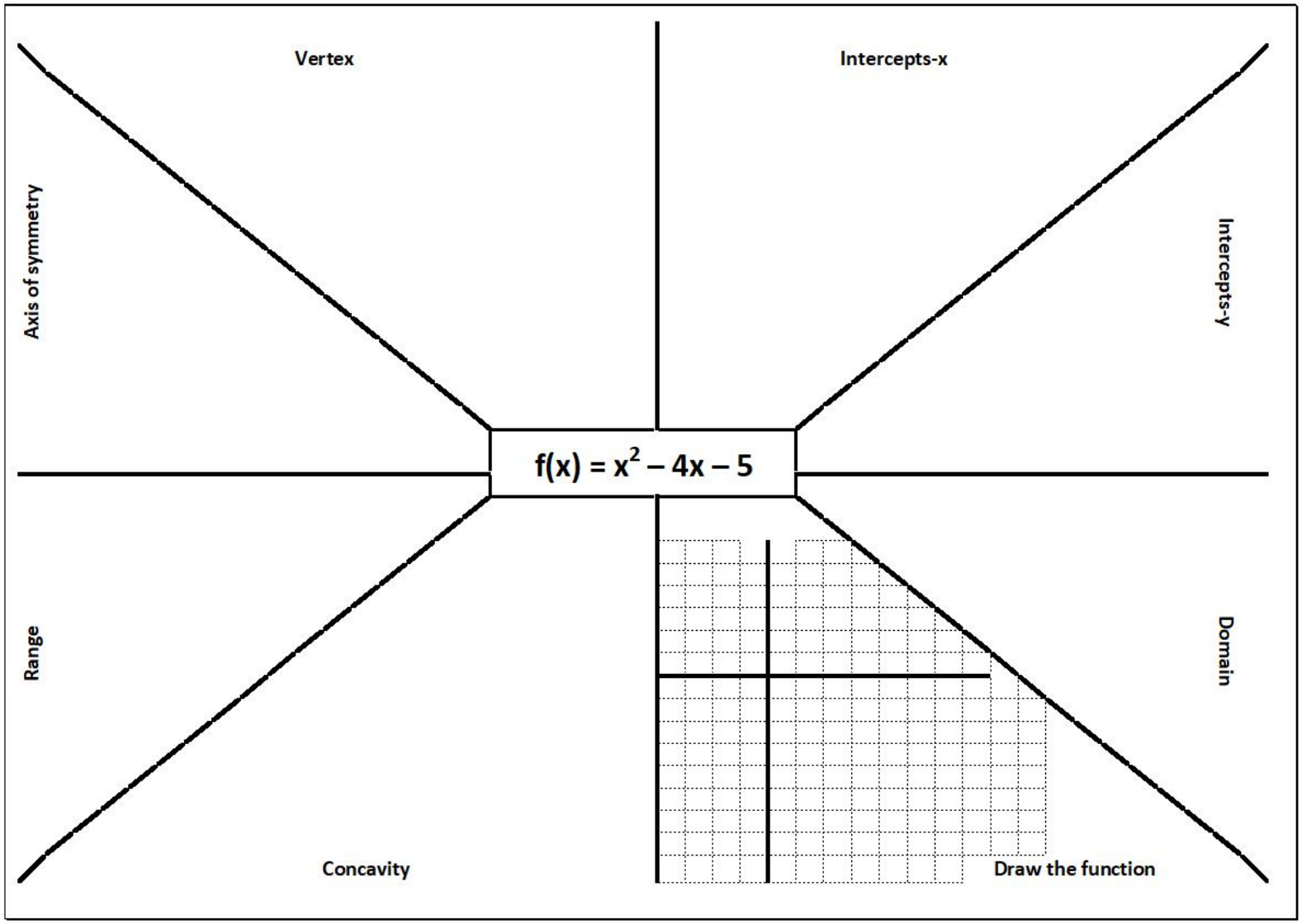
Departament d'Ensenyament



ANNEX: FOUR QUADRATIC FUNCTIONS

The students need to draw a quadratic function themselves. At first, they will need to do it individually. Then, in groups of four students, they need to compare the answers and decide which is correct. Students discover that when the coefficient of x squared is negative the drawing of the function will remain with the branches down (concave down) and when it is positive upwards (concave up). They also discover that when this coefficient is a very small number the parabola is very wide, whereas when the coefficient is a large number the parabola is very narrow

STUDENTS: Draw quadratic function. First individually: Complete the gaps and draw the function. After, in groups compare the answers and you decide which is the correct in your group.

1. $f(x) = 2x^2$

Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

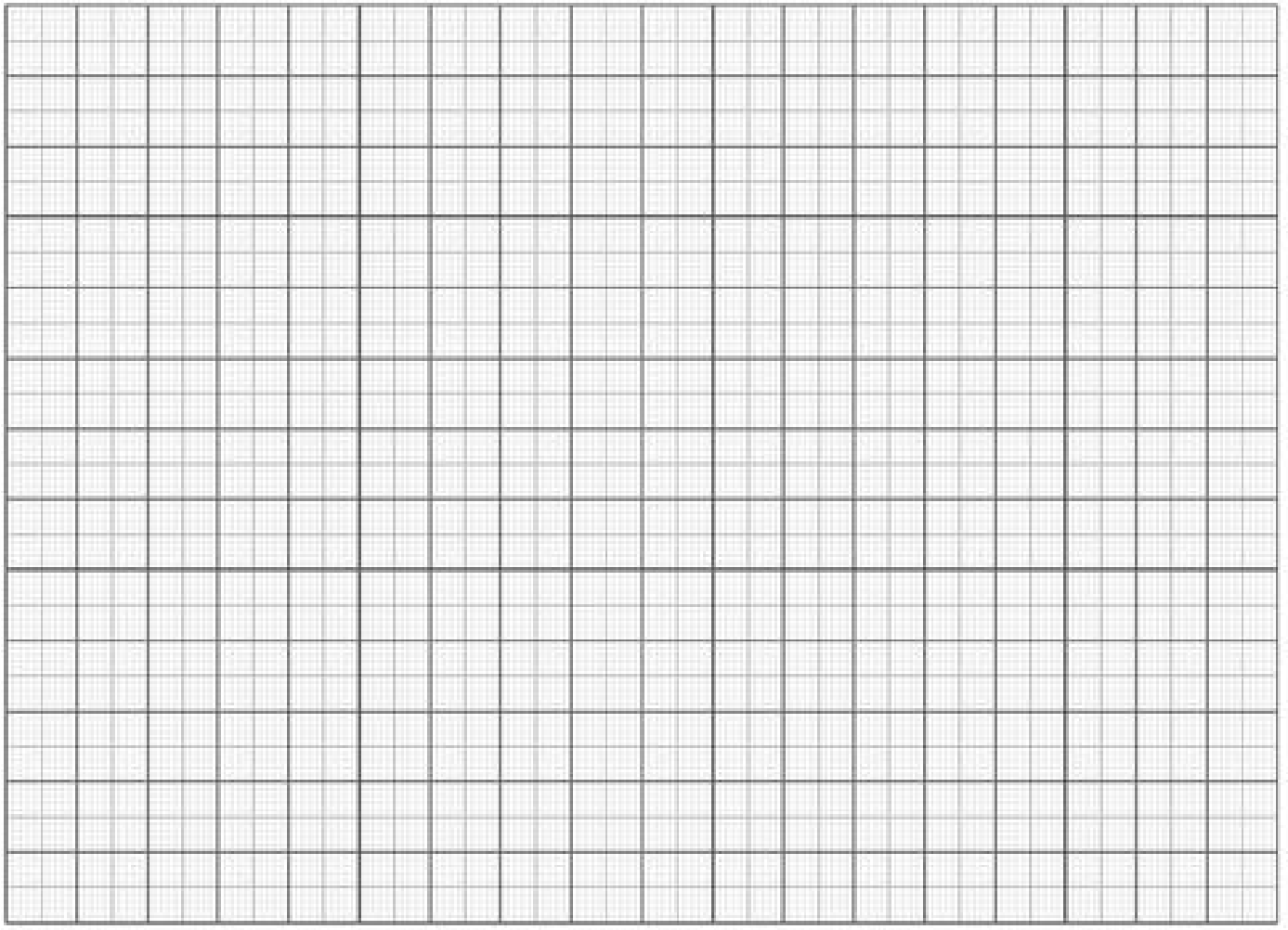
x-intercepts: _____

Domain: _____

Range: _____

Concavity: _____

Draw the graphic:



2. $f(x) = -2x^2$

Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

x-intercepts: _____

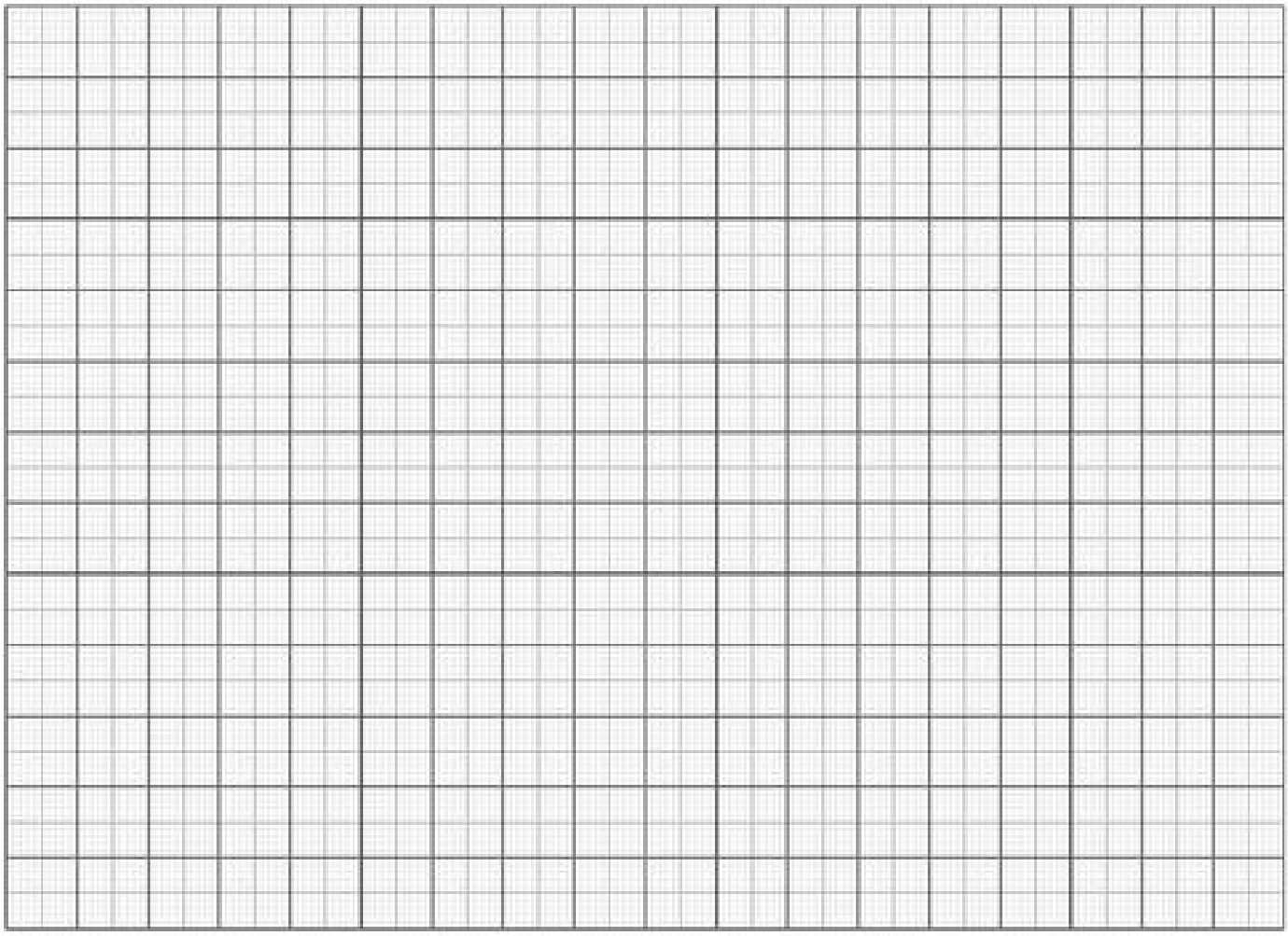
Domain: _____

Range: _____

Concavity: _____

Draw the graphic

Why the graph 1 and 2 have a different concavity?



3. $f(x) = 2x^2 - 5x - 12$

Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

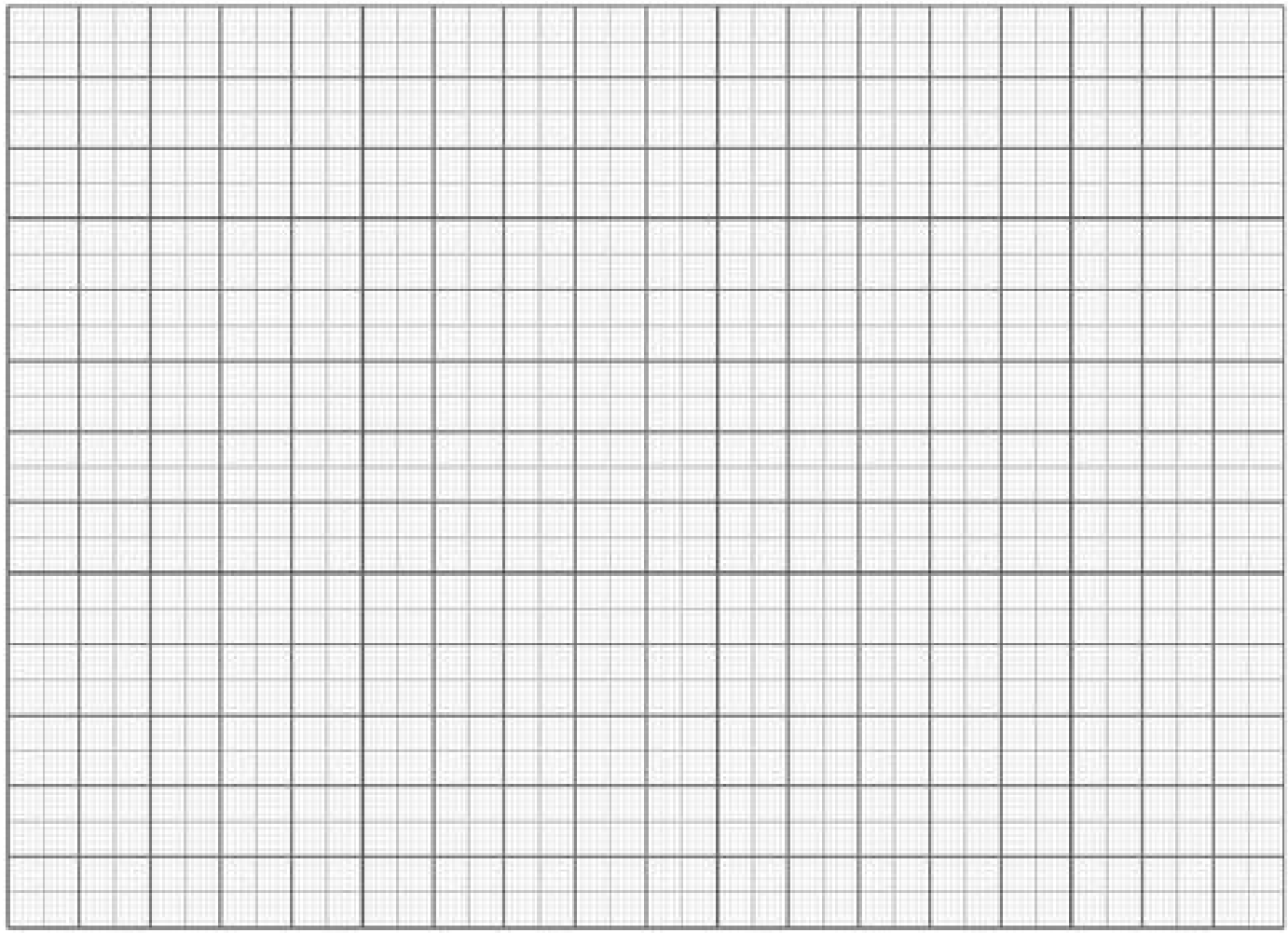
x-intercepts: _____

Domain: _____

Range: _____

Concavity: _____

Draw the graphic



4. $f(x) = \frac{1}{3}x^2 + 3x + 6$

Axis of symmetry: _____

Vertex: _____

y-intercepts: _____

x-intercepts: _____

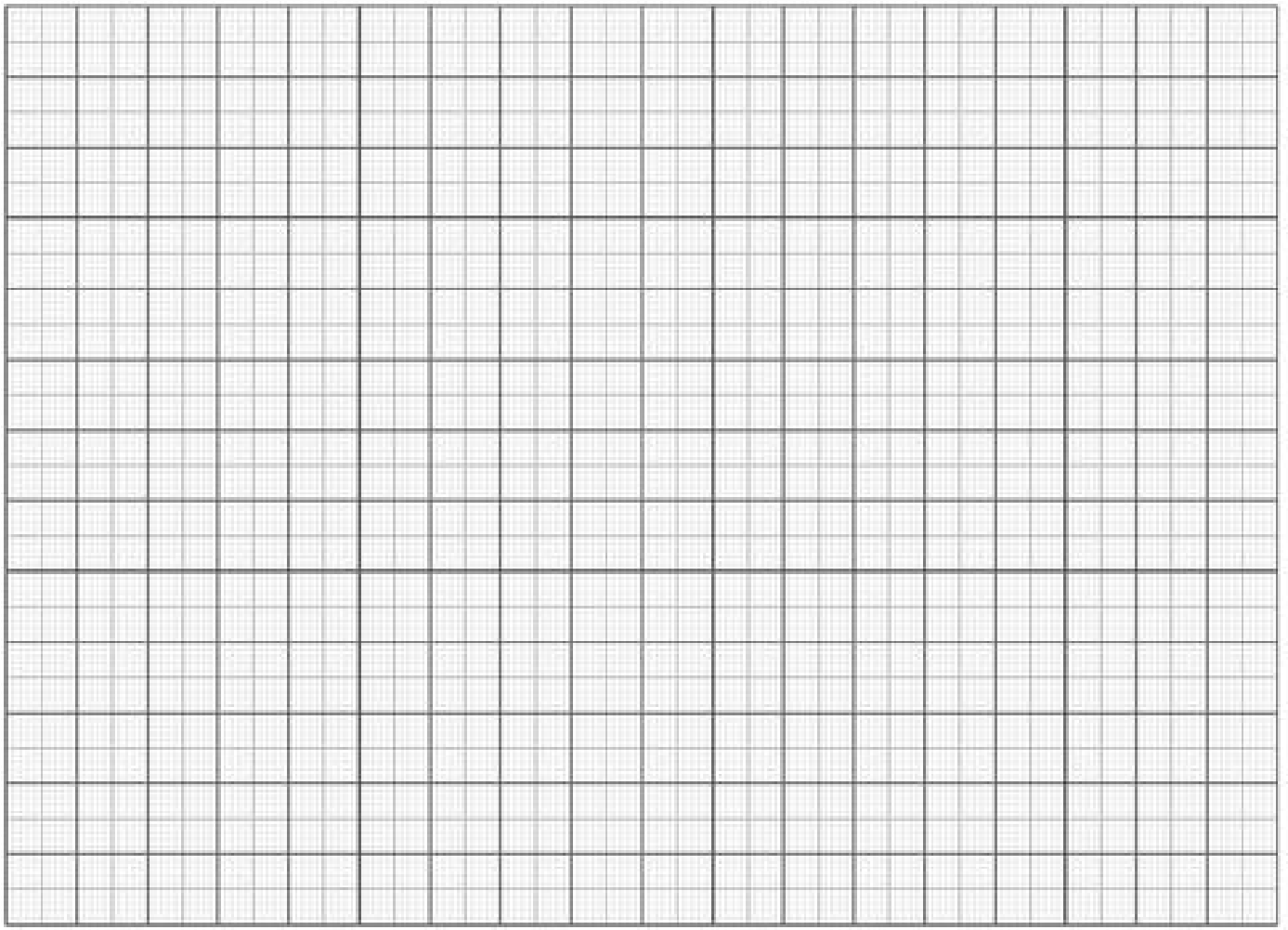
Domain: _____

Range: _____

Concavity: _____

Draw the graphic

Observe the absolute value of ***a*** in parabola 3 and 4, and indicate that it depends on whether the parabola is wider or narrower.



The Akashi-Kaikyo Bridge in Japan, world's longest main span
https://en.wikipedia.org/wiki/Suspension_bridge

ANNEX: Parables in engineering

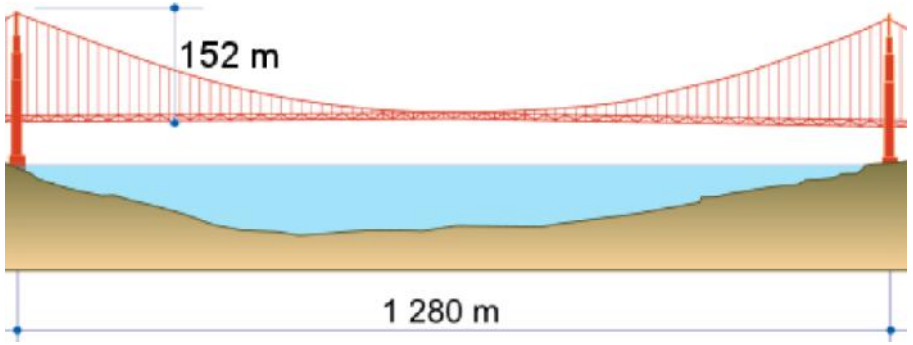
Solution for teachers.
To solve problems words of quadratic function.
1st Individually: answer the questions.
2nd In groups of four students compare the answers and you decide which is the correct in your group.
Formation of the groups: taking a chess piece from a bag (to reinforce the learned vocabulary). Matching pieces form a group.
At the end, the teachers project the solutions in the projector.

Parables in engineering

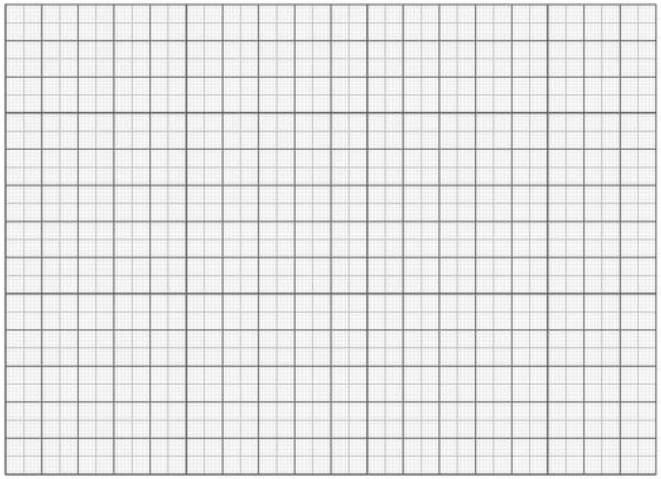
A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical towers. The bridge with the longest span in the world is the Akashi-Kaikyo in Japan with a stretch of nearly 2000 m.

The Golden Gate in San Francisco (USA) is one of the best known suspension bridges.

Below you have an image of this bridge and an outline with the approximate measurements. You should know that the visible height of the towers that hold the cables is 227 m.



https://commons.wikimedia.org/wiki/File:Golden_Gate_Bridge_as_seen_from_Battery_East.jpg
https://commons.wikimedia.org/wiki/File:Golden-Gate-Bridge.svg



Overlay in a scheme of the bridge some axes of coordinates, so that the axis of the abscissas corresponds to the line of the ground, and the axis of the ordinates, to the axis of symmetry of the parabola that forms the cable. Graduate the axes in meters, according to the measurements of the bridge (each box = 100 m). Mark the point of the vertex and the ends of the towers in format (x, y).

1. Indicates whether or not the following quadratic functions may or may not be the function that corresponds to the parabola that forms the Golden Gate. Explain why or why not.

a) $f(x) = -\frac{7}{10}x^2 + 227$ *Solution: This function cannot be because the coefficient of x^2 is negative and therefore would concave down*.

b) $f(x) = \frac{3}{10}x^2 + 75$ *Solution: This function is because the coefficient of x^2 is positive, the independent term is 75 (y-intercept) and also if we substitute a point known as (640, 227) the equality is true.*

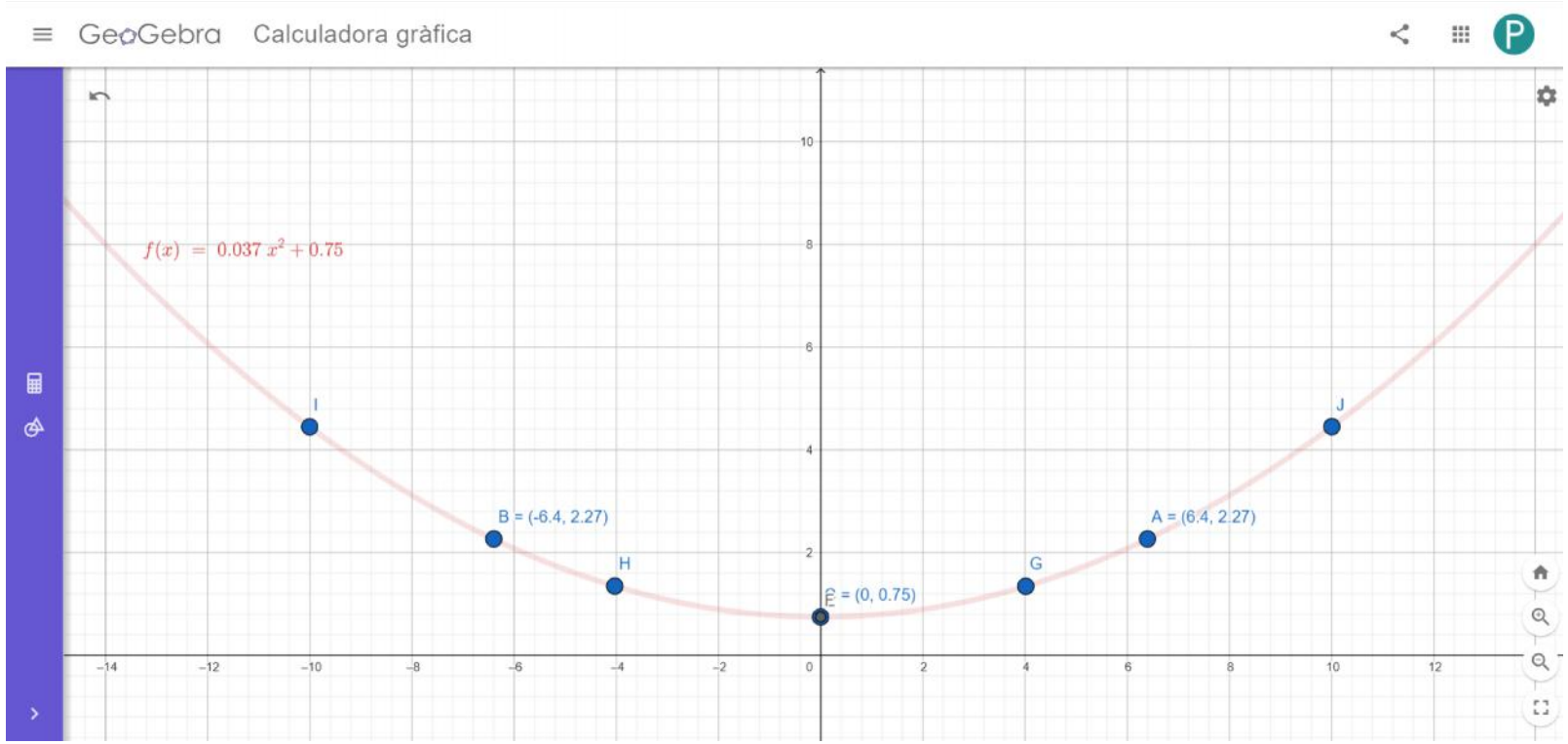
c) $f(x) = 1280\,x^2 + 227$ *Solution: This function cannot be because a coefficient of x^2 so big would give us a very narrow parabola, also if we substitute a point known as (640, 227) the equality would not be true*.

2. A car is 400 m from the centre of the bridge. How high is the cable at this point? Mark it on the graph.

Solution: Substituting x for 400, $f(x) = y = \frac{3}{10} \cdot 400^2 + 75;\ y = 134.2\ m$

3. Imagine that we want to increase the space between the towers to 2000 m as the Japan Akashi-Kaikyo Bridge. If we do not want to vary the equation of the parabola that corresponds to the main cables that support the platform, what height should the towers have? Mark the point on the graph.

Solution: Substituting x for 1000, $f(x) = y = \frac{3}{10} \cdot 1000^2 + 75;\quad y = 445\ m$



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The Akashi-Kaikyo Bridge in Japan, world's longest main span
https://en.wikipedia.org/wiki/Suspension_bridge

STUDENTS: To solve problems words of quadratic function

.1st individually: answer the questions.

2nd In groups of four students compare the answers and you decide which is the correct in your group.

Parables in engineering

A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical towers. The bridge with the longest span in the world is the Akashi-Kaikyo in Japan with a stretch of nearly 2000 m.

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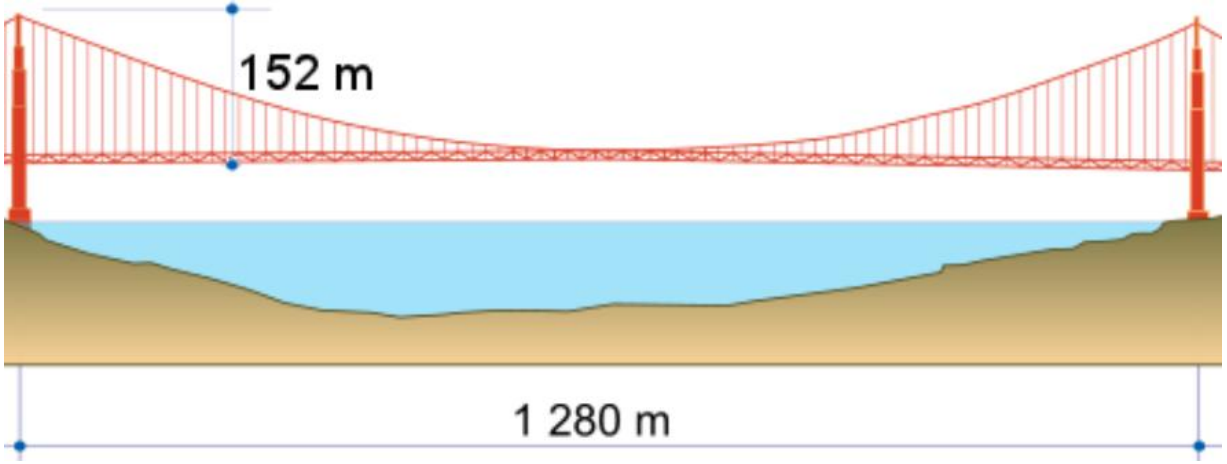
https://commons.wikimedia.org/wiki/File:Golden-Gate-Bridge.svg



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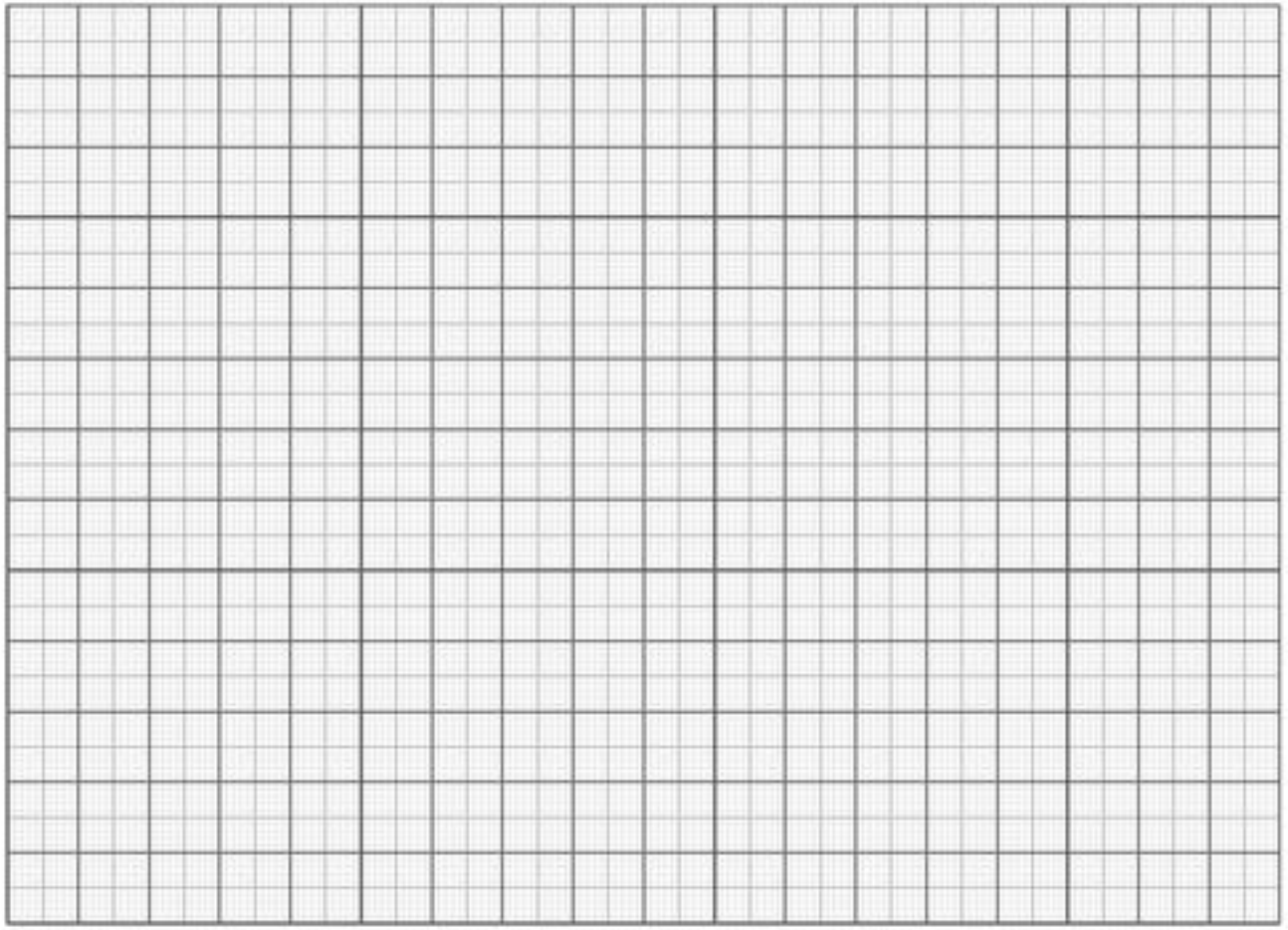

1. Indicates whether or not the following quadratic functions may or may not be the function that corresponds to the parabola that forms the Golden Gate. Explain why or why not.

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c) $f(x) = 1280\,x^2 + 227$

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ANNEX: Self-assessment: Can-do statements

Time: 10 minutes

First the students answer individually. After, they compare their answers.

Adapted from Kay Bentley

Self-assessment (Circle the answer)	**Can-do statements**
I have understood about: 10% 25% 50% 75% 90% 100%	of the sessions
I can explain what Quadratic Function is to another student	True or False?
I can differentiate the parables in real life. How many?	4 / 3 / 2 / 1 / 0
I can define Domain, Range, and Concavity.	Near always / often / sometimes

What I have learnt about axis of symmetry is _____

What I have learnt about vertex is _____

What I have learnt about y-intercept is_____

What I have learnt about x-intercepts is _____

What I want to improve is _____

What I need to find out is _____

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ANNEX

LANGUAGE SUPPORT

GEP 1

Learn how to express your ideas!

- I reckon the vertex is…
- I couldn’t agree more with you/ I couldn’t disagree more with you.
- Who is good at _____?
- What does “narrow” mean?
- What does “wide” mean?
- I don’t see much difference.
- Are you joking? It’s absolutely different.

GEP 1

How can you express yourself in English?

- Let’s think ON the concavity.
- How can the concavity be?
- Why is this concavity and not another? Because this function is… or has…
- Can you help me with this?
- I don’t really get it. How can I do this?
- Spin it!
- Now, it’s my turn to write on that.
- I can’t remember the name of this part of the function. Do you?
- It started with…
- Oh! I need extra help with this.

GEP 1

GEP 1

How can you express yourself in English?

Does anyone remember how the axis of symmetry is calculated? With a fraction…

It’s a negative coefficient of… over a multiplication of another coefficient

Also in negative? Yes, also or even if the denominator is not negative

In the denominator, the coefficient must be multiplied by ...

Does anyone remember how the vertex is calculated?

Who has a steady hand to draw the parable?

Do you have a handy calculator?

Do you want to calculate the formula to know intercepts-x meanwhile?

I do not remember the formula at all.

It is the equation of the second degree, which starts negative b plus minus square root.

Use this vocabulary to help you!

- I think this answer is correct because…
- He (or she) and I have done it the same way / differently.
- After discussing our solutions, we think that the right answer is…
- I don’t think so.
- I don’t agree with you.
- It doesn’t correspond with X due to the fact that…
- It DOES correspond with X since…

Support yourself here!

Mine is concave up or concave down and yours the other way. Why? Because…

Why did you put the vertex here? I get here.

How is it that you get the intercepts-y here? Because it is the number of the function without unknown… in this case it is negative or positive

I don’t agree with you at all or I agree with you totally.

- Can you show me your self-assessment?
- Here, I agree with you on this point.
- I don’t think I have the same here. Mine is different. Why?
- What would you improve?
- What are your weaknesses?
- What about your strengths?
- What is the thing you liked the most?
- Do you think you could have done better?