CAS in de Europese Scholen:

« Work in Progress »

Symposium 2015 - Oostende

L.A.A. Blomme (European School Brussel 3)

A. Jaeckel (European School Strasbourg)

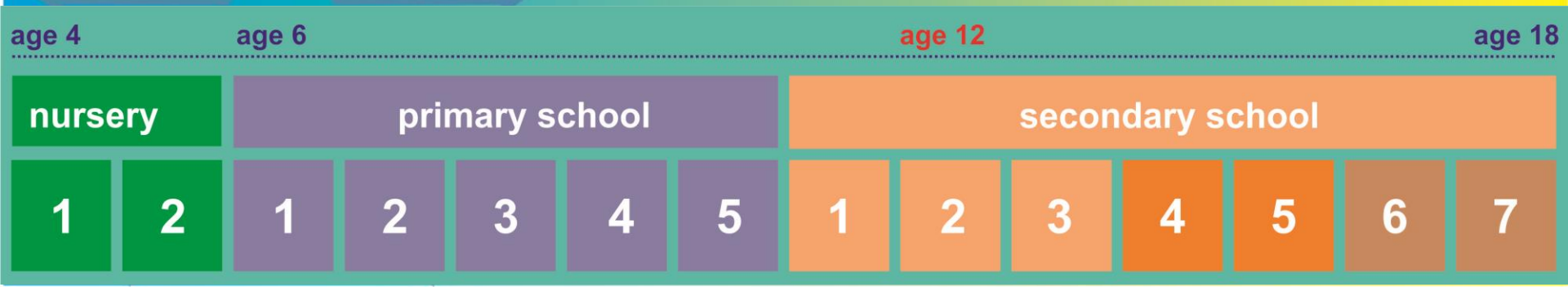
Summary

1. Wie zijn wij?
2. Het vak wiskunde op de ES
3. De wiskundehervorming
4. Het technologisch hulpmiddel - CAS
5. In-service training voor leraren
6. Evalutatie: Examens / Testen
7. Cas in de klas: voorbeelden
8. Valkuilen en pijnpunten met CAS
9. Halen we de doelstelling ?

European Union Member States

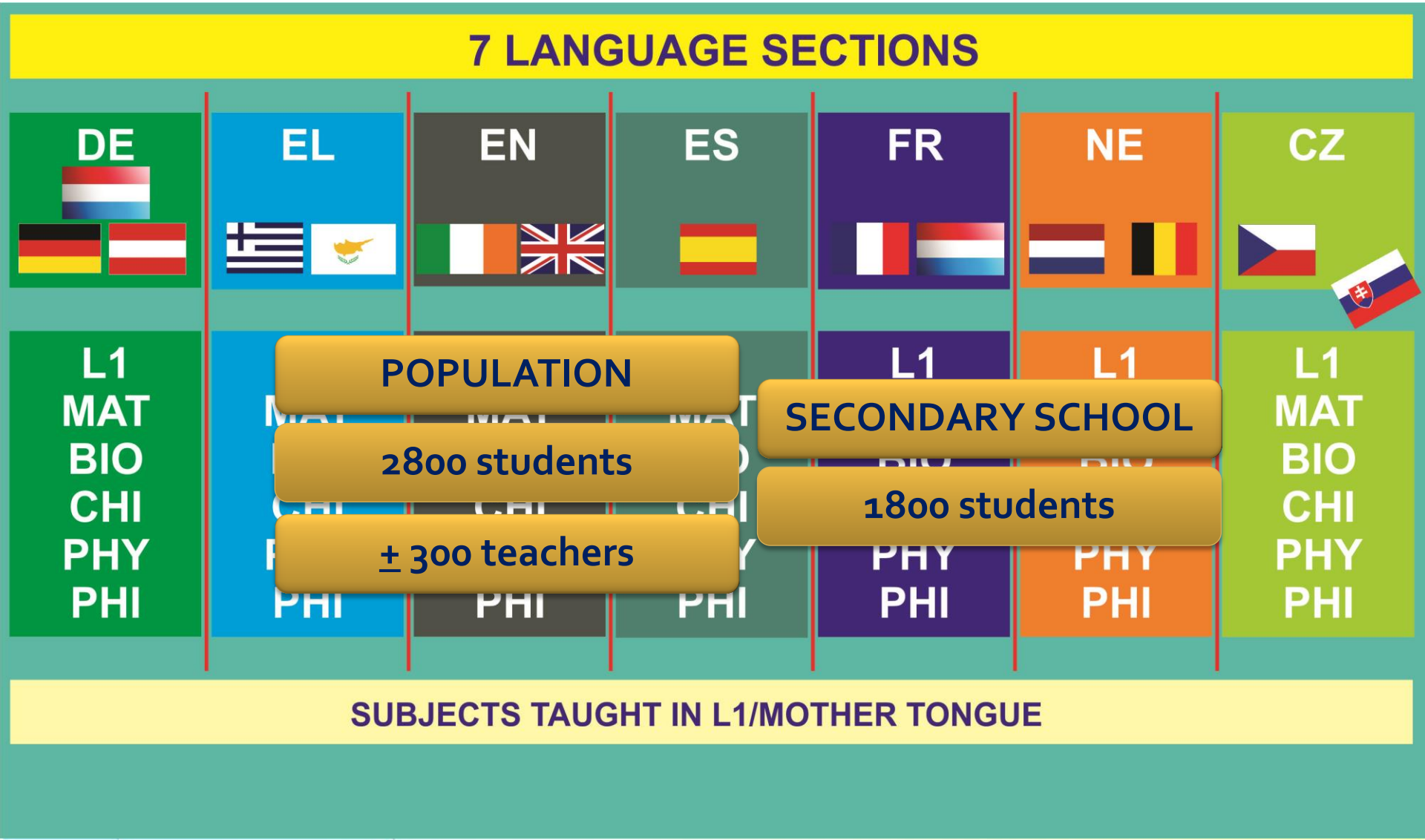
Who are we ?

- Officiële scholen van de EU (sinds 1953)
- Management door alle lidstaten van de EU
  - BoG = ministers van onderwijs van de lidstaten
  - Beslissingen = unaniem
- 30.000 leerlingen
- Kleuterschool, Lagere School en Middelbare School
- Op 1 site

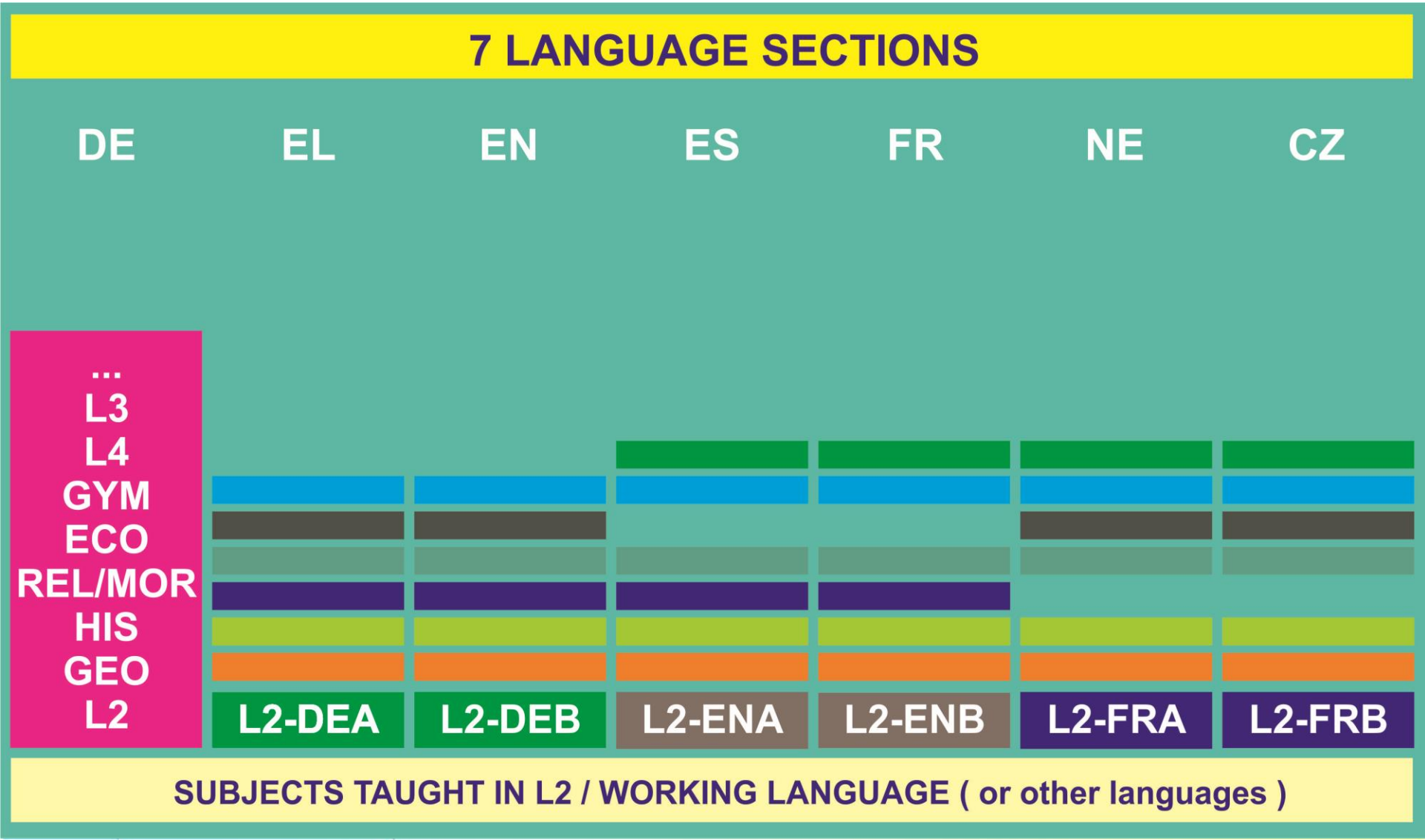


- Type I Schools and accredited schools (type II and type III)
  - Dunshauglin (*Ireland*), Parma (*Italy*), Heraklion (*Greece)* ; Strasbourg and Manosque (*France*), Helsinki (*Finland*), Den Haag (*Nederland*), Bad Vilbel

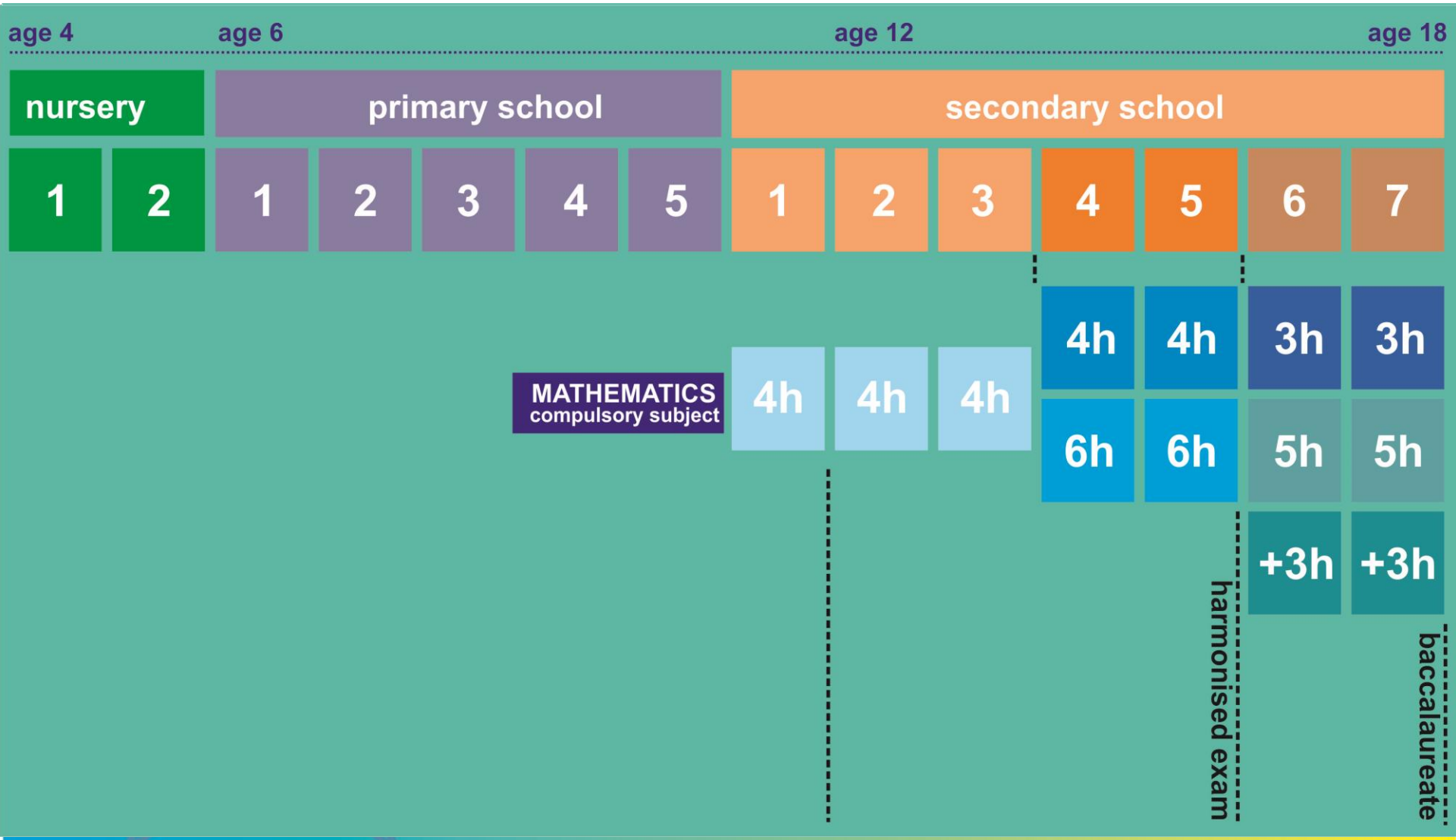
European School Brussels III



European School Brussels III



European Schools and maths courses



European Baccalaureate

5 WRITTEN EXAMINATIONS

GE04	
HIS4	
BIO4	
PHI4	
ECO4	
GREA	ART4
PHY	LAT
CHI	MUS4
L3	L4

L1	L1A
L2	L2A
MAT3/5	
OPTION 1	
OPTION 2	

The Math Reform

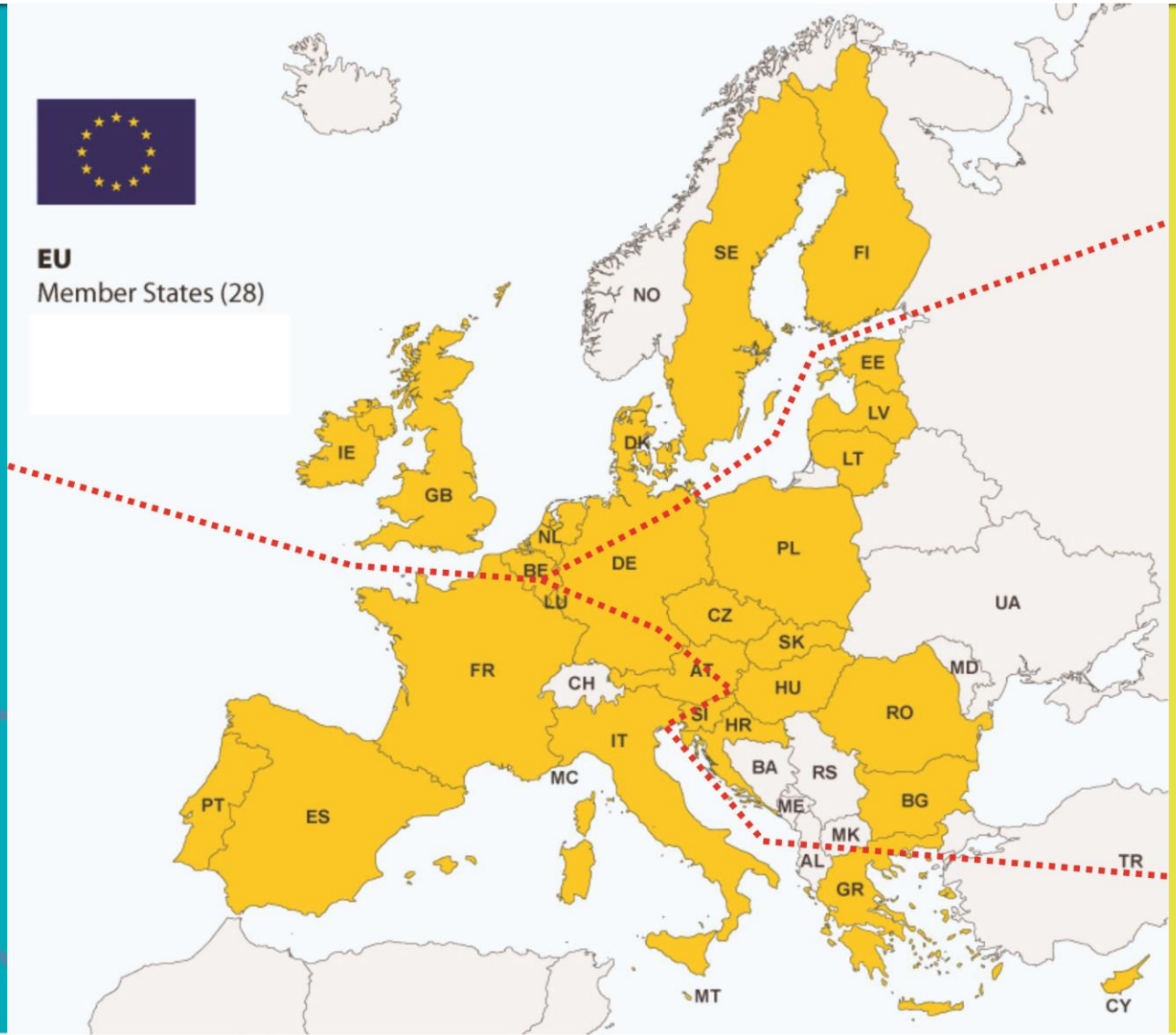
1. <u>Waarom ?</u>

- Gelijkwaardigheid van het Europees Bac
- Ontwikkelingen in de lidstaten van de EU
- Onveranderd sinds 30 jaar
- Eindexamen te repetitief
- Eindexamen te voorspelbaar
- Verplichte en keuzevragen
- Syllabus and eindexamen

The Math Reform

- Basisrekenvaardigheden versterken
- Europees compromis

the Math Reform



S7P3 syllabus abstract 1/2

STATISTICS (for guidance: 25 periods)

TOPIC	KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
Prerequisites for Statistics	Revision of the concepts studied in years 1-5 that were not included in the sixth year syllabus. This should be based on practical examples using technological support where possible and without any theoretical proofs. *Pupils must be able to and/or understand:* ▪ understand and use linear functions ▪ identify and interpret arithmetic mean, mode(s), median, upper and lower quartiles and interquartile range of data in one variable ▪ understand how to use a spreadsheet	*Pupils must be able to and/or understand:* ▪ calculate the mean, standard deviation, median, upper and lower quartiles and interquartile range of data in one variable ▪ enter data into a spreadsheet ▪ use a spreadsheet, including relations between various cells, to automate the calculations
Analysing and Representing data in one variable.	*The emphasis of this unit is on interpretation. Only examples drawn from everyday life (e.g. wages in a business, production of a machine or a biological study, etc…) must be used.* *In examples and exercises without technological support, it is sufficient to use not more than 10 items of data.* *Pupils must be able to and/or understand:* ▪ calculate a weighted mean ▪ use the properties of linearity of the mean, that is	*Pupils must be able to and/or understand:* ▪ calculate a weighted mean ▪ use box plots to represent one or more sets of data

S7P3 syllabus abstract 2/2

KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
and mark it on a scatter diagram ▪ organise in ascending order the data by the independent variable *x*, then split them by putting the first half in one group and the second in another. Find the mean point of each of these subset and connect the two points with a straight line (called line of Mayer) to create an estimate of the linear relationship between the data ▪ understand the method of least squares when calculating the least square regression line (regression of *y* on *x*) ▪ on a scatter diagram by using trial and error, find an appropriate regression model (linear, logarithmic or exponential), taking care to identify and eliminate outliers where necessary. ▪ examine the suitability of a linear regression model by calculating and interpreting Pearsons' product moment correlation coefficient ▪ appreciate that the line of Mayer and the line of regression of *y* on *x* passes through the mean point of the data on a scatter diagram ▪ use a regression model to make interpolations, extrapolations and forecasts ▪ use all of the concepts and results given above to practical applications	▪ calculate the mean point and add it to the scatter diagram ▪ show graphically the idea that the linear regression model will best fit the data when the sum of the least squares is minimised.(*y* on *x*) ▪ calculate Pearsons' product-moment correlation coefficient ▪ find the equation of the line of Mayer and the line of linear regression of *y* on *x* ▪ draw the line of Mayer and the line of linear regression of *y* on *x* ▪ for given bivariate data which is either exponential or logarithmic apply a given (by the teacher) change of variable and observe from the scatter diagram that a linear regression model would be appropriate. From this conclude that the original data is exponential or logarithmic: ○ $(\ln y = a \cdot x + b) \Rightarrow (y = c \cdot d^x)$ ○ $y = a \cdot \ln x + b$ ▪ find a linear, exponential or logarithmic regression equation for bivariate data by using the regression tools.

S7P5 syllabus abstract 1/2

TOPIC	KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
Sequences (10 periods)	*In addition to the concepts met in the 6th year pupils must be able to and/or understand:* ▪ observe the behaviour of a sequence graphically as the relation (n,u_n) (time plot) ▪ determine whether a sequence is increasing or decreasing ○ Given the explicit nth term then let $u_n = f(n)$ and study f' ○ Given a recurrence relation u_n then let $u_n = f(u_{n-1})$ and study the sign of $u_{n+1} - u_n$ ▪ find M an upper and m a lower bound of a sequence: $u_n \le M$ and $u_n \ge m$ ▪ apply the theorem of convergence/divergence : ○ an increasing sequence bounded by M converges ○ a decreasing sequence bounded by m converges ▪ for the basic set of recurrence relations in the form $u_n = f(u_{n-1}),\ n \in \mathbb{N}$ where ○ $f : x \mapsto ax + b$ ○ $f : x \mapsto \sqrt{ax+b}$ ○ $f : x \mapsto \dfrac{ax+b}{cx+d},\ c \neq 0$	*Pupils must be able to and/or understand:* ▪ enter a sequence both explicit and recurrence relation in an appropriate application (spreadsheet, CAS, graph etc.) ▪ given the explicit nth term or a recurrence relation calculate a particular term ▪ given the first terms of a sequence find the explicit nth term and or the recurrence relation where appropriate ▪ investigate the behaviour of a sequence graphically as the relation (n,u_n) (time plot) ▪ create a web diagram of a sequence of the form $u_n = f(u_{n-1}),\ n \in \mathbb{N}$ and find from the diagram possible limits ▪ investigate the behaviour of a sequence by manipulating the initial term ▪ find by solving the equation $f(L) = L$, the limit L of a convergent sequence

S7P5 syllabus abstract 2/2

Unless further specified, students must be able to apply, without a technological tool, the concepts referred to in the second column 'knowledge and skills', for the following basic functions where $a, b, c \in \mathbb{R}$, $\lambda \in \mathbb{Z}$:

- polynomials functions $P(x)$ of degree ≤ 3
- $\dfrac{P(x)}{Q(x)}$ where $P(x)$ and $Q(x)$ are polynomial functions of degree ≤ 2
- $a + \lambda\sqrt{bx+c}; \sqrt{ax^2+bx+c}$
- $a + \lambda\cos(bx+c)$; $a + \lambda\sin(bx+c)$; $\tan x$
- $c + \lambda\ln(ax+b)$; $\lambda x^{\alpha}\ln x$ for $\alpha \in \{-2,-1,0,1,2\}$
- λe^{ax+b}; $ce^{2x}+de^{x}+f$; $c\cdot(e^{ax}+e^{-ax})$; $e^{ax}(ax^2+bx+c)$

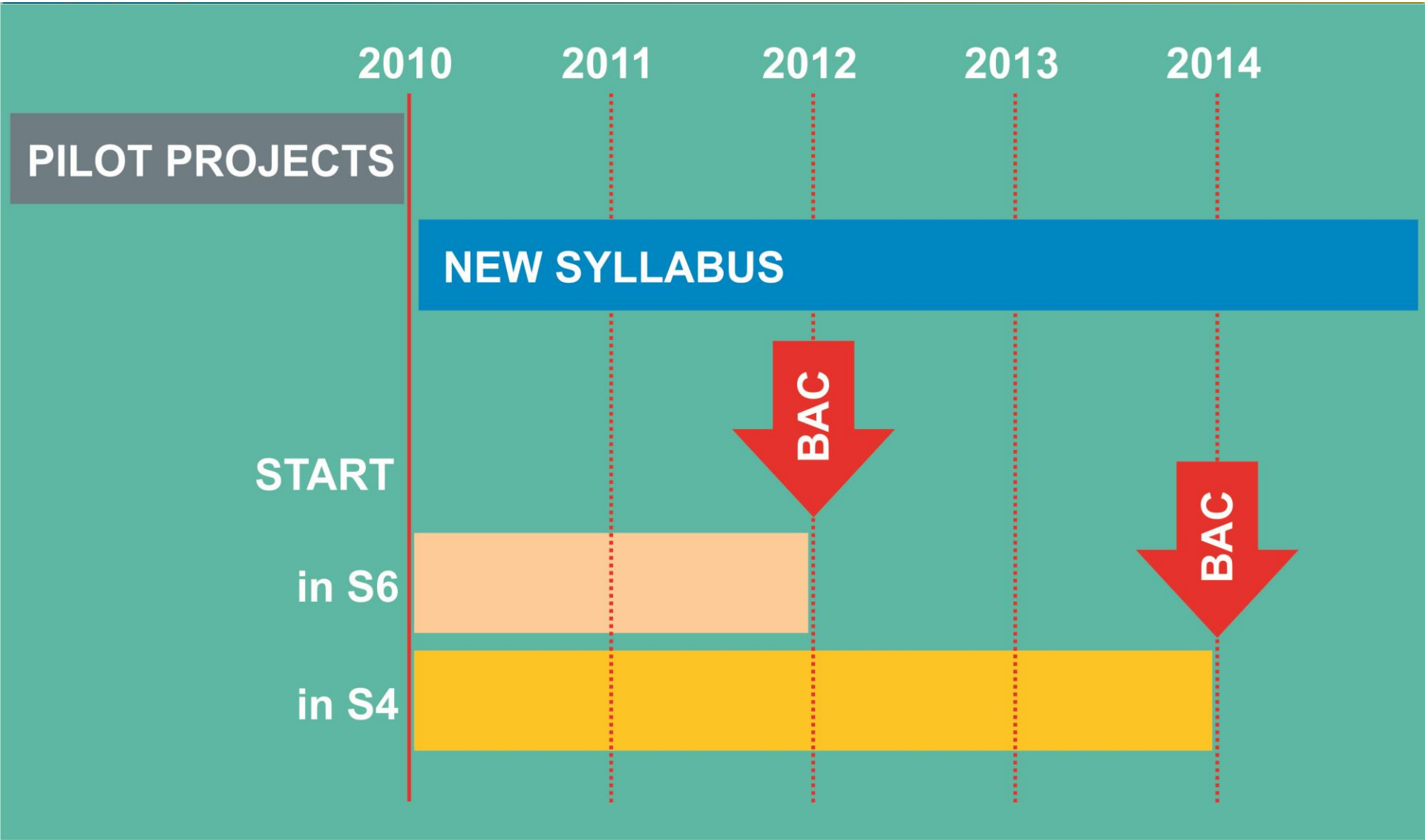
The technological tool in following analysis can be used to not only confirm what has been studied without a calculator but also to mirror, step by step, this process for a function which is not limited to only the basic ones. It may also be appropriate at times to use the tool to immediately give a solution.

TOPIC	KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
Study of Real Functions of One Real Variable	*In addition to the concepts met in the 6th year pupils must be able to and/or understand:* ▪ the concept of an inverse function ▪ study the natural logarithmic and the exponential function of base e ▪ examine the following characteristics for all the basic functions given above: ○ domain ○ intersection with the coordinate axes ○ limits ○ asymptotes ○ derivative and how it may vary ○ tangent at a point ○ extrema	*Pupils must be able to and/or understand:* ▪ draw the graph of a function ▪ choose appropriate units and a window so that the essential characteristics of a graph can be viewed and studied ▪ use the technological tool to perform, step by step, the calculations needed for examining the characteristics referred to in the second column ▪ manipulate by grabbing and moving the graphs of natural logarithms and the exponential to be able to observe the essential characteristics ▪ use sliders to investigate a family of functions with one or more parameters

Guidelines for teachers

Mathematics		secondary school						
						90h		150h
6	3h	ANALYSIS			PROBABILITY	STAT		
7	3h	ANALYSIS		PROBABILITY	STATISTICS			
6	5h	ANALYSIS				PROBABILITY	GEOMETRY	ALGEBRA
7	5h	ANALYSIS			PROBABILITY		GEOMETRY	ALGEBRA
6	+3h	BASIC CONCEPTS	DET. & LIN. ALG.	NUM. ANALYSIS	LIN. VECTOR SPACES GEOM. INT. OP. COMPL.			
7	+3h	TRIGONOM. FUNC.	POWER SERIES	CHOICE SUBJECT 1	CHOICE SUBJECT 2			

Timeline


2010
2011
2012
2013
2014
PILOT PROJECTS
NEW SYLLABUS
BAC
BAC
START
in S6
in S4

The Technological Tool - CAS

1. <u>Omschrijving</u>

- Voor alle (±7500-8000) leerlingen: klas 4 t/m klas 7
- CAS functionaliteit cf syllabus
- Identieke kansen
  - Zelfde tool voor iedereen
  - Enig toegelaten hulpmiddel
  - Press-to-Test
- Fysica, Scheikunde, Biologie, Economie en Aardrijkskunde

The Technological Tool - CAS

1. <u>Waarom TI-Nspire CAS CX ?</u>

- CAS in syllabus: geen link met merk of platform
- "*European Schools Expert Group*" - jaarlijks
  - Marktanalyse
  - Tool / Software
  - 2015-16 = TI-Nspire CAS CS / software 4.xx

The Technological Tool - CAS

2. **Comparison**

	TI-Nspire CX CAS	• Casio Fx-CP440	• HP Prime
Computer software	Real software with emulator function Offers simplified use and a high definition screen	Simply a less user-friendly calculator emulator	Simply a less user-friendly calculator emulator
Operating systems	Windows and Mac OS	Windows and Mac OS	Windows
Text editor with interactive mathematics boxes	Yes	No	No
Programming language	Yes Supports applications developed using Lua	Yes	Yes
Examination mode	Yes	Reset only (loss of all documents and of settings)	Yes, but less well suited to examination conditions in the ES
Training of teachers	Great experience, development of the software and of the calculator in collaboration with teachers	Centralised training structure, more product-oriented	?
Databank of teaching material	Yes (including in particular material developed by teachers in post in ES)	Yes	Yes, but small amount

The Technological Tool - CAS

Interdisciplinary use	Availability of many plug-in data collection modules	Availability of plug-in data collection modules	Availability of plug-in data collection modules
Screen	Colour with resolution of 320×240 pixels	Colour touch screen (stylus) with resolution of 320×528 pixels (see Keyboard section below)	Colour touch screen with resolution of 320×240 pixels

	TI-Nspire CX CAS	• **Casio Fx-CP440**	• **HP Prime**
Keyboard	• Alphanumeric and multifunction keys	Alphabet via touch screen (can be configured to AZERTY, QWERTY, etc.), the virtual keyboard then taking up half the screen	• Alphanumeric on multifunction keys
Computer/calculator connection (wired or wireless)	Port USB Docking station (transfer of data and recharging of batteries) TI-Navigator (wifi)	USB port	USB port Wireless connection kit
ES languages available	DK, DE, EN, ES, FR, IT, NL, POR, SUO, SW	DE, EN, ES, FR, SUO	DE, EN, ES, FR, NL, POR

The Technological Tool - CAS

Justification for the choice of version 4.0.0.235 of the software

The choice of version 4.0.0.235 of the software allows equality of opportunity for students to be ensured, in conformity with the outline reply given in the document *'Arrangements for acquisition of the 'calculator' foreseen by the new mathematics syllabuses'* (ref. 2010-D-242-en-3).

The reason is that calculators purchased and delivered at the beginning of the school year will come with that version of the software. Working with two versions would thus lead to distortion in terms of equality of opportunity, bearing in mind that version 4.0.0.235 of the software:

- enhances the level of security of *Press-to-Test* mode through correction of security vulnerabilities in version 3.9.0.463 (the last one indicated in the reference memorandum, namely 2014-06-M-2-EN) as part of the combating of hacking (possibility of fraud);
- corrects bugs (a problem inherent in any technological tool) and allows reliability to be increased, including at the mathematical level;
- through the new functionalities introduced, allows better implementation of certain points in the syllabuses which are likely to be assessed in tests and examinations.

Now, because of its smaller memory, which no longer allows upgrading of the software to version 4.0.0.235 (or higher), the TI-Nspire CAS TouchPad calculator can no longer be improved (correction of security vulnerabilities, correction of known and future bugs and new functionalities), thus adversely affecting the principle of equality of opportunity for students.

Finally, it should be noted that the colour screen of the TI-Nspire CX CAS calculator, the only one that supports version 4.0.0.235 (or higher) of the software, enables a far higher level of user comfort to be offered compared with that of the TI-Nspire CAS TouchPad, with its harder to read black and white screen, something which could be disadvantageous on pages containing graphs.

The CAS

European Schools

Group of experts in charge of choice of the technological tool

All examinations in S4, S5, S6 and S7

☑ **Mathematics**
☑ **Biology**
☑ **Chemistry**
☑ **Geography**
☑ **Physics**
☑ **Economics**

School year 2015/2016

Acknowledgement of reading of the detailed information note concerning the examination mode ("Press-to-Test" functionality) of the technological tool (TI Nspire CX CAS)[1]

European School: .....

Name : .....

First name: .....

Class: .....

Hereby declares that in accordance with memorandum 2015-06-M-1-en, he/she has, for the examinations in the subject indicated above with a tick, one of the following calculators:

☐ TI Nspire CX CAS Equipped with version 4.0.X.X or later.

Hereby declares that he/she has received the document entitled "S4-S7 Unbiased examination mode ("press-to test" functionality)"[1] 2015-06-D-13-en-1 and has been informed of its content by his/her mathematics teacher.

Done at ....., (date) ....
Candidate's signature

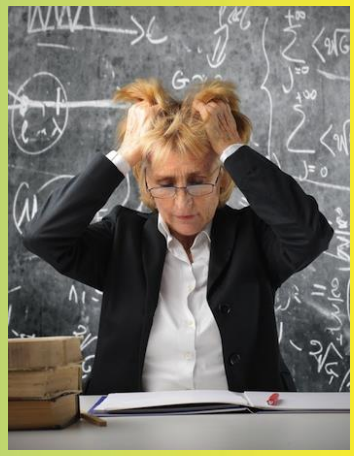
In my capacity as legal representative of ..... I hereby declare that I have read and duly noted the above.

Done at ....., (date) ....
Legal representative's signature

In-service Training

1. <u>Organisatie</u>

- Door "experts group"
- 2 trainers naar elke school
- Meertalig (EN/FR,…)
- 9-jaarscontract
- Basistraining
- Investering door docent

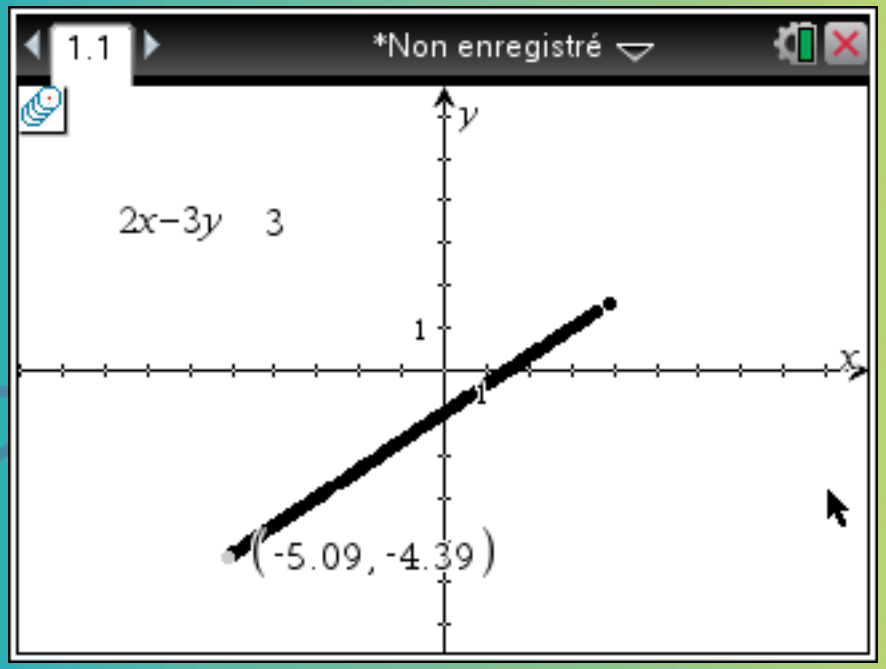


In-service Training

2. <u>Inhoud</u>

<u>TI-Nspire CAS in de klas</u>

- **Voorbeeld:** ***rechte lijn en vergelijking***



In-service Training

Europees Baccalaureaat

1. *Examenvragen bedenken en formuleren*
   - Welke competentie ?
   - Detail uitwerking
   - Meer problem solving ?
   - Wiskunde examen, geen CAS examen
   - Recycling
   - Vertaling
   - Wat moet de leerling doen ?
   - Ja/Nee (*)

In-service Training

Europees Baccalaureaat

2. *Correctie harmoniseren*
   - *Volstaat het juiste antwoord ?*
   - *TI-language ?*
   - *Punten verliezen of punten verdienen ?*
   - *Wat is 'voldoende' (6) ?*

In-service Training

Explanation on front page for Paper B

Answers must be supported by working and/or explanations.
Full marks cannot be given for a correct answer with no working, except when specified otherwise in the question.

In particular, solutions found from the calculator should be supported by a suitable mathematical explanation. If graphs are used to find a solution, you should sketch these as part of your answer.

Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

Réponse

Oui, un tel carré existe.

Assessment in Year 4 and Year 5

Year	*Assessments for the B-mark*	*Detail of the assessments*
4th class (4p and 6p/week)	Each semester two B-tests	• 1st B-test without a tool • 2nd B-test with a tool
5th class (4p and 6p/week)	December and June harmonised exams	• 1 period without a tool • 1 period (4p/week) or 2 periods (6p/week) with a tool

Assessment in Year 4 to Year 7

Year	*Assessments for the B-mark*	*Detail of the assessments*
4th class (4p and 6p/week)	Each semester two B-tests	• 1st B-test without a tool • 2nd B-test with a tool
5th class (4p and 6p/week)	December and June harmonised exams	• 1 period without a tool • 1 period (4p/week) or 2 periods (6p/week) with a tool
	December and June exams	• 1 period without a tool • 2 periods (3p/week) or 3 periods (5p/week) with a tool
7th class (3p and 5p/week)	Prebac and Baccalaureate	• 1 hour without a tool • 2 hours (3p/week) or 3 hours (5p/week) with a tool
6th and 7th class (further level 3p/week)	Each semester one B-test over 2 periods	• minimum 1 period without a tool (1st semester) or with a tool (2nd semester)
	Baccalaureate	oral exam with or without a tool (the indication is given by the teacher separately on each subject)

S7P3 European Baccalaureate

Eur. Baccalaureate Math 3

old

60p

12 = 8+4 compulsory questions

40p	ANALYSIS
20p	PROBABILITY

40p

2 compulsory questions

20p	ANALYSIS
20p	PROBABILITY

duration = 3 hours

new

40p PART A: no calculator

8 compulsory questions

40p	ANALYSIS PROBABILITY STATISTICS

duration = 1 hour

60p PART B: with Tinspire CAS

4 compulsory questions

10p	ANALYSIS
15p	ANALYSIS
15p	PROBABILITY
20p	STATISTICS

duration = 2 hours

S7P5 European Baccalaureate

Eur. Baccalaureate Math 5

old

50p

4 compulsory questions

12p	ANALYSIS
12p	DIFFERENTIAL EQ.
13p	GEOMETRY
13p	PROBABILITY

50p

2 choice questions

25p	ANALYSIS
25p	GEOMETRY
25p	PROBABILITY

duration = 4 hours

new

30p PART A: no calculator

7 compulsory questions

30p	ANALYSIS GEOMETRY PROBABILITY COMPLEX NUMBERS SEQUENCES

duration = 1 hour

70p PART B: with Tinspire CAS

4 or 5 compulsory questions

20p	ANALYSIS
20p	GEOMETRY
20p	PROBABILITY
10p	SEQ. / COMPLEX

duration = 3 hours

BAC 2012

EUROPEES BACCALAUREAAT 2012: WISKUNDE 5 PERIODEN

DEEL B		
VRAAG B1 ANALYSE	**Blz. 1/5**	**Punten**
Gegeven is de familie van functies g_n, gedefinieerd door $$g_n(x) = \frac{e^{nx}}{1+e^x}$$, voor alle gehele getallen $n \geq 0$.		
a) Schets de grafiek van g_0.		2 punten
b) Toon aan dat $g_0(x) = g_1(-x)$ voor alle reële getallen x.		
Geef de meetkundige betekenis van deze betrekking en schets de grafiek van g_1 in hetzelfde assenstelsel als de grafiek van g_0.		2 punten
c) Toon aan dat de krommen $y = g_n(x)$ een gemeenschappelijk punt hebben en geef de coördinaten van dat punt.		2 punten
d) Onderzoek, voor $n \geq 2$, het verloop van de functie $g_n(x)$ als $x \to -\infty$ en als $x \to +\infty$, en geef de vergelijking van de asymptoot.		3 punten
e) Bereken, voor $n \geq 2$, de afgeleide $g_n'(x)$ en geef aan of g_n stijgend of dalend is.		3 punten
f) In het punt met $x = 0$ heeft de grafiek van g_n een raaklijn die parallel is met de lijn $9x - 4y - 1 = 0$.		
Bereken n en geef een vergelijking van deze raaklijn.		3 punten
g) Bereken de oppervlakte van het vlakdeel ingesloten door de grafieken van g_0 en g_1 tussen de lijnen met vergelijkingen $x = -1$ en $x = 1$.		3 punten
h) Voor de gehele getallen $n \geq 0$ is gegeven een rij I_n gedefinieerd door $I_n = \int_{-1}^{0} g_n(x)\,dx$.		
Bereken met de rekenmachine de kleinste waarde van n waarvoor $I_n \leq 0{,}11$.		2 punten

BAC 2015

EUROPEES BACCALAUREAAT 2015: WISKUNDE 5 PERIODEN

DEEL A		
	Blz. 1/2	**Punten**
1) Bereken $\int_1^e 2 \cdot \frac{\ln(x)}{x} dx$.		4 punten
2) In een driedimensionale ruimte zijn gegeven de bol S: $(x-3)^2+(y+1)^2+z^2=\frac{1}{3}$ en het vlak π: $x-y+5z=1$. Toon aan dat π een raakvlak is van bol S.		4 punten
3) In een bepaald land wordt 80 % van de mannen tenminste 70 jaar oud en 50% van de mannen tenminste 80 jaar oud. Bereken de kans dat een man die zojuist zijn 70ste verjaardag heeft gevierd tenminste 80 jaar oud zal worden.		4 punten
4) De rij u_n is gegeven door $u_n = 3 \cdot n + (-1)^n$, met $n \geq 1$. Is deze rij stijgend?		4 punten

S7P8 (+P3) European Baccalaureate

- 20 min voorbereiding
- 20 min mondeling examen

1. GONIOMETRIE

a. Geef de **definitie** van Bgsin(x) en leg het verband uit met de sinus-functie.

Leg uit m.b.v. de grafieken van de functies.

b. Gebruik een eigenschap van **cyclometrische functies** en los stap voor stap de volgende vergelijking op in $\mathbb{R}$:

$$Bg\tan x + Bg\cot x = Bg\cos x + Bg\cos\left(x\sqrt{3}\right)$$

2. ALTERNERENDE REEKSEN

a. Formuleer de **Stelling van Leibniz** voor *alternerende* reeksen.

b. Welke van de volgende reeksen **voldoet** aan de voorwaarden van de stelling ?

- $\sum \frac{(-e)^{n+1}}{9^{n/2}}$
- $\sum \frac{(-1)^n \pi^{n+1}}{e^n}$
- $\sum \frac{e^{n+1}}{-\pi^n}$

c. Als je de reeks (waarop de stelling van toepassing is) afbreekt na de term met n = 4

bereken dan een **bovengrens** van de gemaakte **fout**.

European Baccalaureate

1. <u>Voorbereiding en tijdslijn</u>
   - Sept-Nov: één voorstel per school
     - Vertaling EN-FR-DE + modeloplossingen
   - Dec-Jan: keuze door externe experts
   - Juni: 100 % geharmoniseerd BAC
2. <u>Correctie</u>
   - 1ste: leraar
   - 2de: externe expert
   - Cijfer = gemiddelde
   - 3de ?

European Baccalaureate 2012

3. <u>Nieuw BAC 2012</u>
   - Wisk 5: gemiddelde 1,4 lager
   - Probleemanalyse
     - CAS rekenmachine
     - Korte tijd = 2 jaar
     - Geen keuzevragen
     - Volledige syllabus
     - Deel zonder rekenmachine
   - +1,4/10

CAS in de KLAS

1. **Introduceren, onderzoeken, ontdekken en illustreren met CAS**
   - *Goniometrische cirkel en functies*
     - *sin en cos*
   - *Omgekeerde functie*
     - *Bgsin en sin*
     - *Log en exp*
   - *Rijen*
     - *Limiet*
     - *Insluitstelling*
   - *Taylor en Mc-Laurin*
   - *Middelwaardestellling van Lagrange*
   - *Maximum en minimum problemen*

CAS in de KLAS

- *Een leerling…*

$\text{solve}(f1(x)=f2(x),x)$	$x=-1.79974$ or $x=5.62084$
$\text{solve}\left(\frac{d}{dx}\left(\frac{\lvert f1(x)-f2(x)\rvert\cdot(x+1.79974)}{2}\right)=0,x\right) \mid -1.79974\le x$ and $x\le 5.62084$	$x=1.17158$ or $x=4.0611$ or $x=4.64484$

1. **Hoe interpreteer je de resultaten gegeven door de rekenmachine ?**
2. **Wat als je geen grafische voorstelling gemaakt hebt ?**
3. **Is de redenering correct ?**
4. **Deze leerling heeft het probleem begrepen en het kan oplossen. Klopt dat ?**

CAS in de KLAS

- *Een leerling…*

$\text{solve}(f1(x)=f2(x),x)$	$x=-1.79974$ or $x=5.62084$
$\text{solve}\left(\frac{d}{dx}\left(\frac{\lvert f1(x)-f2(x)\rvert\cdot(x+1.79974)}{2}\right)=0,x\right) \mid -1.79974\le x$ and $x\le 5.62084$	$x=1.17158$ or $x=4.0611$ or $x=4.64484$

5. **Is het compleet ?**
6. **Is enkel het antwoord voldoende ?**
7. **TI-language ?**
8. **Met CAS meerdere methodes**
9. **Hoe duidelijk formuleren ?**

CAS in de KLAS

2. **Oefenen met CAS**
   - *Na ontdekken, toepassen en oefenen*
     - *Rico van een lijn*
     - *Transformaties*
     - *Afgeleide functie / afleidbaarheid*
3. **Simuleren met CAS**
   - *Som van de ogen van 2 dobbelstenen*
   - *Som en normale verdeling*
4. **Problem Solving met CAS**
   - *Raaklijn aan een functie door de oorsprong*

CAS in de KLAS

5. **Integreren van de CAS applicaties**
   - *Bestand – opgave – pagina – variabele*
   - *Kracht = meerdere applicatie*
   - *Notities*
     - *Functieonderzoek*
     - *Oefeningen en examens*
   - *Programmeren*

Valkuilen en pijnpunten

1. **Press-to-test**
   - *Essentieel*
   - *Oefenen in de klas*
   - *Examen procedure in ES*
     1. *TI aan + in normale modus*
     2. *Leerlingen: Press-to-Test*
     3. *Controle (Led)*
     4. *Verdeling van de vragen*
   - *Reserve machines*

Valkuilen en pijnpunten

2. Perceptie

=

Valkuilen en pijnpunten

3. **Afhankelijkheid van één bedrijf**
   - *Alle leerlingen zelfde rekenmachine*
   - *Veranderen niet eenvoudig*
   - *Te duur ?*
   - *3 hardware versies*

Valkuilen en pijnpunten

4. Bugs… en examen: BAC WISK3 2015

À 22h00, la température d'une pièce est de 20°C. À cette heure, on éteint le chauffage dans la pièce.

La température $f(t)$ de la pièce après 22h00 est donnée par

$$f(t) = 9e^{-0,12t} + 11$$

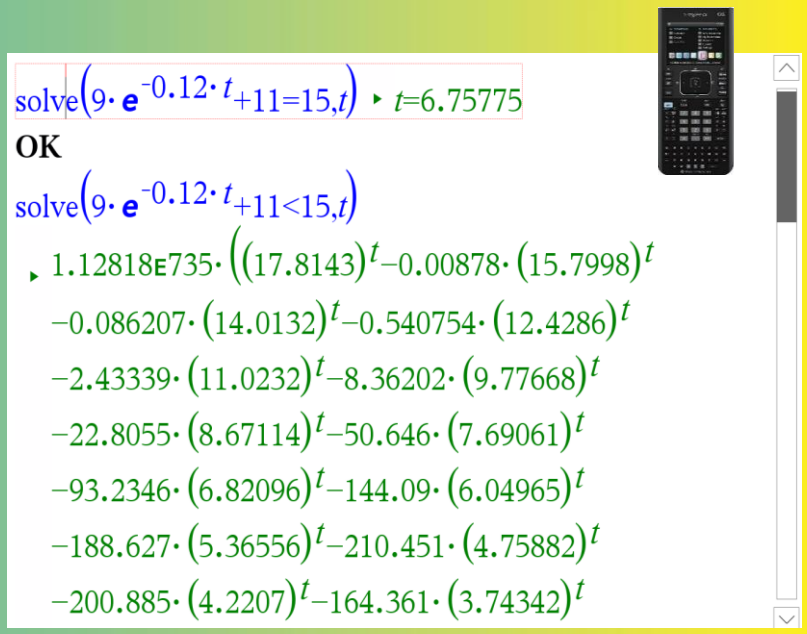
où t est le nombre d'heures après 22h00 et $f(t)$ est exprimée en °C.

a) Calculer la température à minuit et à 7h00 le lendemain matin.

b) Déterminer $f'(t)$ et démontrer que f est une fonction décroissante.

c) Déterminer $f'(2)$.
Que nous révèle ce résultat à propos de la température de la pièce ?

d) À quelle heure de la matinée la température tombera-t-elle sous 15°C ?



Valkuilen en pijnpunten

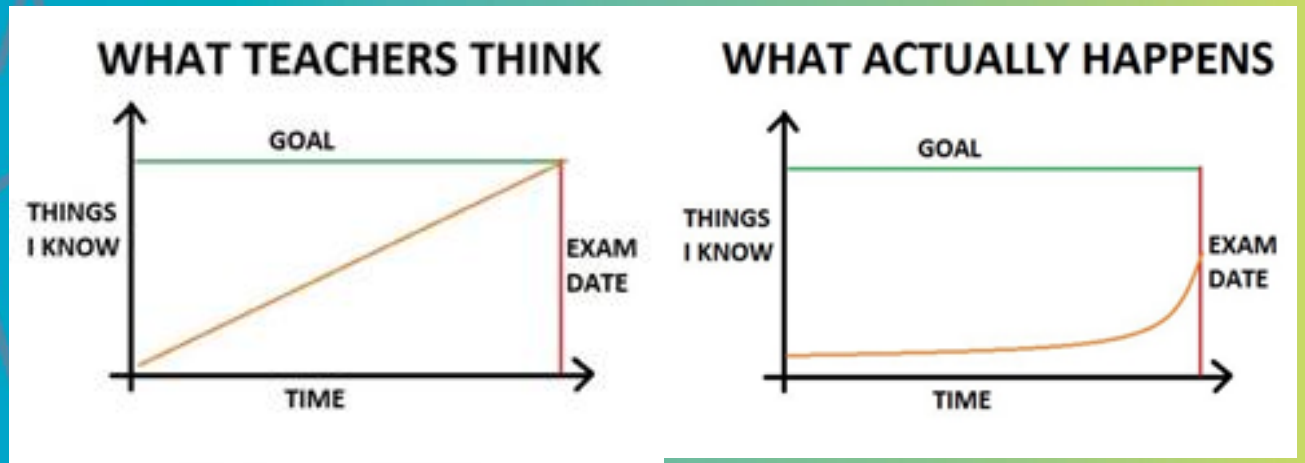
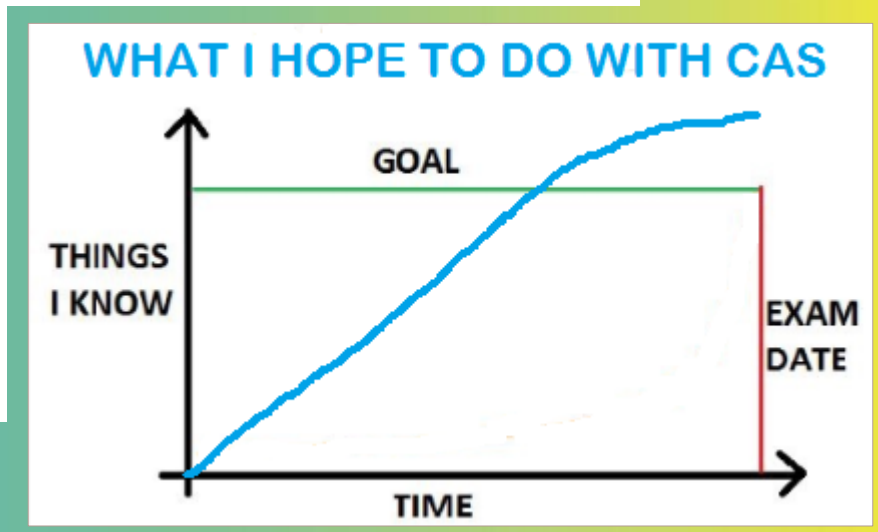
5. **Voorbeelden en oefeningen**
   - *Handboeken en methodes*
   - *Zelf*
   - *Het kaf van het koren scheiden*
6. **Vorming**
   - *Conditio sine qua non*
   - *Permanent*
   - *9 jaars contract*
   - *Zelf*
   - *Grote diversiteit*

Valkuilen en pijnpunten

7. **‘lelijke’ getallen**
   - *Niet de bedoeling*
   - *Reële data*
8. **Vervolgonderwijs**
   - *CAS aan de universiteit / hogeschool ?*
   - *Normale Verdeling*
9. **De ‘unieke’ oplossing**
   - *Andere opstelling docent en student*
   - *Meerdere oplossingsmethodes*
10. **CAS = hulpmiddel niet het doel**

Meer wiskunde, minder rekenwerk

Halen we de doelstelling ?

- *Zonder rekenmachine*
- *Boeiend en verrijkend*
- *Onderzoek ?*
- *Work in Progress*

Thank you for listening…