The Use of Dynamic Geometry Software by High School Teachers in Vietnam: Analysis from Case Studies

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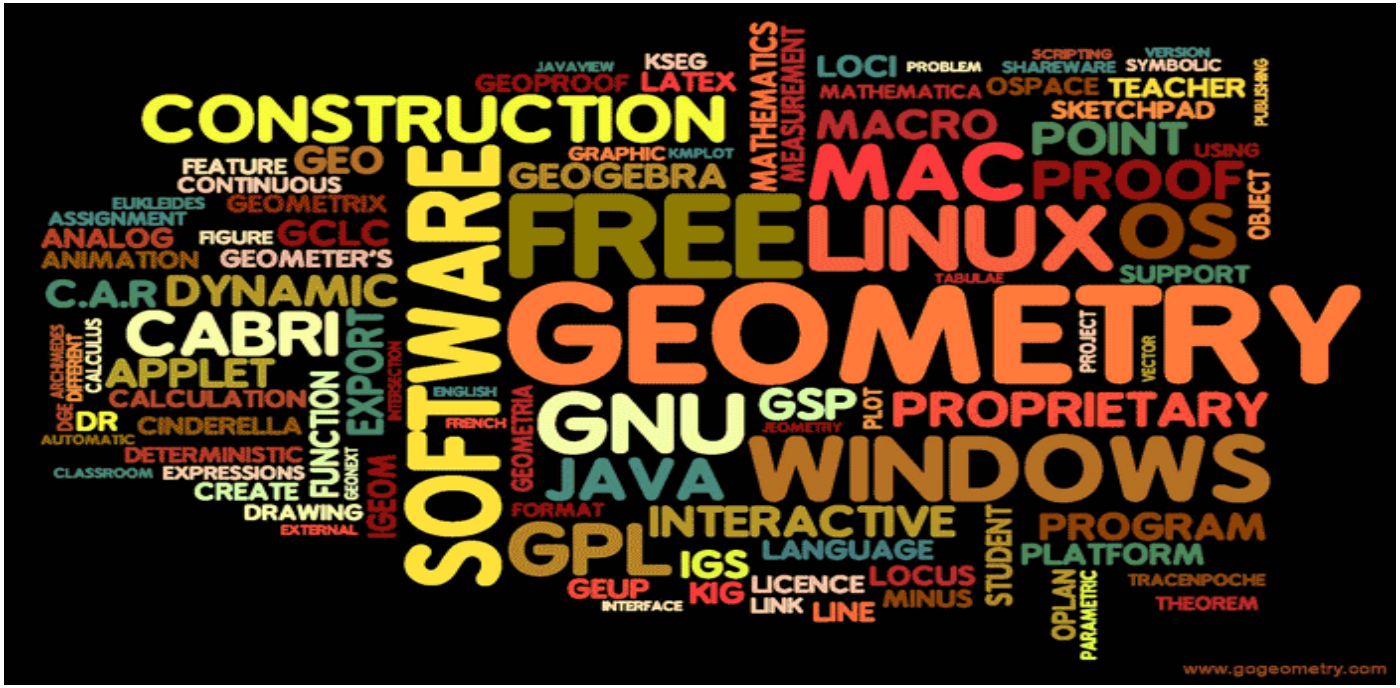
Hiroshima University, the 8th Mars 2013

Plan

- **Some remarks from the 1rst seminar**
- Introduction DGS
- An institutional analyse: actual situation in Vietnam
- Teacher professional development
- Conclusion



Some remarks from the 1rst seminar

- High school teacher (HST) training : 3 models
- No specific content in ICT use in pre-service teacher training
- No specific (or very little) in computer softweres in teaching and learning

Pre-in service teacher are mostly weak in presentation skill, ICT use skill, repport elaboration skill and real life problem solving skill. (Dinh Quang Bao, 2011)

- In despite of some positive modification recenly made, mathematics curriculum at high school remains accademic, formal and ''skillful" based orientation
- Very strong institutional recommendation in terms of ICT use and integration in mathematic education

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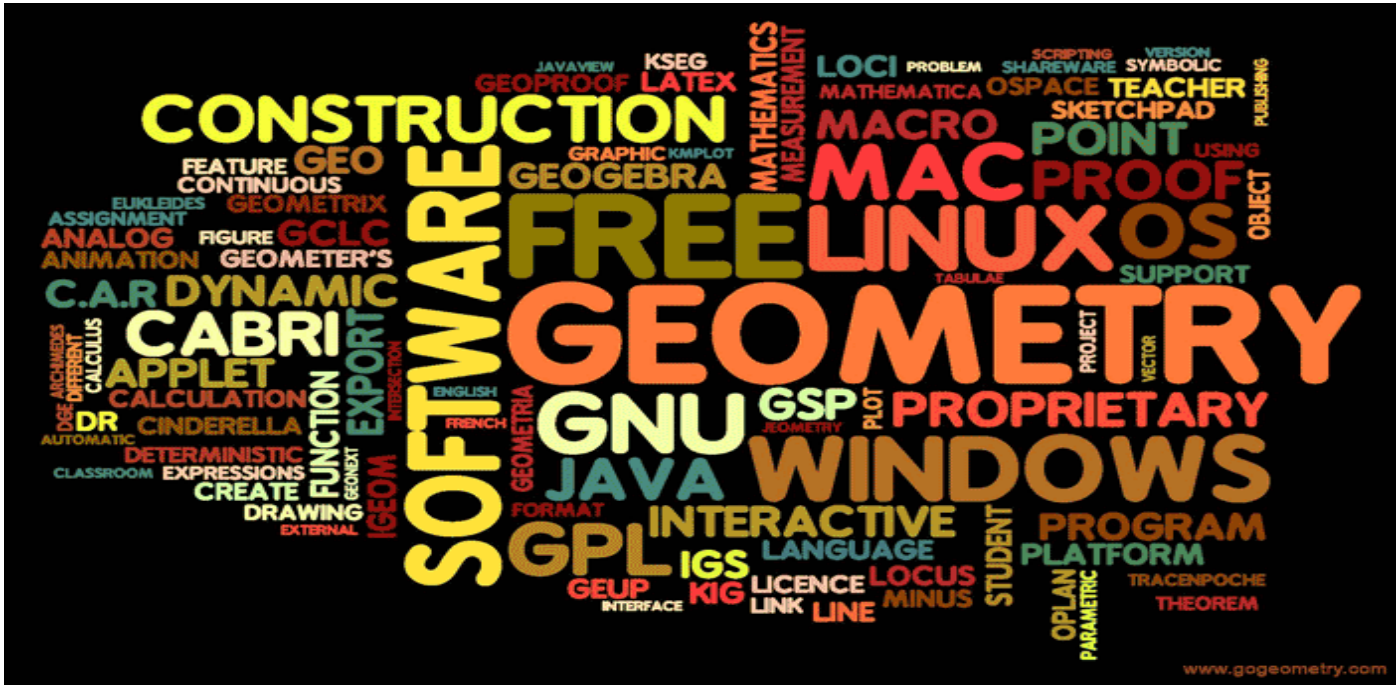


What is expected from technology?

Must help students to adapt
to the technological world

Must allow students
to master current math
practices

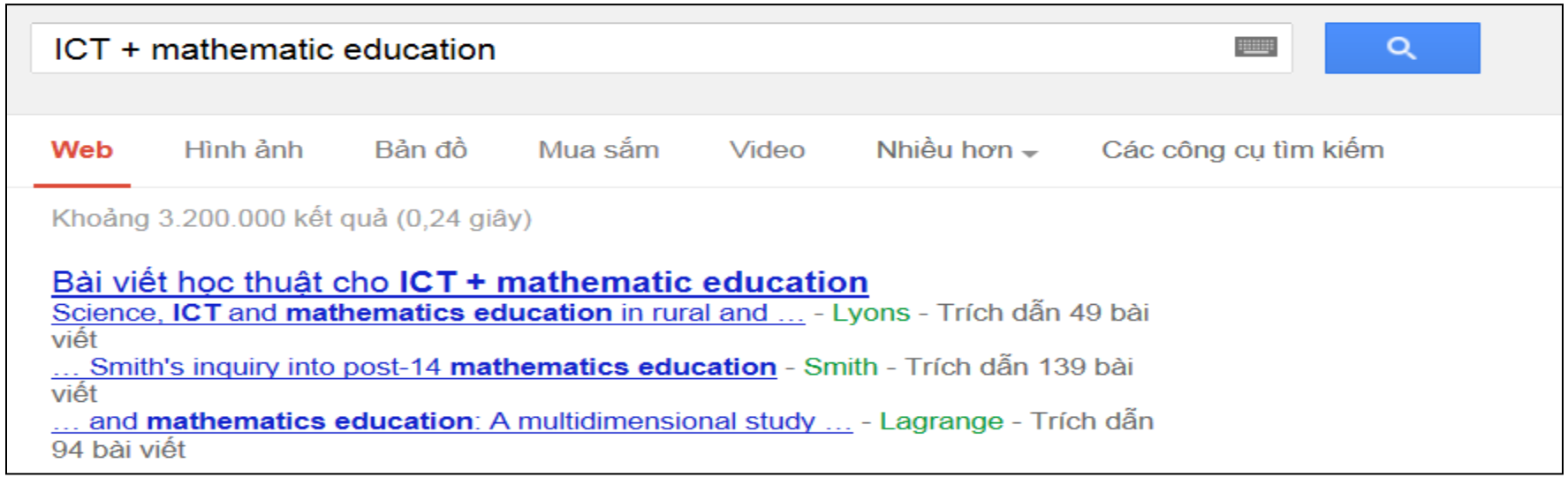
Must help to renew pedagogical practices,
must provide new teaching tools,
for visualising, communicating…

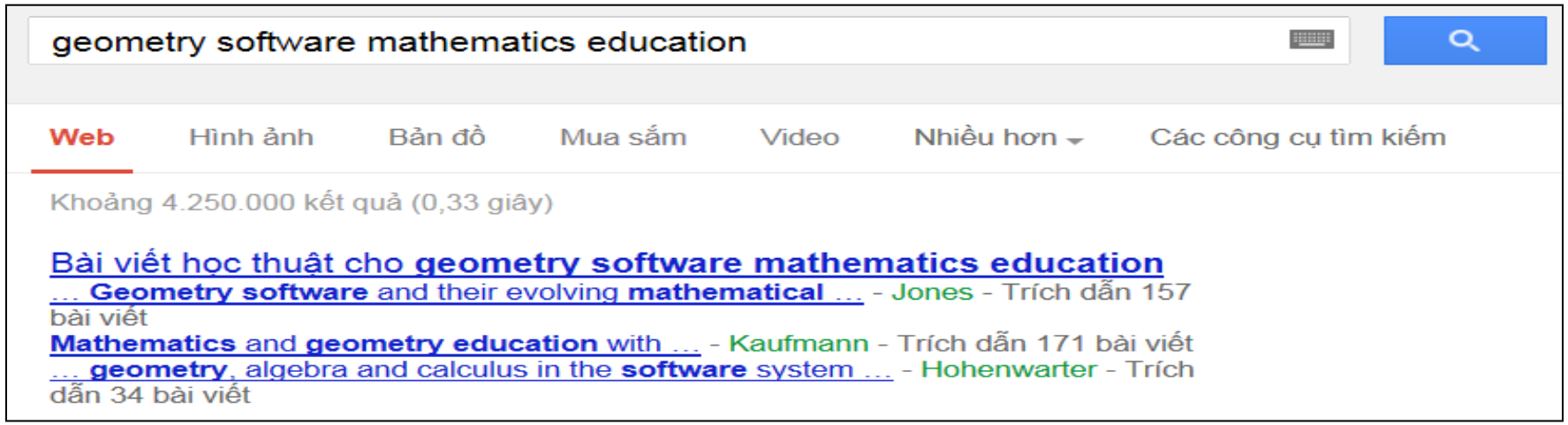
Must save teaching
and learning time

Must help to understand
mathematical concepts,
must increase students' math power

Must make teaching and learning easier and better

Why Dynamic Geometry Software (DGS) ?





Why Dynamic Geometry Software (DGS) ?

- Over the last two decades, DGS has become one of the most widely used pieces of software in schools and colleges all over the world (there are versions of the software in French, German, Japanese, Spanish and Swedish etc.).
- In terms of research, Sträßer (2001) thinks that DGS may be one of the best, if not the best, researched type of software within mathematics education research. In respect of geometry in secondary schools, Hollebrands (2003) and colleagues consider DGS research to be the sort of software research that offers most insight into its use in the classroom.

A statistic figure about DGS (Wikipedia 2013)

2D programs
- 3.1 C.a.R.
- 3.2 CaRMetal
- 3.3 Cabri II Plus
- 3.4 Cinderella
- 3.5 Euklid DynaGeo
- 3.6 Eukleides
- 3.7 Dr Genius
- 3.8 Dr. Geo
- 3.9 Gambol
- 3.10 GCLC
- 3.11 GeoGebra
- 3.12 Geolog
- 3.13 Geometry Expressions
- 3.14 The Geometer's Sketchpad
- 3.15 Geometrix
- 3.16 Geonext
- 3.17 The Geometric Supposer
- 3.18 Géoplan-Géospace
- 3.19 GeoProof
- 3.20 GEUP
- 3.21 GRACE
- 3.22 iGeom
- 3.23 Jeometry
- 3.24 Isard
- 3.25 Kig
- 3.26 Kgeo
- 3.27 KmPlot
- 3.28 KSEG
- 3.29 Non-Euclid
- 3.30 OpenEuclide
- 3.31 Sphaerica
- 3.32 Live Geometry
- 3.33 TracenPoche
- 3.34 Tabula
- 3.35 Tabulae
- 3.36 Wingeom

2D DGS: 36

3D DGS: 9

3D programs
- 4.1 Archimedes Geo3D
- 4.2 Cabri 3D
- 4.3 Euler 3D
- 4.4 Geometria
- 4.5 Geomview
- 4.6 GEUP 3D
- 4.7 PyGeo
- 4.8 JavaView
- 4.9 SingSurf

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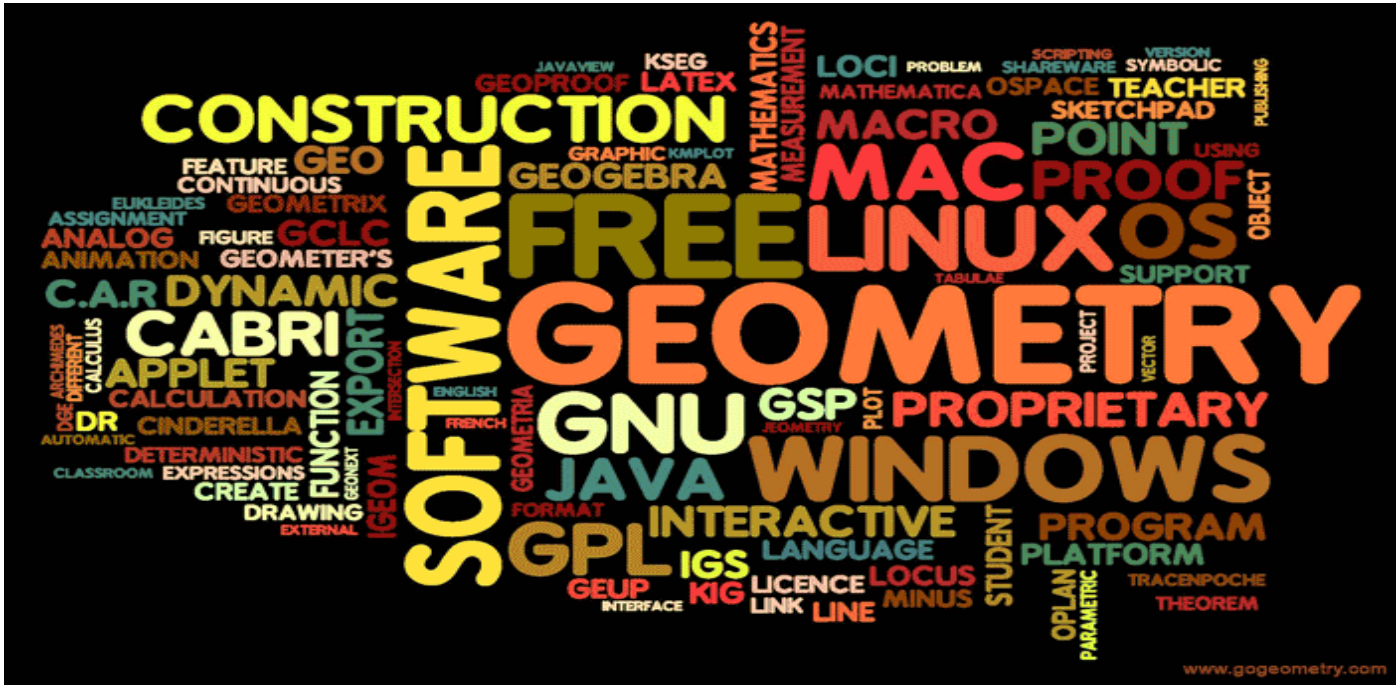


Introduction to DGS

- **Interactive geometry software** (or Interactive Geometry Software IGS, or Dynamic Geometry environments, DGE) are computer programs which allow one to create and then manipulate geometric constructions, primarily in plane geometry. In most DGS, one starts construction by putting a few points and using them to define new objects such as lines, circles or other points. After some construction is done, one can move the points one started with and see how the construction changes.
- DGS provides a range of tools for constructing geometric objects from a range of `primitive' objects (such as points, segments, lines, circles etc.). The tools available in the software include 'classical' constructions (midpoint, perpendicular, parallel, etc.) as well as transformations (reflect, rotate, translate, etc.).

Generalities about a DGS: Cabri software

Cabri is flexible ...

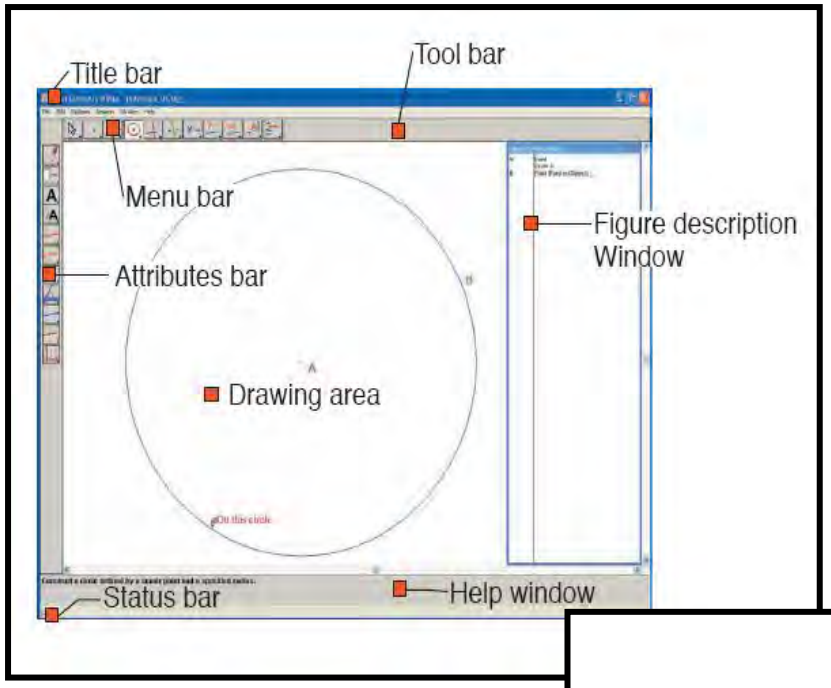
- Teachers can customise menus to display only relevant tools
- Add macros to any menu to automate steps
- Redefine points or objects

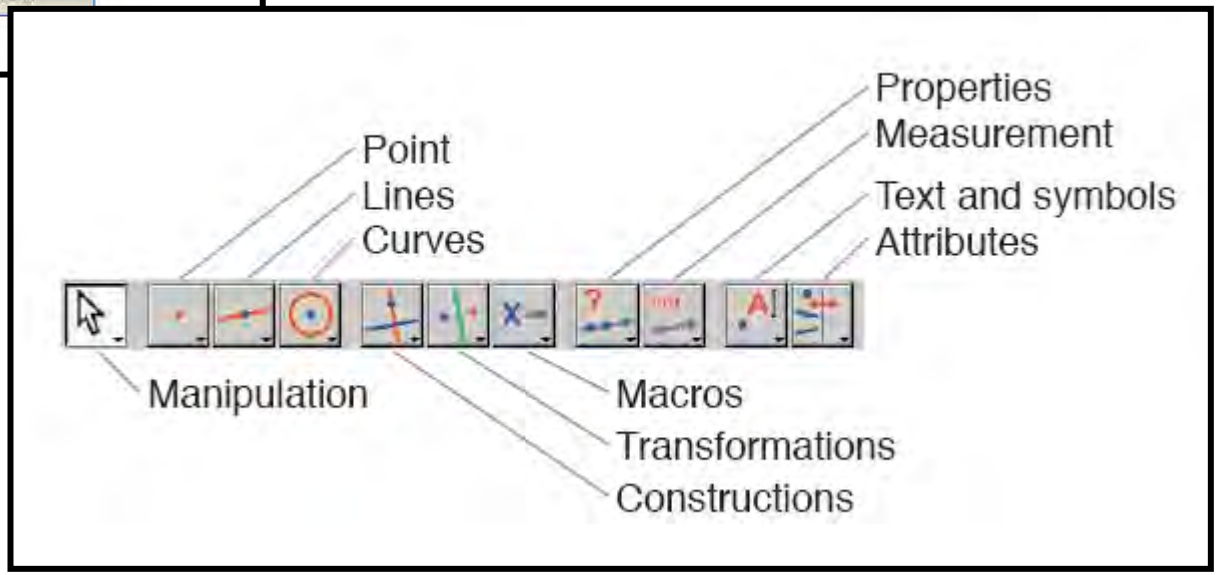
and very powerful ...

- Display loci of points or objects, loci of loci, and intersections with loci !
- Create objects involving elements at infinity
- Equation tool can obtain the equation of a locus for algebraic curves !

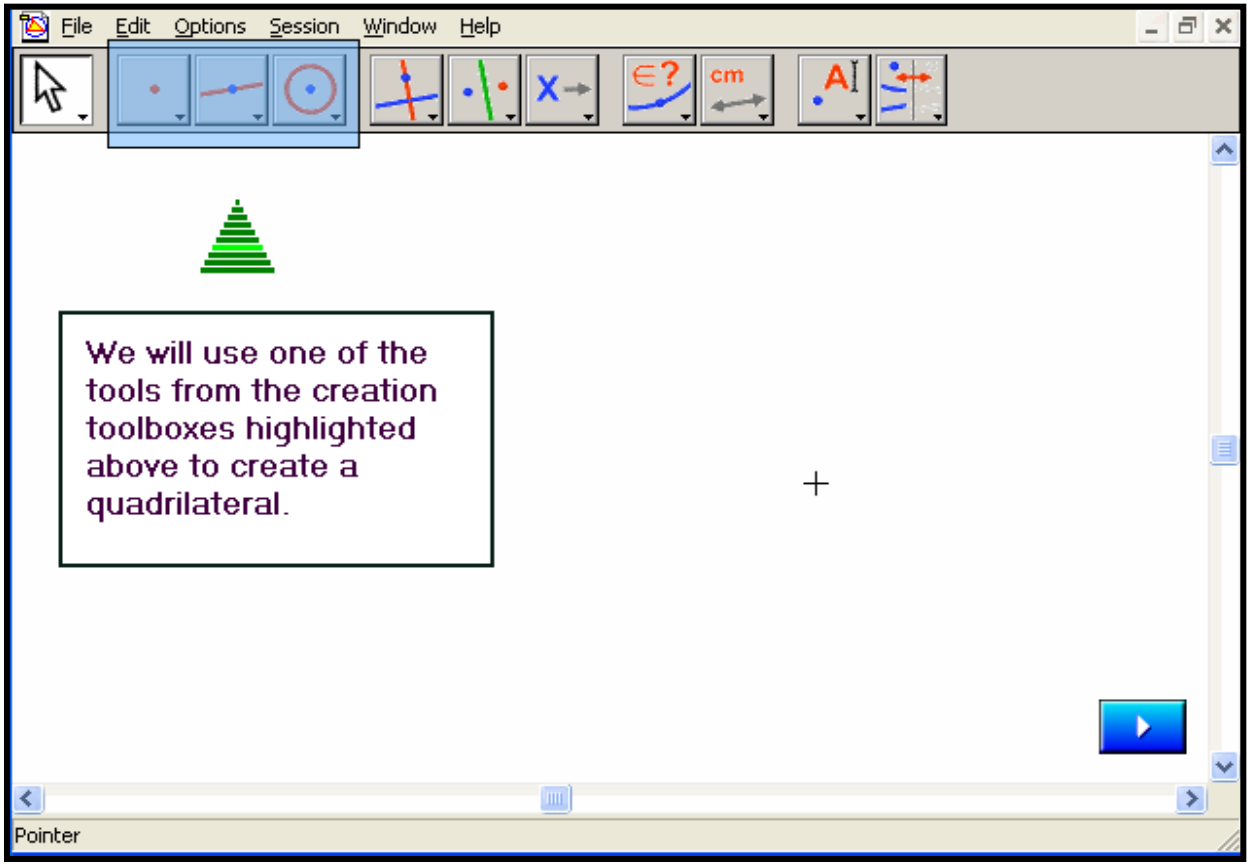
.../Continued

Cabri: User interface

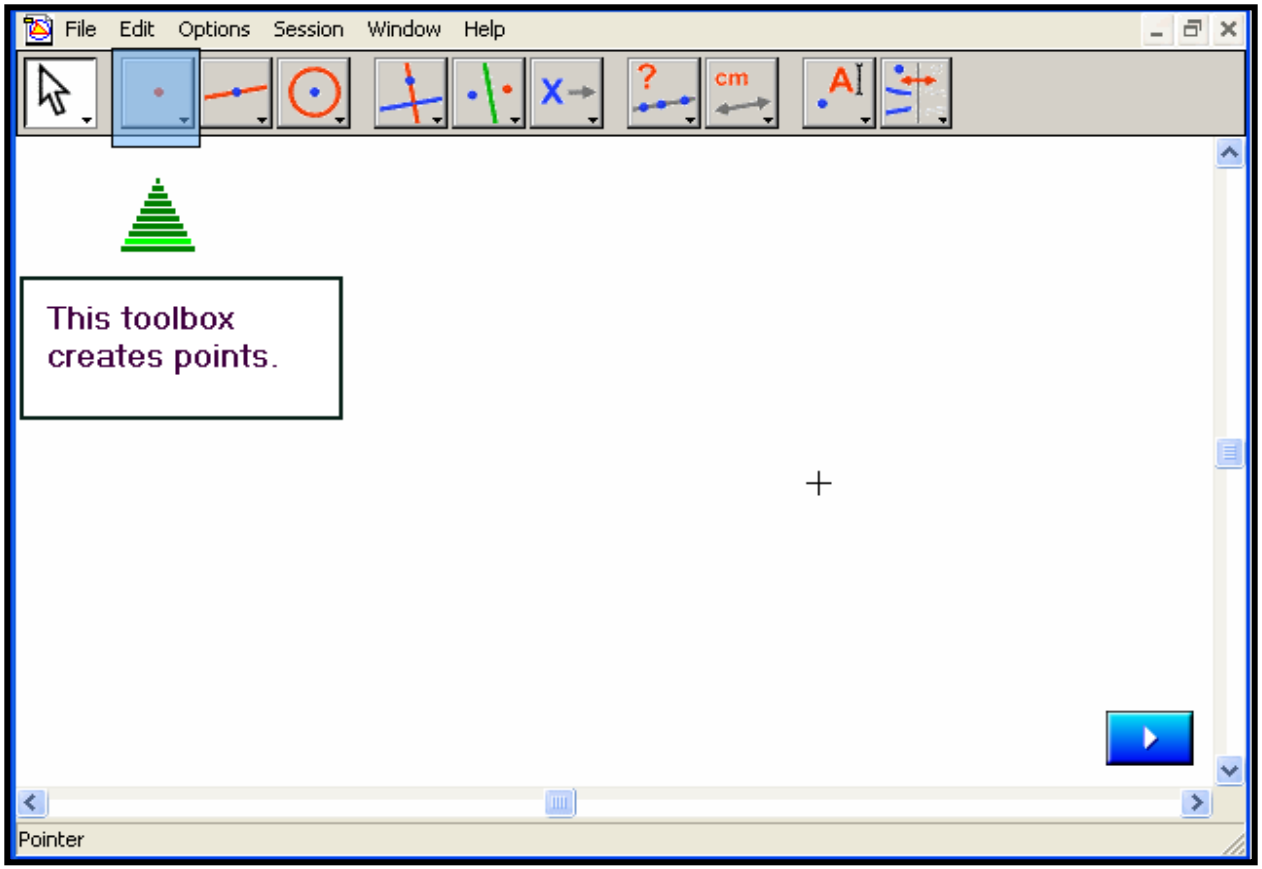




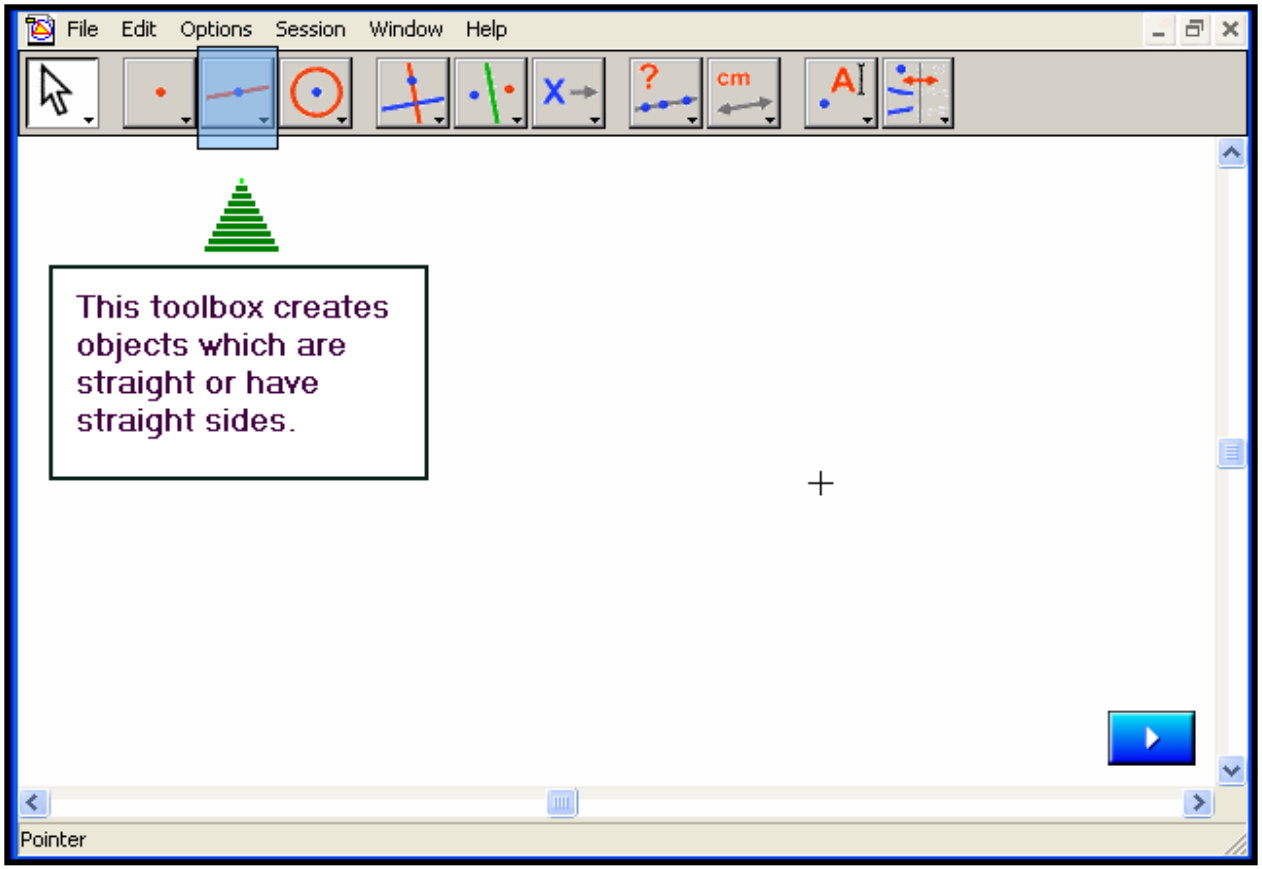
Example I


File Edit Options Session Window Help
We will use one of the tools from the creation toolboxes highlighted above to create a quadrilateral.
Pointer

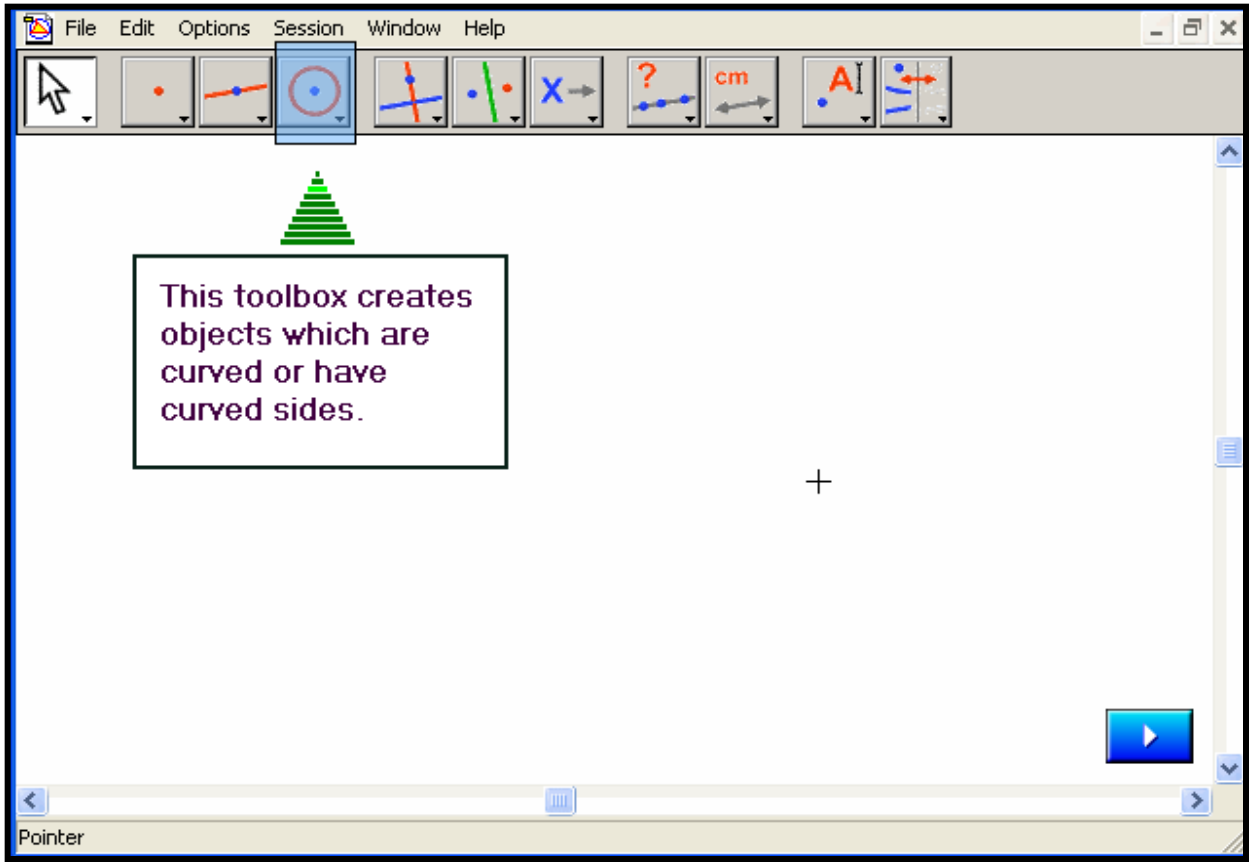
Example I


File Edit Options Session Window Help
cm
This toolbox creates points.
Pointer

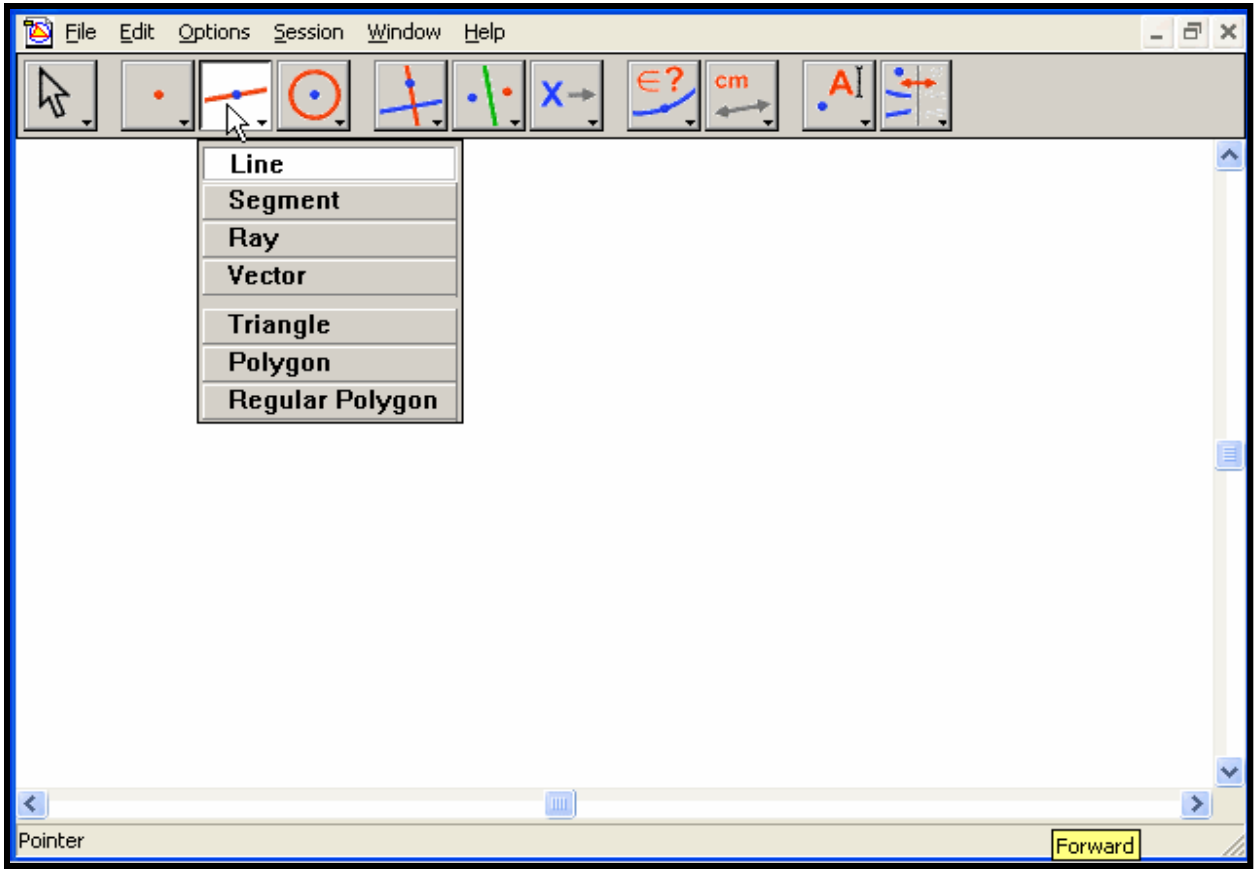
Example I


File Edit Options Session Window Help
cm
This toolbox creates objects which are straight or have straight sides.
Pointer

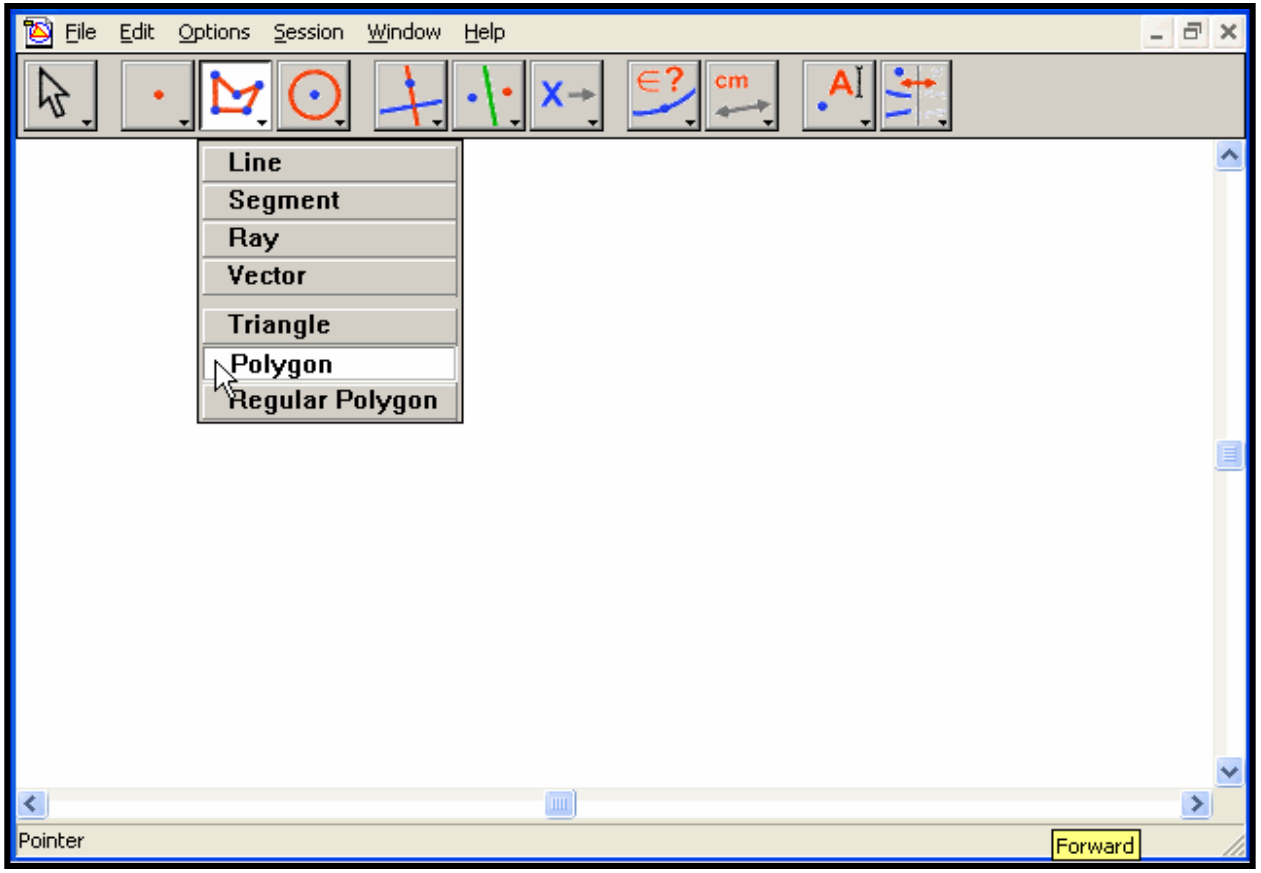
Example I


File Edit Options Session Window Help
cm
This toolbox creates objects which are curved or have curved sides.
Pointer

Example I


File Edit Options Session Window Help
Line
Segment
Ray
Vector
Triangle
Polygon
Regular Polygon
Pointer
Forward

Example I


File Edit Options Session Window Help
Line
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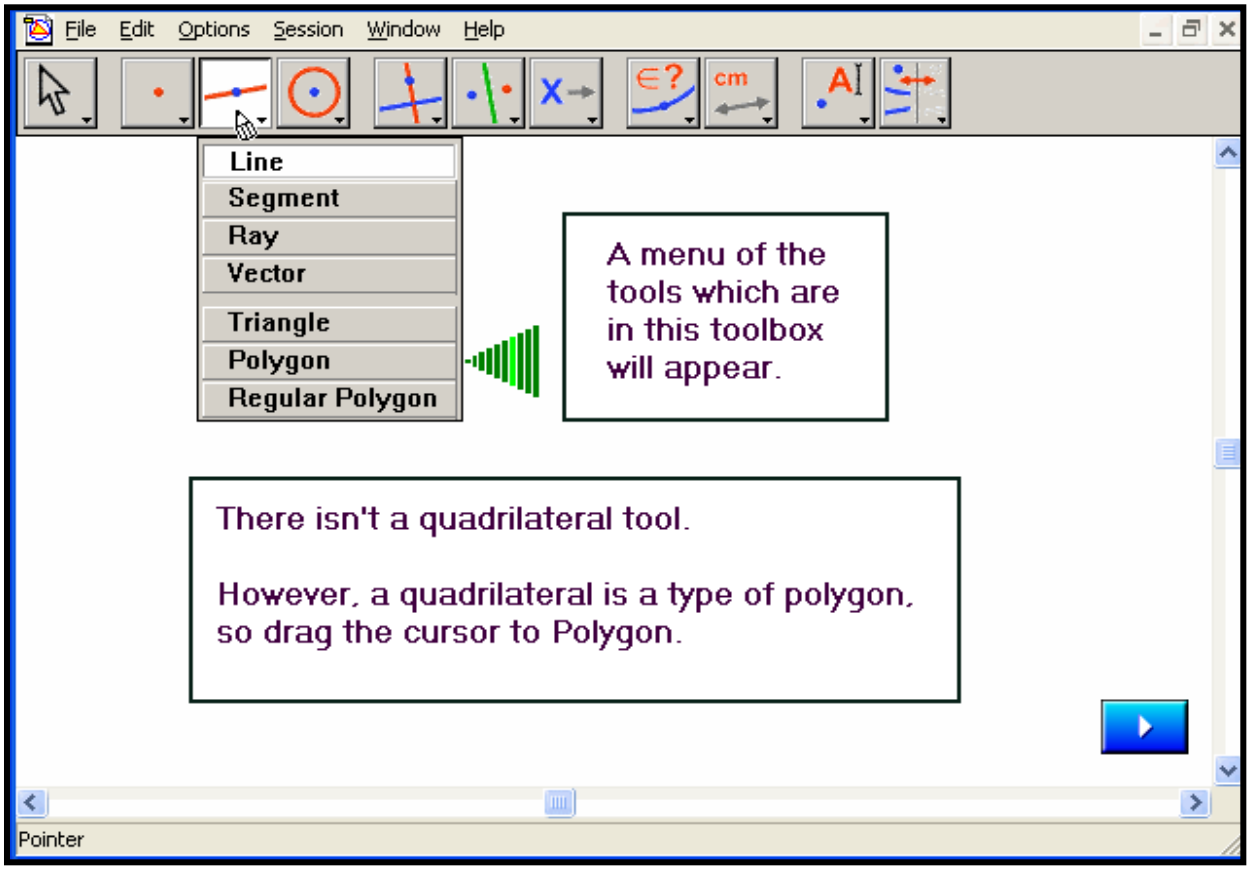
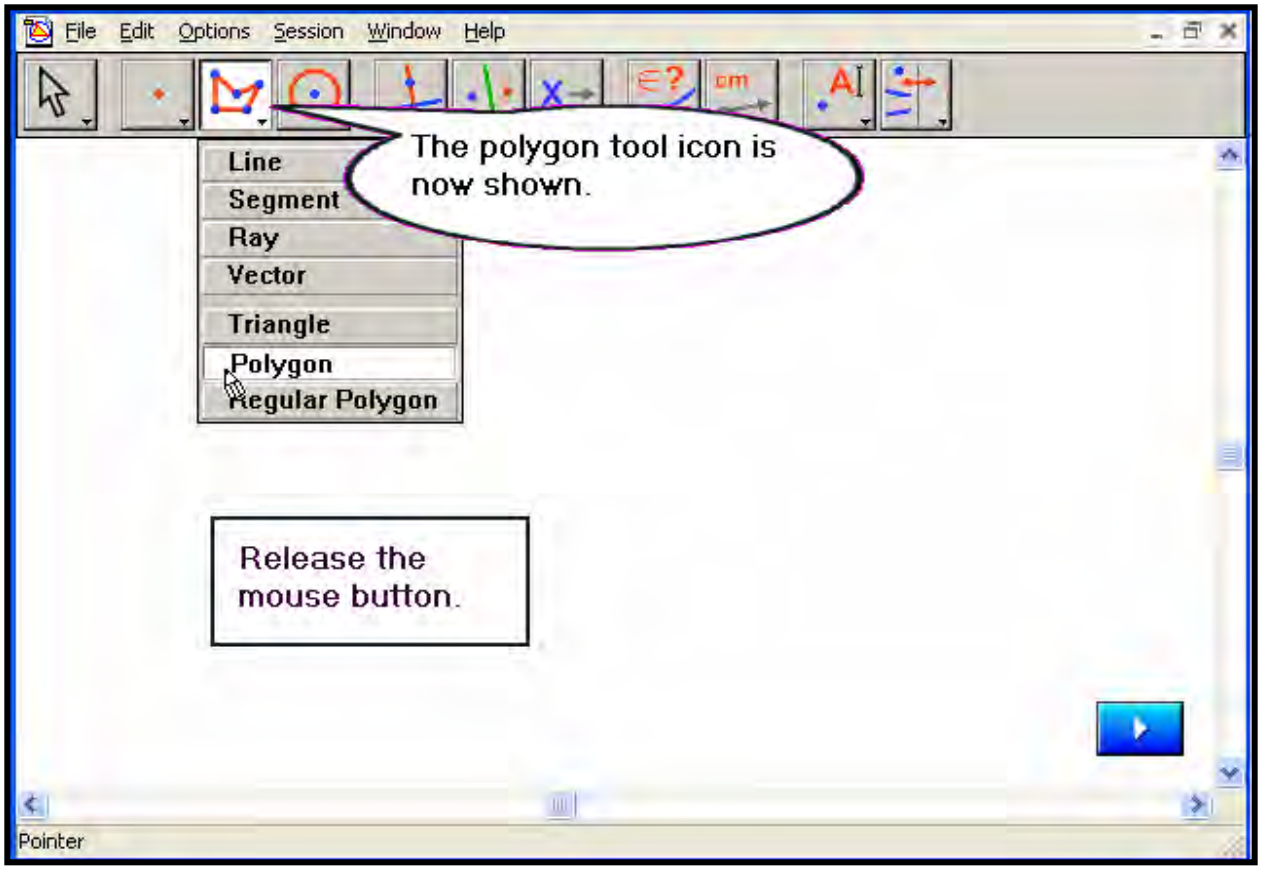
Regular Polygon
Pointer
Forward

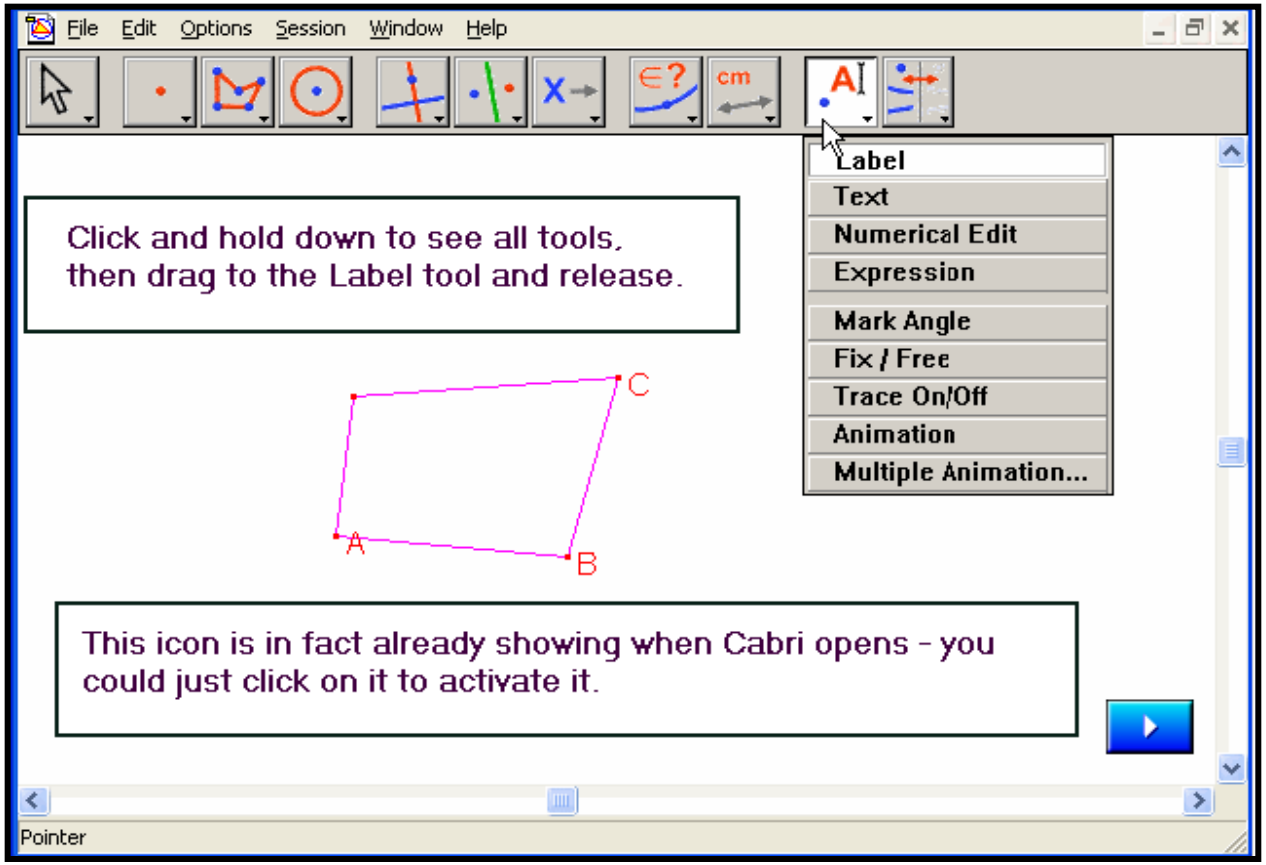
Example I


File Edit Options Session Window Help
Line
Segment
Ray
Vector
Triangle
Polygon
Regular Polygon
A menu of the tools which are in this toolbox will appear.
There isn't a quadrilateral tool.
However, a quadrilateral is a type of polygon, so drag the cursor to Polygon.
Pointer

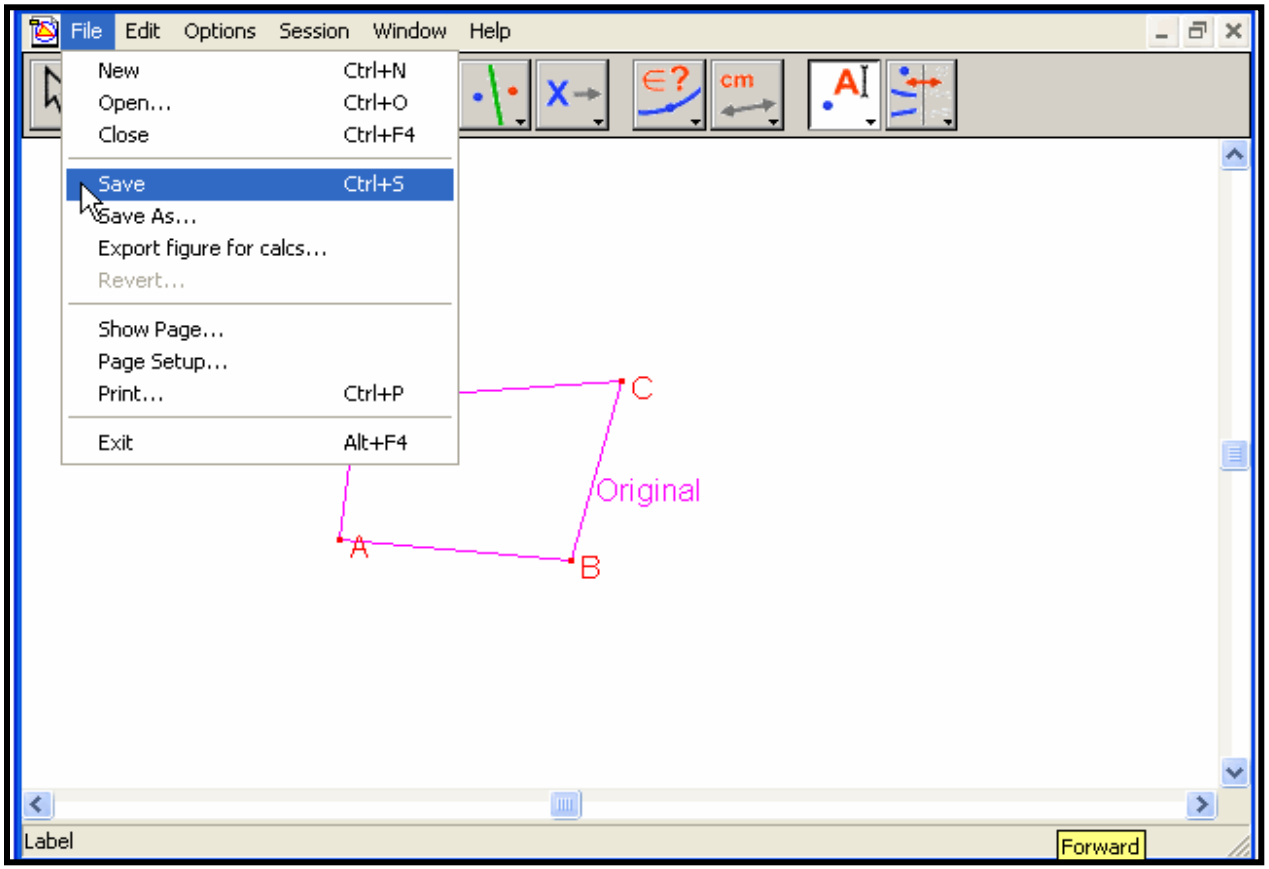
Example I


File Edit Options Session Window Help
The polygon tool icon is now shown.
Line
Segment
Ray
Vector
Triangle
Polygon
Regular Polygon
Release the mouse button.
Pointer

Example I


File Edit Options Session Window Help
Label
Text
Numerical Edit
Expression
Mark Angle
Fix / Free
Trace On/Off
Animation
Multiple Animation...
Click and hold down to see all tools, then drag to the Label tool and release.
C
A
B
This icon is in fact already showing when Cabri opens - you could just click on it to activate it.
Pointer

Example I


File
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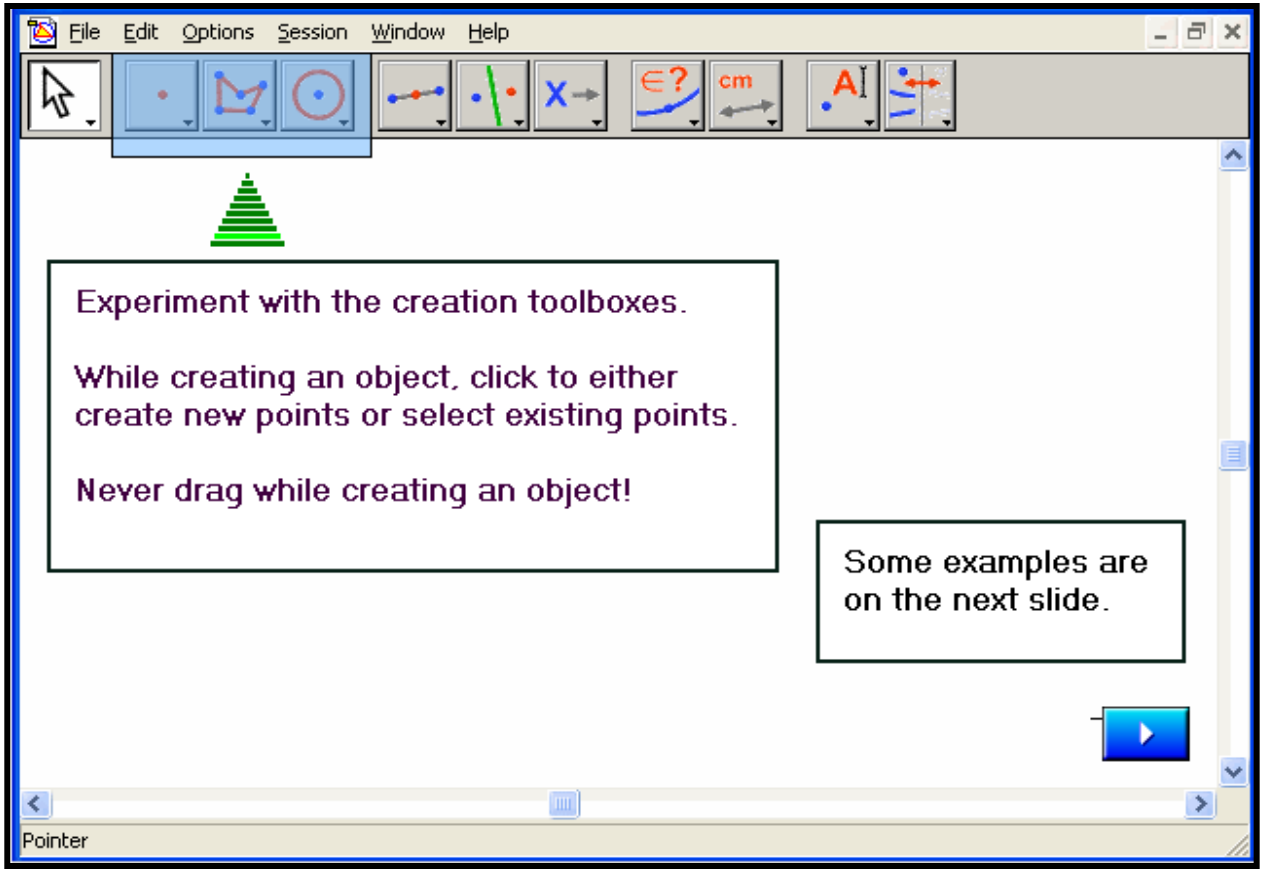
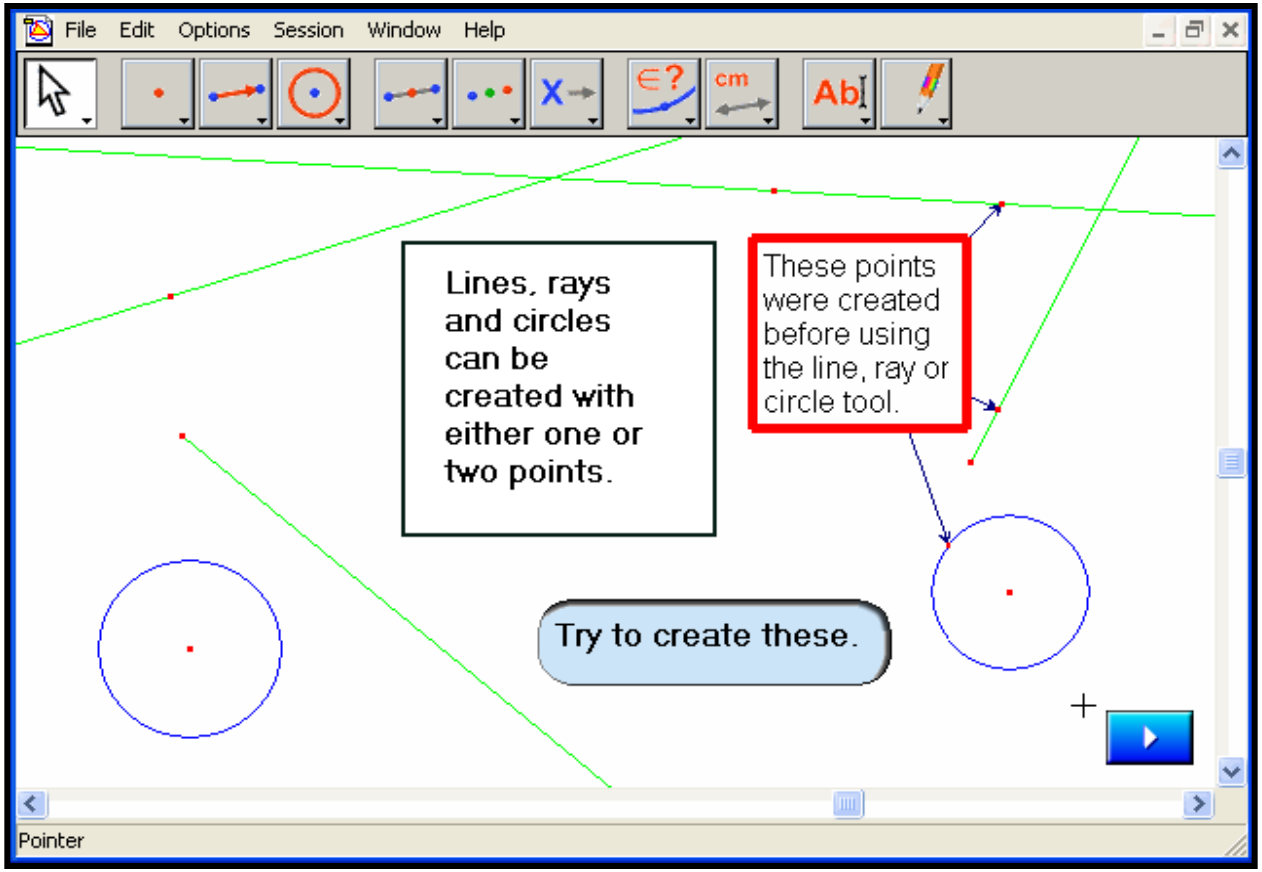
Help
New Ctrl+N
Open... Ctrl+O
Close Ctrl+F4
Save Ctrl+S
Save As...
Export figure for calcs...
Revert...
Show Page...
Page Setup...
Print... Ctrl+P
Exit Alt+F4
C
Original
A
B
Label
Forward

Example I


File Edit Options Session Window Help
Experiment with the creation toolboxes.
While creating an object, click to either create new points or select existing points.
Never drag while creating an object!
Some examples are on the next slide.
Pointer

To do now…


File Edit Options Session Window Help
Lines, rays and circles can be created with either one or two points.
These points were created before using the line, ray or circle tool.
Try to create these.
Pointer

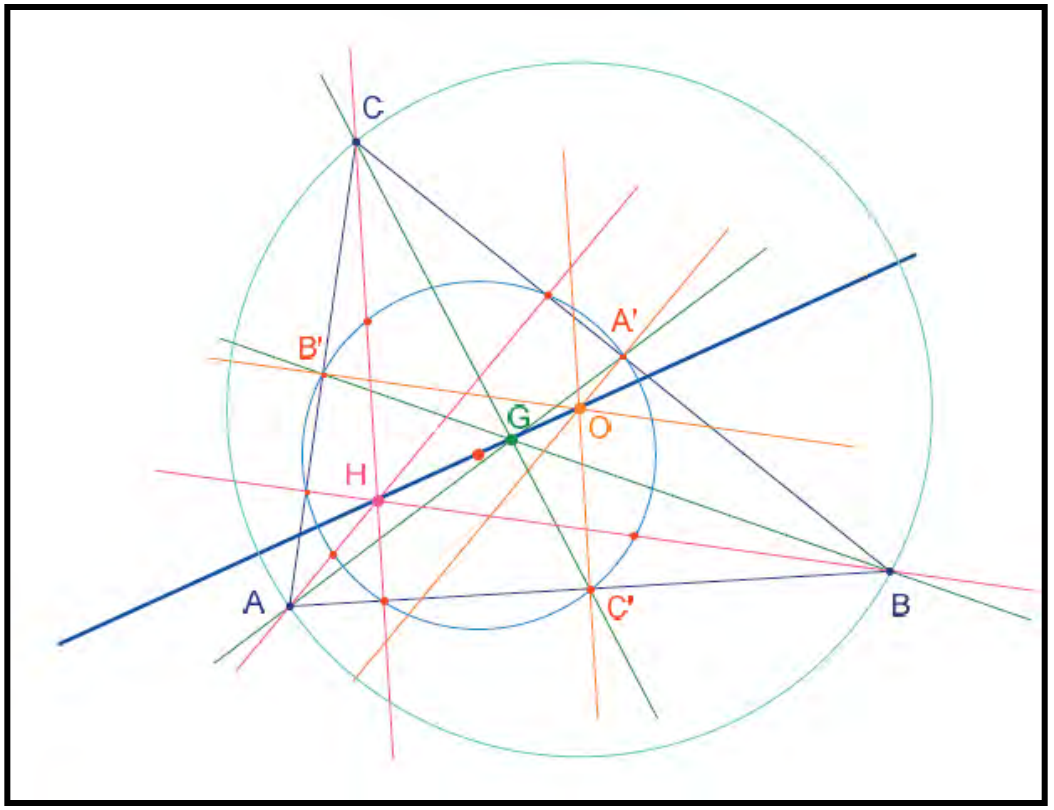
The Euler line in a triangle

We will construct a general triangle ABC,

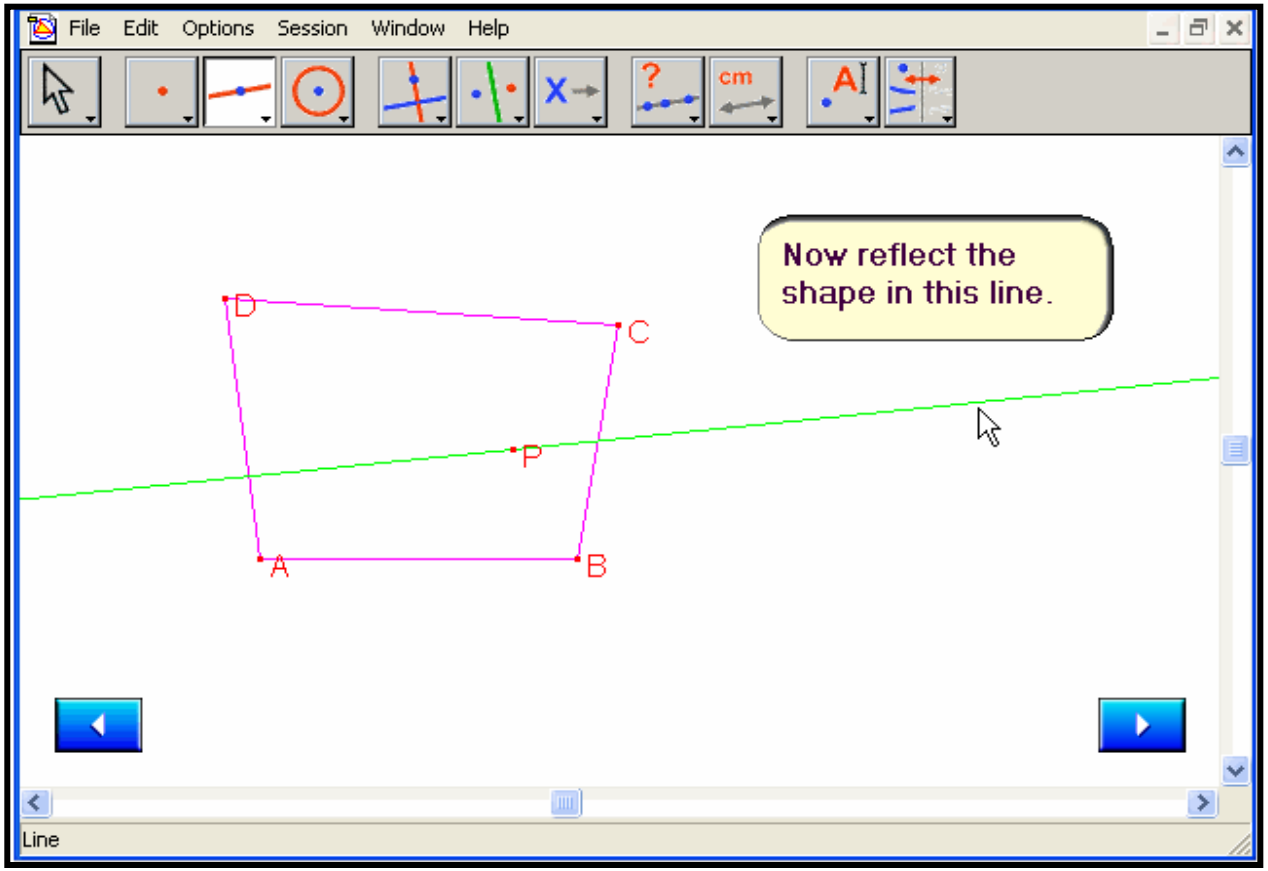
- then its three medians (the lines that join a vertex to the midpoint of the opposite side)
- Next the tree altitudes of the triangle (the lines through each vertex in turn, perpendicular to the opposite side)
- Finally the tree perpendicular bisectors (lines perpendicular to each side, through the midpoint of the side
- The Euler line of the triangle

The Euler line and…the Euler circle

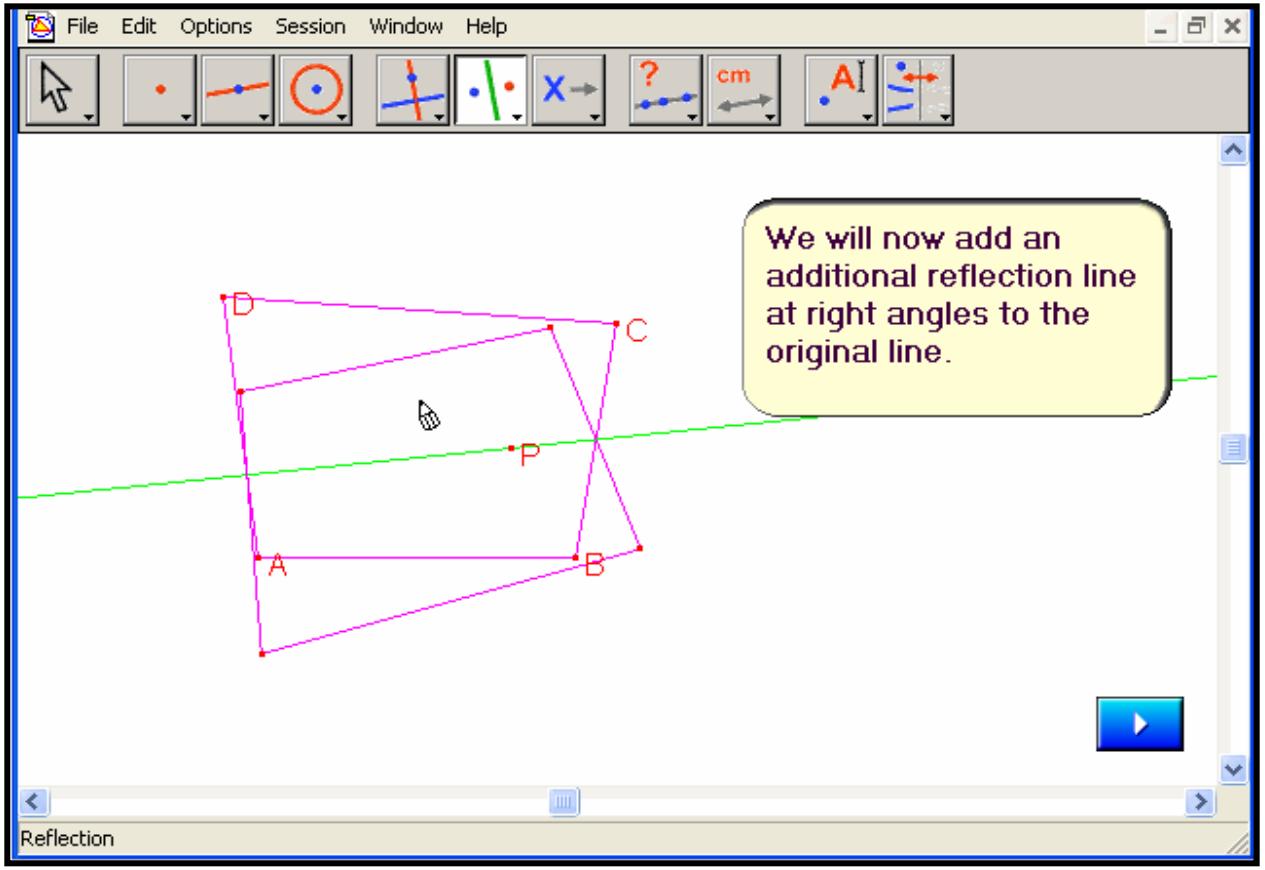
Next, construct the nine-point circle for the triangle. This is the circle whose centre is at the midpoint of OH, and which passes through the midpoints of the sides: A', B' and C' the foot of each altitude, and the midpoint of each the line segments HA, HB, HC.



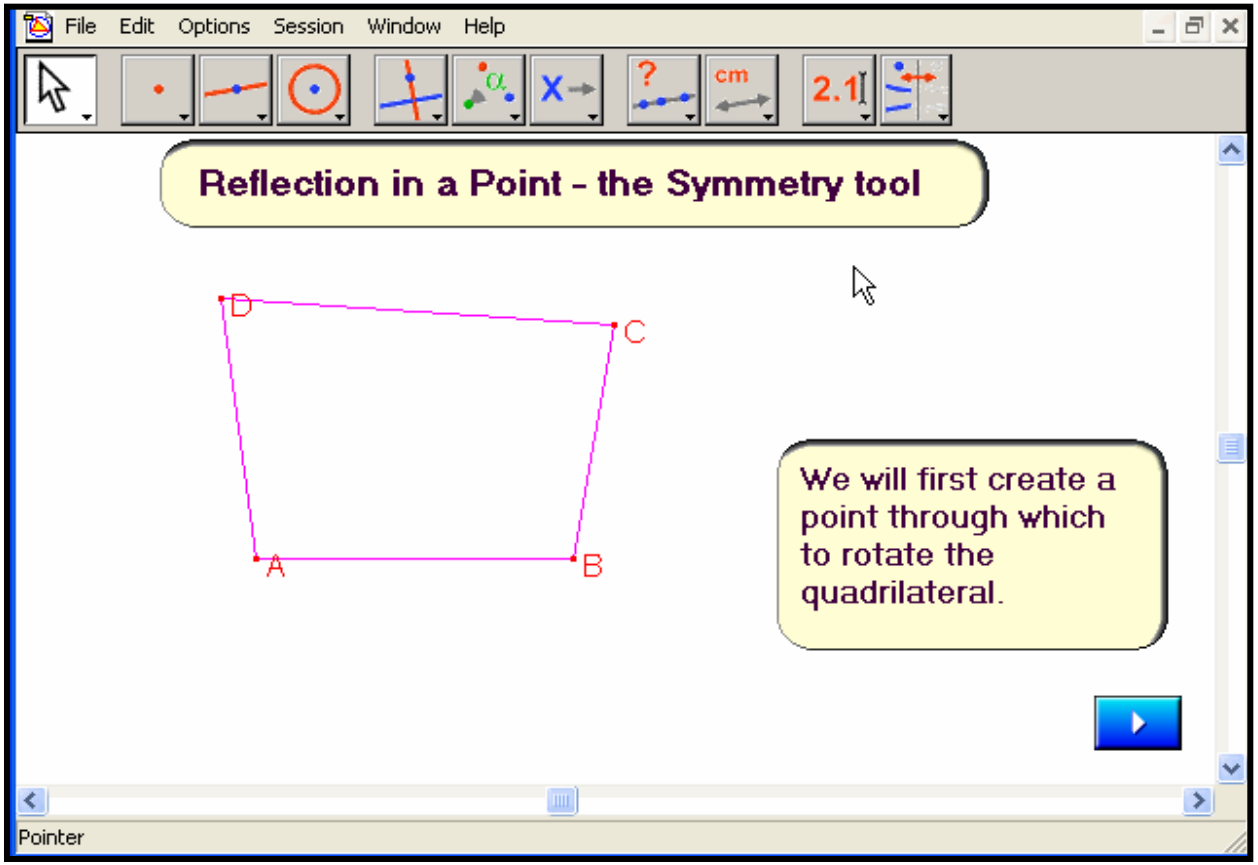
Example II


File Edit Options Session Window Help
cm
Now reflect the shape in this line.
D
C
P
A
B
Line

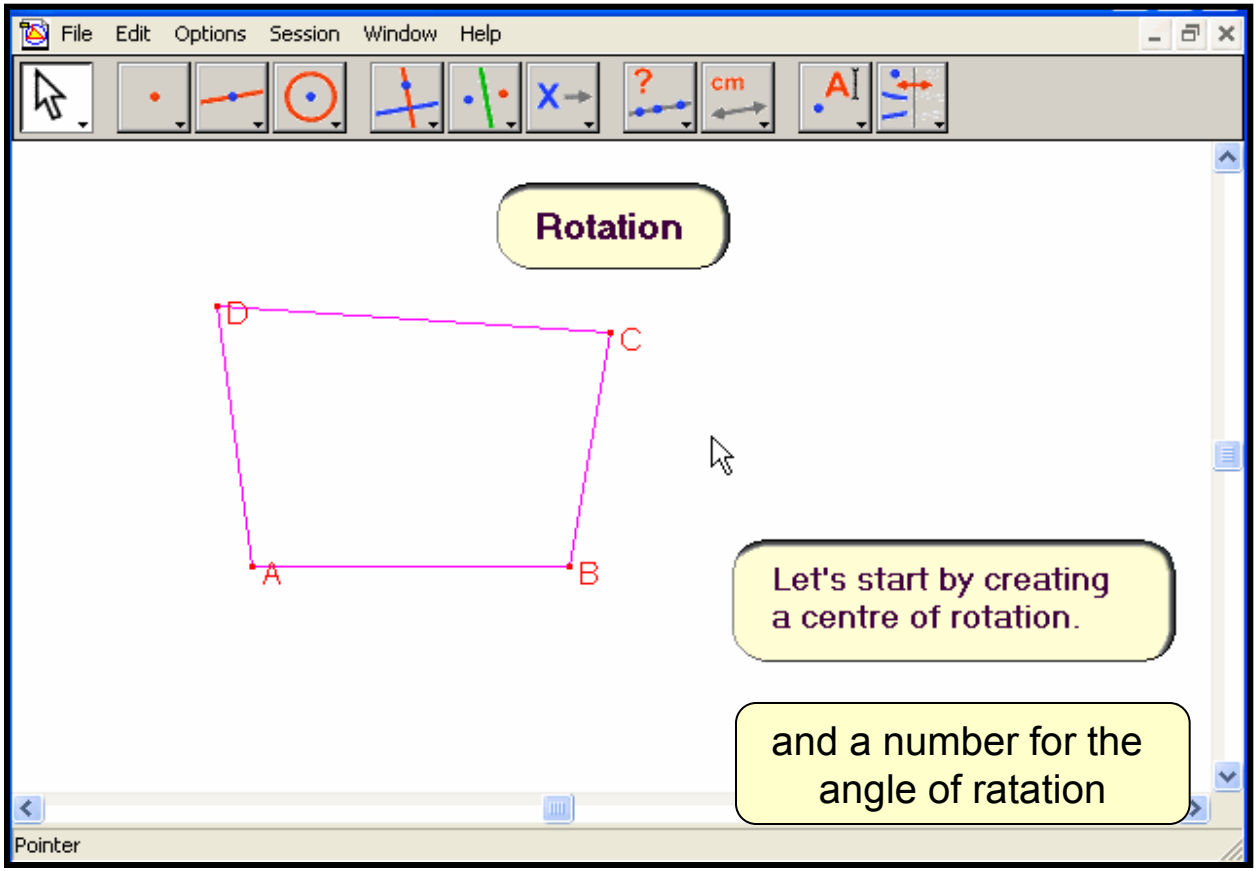
Example II


File Edit Options Session Window Help
We will now add an additional reflection line at right angles to the original line.
D
C
P
A
B
Reflection

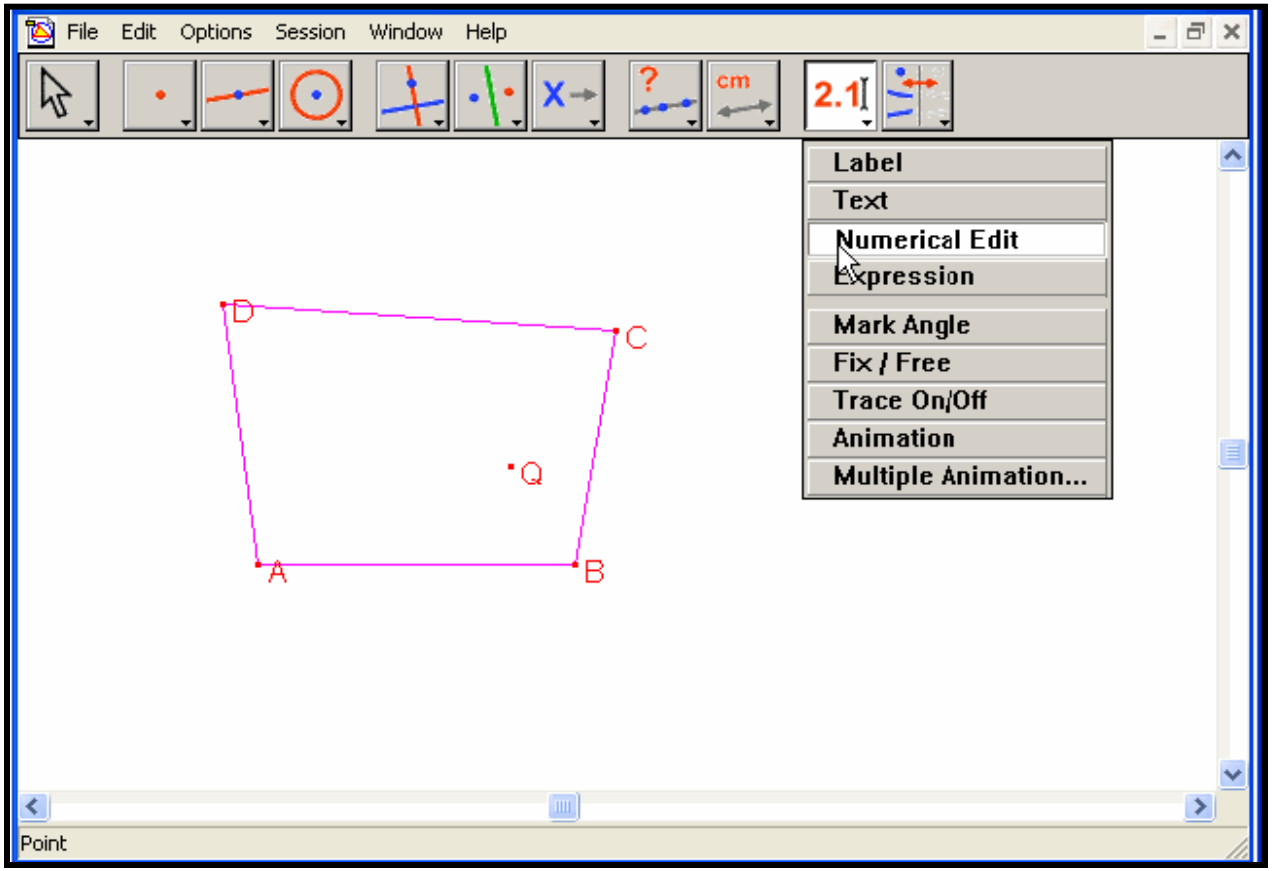
Example III


File Edit Options Session Window Help
Reflection in a Point - the Symmetry tool
D
C
A
B
We will first create a point through which to rotate the quadrilateral.
Pointer

Example IV


File Edit Options Session Window Help
Rotation
D
C
A
B
Let's start by creating a centre of rotation.
and a number for the angle of ratation
Pointer

Example IV


File
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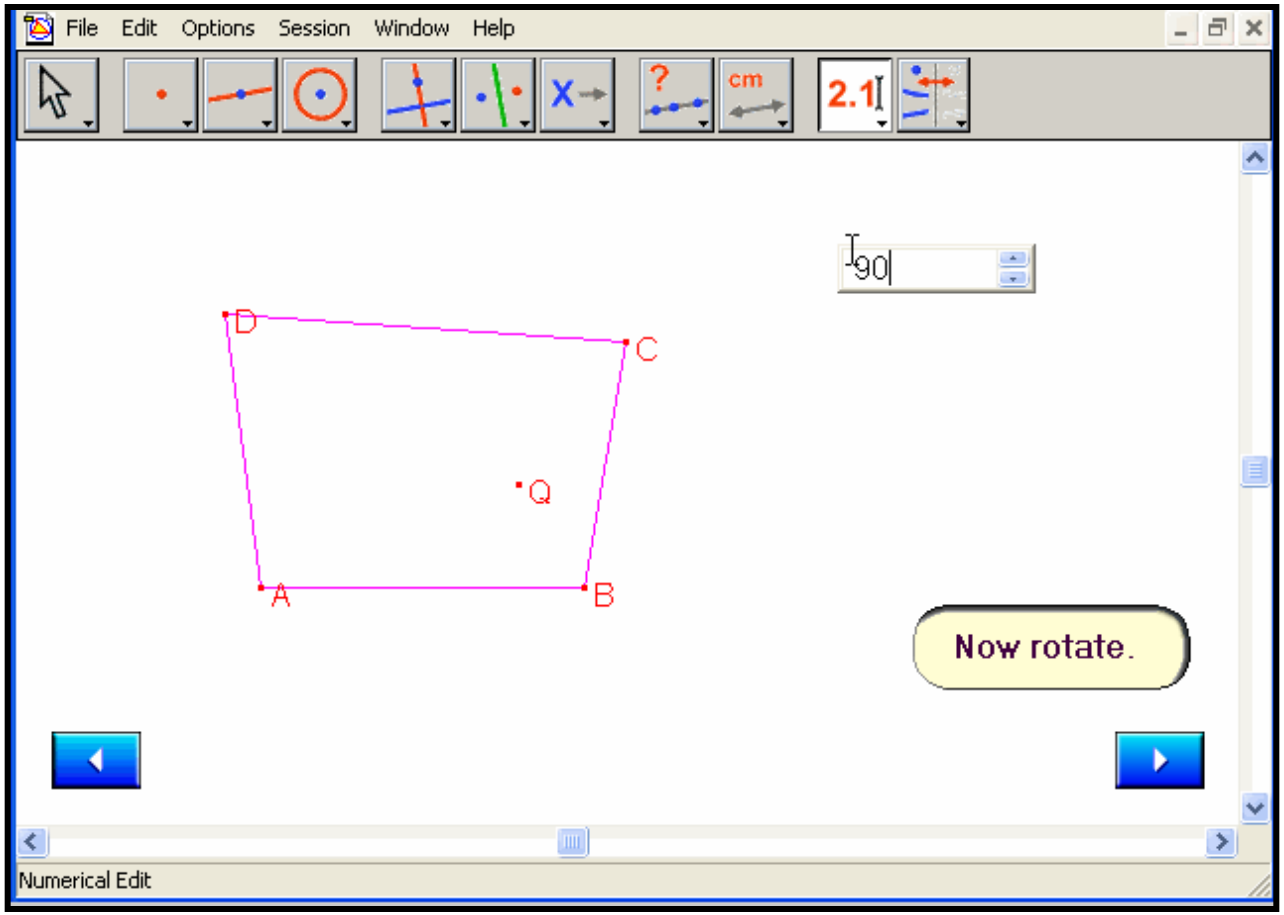
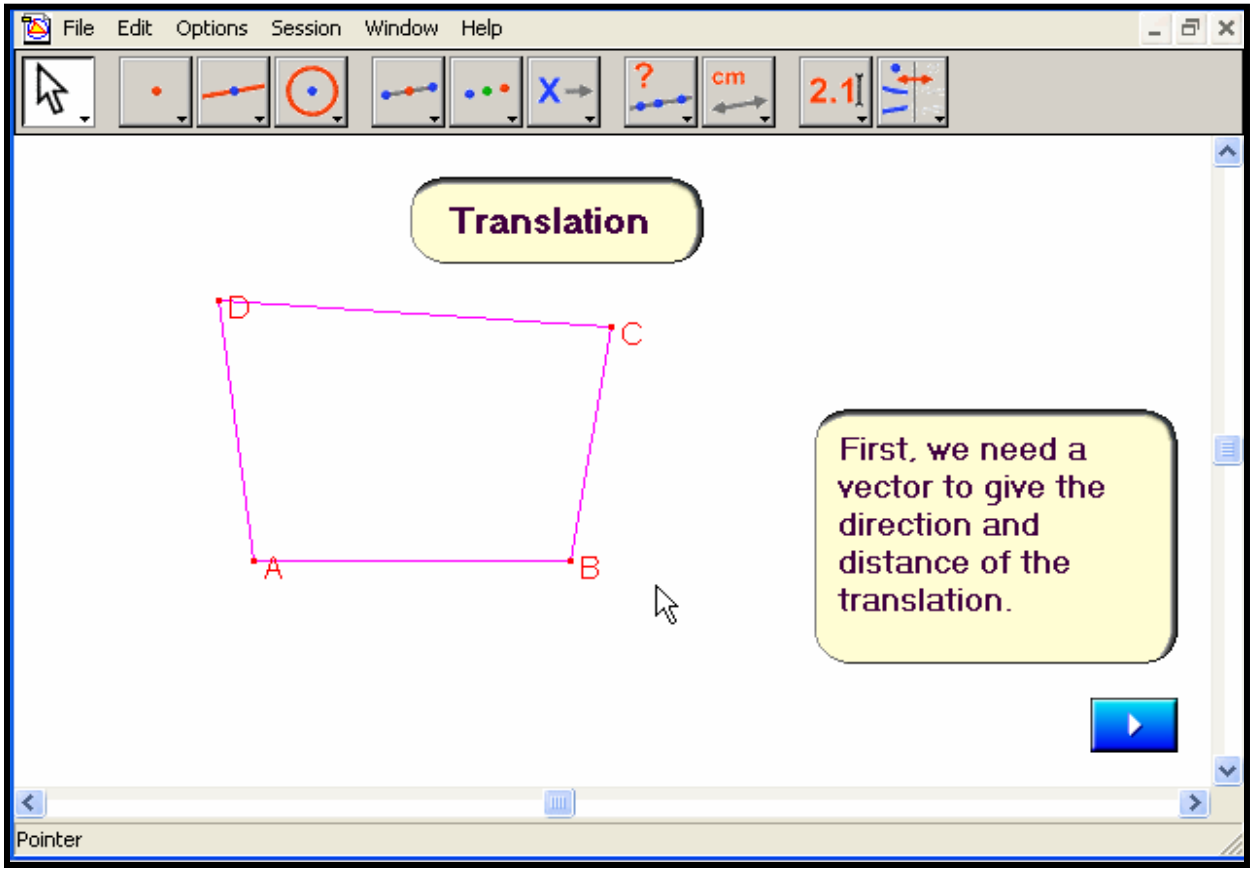
Help
cm
2.1
Label
Text
Numerical Edit
Expression
Mark Angle
Fix / Free
Trace On/Off
Animation
Multiple Animation...
D
C
Q
A
B
Point

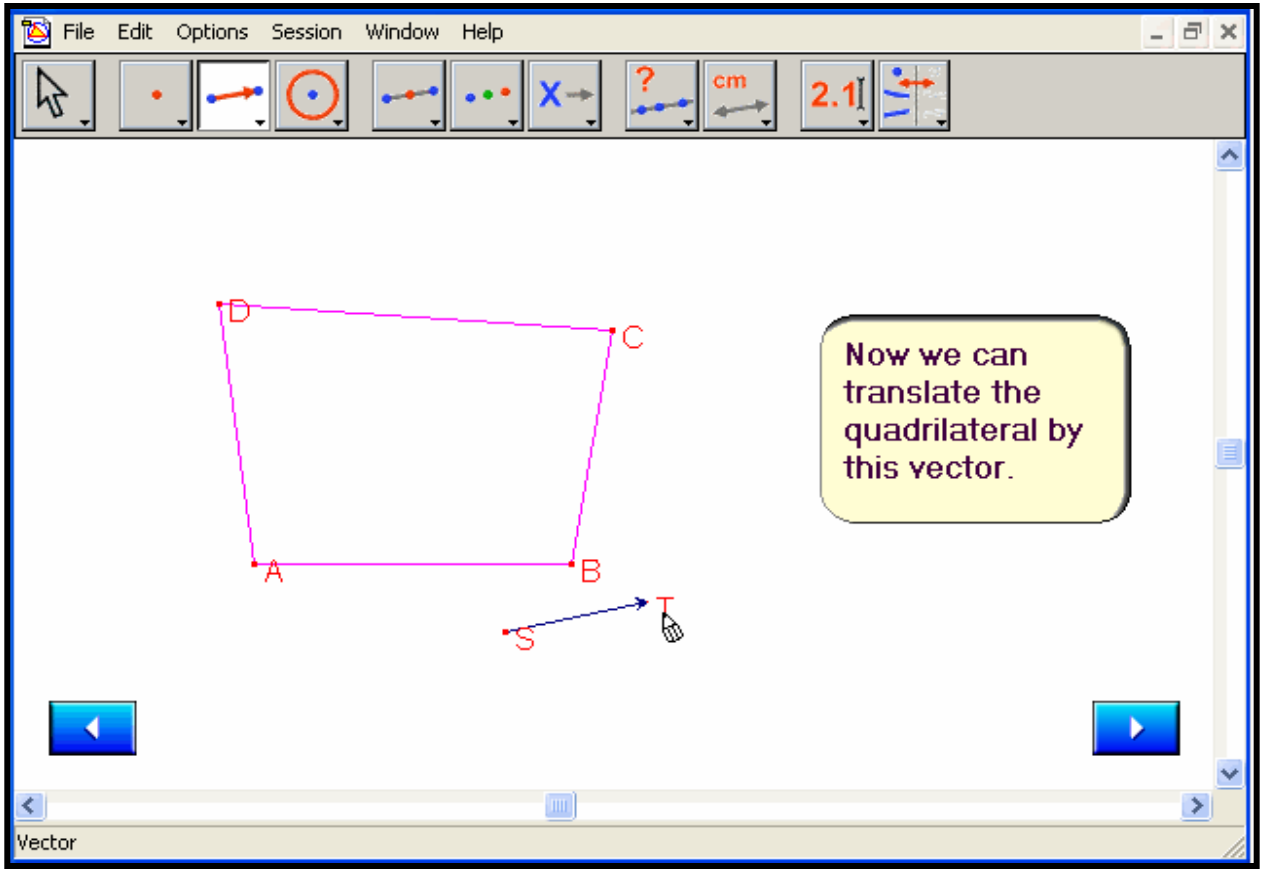
Example IV


File Edit Options Session Window Help
cm
2.1
90
D
C
Q
A
B
Now rotate.
Numerical Edit

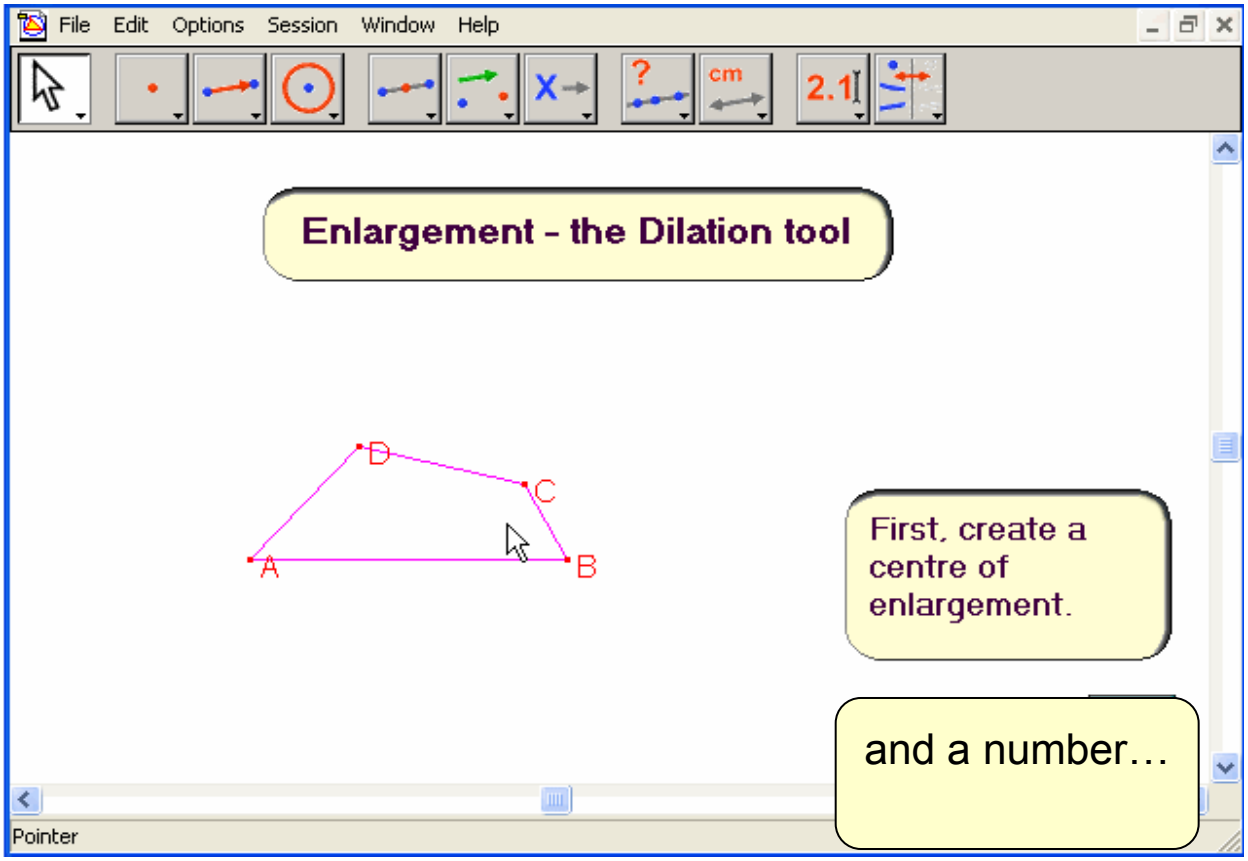
Example V


File Edit Options Session Window Help
Translation
D
C
A
B
First, we need a vector to give the direction and distance of the translation.
Pointer

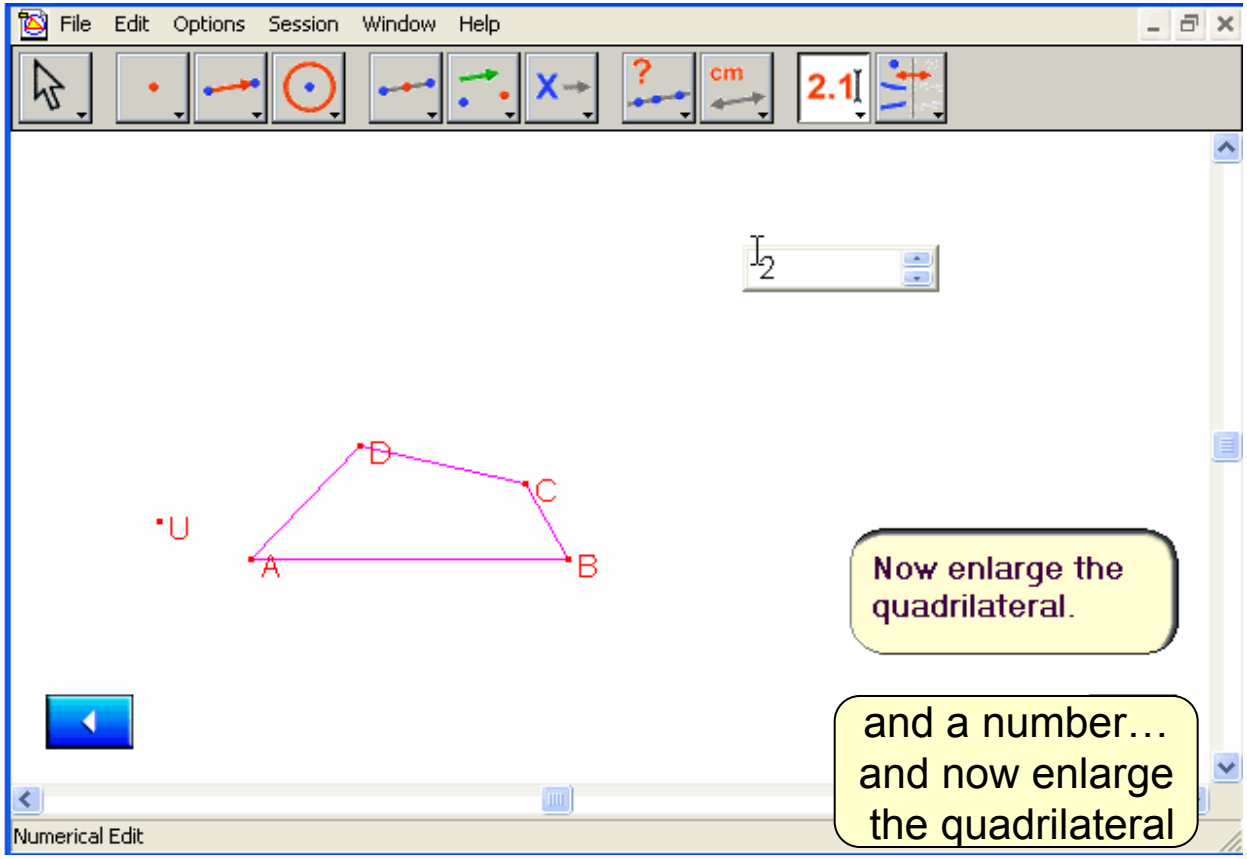
Example V


File Edit Options Session Window Help
cm
2.1
D
C
A
B
S
T
Now we can translate the quadrilateral by this vector.
Vector

Example VI

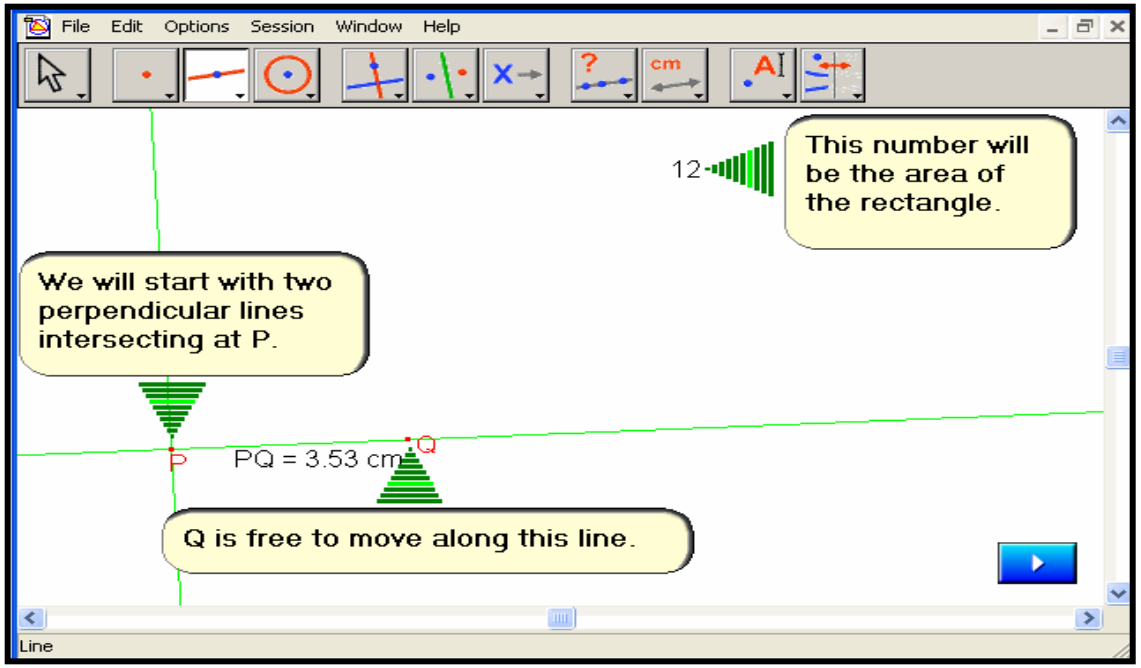

File Edit Options Session Window Help
Enlargement - the Dilation tool
D
C
A
B
First, create a centre of enlargement.
and a number…
Pointer

Example VII

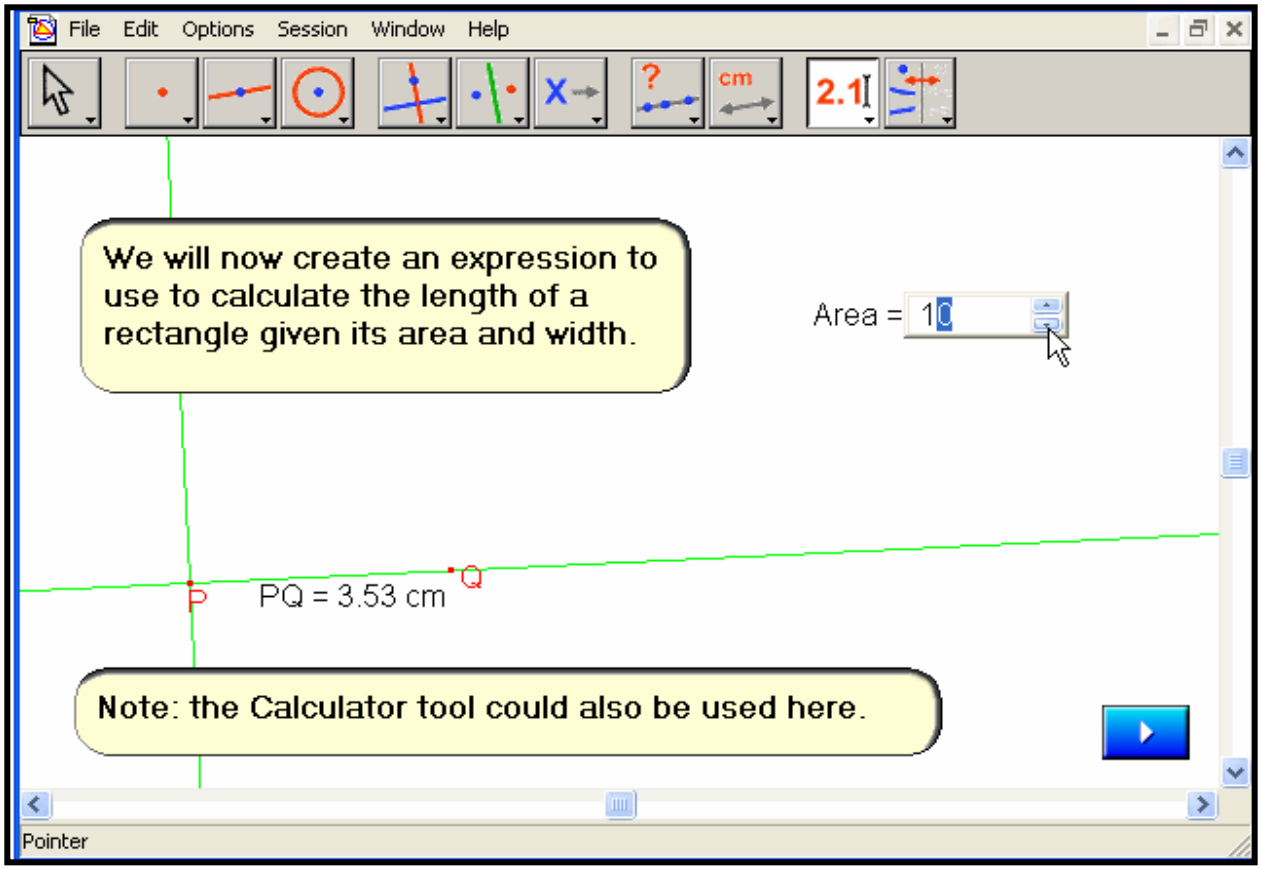

File Edit Options Session Window Help
cm
2.1
2
D
C
U
A
B
Now enlarge the quadrilateral.
and a number… and now enlarge the quadrilateral
Numerical Edit

Example VIII

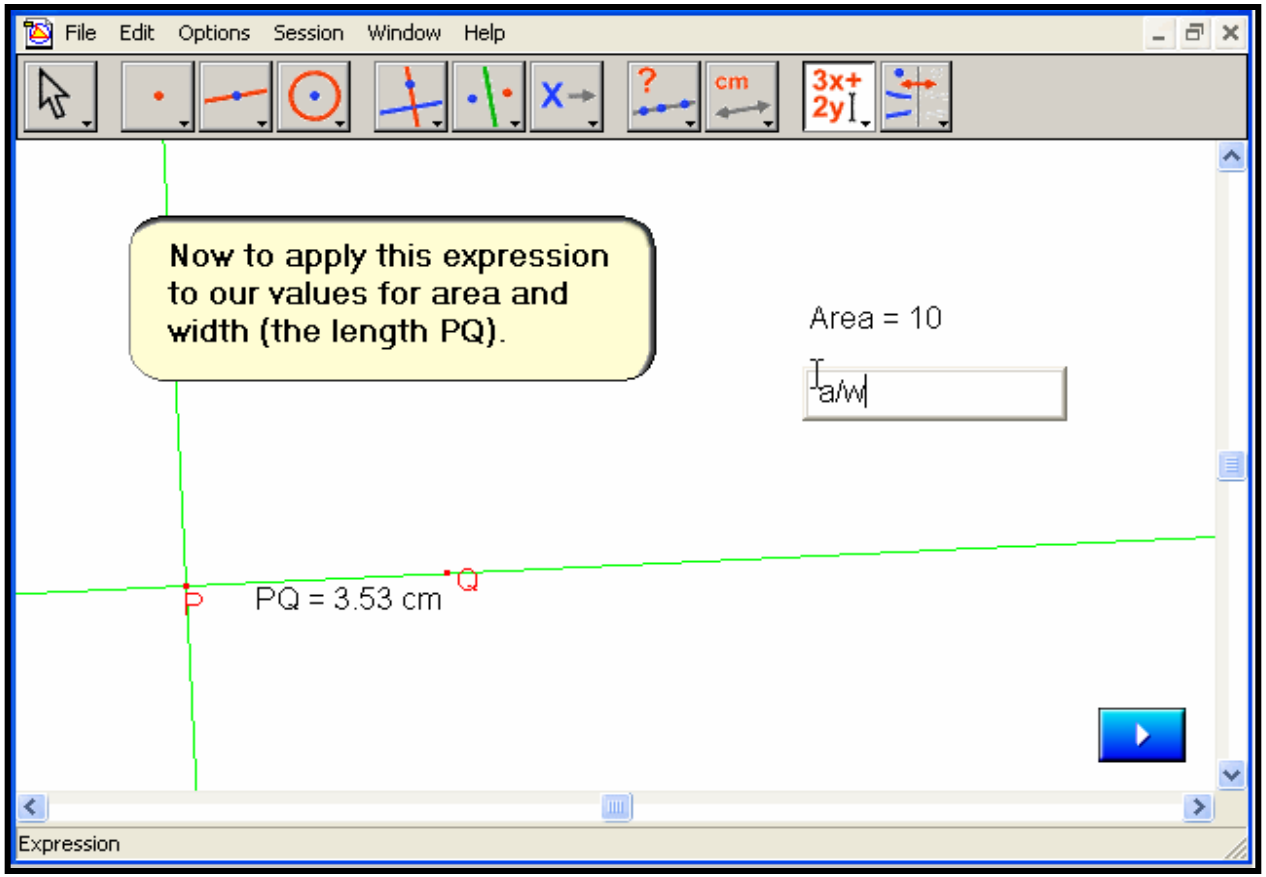
Using the expression tool to create a rectangle of constant area with Cabri 2 plus



Example VIII



Example VIII



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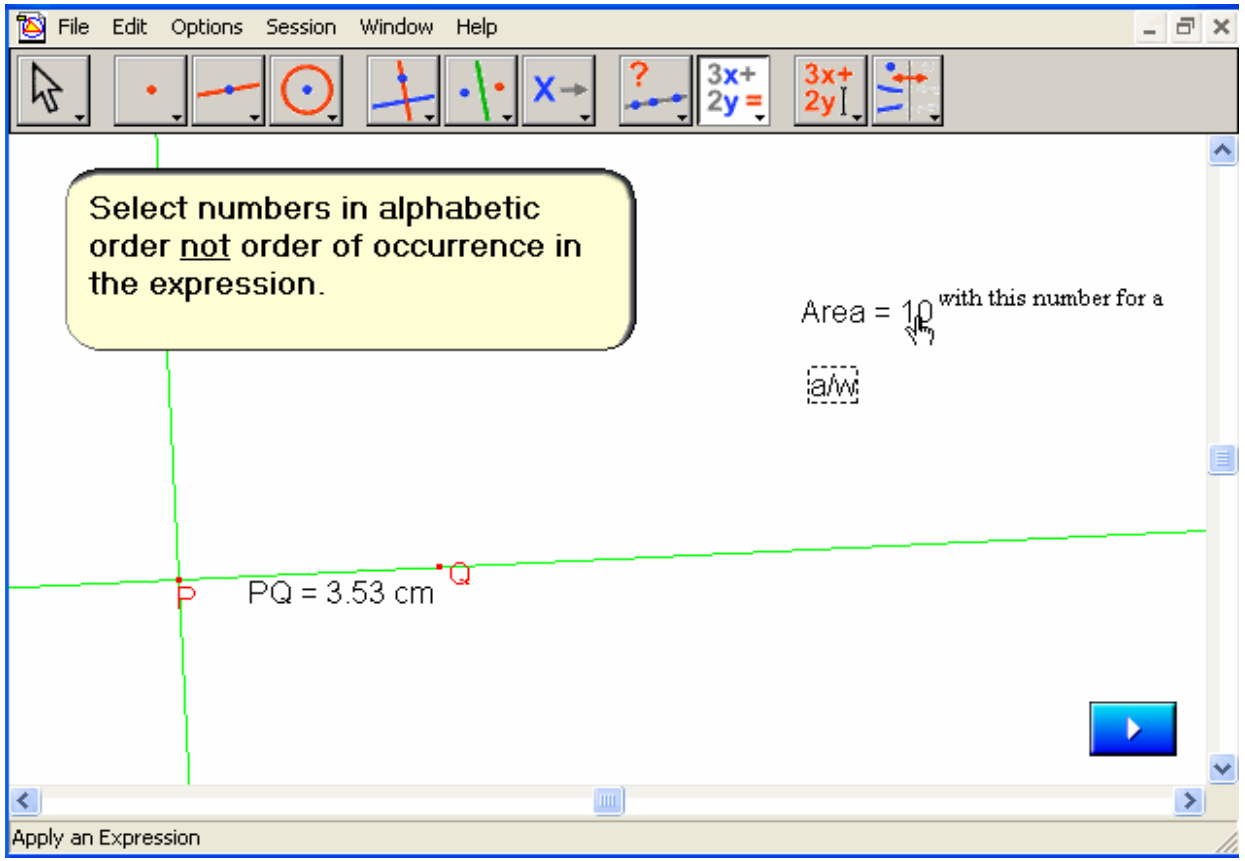

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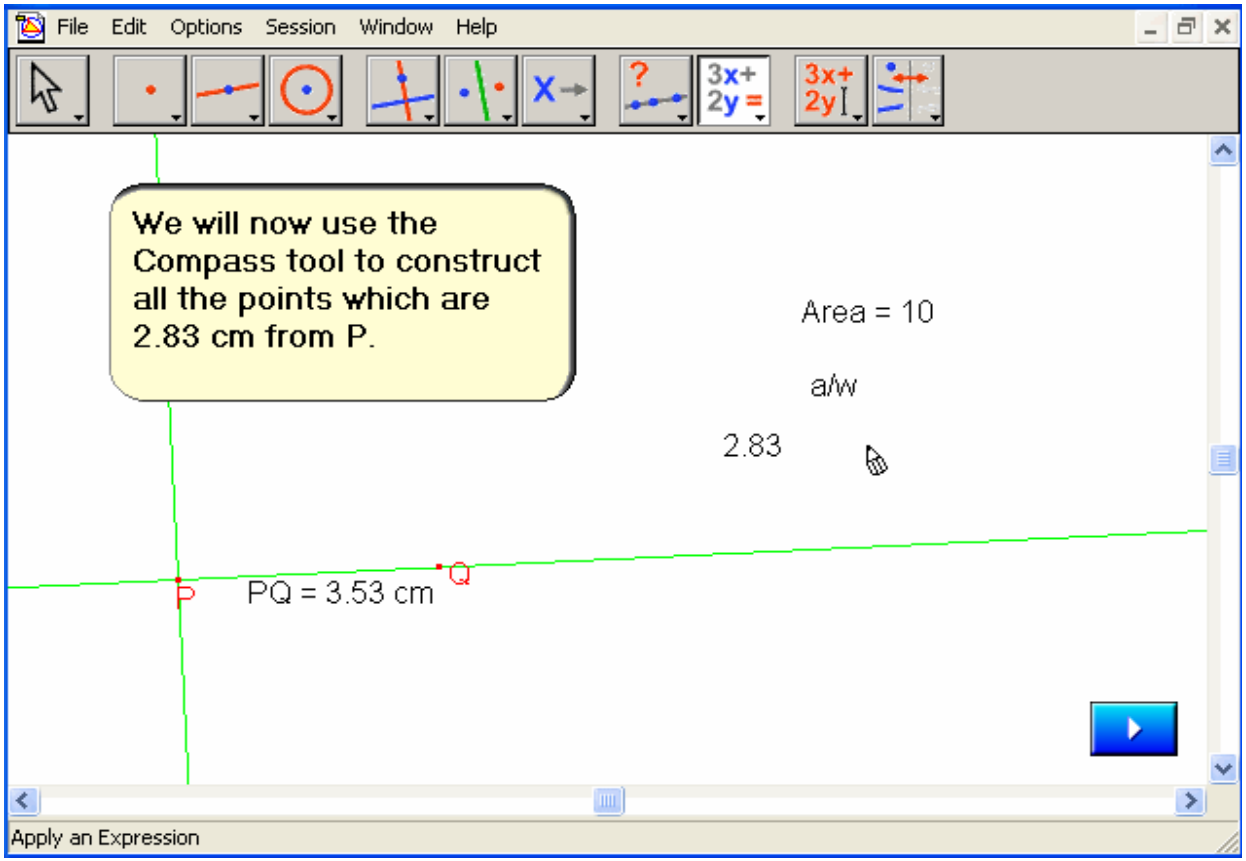

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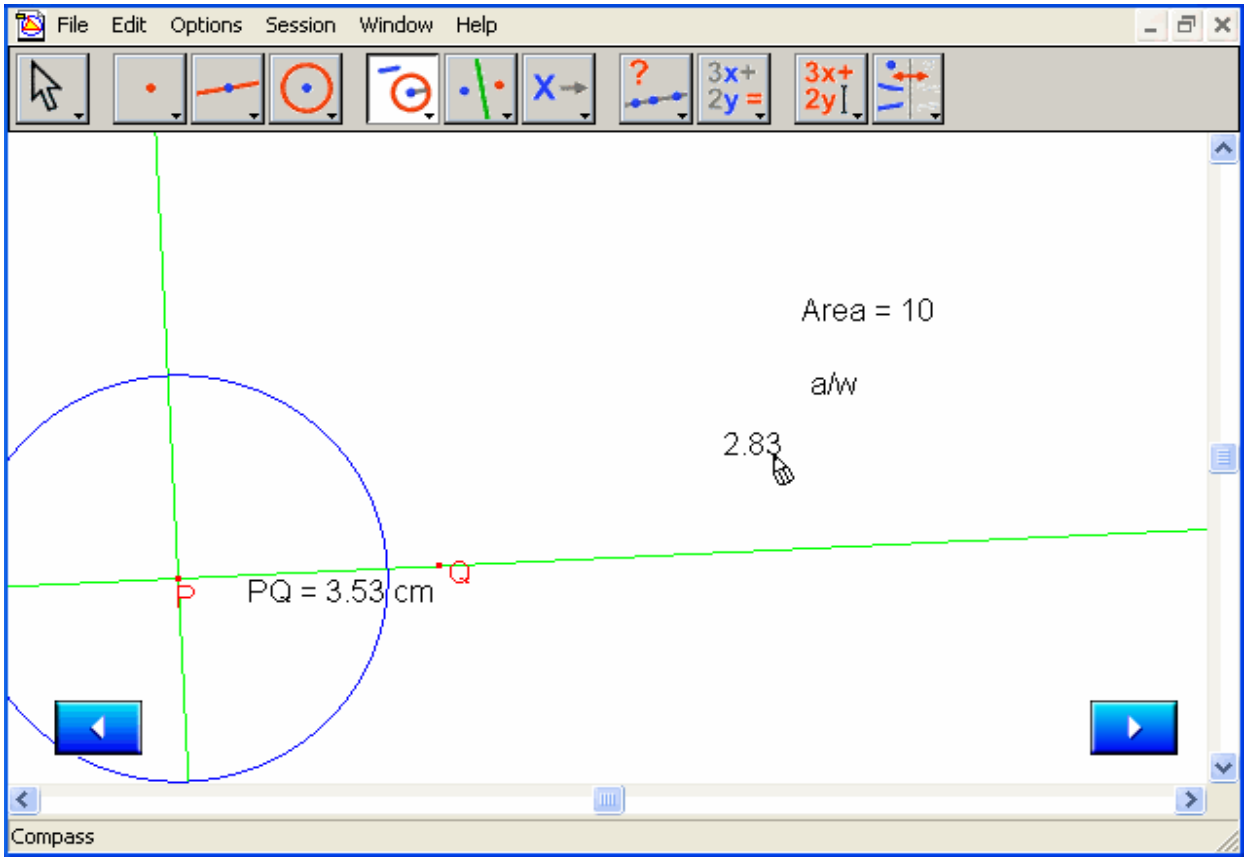

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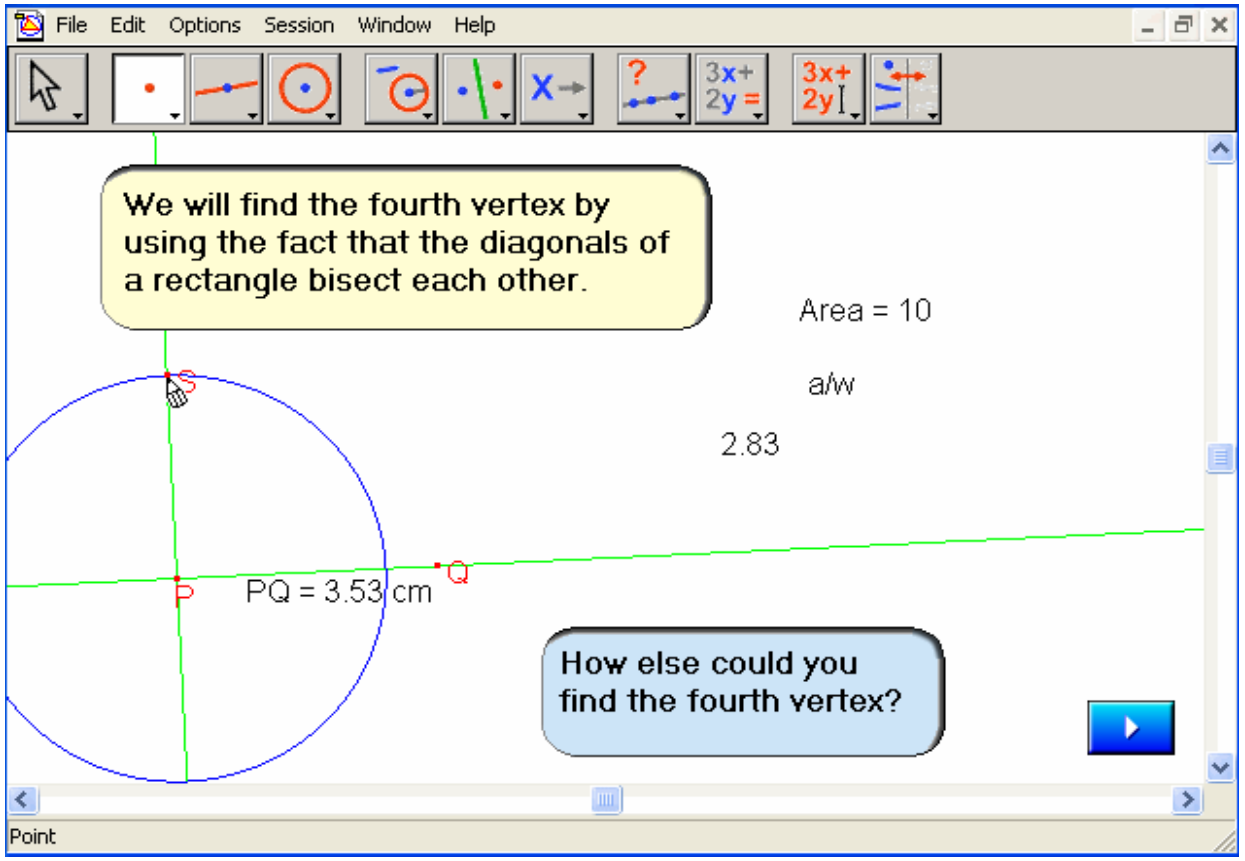

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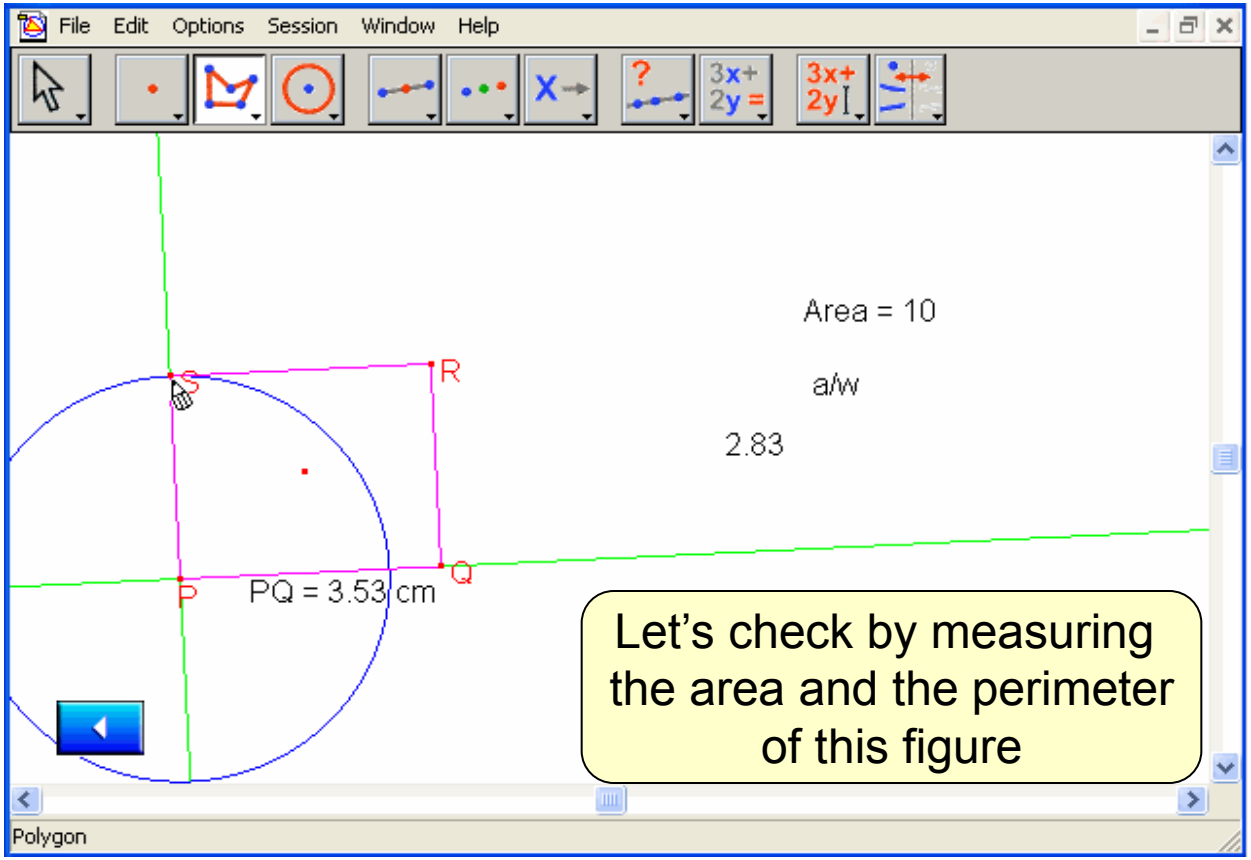

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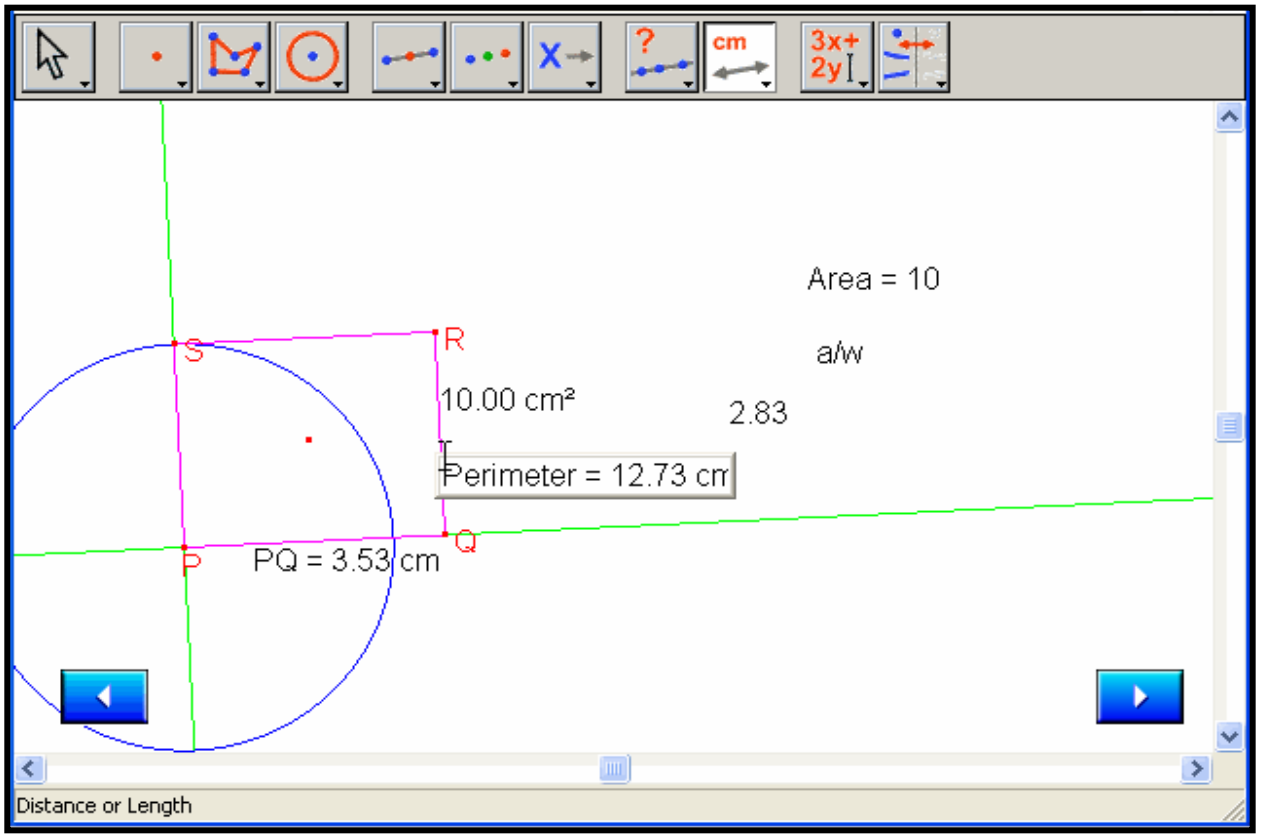

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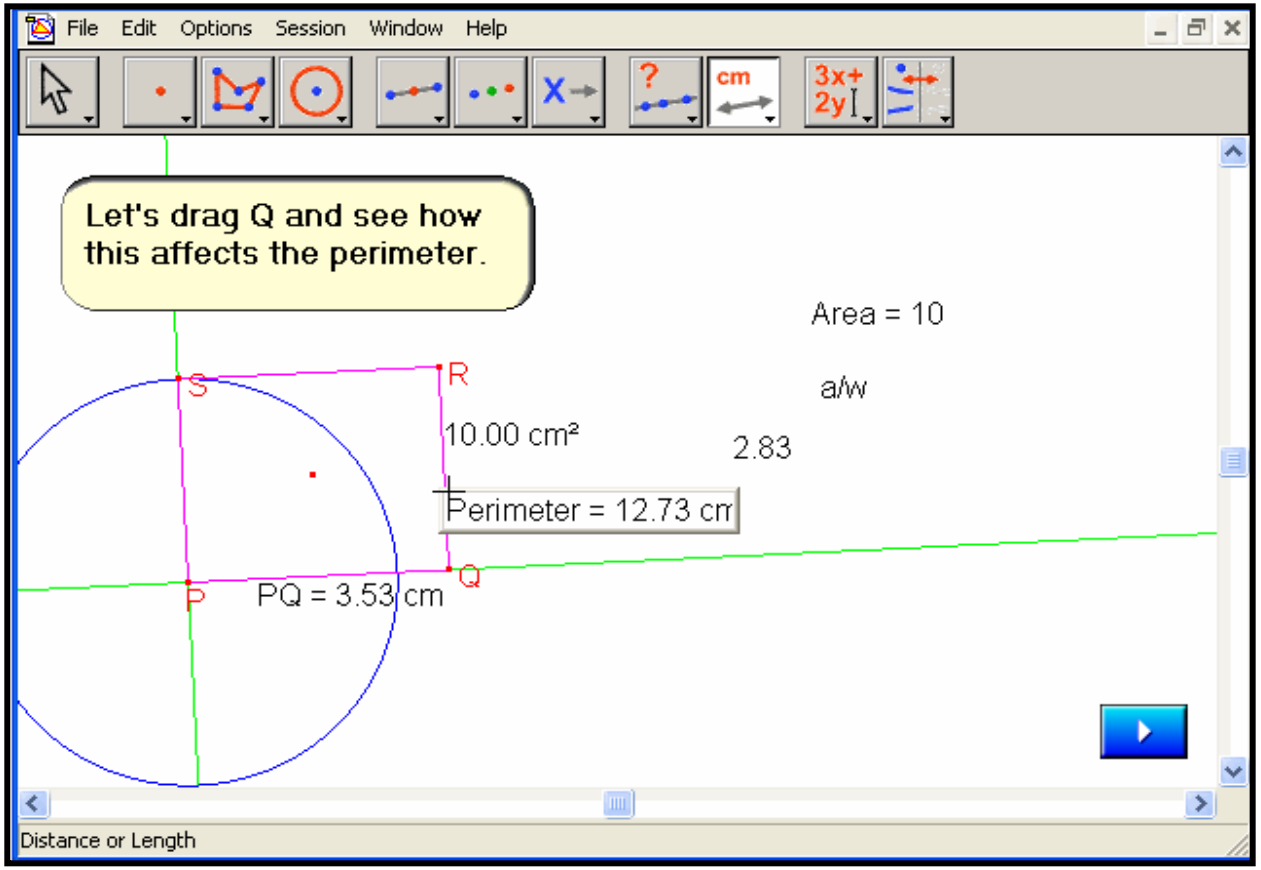

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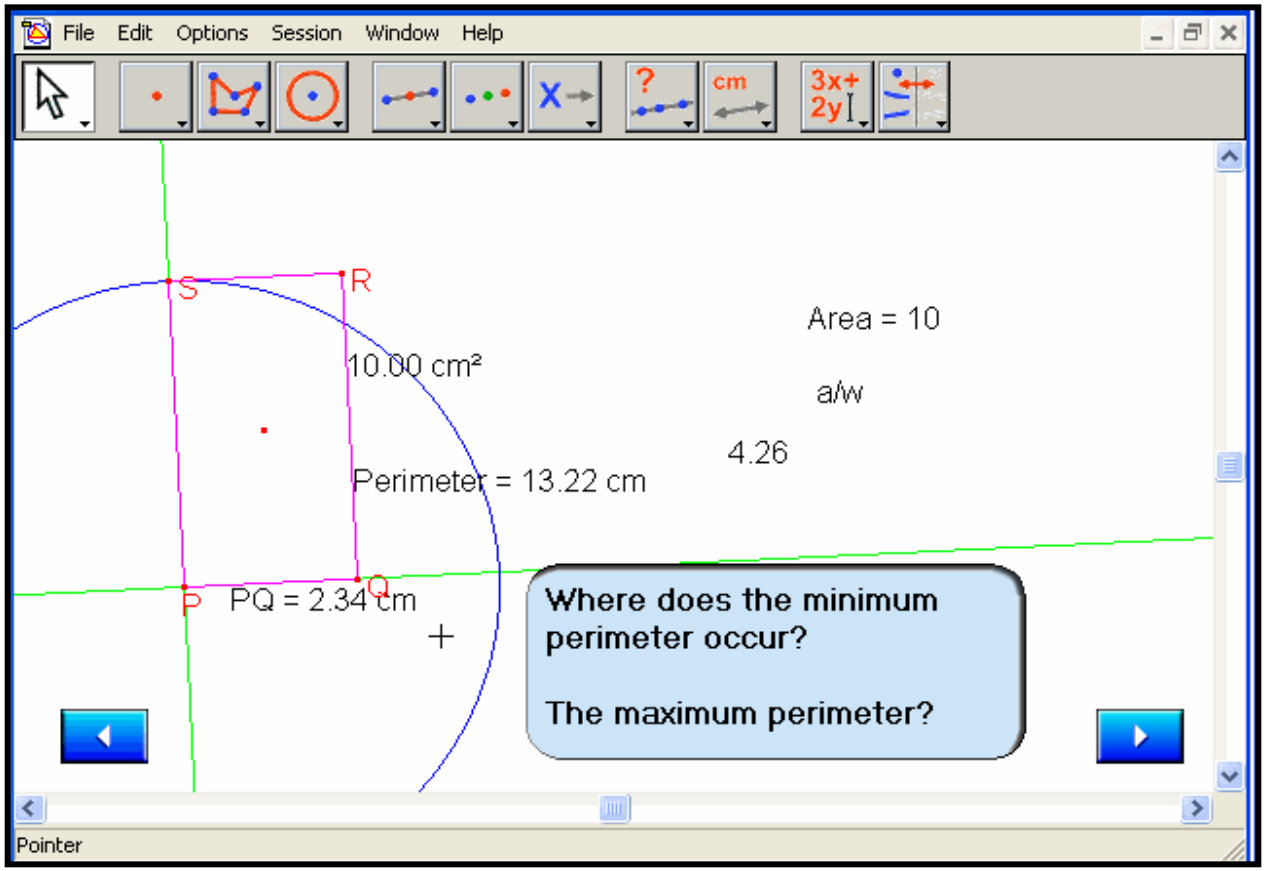


Cabri 3D: the unique 3D Interactive geometry software

- Example 1
- Example 2

Introduction to DGS

With a DGS in general, we can do followings:

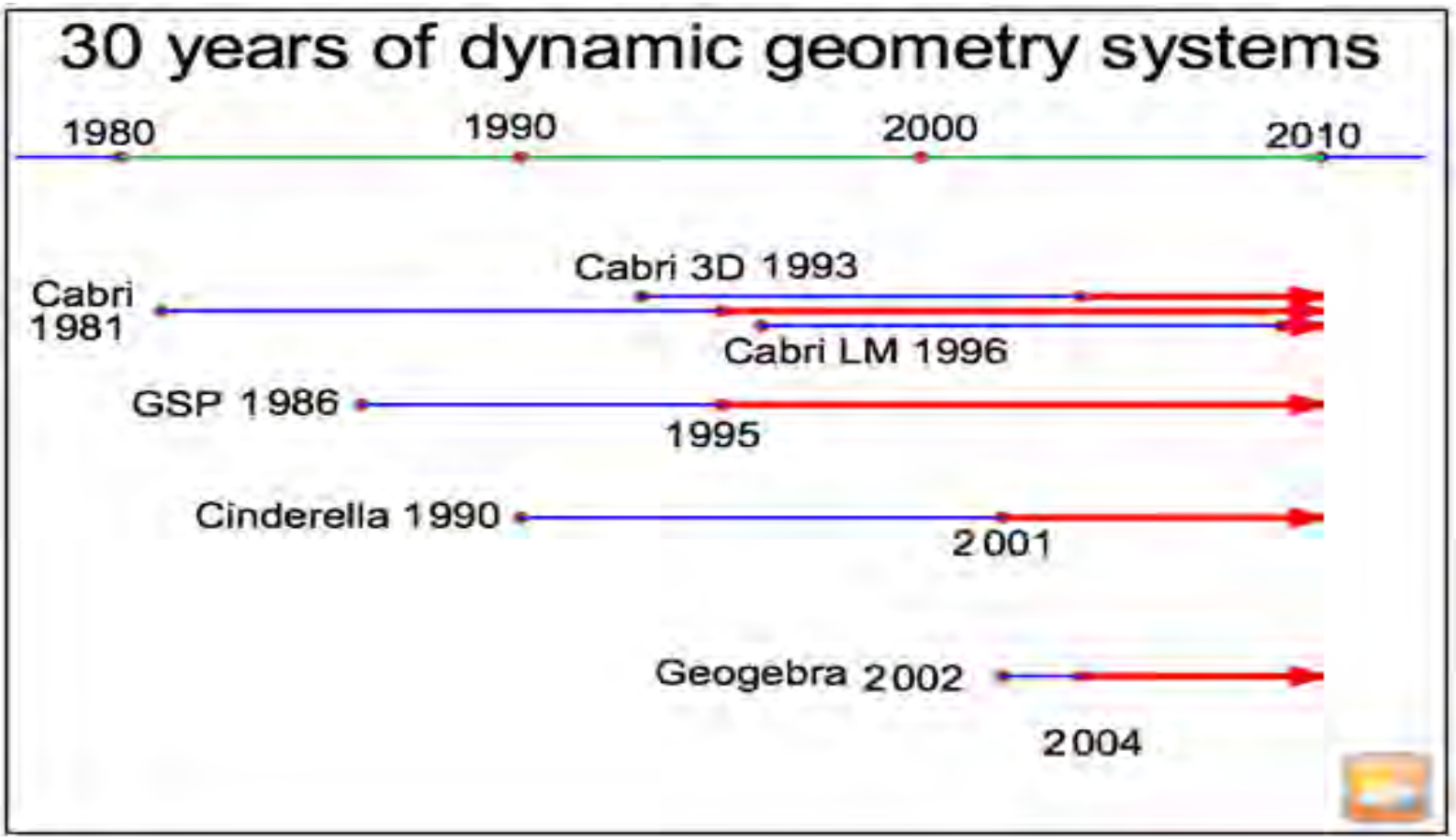
- General geometric constructions
- Macros
- Loci
- Measurements and calculation
- Graphics Export Formats
- Object attributes
- Proof

Introduction to DGS: a historical perspective

- End of 70s and in the 80s "significant" software started. They were the result of university type research and spread through pioneering teachers.
- Let us think in first place of Logo developed and spread under Seymour Papert's impulse at Media Lab-MIT, USA.
- Later we have had soft ware like Geometric Supposer (MIT) and rather soon, authentic dynamic geometry software, came to live, say (historically):

- Cabri (University of Grenoble –France) and
- GSP (Swarthmore College – USA)

Introduction to DGS: a historical perspective (Laborde J-M, 2010)



From high perspective does DGS really matter?

- When participating in conferences on Computer in Education you learn just (very often):

- How wonderful the use of ICT is;

- How much kids learn through technology;

- How good my (i.e. presenter's) DGS is good;

- …

- Looking at actual data about the use of ICT shows that in fact, mostly everywhere, ICT use is only marginal (even if in some country it is officially part of the curriculum) - best cases 20%- (Laborde J-M, 2010)
- Why such an apparent contradiction?

Actually DGS matters

- In various countries some politicians claim that

- the use of technology is a big mistake

- one should come

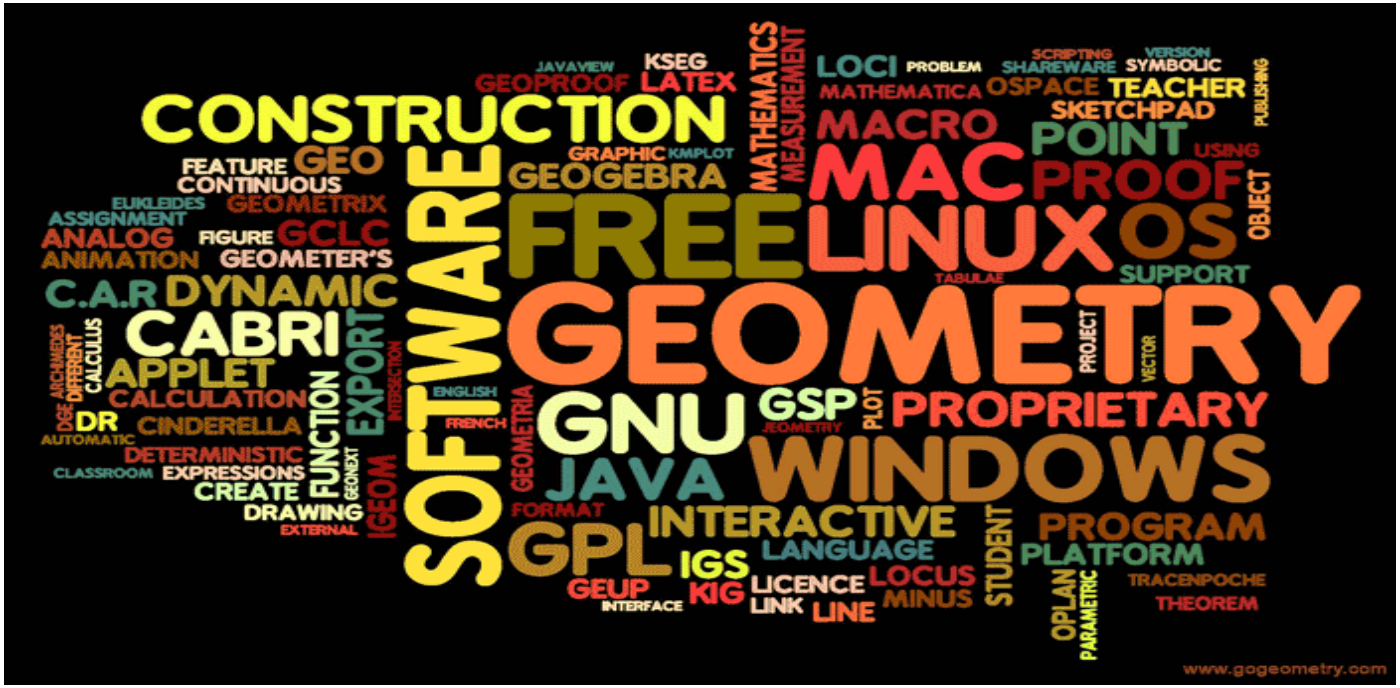
+come Back to Basics (USA);

+ learn long division (GB);

+ learn to extract square roots by hand (France).

Plan

- Some remarks from the 1rst seminar
- Introduction DGS
- **An institutional analyse: actual situation in Vietnam**
- Teacher professional development
- Conclusion



Shared research claims

- There are several technological environments very promising in terms of learning
- The usual teaching practice does not take full advantage of these possibilities
- A critical element in the integration of technology into usual teaching is the teacher (Artigue, Bottino and Furinghetti, Guin and Trouche, Monaghan, Ruthven, Sutherland…)

An institutional analyse

- Teacher training programme
- Mathematic curriculum at high school: no or few activity with DGS

Textbook	Without others ICT (calculator, computer)	With DGS
Edition 2000	5	0
Edition 2005	15	0

- Teacher use

- Example 1 (support of powerpoint presentation)
- Example 2 (illustration of geometrical propeties)
- Example 3 (exploring geometrical propeties)

Reasons mentioned by teachers

- Benefit for teachers
  - Facing the students
  - More comfort (no pain in arms and back)
  - Clean, precise and beautiful figures
  - Saving construction and time
- Benefit for students
  - Saving construction and time
  - Multiplying cases
  - Amplified Visualization

How does a teacher usually design tasks?

- Duplication from pencil environment to DGS environment
- Adaptation from text book
- ‘’do-it-yourself” from the available resources
- Very few teachers design tasks from scratch

How does a teacher usually design tasks?

- The most immediate use by teachers is just "showing" geometrical theorems: teachers manipulate themselves or the students are allowed to have a restricted manipulation (dragging a point on a limited part of line)
  - It would take a long time in order for them to master the package and I think the cost benefit does not pay there… And there is a huge scope for them making mistakes and errors, especially at this level of student… and the content of geometry at foundation and intermediate level does'nt require that degree of investigation »
  - The student is a **spectator** of beautiful figures (showing the power of the software) or of properties part of the content of the curriculum (quoted by Laborde 2002)
- Sometimes the students must formulate the theorems

Three possibilities

- Three possibilities for the design of tasks
  - using ready made tasks for technology
  - adapting tasks designed for paper and pencil
  - designing his/her own tasks

Designing technology based tasks is problematic

- Designing technology based tasks is out of the range of the ordinary activities of teachers
  - Limited number of such tasks in textbooks
  - Limited number of resources
- Including the new element "technology" is not just adding it but affecting all dimensions of the design activity
- And introducing a hidden dimension: the instrumental dimension

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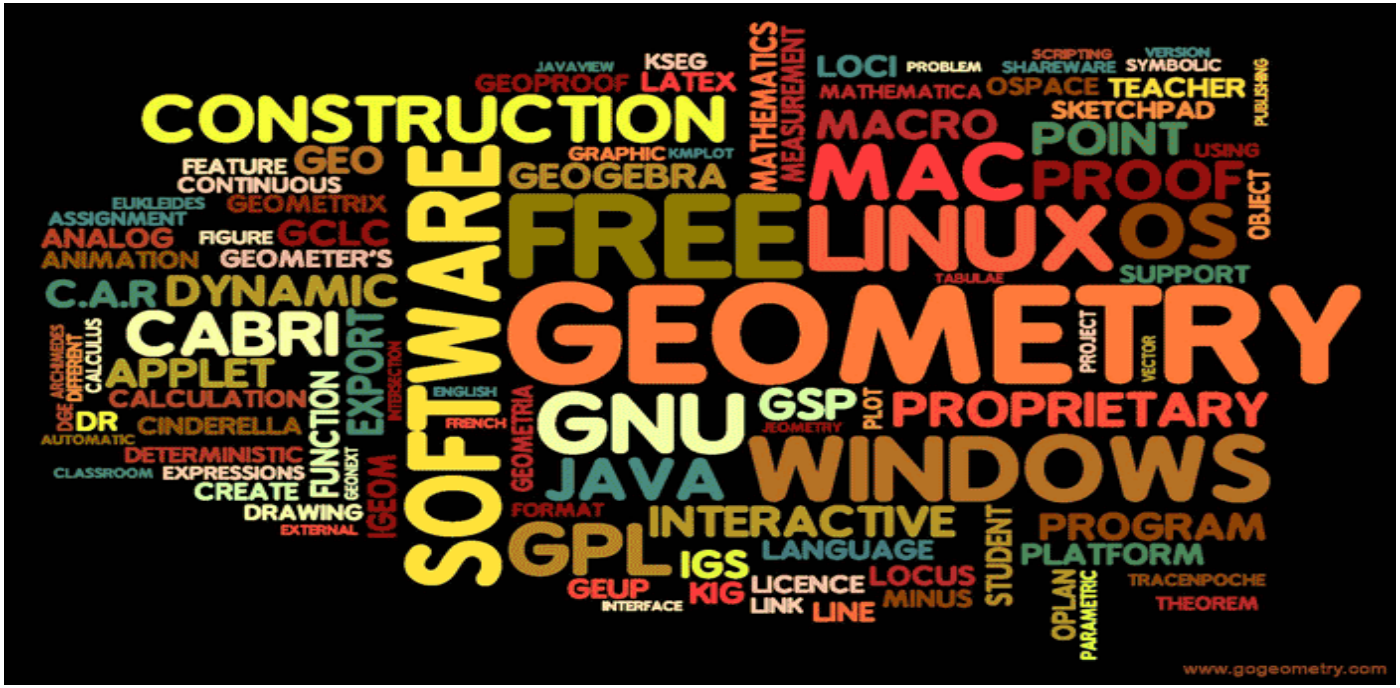
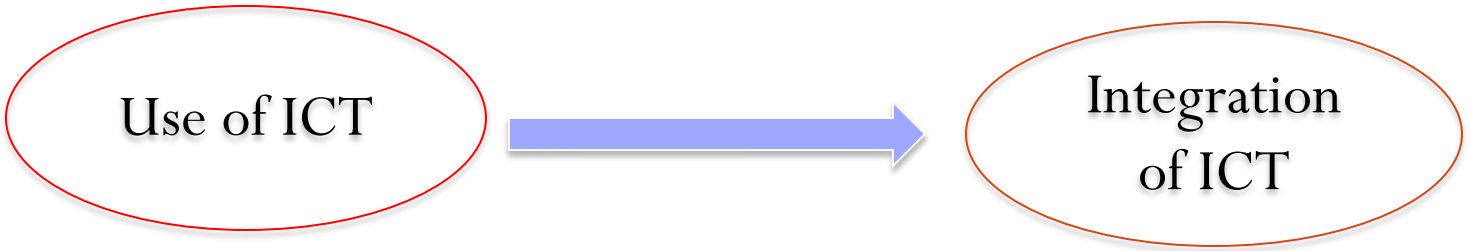


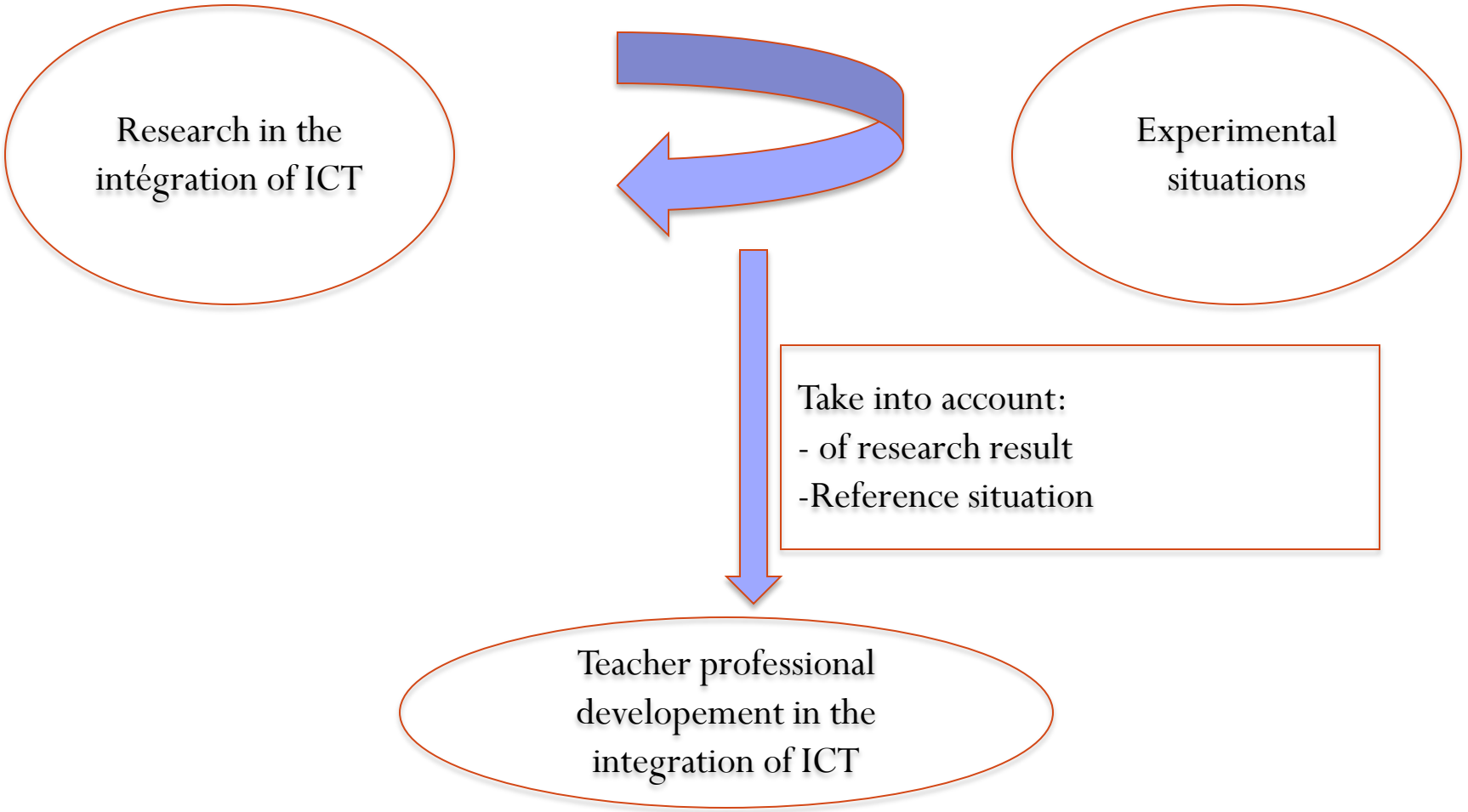
Integration of ICT



- A change in depth in:
  - content presentation
  - forms of activity

  (Laborde C., 1998)

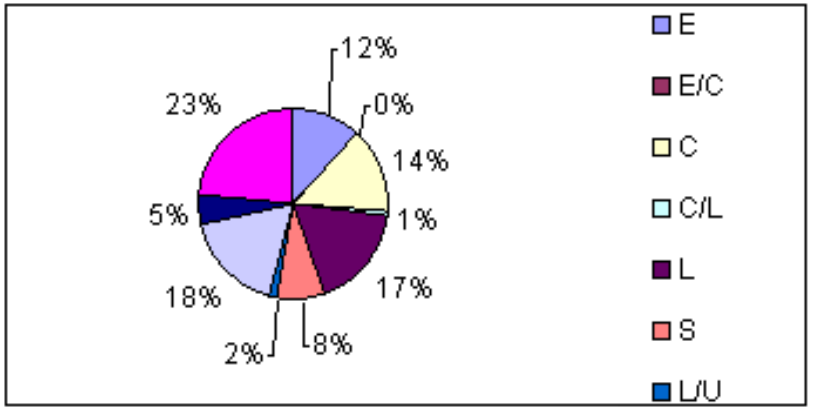
Integration of ICT

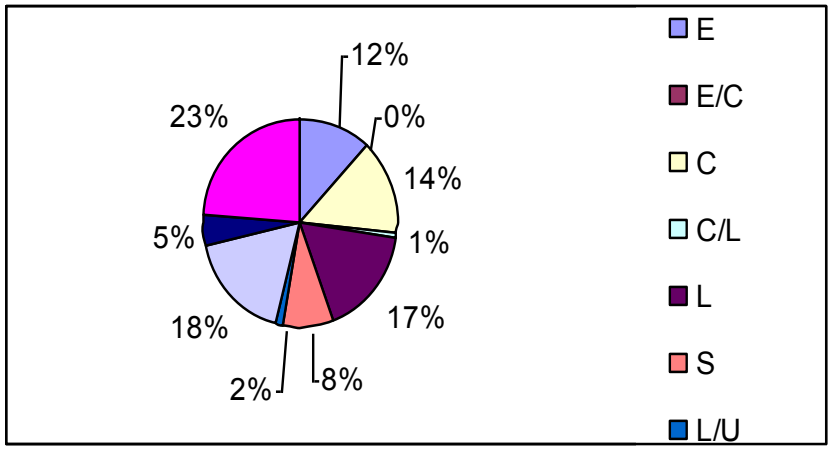


An litterature review on the field (Artigue, Lagrange, Laborde 2000)

Corpus : 662 publications

- E : Primery school
- C : Lower secondary school
- L : Uper secondary school
- S : Secondary school
- U : Higer Education
- **FE : Teacher professional developement 5%**





Dynamic geometry: major specific features

- Dragging is one of the distinctive features of DG
- Geometric tools for constructing figures preserving their properties when dragged
- Three possible uses of dragging
  - Dragging for seeing
  - Dragging for conjecturing
  - Dragging for validating/invalidating

Importance of tasks (1/2)

stressed by research in maths education: "importance of tasks in mediating the construction of students' scientific knowledge" (Monaghan)

- Central role in several theoretical frameworks about teaching and learning processes
  - even if they do not use the word "task" itself
- Constructivist and socio-constructivist approach: problematic tasks for the learners
  - Problem is the source and criterion for knowledge (Vergnaud)
  - Learning comes from adapting to a new situation creating a perturbation (Brousseau)

Importance of tasks (2/2)

In the praxeological approach (Chevallard)

- Knowledge used in an institution is characterized by a system of
  - tasks,
  - techniques to solve the tasks,
  - justifications of the techniques,
  - and theories from which justifications may come

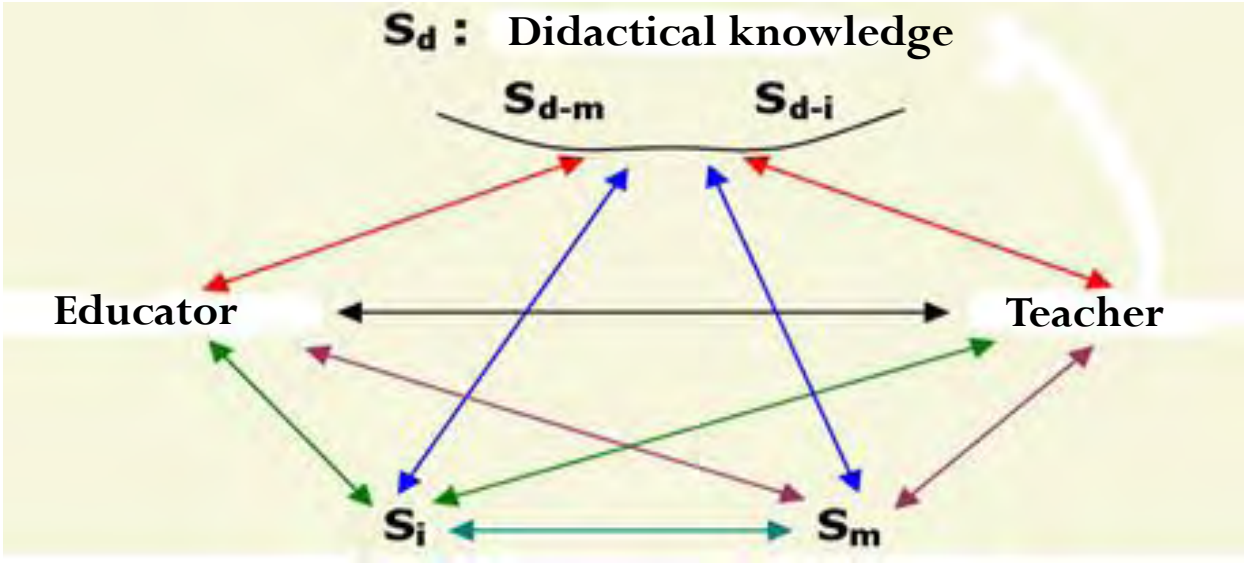
Activity of designing tasks

- Design activity is complex
- Requires to coordinate various types of knowledge about maths, pupils, technology, learning
- As such it may be a tool for professional development provided that some conditions are fulfilled

Resorting to several types of knowledge (Laborde C., 2005)

- Three kinds of knowledge strongly intertwined in the design of tasks
  - Mathematical knowledge
  - Knowledge of DGS
  - Pedagogical content knowledge
    - about mathematics teaching
    - and about the use of DGS for fostering learning

The design of tasks taking full advantage of dynamic geometry: What kinds of knowledge does it require from teachers? (Hamid C., 2013)



S_m: mathematical knowledge

S_i: artifact knowledge

S_{d-i}: didactical knowledge relatied to the artifact implementation in a learning situation

S_{d-m}: knowledge related to the implemetation of mathematical objects in a didactical situation

A professional activity

- Designing tasks is a teacher professional activity (Robert)
- It is a complex activity involving several dimensions
  - Epistemological dimension: choosing
    - features of mathematical knowledge
    - how to use them
  - Cognitive dimension: what kind of learning does promote the task?
  - Didactic and institutional dimensions:
    - How does the task fit
      - the constraints and needs of the teaching system,
      - of the curriculum,
      - of the specific class and of its didactic past?

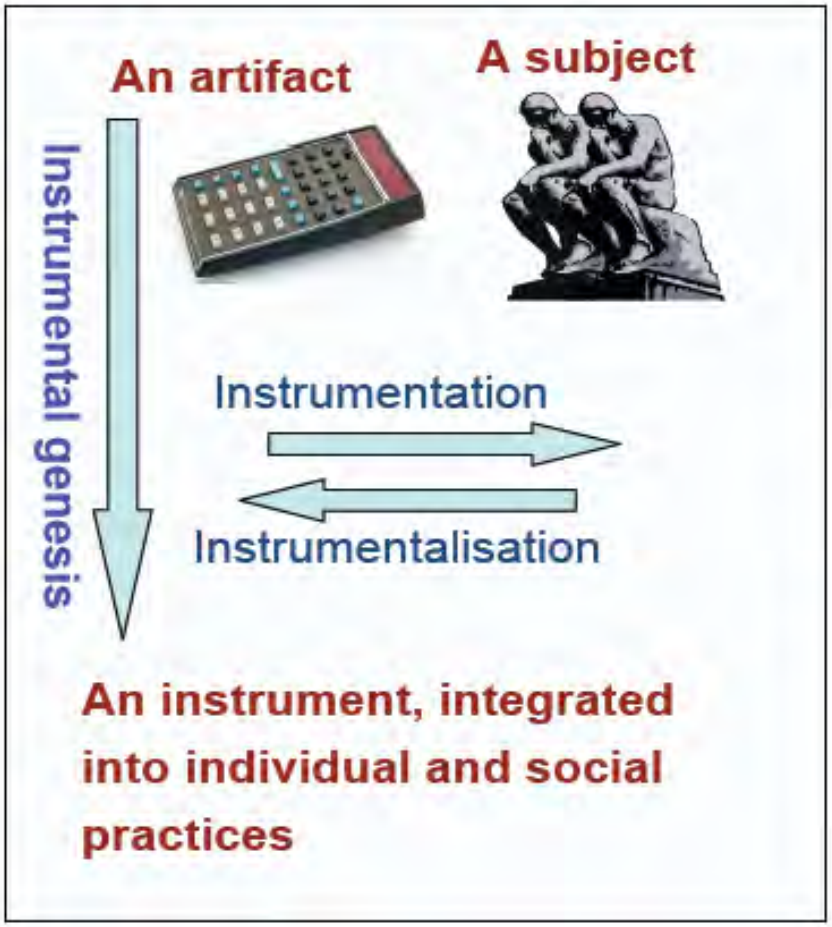
Key points in the anthropological approach (Chevallard Y., 1998)

- Mathematical objects are nothing absolute; they arise from institutional practices : « praxeologies »
- Praxeologies can be seen as complexes of tasks-techniques-technology-theory
- Knowing = ideoneity with institutional relationships
- The advance of knowledge goes along with the routinisation of tasks and techniques, the naturalization of knowledge

Instrumental dimension

- A tool affects the way of solving a task
- A tool is not transparent but must be appropriated by the user
- The user constructs schemes of utilization of the tool to perform tasks with the tool
- Construction process of these schemes: *instrumental genesis* (Rabardel)
- Using a tool shapes the way to do mathematics and consequently may affect mathematical knowledge constructed by the user

Instrumental dimension (Trouche 2003)



Vygotsky situates each piece of learning in a world of culture

where the *instruments* (material as well as psychological) play an essential role

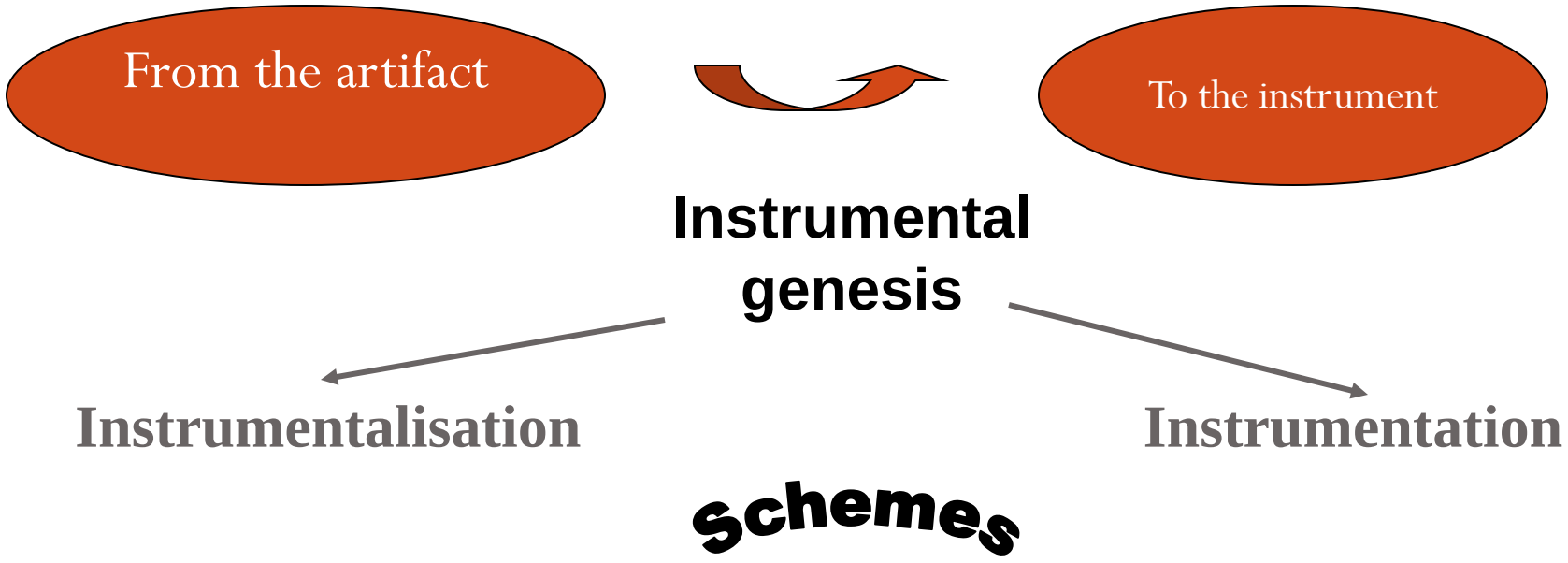
Artifacts are only *propositions* exploited or not by users (Rabardel)

Two processes closely interrelated:

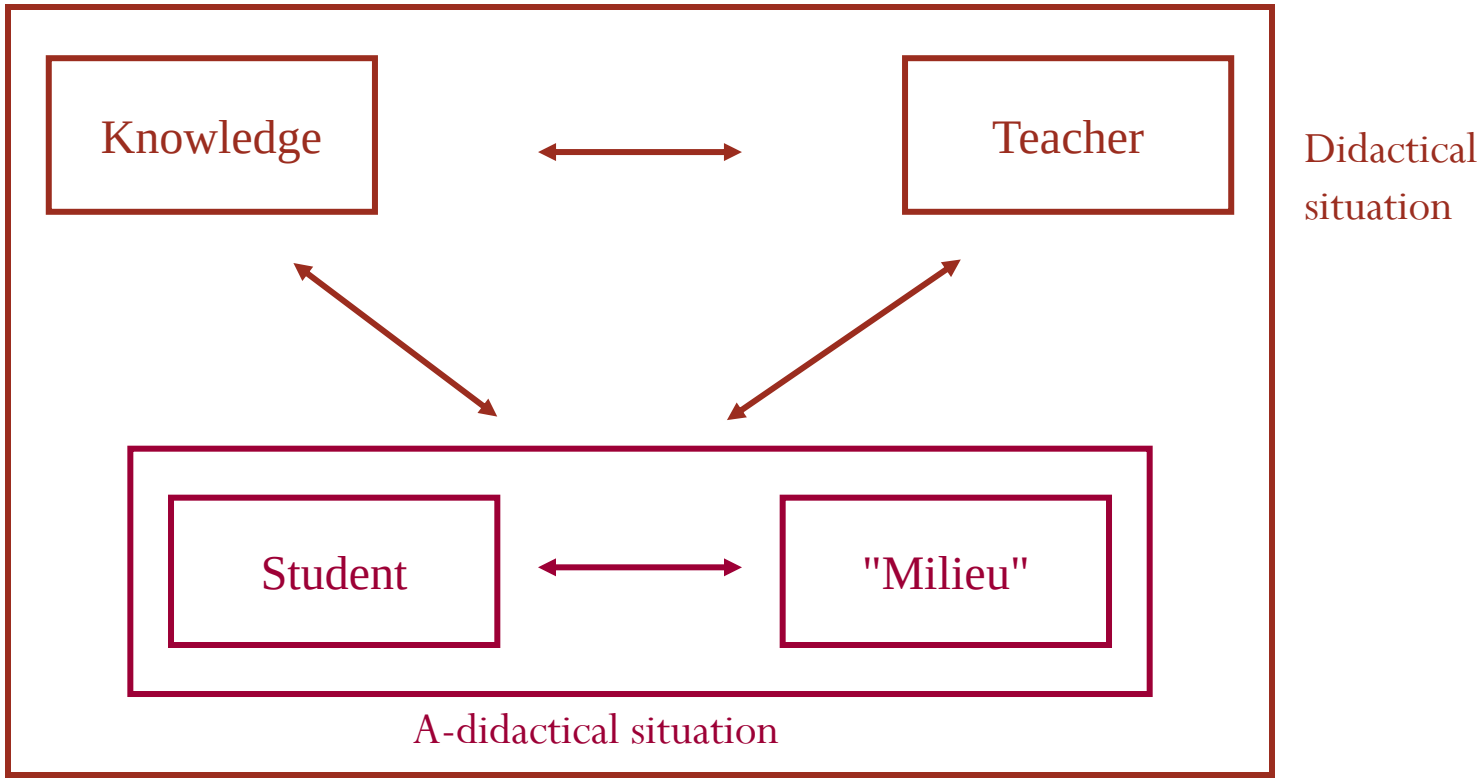
- the first one directed towards the artifact (*instrumentalisation*);

- the second one directed towards the subject (*instrumentation*).

Instrumental dimension (Trouche 2003)

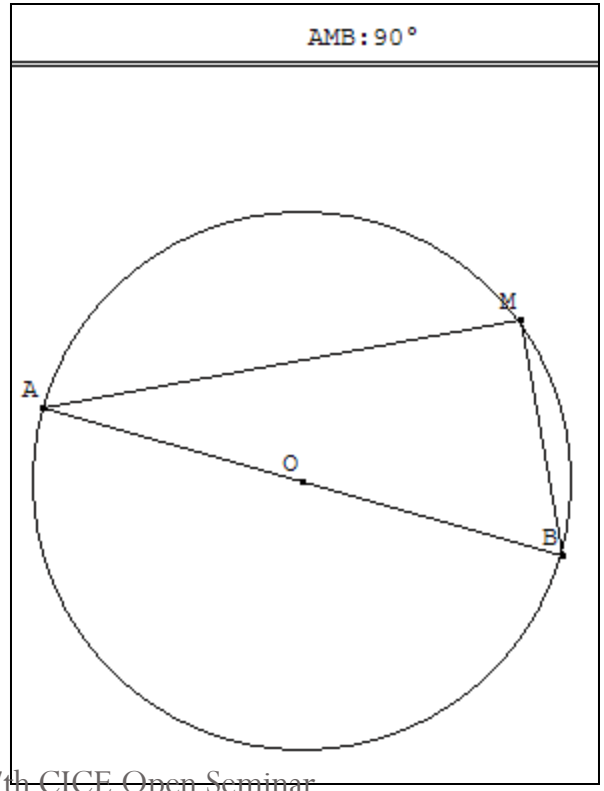


Didactical situation



Example of analysis of "milieu" (Laborde, 2005)

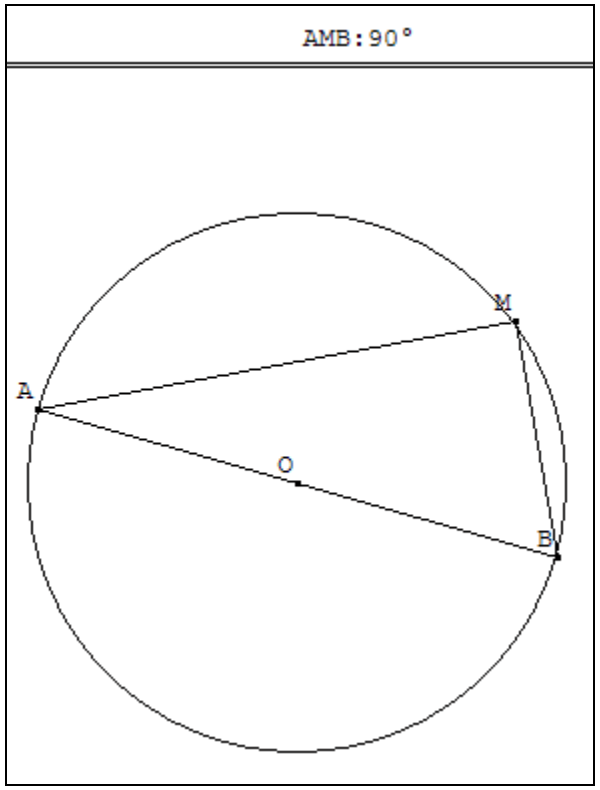
- Teaching goal:
  - make the students learn the theorem according to which an angle inscribed in a semi-circle is a right angle



Task with dynamic geometry software:
Create a circle with center O and a point A on this circle. Construct B such that [AB] is a diameter of the circle. Create a point M on the circle and the segments [AM] and [MB]. Measure the angle AMB.

Drag M on the circle. What do you observe?

Example of analysis of “milieu”



- “Milieu”:
  - Geometric figure (*robust* construction)
  - Feedback:
    - Invariance of the measure of the angle AMB
- Contribution to identification of elements of the theorem:
  - Varying nature of M and invariance of angle measure
  - Exteriorizing of the variable nature of M and the set on which it varies

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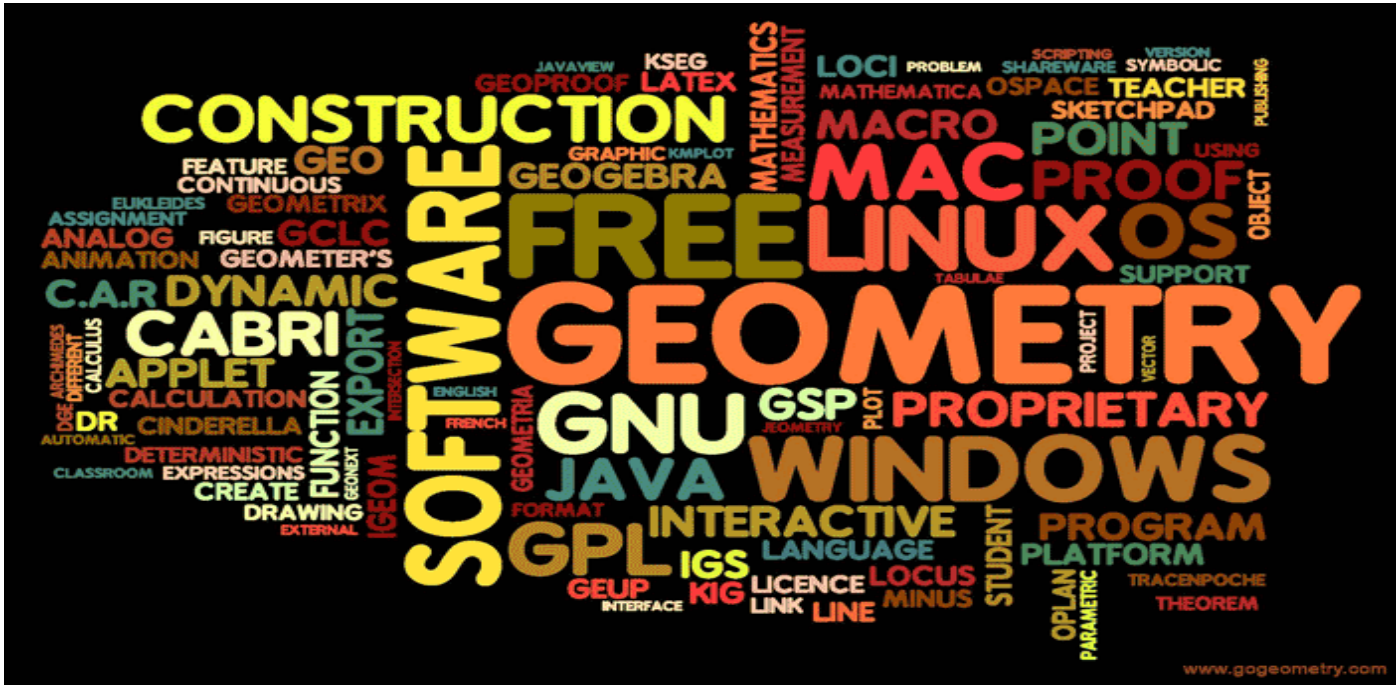

Conclusion

- Related to research about the integration in ICT in mathematical education, there is a almost no *significant* result in Vietnam
- Teacher professional development in the domain: a huge demand and a lot of effort to do
- Some research show:

- The integration of ICT is a long and complex process

- Political will and the hardware are necessary but not sufficient

- Professional development is critical for contributing to increase the confidence of teachers

- The role of research is crucial

  + Time for investigating different kinds of tasks

  + A better knowledge of students faced with different kinds of tasks

  Informing professional development

Conclusion

- New devices (tools) are coming in Vietnam classroom:
  - Forum
  - Tablet
  - Smart interactive board

....

New research questions

New challenges for teacher professional developpment

Reference

- **ARTIGUE M.,** (2005), The instrumental approach: the institutional dimension, *Seminar at the Unversity of Leed*, England
- **CHAACHOUA H.,** (2013*), Formation des enseignants et nouvelles technologies*, France –Vietnam Conference in Didactic of mathematics, HCM city, Vietnam
- **KEITH J.,** (2002), ''Implication for the classroom: research on the use of DGS", *Micromat*h, England
- **LABORDE C.** (2002), The design of tasks taking full advantage of dynamic geometry: what kinds of knowledge does it require from teachers?, *Conference CERME*
- **LABORDE J.** (2010), ''Does DGS matters ?", the *14th ATCM*, Malaysia
- **NGUYEN C.T.** (2006), « Integrate the dynamic geometry software Cabri in to the pratices of Teachers: a didactical perspective », Workshop at the 17th ICMI *Study Digital technologies and mathematics teaching and learning: Rethinking the terrain*, Vietnam