Digital technology and its various uses from the instrumental perspective

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Symposium on Artificial Intelligence for Mathematics Education (AI4ME)
Castro Urdiales (Spain), February 28th - March 1st, 2020

Plan

- Digital technology
  - Frameworks to think about its role in education
- Example of dynamic geometry
  - Various usages following the SAMR frameworks
  - Analysis from the instrumental perspective

Role of technology in education

- Two metaphors (Pea, 1985)
  - Amplifier metaphor
    - technology changes "how effectively we do traditional tasks, amplifying or extending our capabilities, with the assumption that these tasks stay fundamentally the same" (p. 168)
  - Reorganizer metaphor
    - technology changes "the tasks we do by reorganizing our mental functioning, and not only by amplifying it" (ibid.)

- Two approaches to e-assessment (Ripley, 2009)
  - Migratory
    - traditional paper-based tasks are translated into digital format, but remain qualitatively unchanged
  - Transformative
    - aims at assessing skills and abilities that are usually not assessed

Role of technology in education

- RAT framework (Hughes et al., 2006)
  - Considering three dimensions of the instructional event:
    - Instructional method
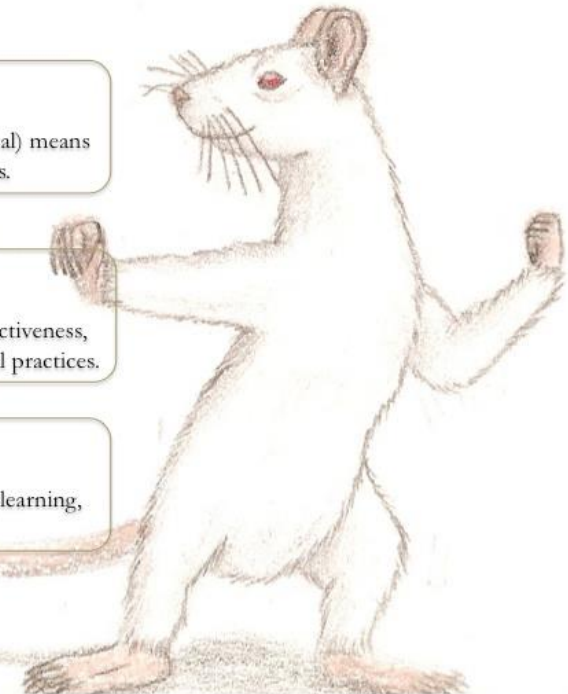   - Student learning processes
    - Curriculum goals

Replacement
Technology serves as a different (digital) means to same instructional practices.

Amplification
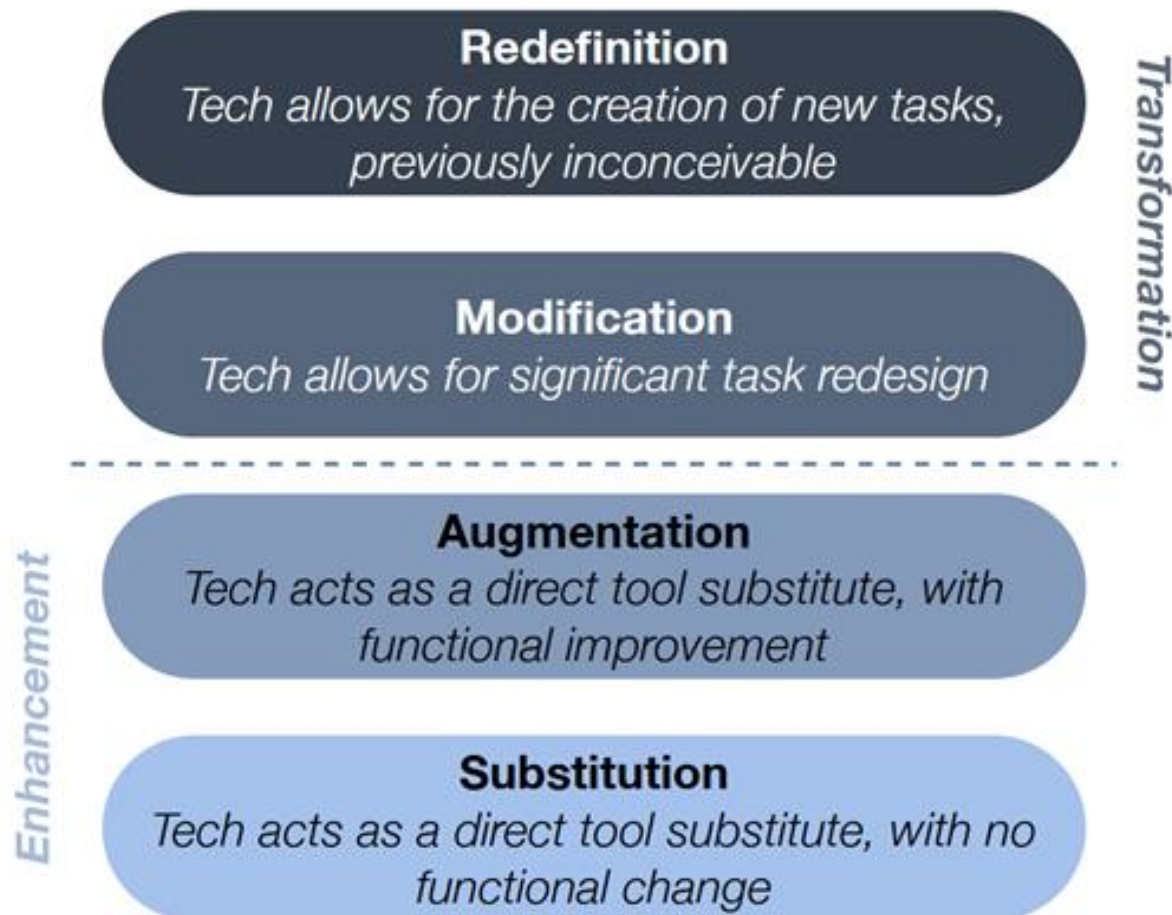Technology increases efficiency, effectiveness, and productivity of same instructional practices.

Transformation
Technology invents new instruction, learning, or curricula.

Role of technology in education

- SAMR model (Puentedura, 2006)

Redefinition
Tech allows for the creation of new tasks, previously inconceivable

Modification
Tech allows for significant task redesign

Augmentation
Tech acts as a direct tool substitute, with functional improvement

Substitution
Tech acts as a direct tool substitute, with no functional change

Transformation

Enhancement

Example of dynamic geometry (DG)

- DG can play four different roles (Laborde, 2001)

  - DG is used mainly as facilitating material aspects of the task while not changing it conceptually (e.g., draw a figure with DG tools)

    Substitution

  - DG is supposed to facilitate the mathematical task that is considered as unchanged: this is the case where DG is used as a visual amplifier in the task of identifying properties (e.g., given a polygon and its translated image, conjecture relations between their sides)

    Augmentation

  - DG is supposed to modify the solving strategies of the task due to the use of some of its tools and to the possibility that the task might be rendered more difficult (e.g., construct a square with a given side)
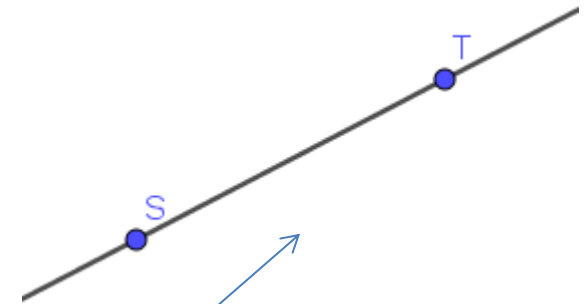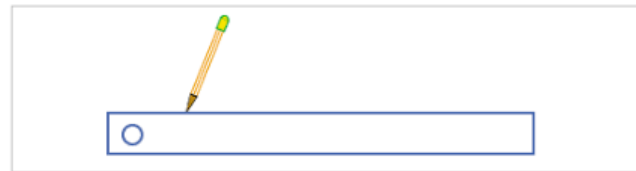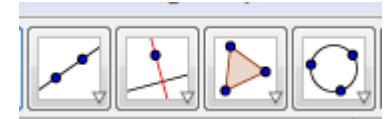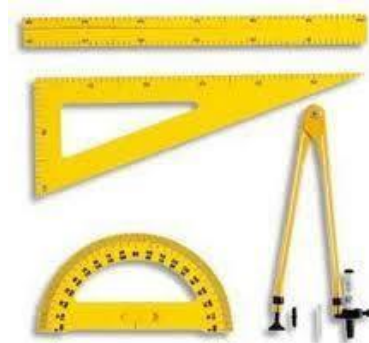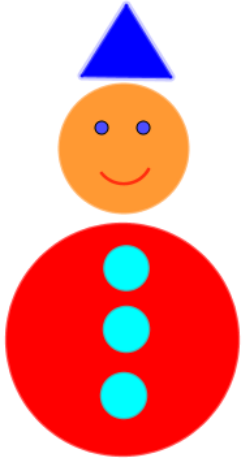
    Modification

  - the task only exists in DG (e.g., reconstruct a dynamic diagram)

    Redefinition

Types of tasks with DG
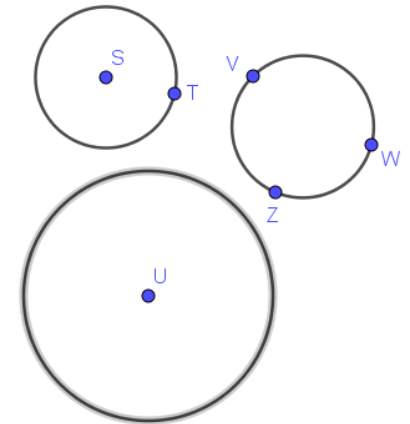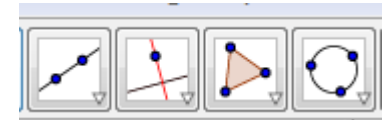## Substitution

Free drawing

straightness
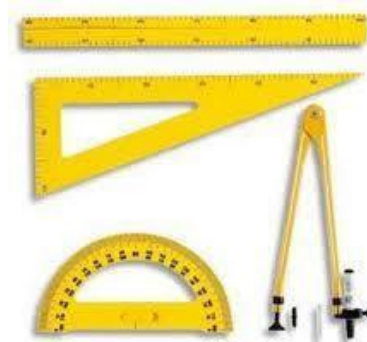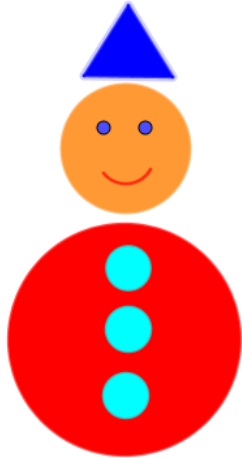
a straight line passes through 2 distinct points

different semiotic potential

Types of tasks with DG
Substitution

Free drawing

equidistance from
a given point

3 non-aligned
points define a
circle

different semiotic potential

Types of tasks with DG
Substitution

Consigne.

Propriété de l'aire d'un triangle.

1) Marque trois points A, B, C, puis construis un triangle ABC en traçant les segments [AB] ; [AC], [BC]. Ton triangle doit être quelconque, assez grand et tous ses angles doivent être aigus.
2) Construis la droite (BC).
3) Construis la droite parallèle à la droite (BC) qui passe par le point A. Colore ces deux droites en rouge.
4) Place sur cette parallèle les points A1, A2, A3 bouton .
5) en utilisant le bouton termine la construction des triangles A1BC, A2BC, A3BC.
6) Dans la zone Analyse recopie:
aire(ABC)=
aire(A1BC)=
aire(A2BC)=
aire(A3BC)=   puis appuie sur F9.
7) Que remarques- tu? réponds sur la feuille.
8) a) Construis la hauteur issue de A du triangle ABC, appelle H l'intersection de cette hauteur et de la droite (BC).
   b) Construis la hauteur issue de A1 du triangle A1BC, appelle H1 l'intersection de cette hauteur et de la droite (BC).
   c) Construis la hauteur issue de A2 du triangle A2BC, appelle H2 l'intersection de cette hauteur et de la droite (BC).
   d) Construis la hauteur issue de A3 du triangle A3BC, appelle H3 l'intersection de cette hauteur et de la droite (BC).
Colore les quatre hauteurs en vert.
8) Dans la zone Analyse recopie:
AH=
A1H1=
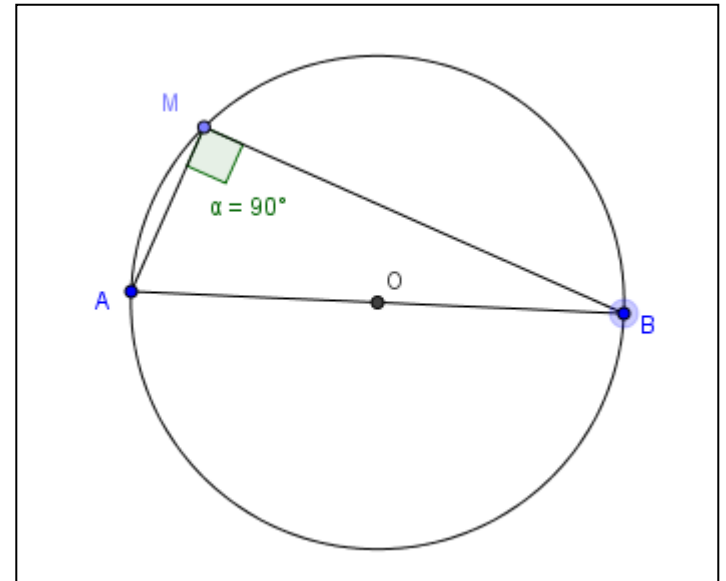A2H2=
A3H3=   puis appuie sur F9.
9) Que remarques - tu? Réponds au questions sur la feuille.
10) Valide ton exercice .

Types of tasks with DG
Augmentation

Conjecture / verify a geometric property

Semiotic potential of the drag mode:

- Drag mode generates a number of different configurations

- Geometric property is what remains unchanged while dragging free points

DG as a visual amplifier facilitates the identification of geometric properties

Types of tasks with DG
Augmentation

Conjecture / verify a geometric property
(robust construction)

21 Avec un logiciel de géométrie dynamique

a. Trace un triangle MRV.

b. Trace ses médianes qui se coupent en G.

c. Trace ses hauteurs qui se coupent en H.

d. Trace ses médiatrices qui se coupent en O.

e. Déplace les sommets M, R et V du triangle. Décris ce que tu observes pour les trois points G, H et O.
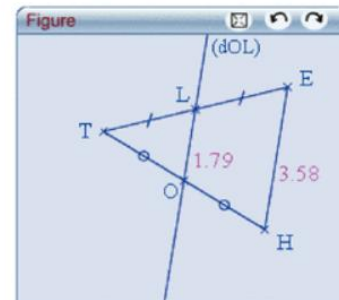
Activité 1 : Un triangle et deux milieux

1. Conjecture avec TracenPoche

a. Construis un triangle THE.
En utilisant le bouton [✎], place le point O milieu de [TH] et le point L milieu de [TE].
Trace la droite (OL).

À l'aide du bouton [✎], fais apparaître les longueurs des segments [OL] et [HE].

Figure (dOL)

1.79   3.58

b. Déplace les sommets du triangle et note, sur ton cahier, les longueurs OL et HE pour quatre triangles différents. Que remarques-tu ?

c. Déplace les sommets du triangle. Comment semblent être les droites (OL) et (HE) ?
Dans la fenêtre *Analyse*, saisis : « position(OL,HE) = » puis appuie sur la touche F9.
Déplace à nouveau les sommets du triangle. Qu'indique Tracenpoche ?

Types of tasks with DG
Modification

Construct a (robust) figure
(the figure must resist while dragging)

Role of dynamic geometry

- Forces the **resort to geometric properties** (construction task modified)

- Drag mode is used to **validate / invalidate** the construction

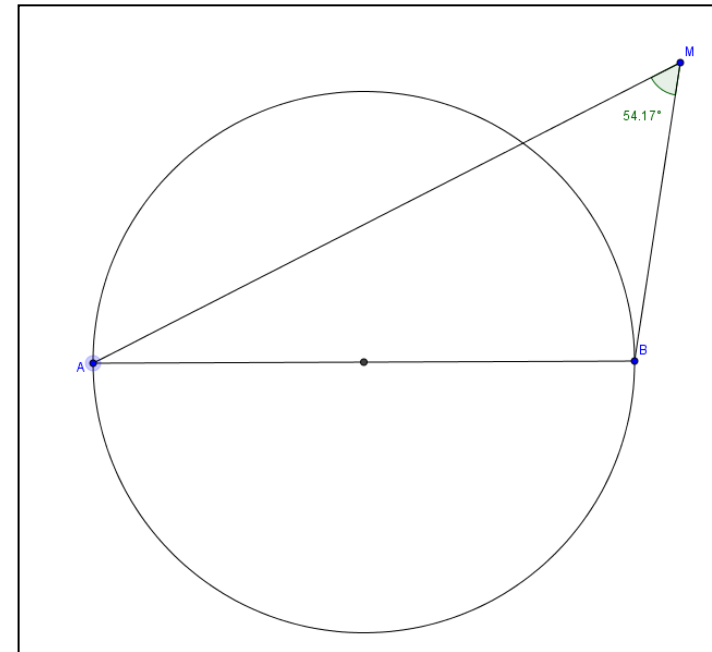- Facilitates distinguishing between **drawing and figure**
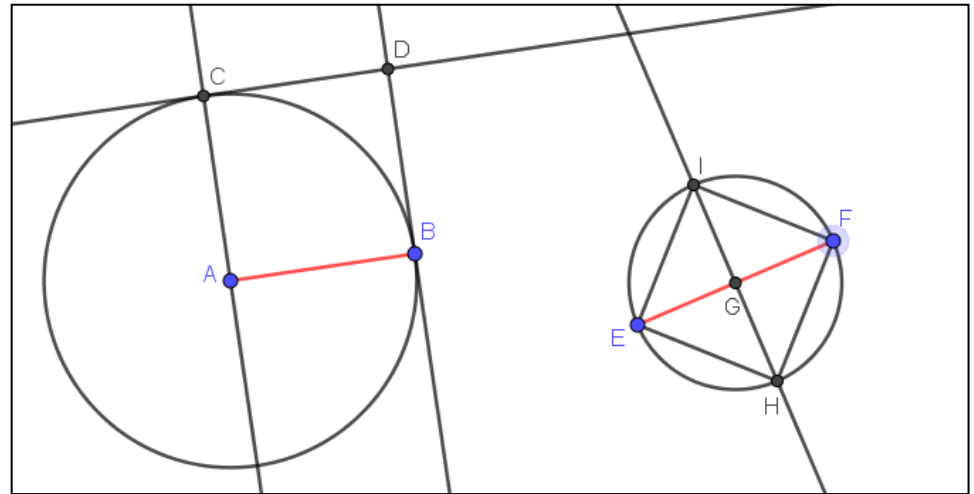
Types of tasks with DG
Modification

Search for conditions that lead to obtaining a specific configuration (soft construction)

Role of dynamic geometry

- Support **exploring the situation**: this "**what-if property**" is a creative means for generating and testing various scenarios for what could be, given different hypothetical conditions (Pea, 1985)

- Help **distinguishing between hypothesis** (condition) **and conclusion** (toward hypothetico-deductive reasoning)
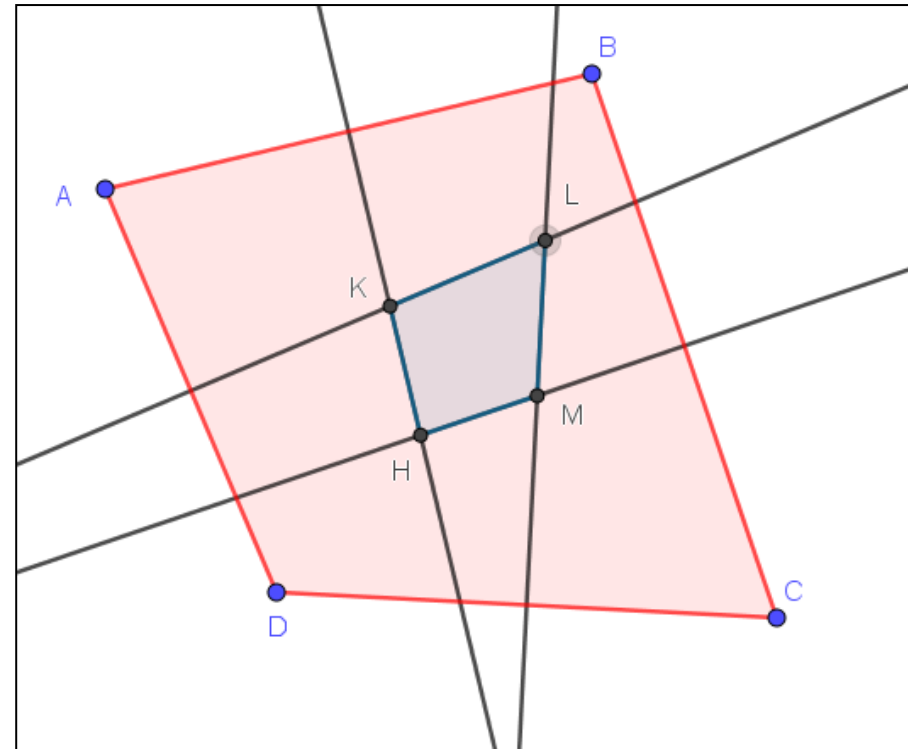
Types of tasks with DG

Modification

Search for conditions that lead to obtaining a specific configuration (soft construction)

Instrumental issues

Drag mode used for different purposes (Arzarello et al. 2002):

- explore freely the situation => **wandering dragging**

- obtain a particular configuration (what-if) => **guided dragging**

- search for positions of a point that satisfies a condition (locus) => **dummy locus dragging**

(Olivero, 2002)

Different **drag instruments => different solutions**
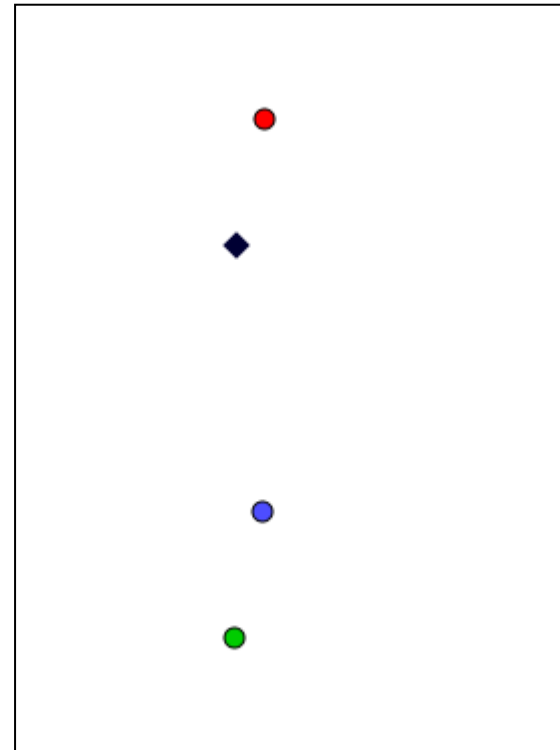
Types of tasks with DG
Redefinition
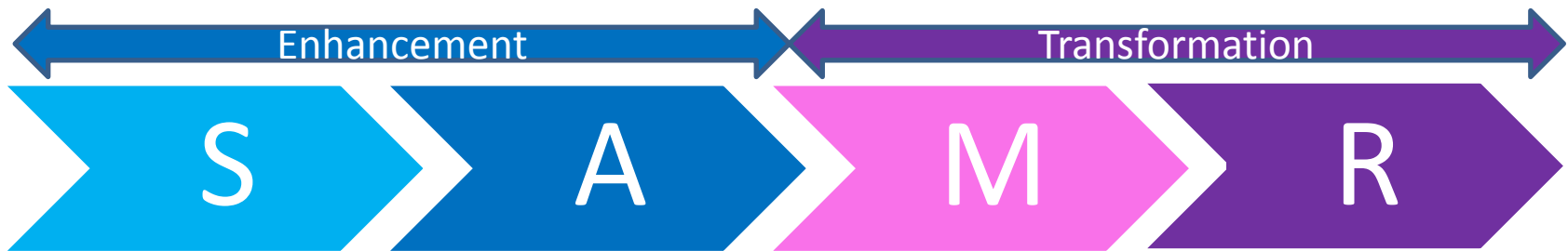
Find the relation between objects
(black box)

Dragging supports

- **experimenting** on the drawing

- **conjecturing** (hidden) geometric properties

- **testing conjectures**

(Restrepo, 2008)

Types of tasks with DG

Enhancement ⟷ Transformation

S A M R

Cognitive activity: observation

Pedagogical approach: teacher-centered

Drag mode:

- Points to drag are indicated
- Variations to discern properties

Paradigm: robust constructions

Proof: seems unnecessary

Cognitive activity: inquiry, exploration, problem solving

Pedagogical approach: student-centered

Drag mode:

- Part of problem solving strategy, choice of points to drag is the student's responsibility
- Various modalities and various purposes => various "drag instruments"

Paradigms: robust and soft constructions

Proof: meaningful

Conclusion

- Technology itself is not transformative, it is the way how it is used that can be transformative
- Various ways of using technology (from S to R)
  - More or less student-centered
  - More or less engaging cognitive activity
  - More or less transformative
- Instrumental issues
  - Students' instrumental geneses => variety of instruments yielding different solution paths
  - Teachers' double instrumental genesis => instrumental orchestration

Références bibliographiques

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