SAILS Strategies for Assessment of Inquiry Learning in Science

Introducing STEM Education In Secondary Schools: KOGEKA's Story

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KOGEKA

- Group of six secondary schools
- In Geel and Kasterlee, Flanders, Belgium
- Intense co-operation – pedagogical freedom
- 4400 pupils – 700 personnel
- Pupils aged 12-18 (19)

Science, Technology, Engineering, Mathematics

- Action Plan STEM 2012-2020 (Flemish Government 2012)
- Report 'Choosing For STEM' (Flemish Council for Science And Innovation 2012)
- Final Report SECURE Project (FP7, Thomas More University College 2013)

- A number of youngsters loose interest in / motivation for STEM subjects, specially between the age of 10 and 14

- Result 1: declining numbers of pupils in STEM fields of study in secondary education
  e.g. KOGEKA Mechanics – Electricity: in 1999 664 pupils – in 2013 372 pupils = 56%

- Result 2: too small numbers of engineers and scientists graduating at universities and colleges

- Result 3: shortage of engineers and scientists on the labour market

Action Plan

1. Connecting seperated STEM initiatives
   into an integrated action plan
   for the six KOGEKA schools

2. Anchoring STEM projects structurally
   into curricula and lesson plans

Connecting STEM Initiatives

- For pupils aged 10-12

Supply of technology lessons for primary schools (since 2011)

- Technics
  - Building construction: measuring corners
  - Electricity: building an alarm system
  - Wood: building a coat rack
  - Leverages and pulleys

Kogeka I ♥ TECHNO

- ICT (Information & Communication Technology)
  - 3 lessons
  - Frame of reference: ICT Diamond
  - Content defined in collaboration with primary school

Kogeka I ♥ TECHNO

- GIS (Geographical Information Systems)
  - Project on road safety in 3 steps:
    - Pupils draw digital school route maps
    - Pupils discuss road safety based on their school route maps
    - Pupils present road safety problems & proposals for solutions to the city council

Connecting STEM Initiatives

- For pupils aged 12-14
  - STEM projects in the curriculum (from 2014 onwards)

- For pupils aged 14-16
  - Project 'STEM@school' (KULeuven University 2014-2018)
    - Developing and introducing integrated STEM education to Flemish secondary schools

- Research project:
  - Scientists & engineers
  - Pedagogues
  - Policy makers
- 20 Flemish pilot schools – KOGEKA = one of them
- Testing and validating STEM didactics
- Implementing these didactics in new curricula and teacher training

Connecting STEM Initiatives

- For pupils aged 16-18

  Co-operation with universities and scientific institutions
  - Youngster's Lab (Vito 2012-2013)

    - Pupils have a one week internship
      in a scientific research institute
    - They follow a researcher (PhD)
      in his/her activities
    - They exchange experiences daily
    - They provide feedback to their class mates / teacher
    - They make a permanent external communication:
      - a scientific poster about the research they followed
      - a YouTube movie explaining the poster

Connecting STEM Initiatives

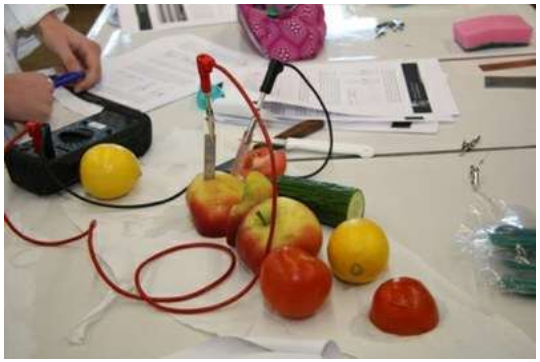
- Innovation Lab (KULeuven 2013-2014)

Engineering project at school (1 day)

Topic 1: developing an eye-controlled interface for driving a wheelchair

Topic 2: green energy

Testing energy turn-over and storage



Anchoring STEM Projects

- So far:
  - Inquiry-based scientific and technical projects as one-shots (1/2 day, 1 day, 1 week)
  - Research and engineering assignments in curricula in limited amounts (e.g. 1 / week, 1 / month, 1 / semester)
  - Strong focus on theoretical knowledge rather than researching and engineering competences

- From 2014-2015 onwards:
  - More focus on inquiry-based scientific and technical education in curricula and lessons
  - Introduced gradually for pupils aged 12 onwards (year 1A)

STEM@1A

- STEM as a new field of study in year 1A

- For 12 year old pupils who
  - Reach a high level of abstractness
  - Can handle a high tempo of learning
  - Have an explicit interest in sciences and technology

- 3-4 hours / week STEM as a subject

Distinctive part of the schedule

Latin	STEM	Modern Sciences	Industrial Sciences/STEM
5 h Latin (incl. social skills)	4 h STEM projects	1 h French	3 h STEM projects
	1 h social skills	1 h English	1 h mathematics
		1 h Dutch	1 h social skills
		1 h mathematics	
		1 h social skills	

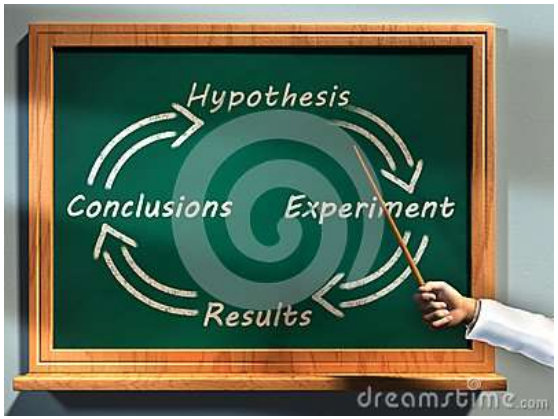
Full programme: 32 h / week

science • technology • engineering • mathematics

PROJECTS

- Constructed according to the principles of inquiry-based learning

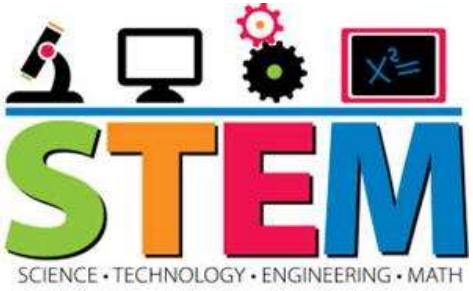
- Aim: to stimulate the problem-solving ability of the pupils



PROJECTS

- Try outs in 2013-2014 in a choice group of pupils outside the 32 h lessons schedule
  - 90 volunteers = 22% of year 1A!

- Developed by a working group of 30 people
  - Science, maths & technics teachers of all 6 schools
  - Headmasters
  - External STEM specialists:
    - university
    - teacher training institute
    - pedagogical coaching service



PROJECTS

Vision on integrated STEM education: 10 criteria

1. Project work: packages of 6-10 lessons
   STEM projects deal with realistic, present-day problems
2. Each project is to some extend a mix of science, technology, maths and IT
3. Focus on inquiry-based learning
   Therefore: the process is more important than the product
4. Understanding is more valuable than knowledge
   Therefore: the use of knowledge is more important than the knowledge itself
   We train to become scientists and engineers, not quiz players
5. Scientific method / technical process is our guide line

CRITERIA

6. We stimulate problem-solving thinking
   Therefore: engineering is more important than technics

7. Evaluation must be adapted to inquiry-based learning
   Therefore: process evaluation is more important than product evaluation

8. Topics / contexts / projects differ from those in other curricula (natural sciences, scientific work, technics)
   Therefore: we check curricula and year plans

9. We take the social aspects into account
   Team work, presentations, group discussions, peer evaluations

10. STEM projects are examples of constructivism

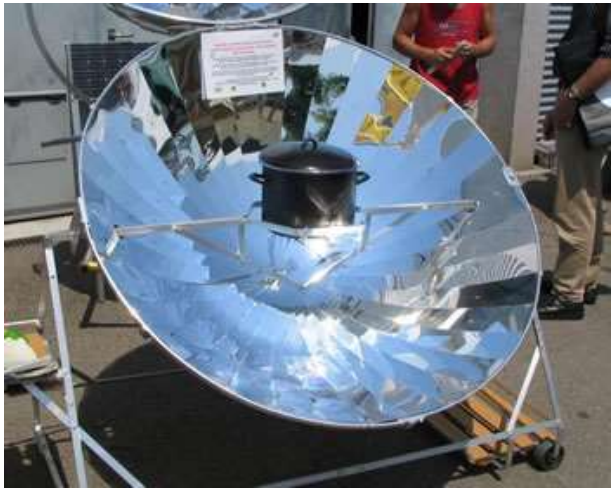
CURRICULUM

- Working group is writing a STEM curriculum
  - Curriculum objectives
    20 objectives in accordance with our 10 STEM criteria
  - Pedagogical-didactical guidelines
    Constructivistic method
  - Material requirements
    Instruments, classroom
  - Evaluation
    How do you evaluate (progress in) inquiry-based learning and problem-solving thinking?
- Participation in SAILS Strategies for Assessment of Inquiry Learning in Science

PROJECTS

- 1st series of 7 STEM projects developed

1. Light
2. Robotics
   Lego Mindstorms
3. Solar oven
4. Windmill
5. Weather station
6. Pineapple boat
   sustainable transport
7. Glider



SCIENCE | TECHNOLOGY | ENGINEERING | MATHEMATICS

PROJECTS

- 2nd series of STEM projects under construction
  1. Sound
  2. Water power
     Hydro-electric energy
  3. Maths in nature
  4. Grab the challenge
     Leverages and pulleys
  5. Micro macro
     Microscopy
  6. Scratch
     Computer programming
  7. The energy-efficient house

FUTURE

- 2014-2015
  - 1 September 2014: D-Day – STEM in 1A (age 12-13)
    - Research assignment KHLim university college
      - Measure the effect of STEM on
        - » The inquiry-based learning ability of the pupils
        - » The problem-solving capacity of the pupils
      - Zero measurement in September 2014
        - » In 1A STEM
        - » In other class groups (control)
      - New measurement in June 2015
      - Repetition of the measurements in 2015-2016
  - Developing STEM projects for 2A (age 13-14)
    - Participation in learning community KHLim

FUTURE

- 2015-2016
  - STEM in 2A (2-4 h / week)
    - More projects
    - Fascinating subjects
- 2016-2018
  - STEM in curricula for pupils aged 14-16
    - Developed, tested & prepared by STEM@school (KULeuven)
- 2018-2020
  - STEM in curricula for pupils aged 16-18

FUTURE

- We'll need improvement of professional skills on inquiry-based learning
- A.o. attention for assessment
- Participation in Community Of Practice

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Conclusion

- The future's so bright, I gotta to wear shades!

(Pat MacDonald, Timbuk3)

- Thank you very much for your attention

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