



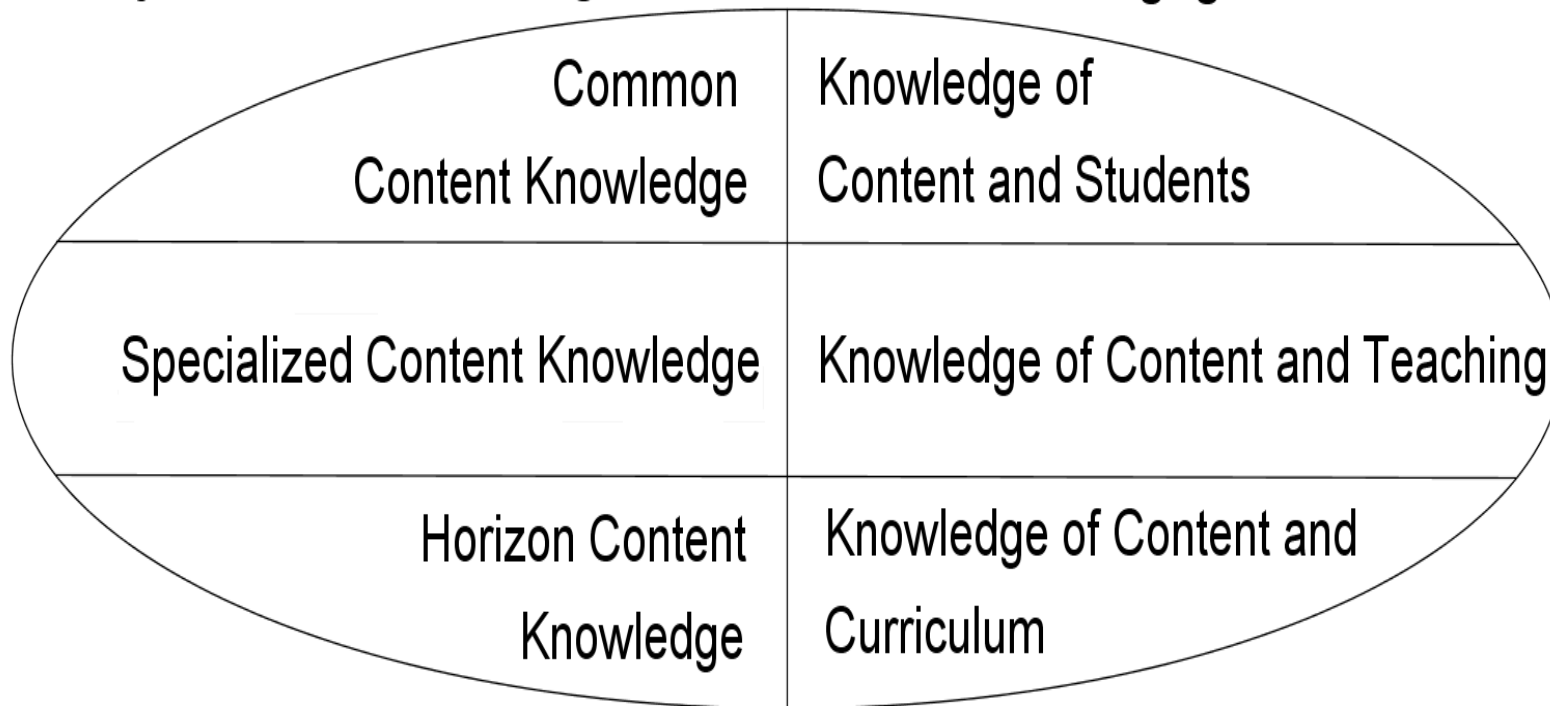
INQUIRY BASED LEARNING IN MATHEMATICS TEACHERS EDUCATION

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Sofia, February 14th 2015
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Teacher's knowledge

Subject Matter Knowledge

Pedagogical content knowledge



Inquiry-Based Learning (IBL)

Valued outcomes

- Inquiring minds: critical & creative
- Preparation for uncertain future & lifelong learning
- Understanding of nature of science & math

Classroom culture

- Shared sense of ownership and purpose
- Value mistakes, contributions (open-minded)
- Dialogic

Learning Environment

- Problems: Open, multiple solution strategies, experienced as real and/or scientifically relevant
- Access to tools and resources
- From problems to explanations (not from examples to practicing)

Teacher

- Foster and value students' reasoning
- From telling to supporting and scaffolding
- Connects to students' experiences

Pupils

- Pose questions
- Inquire / 5 E's
 - Engage
 - Explore
 - Explain
 - Extend
 - Evaluate
- Collaborate

Every baby
knows the

scientific method!



Project web

<http://www.primas-project.eu/>

PRIMAS

- ☐ Professional development
- ☐ Background

Processes of inquiry ☐ select all

- ☐ Exploring situations
- ☐ Planning investigations
- ☐ Experimenting systematically
- ☐ Interpreting and evaluating
- ☐ Communicating results

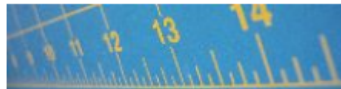
Issues for teachers ☐ select all

- ☐ Organizing student-led inquiry
- ☐ Using unstructured problems
- ☐ Developing concepts
- ☐ Asking questions
- ☐ Managing classroom interaction
- ☐ Supporting collaborative work
- ☐ Using assessment to promote learning

Discipline ☐ select all

- ☐ Mathematics
- ☐ Physics
- ☐ Chemistry
- ☐ Biology
- ☐ Science

PROFESSIONAL DEVELOPMENT

[► More articles](#)

Professional development modules
for inquiry-based, collaborative learning



PD Module 1: Student-led inquiry
How to ask productive questions for learning



PD Module 2: Tackling unstructured problems
Selection of mathematical techniques

TEACHING MATERIALS

[► More articles](#)

Animal footprint
Interpretation of observations



Learning to model
Guiding low achieving students



Hydratation of legumes
Teachers experiencing IBL as students

BACKGROUND

[► More articles](#)

Pollen
Promotion of science teaching renovation



Fibonacci
For dissemination of inquiry-based education

IBL Moduls

[PD Module 1: Student-led inquiry](#)

[PD Module 2: Tackling unstructured problems](#)

[PD Module 3: Learning concepts through IBL](#)

[PD Module 4: Asking questions that promote reasoning](#)

[PD Module 5: Students working collaboratively](#)

[PD Module 6: Building on what students already know](#)

[PD Module 7: Self and peer assessment](#)

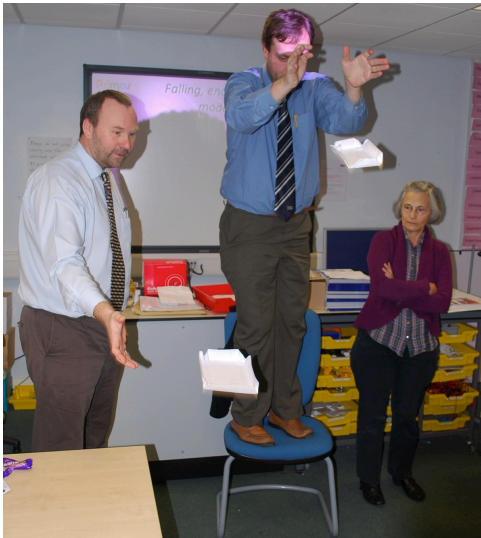
For the situation you choose to explore

- Make a list of things you notice about the situation.
- What questions occur to you?
- You might begin by asking questions that start:
 - What would happen if?
 - What can I vary ...?
 - What effect will each variable have on ...?

Set a problem and attempt to tackle it.

- When you have experimented with the situation try to analyze your findings.
- What data have you collected?
- How have you organized your data?
- How can you explain your findings?

Free fall

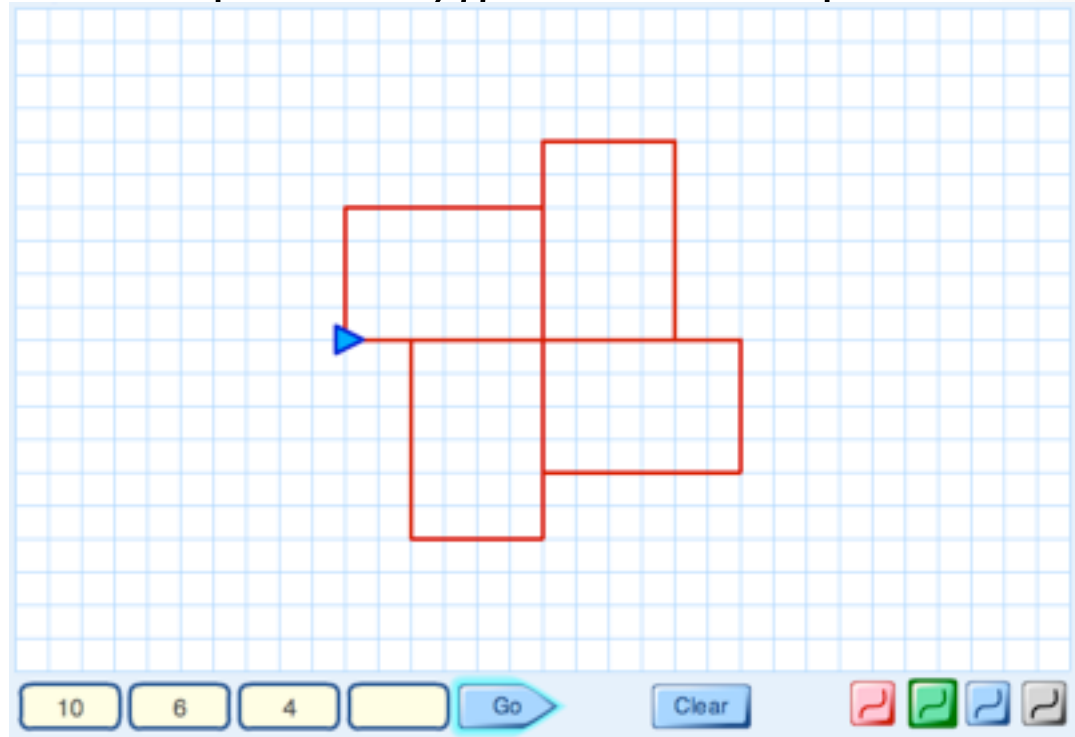


Two-cubes calendar



Spirolaterals

- Simple computer microworld exploration
- Own questions formulation
- Tackle questions systematically, using scientific reasoning
- The task offers students to experiment, generalise and prove
- Pupils 9 – 16 years
- Pre-service teachers



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IBL Processes

- Observe a computer microworld, explore by changing variables, formulate questions and hypotheses.
- Plan a systematic investigation into their own question. They select ways of representing the data they collect, for example, using tables. They draw on their mathematical knowledge to describe their findings (e.g. symmetry).
- Students carry out their investigation, systematically collecting, documenting and analysing data and further information.
- Make, explain and prove generalisations (e.g. entering a sequence of three numbers will result in a closed shape)
- Communicate results and reflect on what has been learned.

Pedagogical Issues

- Organising student-led inquiry
- Helping students to tackle unstructured problems
- Managing classroom interaction that encourages IBL
- Supporting collaborative work

Questions

- How do the numbers control what is drawn on the screen?
- List some questions to explore.

These might start like this:

"How can we make the computer draw?"

"What will happen if we?"

Try and answer your own questions!

- Make up some conjectures. These might start like this:
 - " When you use three numbers then ..."
 - " When you repeat a number then ..."
 - " If you change the order of the numbers then ..."

Can you *prove* your conjectures?

Think strategically and analytically

- Can you state your problem to me clearly?
- What examples have you tried so far?
What are you keeping fixed? What are you changing?
Can you do this in a systematic way?
- What have you found out so far?
Can you see any patterns or relationships here?
- Can you explain **why** your idea seems to work?
- How are you keeping a record of your work?
- Can you use a helpful notation?
- Why do you need to do this?
- Can you use the computer to do this?

Conclusions

Tell us about:

- the problem you are solving;
- how you have organised your work;
- any conclusions you have reached so far.
- any explanations you have for your answers?

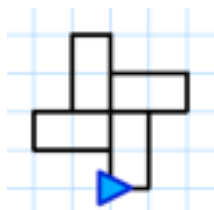
For homework

students could be asked to write an account of their discoveries.

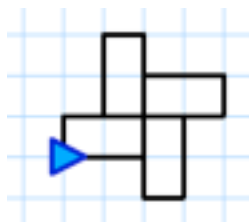
Discoveries

- When a single number a is entered, a square with side length a is obtained.
- When two numbers a, b are entered, a rectangle with sides a, b is obtained.
- Any cyclic reordering of the three numbers: (a,b,c) ; (b,c,a) ; (c,a,b) gives the same design, but start in different places:

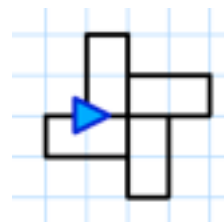
$(1,2,3)$



$(2,3,1)$

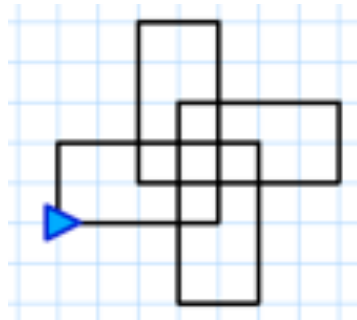


$(3,1,2)$

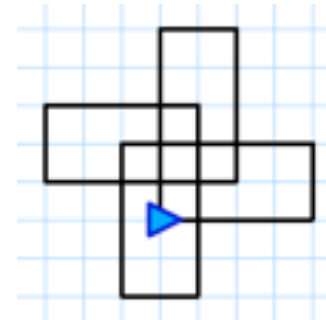


Discoveries

- Changing the cyclic order of the three numbers (a,b,c) to (a,c,b) produces a reflection:



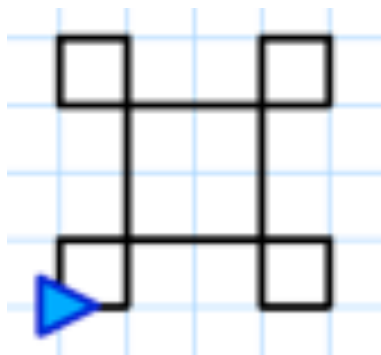
$(4,5,2)$



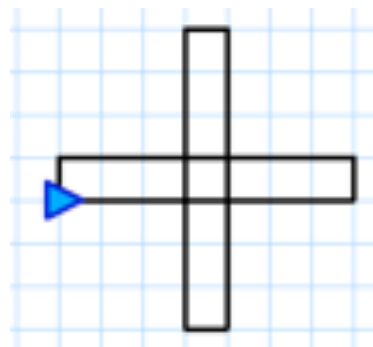
$(4,2,5)$

Discoveries

- Three numbers where one or more is repeated (a,b,b) or (a,b,a) give patterns with lines of symmetry.



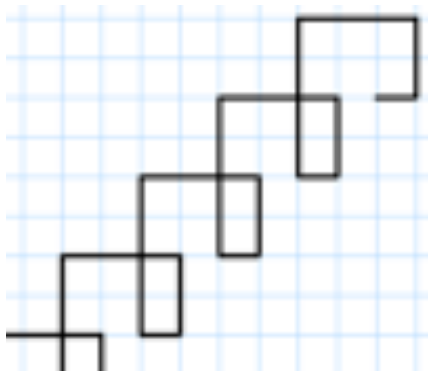
$(1,4,1)$



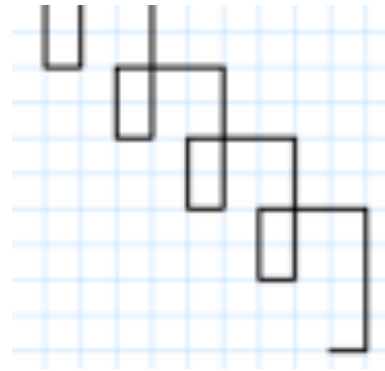
$(4,4,1)$

Discoveries

Patterns with 4 different numbers (a,b,c,d) tend to "walk off" the screen...



$(1,2,3,4)$



$(1,4,3,2)$

