High School Teachers' Approaches to Promoting Self-Monitoring in Physics Problem Solving by their Students

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What Troubled Us

Research:

Shows traditional teaching ⇒ weak problem solving skills

Explores Learning difficulties

Research based curricula:

Shows improvement in problem solving skills

- Context rich problems - Analyze, plan, try out, revise
- Problem solving strategy - Strategic decision making
- Cooperative problem solving - Evaluate and diagnose

[Heller et al, 1992, Huffman, 1994, Foster, 2000]

Teachers practice:

Reflects some aspects of research based curricula

Yet, seldom are they fully implemented.

Possible Solution

Analysis - What is required of teachers:

Change roles, Change concepts and habits

Coordinate new and traditional agenda [Hammer, 2000]

Leads to:
- Fear of trying new practices
- Giving up what does not work on first shot

Yet,

For change to occur teachers must face their fears

Teachers' educators: [Feldman, Hammer]

Collaborative Physics Teacher Inquiry

Teacher reflect on the very process of applying a new classroom practice

- Enrich teachers' interpretations of class events
- Support teachers in a process of change

Outline:

- Design of physics teachers' workshop:

  Collaborative teacher inquiry to promote self-monitoring in problem solving
- Professional development of participants

Results:

What does not work?

Research Based Curricula + Concerned and Experienced teachers + Collaborative Inquiry

What works?

R.B.C. + Teachers with Ownership and Experience + Management Framework for Collaborative Inquiry

What happened to teachers?

Teachers tried R.B.C., refined it to meet their needs.

- "Teachers curricula": Diverse, incomplete
- Change in teachers' perceptions: Long time-scales

Design of Teachers' Workshop

Workshop goals: To help teachers to

- Tailor existing curricular developments
- Develop in their own instruction

Important elements:

- Introductory constructivist workshop:

  Introduce research, Induce concern

- Yearlong meetings:

  Leader imports Research + Curriculum

  Teachers Autonomous to implement

  Discussion: external + internal innovations

Formative evaluation

2 workshops, ~ 7 Motivated, experienced teachers, teacher centered practices.

Diverse schools, ~ 30 students per teacher

Matriculation exam

Results

Teachers' concerns ⇕ Students problem solving

Short time accountability (Matriculation)

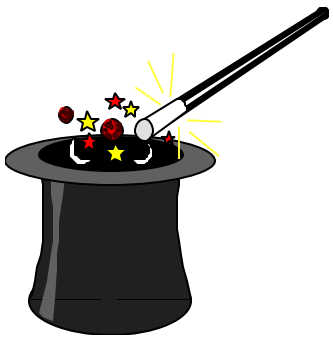
Teachers: ⇕ Fear of trying new practices

Giving up what does not work on first shot

Our conclusion

Research Based Instruction + Concerned and Experienced teachers + Collaborative Inquiry

Does not work!



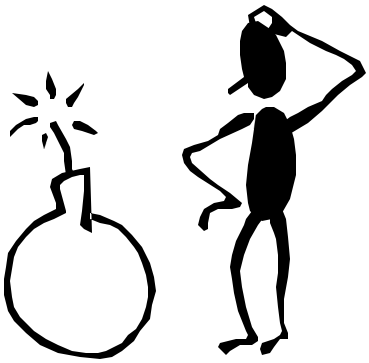
No magic solutions,

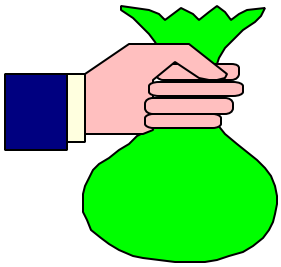
Teachers need to design, try, fail, and refine their own solutions, ⇒ Support is needed

Third Workshop - Did Work

Introductory workshop:

Beyond concern ⇒ Ownership





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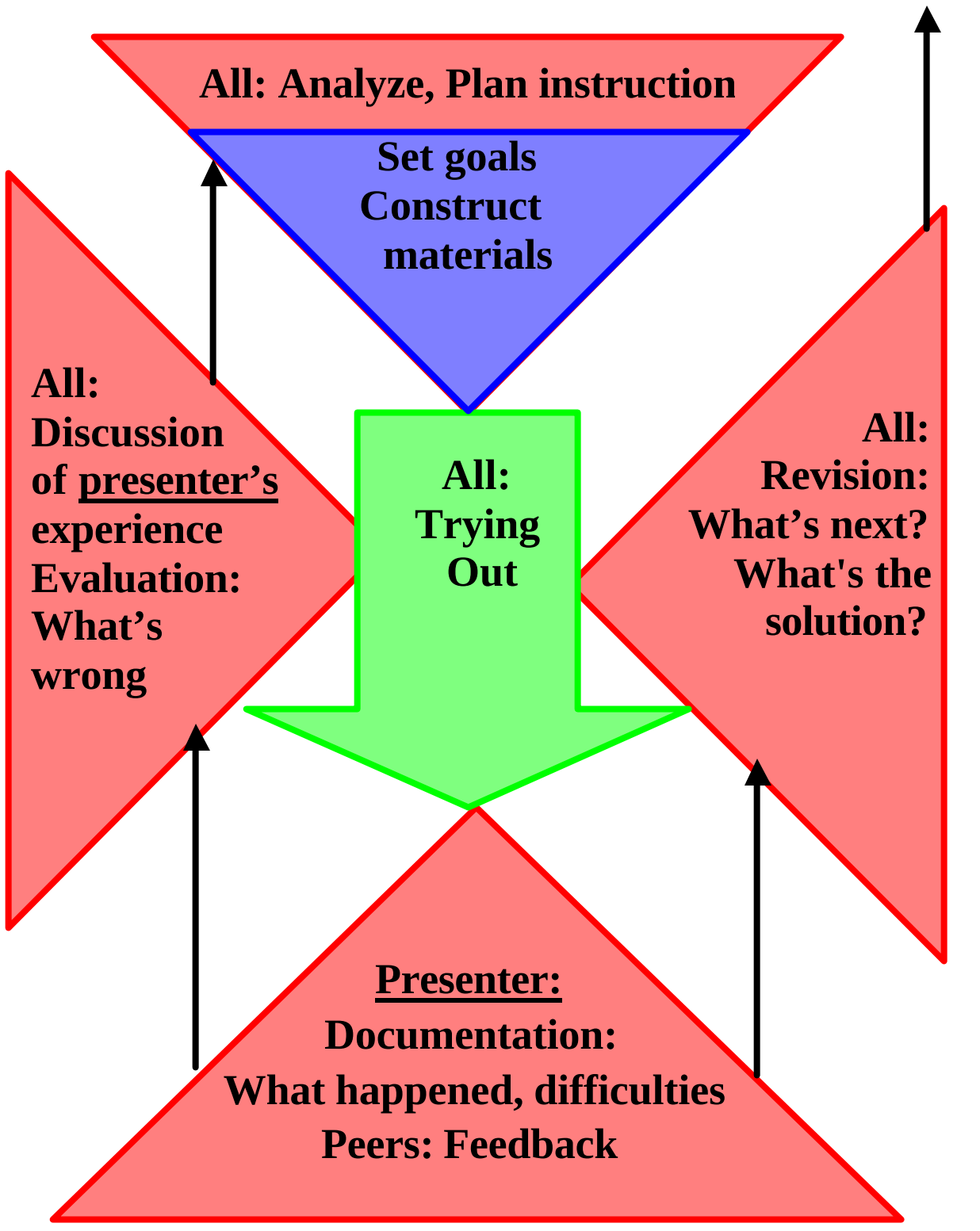
Yearlong meetings: Management framework where teachers follow action research steps:

- Analyze existing practice
- Suggest new practice
- Try
- Evaluate and Refine

Flag man (presenter) method:



Class Teacher Group

Management framework implementation

9 learning cycles, interwoven with other activities

In person setting transferred to computerized setting: (1st accessibility, 2nd teachers' request)

Friday: Editing documentation

Presenter e-talks to workshop leader

Monday: Distributing documentation

Presenter sends documentation to e-forum

Monday-Wednesday: Reading, writing feedback

Peers read documentation and write feedback at home

Wednesday: Distribution - feedback

Peers send feedback to e-forum

Thursday 18^{00}: Distribution - questions

Presenters send questions to e-forum

Thursday 22^{00}-23^{00}: Discussion

All participate in e-conference

Management features	Þ **Teacher inquiry**	⇒ **What changed**
Distinct steps of learning cycle Distribution of documents Extended Timetable Obligatory participation	Comprehensive, clear and concise documentation Suggestive Feedback that refer to class materials Commitment of teachers to formulate questions Focused, informed and tolerant discussion	Teachers tailored existing research based instruction, while changing perceptions and practice

We concluded

Research Based Instruction +

Teachers with Ownership and Experience

+ Management Framework for

Collaborative Inquiry

Works

Professional development of teachers

Tracing teachers' curricular development

- Problem solving via strategies
- Self diagnosis by students

Data collected in intra-net over 2 years

- **Documentation**: Implementation, Materials developed for class.
- **Questions** for e – conference

A short version: Strategy for solving problems in "work and energy"

Analysis:

Physics:

Draw diagrams adequate for the problem

Divide the problem to sub-problem, in a manner helpful to solve it. For each sub-problem write equations that represent the principal of energy conservation.

Math: …Check …

Self diagnosis based on sample solution

Students re-submit their tests with a diagnosis of their solutions (Credited).

Sample questions for e-conference

“The strong students don’t want to cooperate with the weak ones, how do you manage to cope with the problem?

A detailed version: Strategy for solving problems in "work and energy"

Divide: Does the body change it's motion (linear or curved trajectory, constant or changing speed)? Does the forces on it change? Are they conservative? Do they do work?…

Strategic diagnosis - 1

The student has to diagnose his solution, using a given strategy, on a diagnosis-form, for example:

Strategic steps	Exist?	Correct?	Explanation
Description	Did he	Define	Explain
Physics	perform	what	what
Execution	"Strategic	is wrong	went
Check	steps"?		wrong

Sample questions for e-conference

"The activity demanded students to find and correct their mistakes. I see three different groups:

1. Those who are willing and able
2. Those who tried but did not succeed
3. Those who did not bother

What, If at all, Do you think students from group 2 gained from taking part in the activity?

Strategic diagnosis - 2

Strategy represented as requirements and

Not as consecutive directions

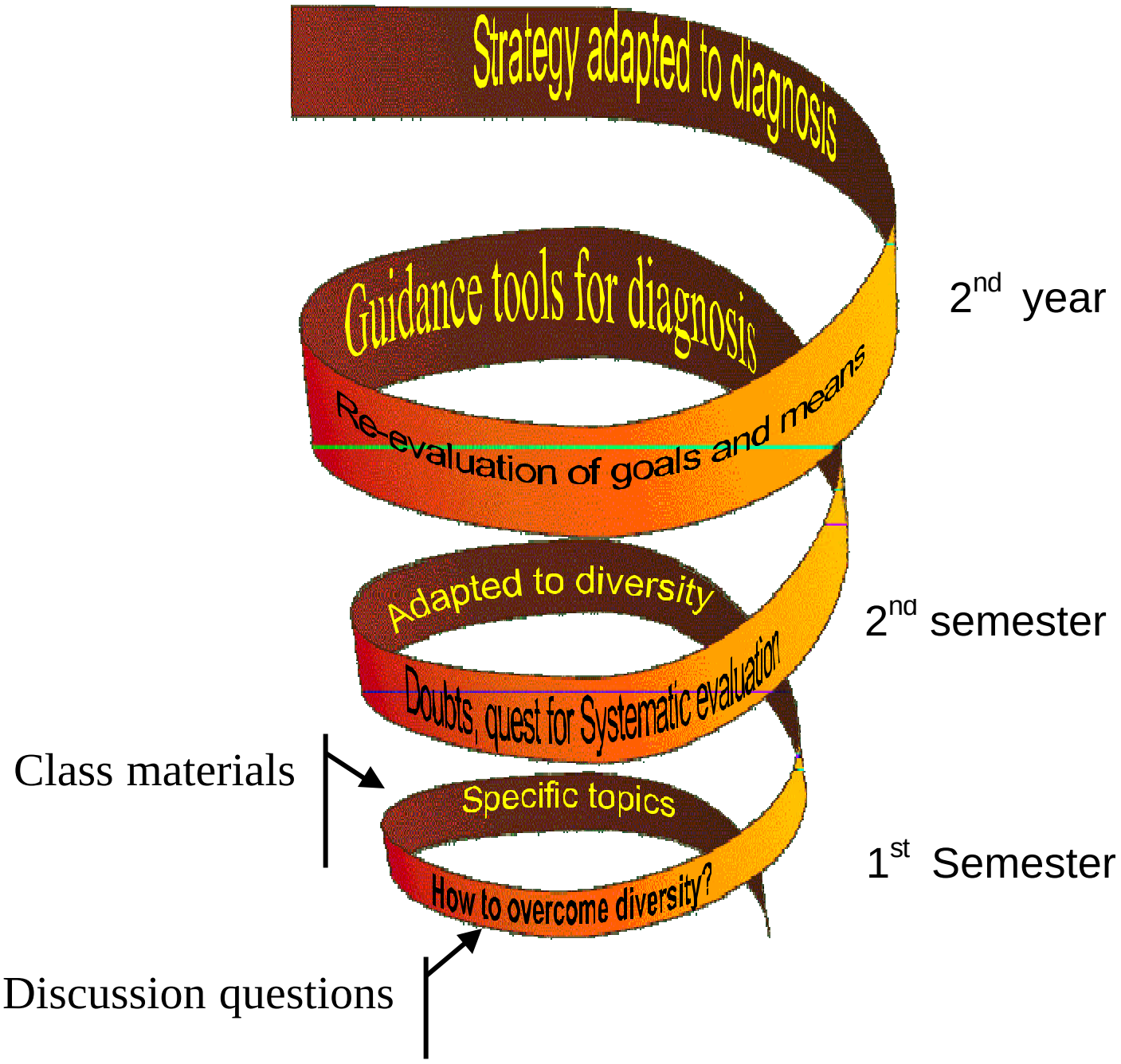
Requirements from problem solution

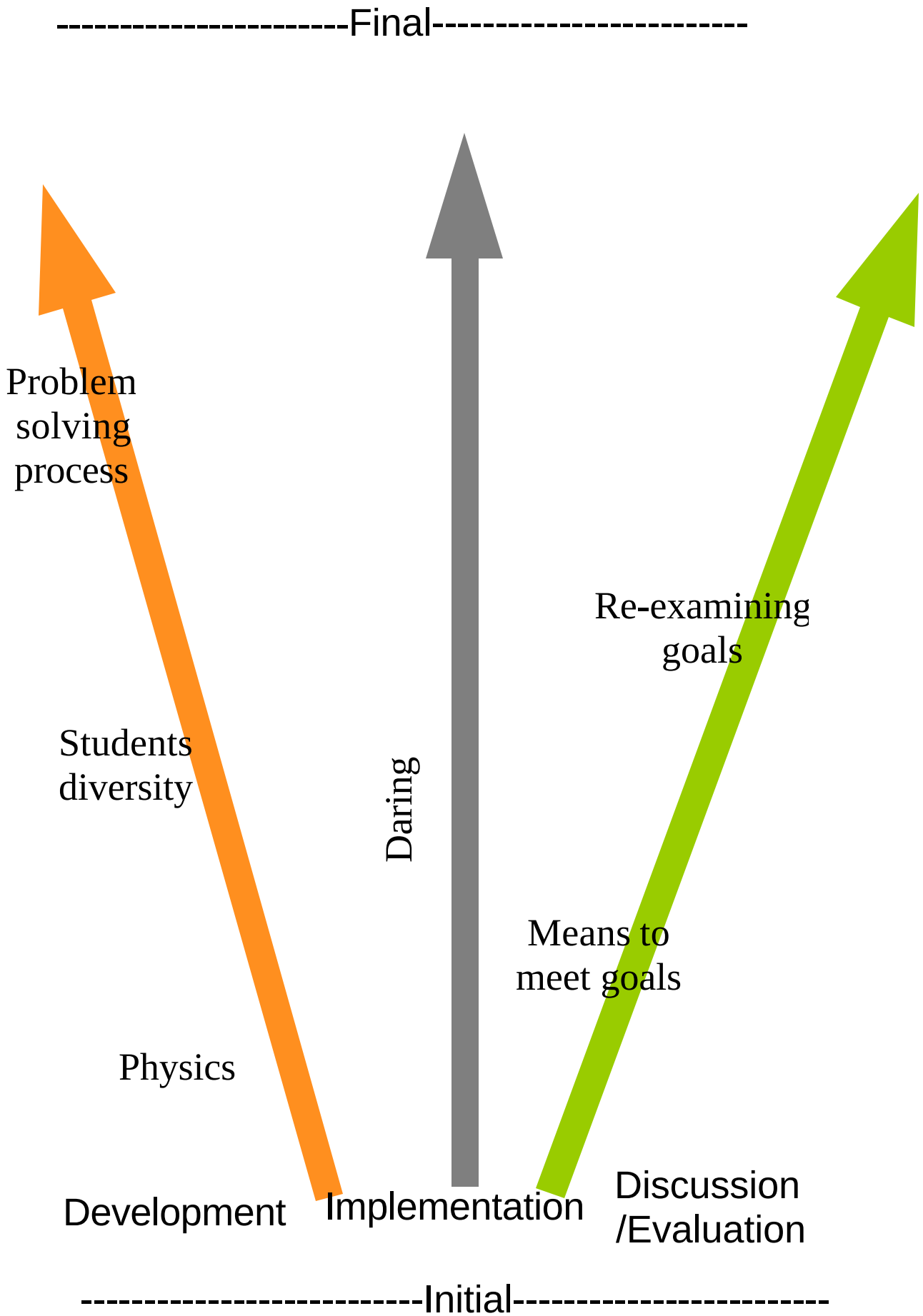
Planning

Identification of sub-problem: choice of a body;

Listing of known and wanted quantities in the sub – problem…

- **Teachers professional development**

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Problem solving process
Students diversity
Physics
Daring
Re-examining goals
Means to meet goals
Development
Implementation
Discussion /Evaluation
----------Initial----------

Results:

Teachers elaborated Curriculum while implementing innovative instruction

- Diverse, but not complete
- Long Time-scales

Questions:

Engineering: How to reduce time-scale?

How to benefit others?

Research:

Class observation: What an external observer sees happening in class?

To the students?