The FITS model
An approach for teaching and learning through design and inquiry

Focus
Investigation
Technological design
Synergy

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Content

- A brief history of science education in The Netherlands
- Why a tendency towards interdisciplinary STEM education?
- Design-based learning (DBL) as educational approach
- Common issues and challenges of DBL
- The FITS model: learning by design and inquiry
- Fundamental didactic principles
- The crucial role of teachers
A brief history of science education (The Netherlands)

- **1900 - 1980**
  - **Education in science**
  - Strong focus on concepts
  - Aim: careers in science
  - Laboratory skills as algorithm
  - Teacher-centred/dominated

- **1980 - 2000**
  - **Education about science**
  - Focus on concept-context
  - Aim: scientific literacy
  - Inquiry-based learning
  - Teacher-driven

- **2000 - present**
  - **Tendency towards STEM**
  - Knowledge AND skills
  - Aim: STEM literacy and skills
  - Problem-based learning
  - Student-centred

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Why a tendency towards interdisciplinarity and STEM?

- The modern society and economy ask for STEM graduates
- Interdisciplinarity improves understanding and motivation
- STEM disciplines share a lot of knowledge and skills
- Connecting “knowing and doing” enhances learning
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Design-based learning as educational approach

CHARACTERISTICS
- problem- and project-based
- design- and inquiry-based
- cooperative (design groups)
- knowing-doing connections
- student-centred
- iterative
- contextual

Teacher-guided rituals: sharing experiences/ideas among design groups
Whole-class discussions: understanding principles and concepts

Teacher-guided rituals: sharing experiences/ideas among design groups
Whole-class discussions: understanding principles and concepts

Design solutions

Final design and redesign

Exploration: What to do and learn?

Modeling and prototyping

Investigate: finding answers

(Kolodner, 2000)
What research shows?  
(Kolodner et al., 2003; Van Breukelen et al., 2015)

- Design-based learning seems a promising educational approach
- Students get highly motivated due to the social, dynamic and contextual environment
- The learning level of skills exceeds levels found in traditional learning environments
- The learning level of concepts (knowledge) lags behind the level of skills

According to concept learning...  
(Van Breukelen et al., 2017)

**Complexity**
- Extensiveness
- Diversity
- Dynamic

**Process focus**
- “Doing” mode
- Product focus
- Trial & error

**Implicit learning**
- Think...?
- Fragmented
- Masking
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An educational model for learning by design and inquiry

FITS model

(Van Breukelen, Schure & De Vries, 2016)
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Fundamental didactic principles

FITS model
Towards **explicit teaching and science lectures by backward design**

- Analysis of design challenge
- Learning objectives
- Didactic and pedagogical design

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**CONTENT PYRAMID**

- **Strongly connected**
  - [direct content]
- **Weakly connected**
  - [indirect content]


Van Breukelen (2016)
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Example: Paper airplane  ■ centre of gravity  ■ forces  ■ torque

POOR FLIGHT

ACCEPTABLE

CONTEXTUALISED: PITCH

DEONTEXTUALISED: BALANCE
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Fundamental didactic principles

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Scientific knowledge domain

ID Informed Design  CO Continuity (of the process)
Informed design facilitates continuity of the learning process

### The FITS model
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<table>
<thead>
<tr>
<th>KNOWLEDGE AND SKILL BUILDERS</th>
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<td><strong>Learning skills</strong></td>
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<tr>
<td>- Collaboration</td>
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<tr>
<td>- Feedback &amp; reflection</td>
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<tr>
<td>- Organise &amp; plan</td>
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<td>- Use of tools (craft)</td>
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<tr>
<td>- Experimentation</td>
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<td><strong>Learning knowledge</strong></td>
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<tr>
<td>- Procedural</td>
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<tr>
<td>- Technology</td>
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<tr>
<td>- Science</td>
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<td>- Mathematics</td>
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<tr>
<td>- Engineering</td>
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<tr>
<td><strong>Exploring design</strong></td>
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<td>- Design examples</td>
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<td>- Reversed design</td>
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<td>- Excursions</td>
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<td>- Thinking challenges</td>
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### CYCLE ZOOMING

<table>
<thead>
<tr>
<th>Type A</th>
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<tbody>
<tr>
<td>- Defining problems</td>
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<td>- Requirements &amp; rules</td>
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<tr>
<td>- Divergent thinking</td>
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<td><strong>Type B</strong></td>
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<tr>
<td>- Divergent thinking</td>
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<tr>
<td>- Design solution</td>
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<td>- Design creation</td>
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<td><strong>Type C</strong></td>
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<td>- Design testing</td>
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<td>- Design analysis</td>
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<td>- Redesign and retesting</td>
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Fundamental didactic principles

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Guided discussion creates a deeper understanding of content

Teacher-guided classroom discussion
Consider objectives
Explore students’ insights

Ask specific questions
Use students’ input
Deepen understanding

Objectives
1.
2.
3.

Ideas
Assumptions
Design groups

Insights
The teacher’s role: **sensative assistance** and **continuity**

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- **Executer**
  - Lecturer
  - Teacher-driven

- **Adaptive Instructor**
  - Teacher-centred

- **Creative Facilitator**
  - Student-centred

- **Developer Coach**
  - Student-driven

**Restricted Professional**

PREPARATORY TEACHING SKILLS ▭ ANTICIPATORY TEACHING SKILLS

**Extended Professional**
### Learning-related teaching guidelines

A = anticipatory skills  P = preparatory skills

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<thead>
<tr>
<th>Interaction</th>
<th>Learning-related elements and teaching guidelines</th>
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<td><strong>Student (to student) interaction</strong></td>
<td><strong>[A] COLLABORATION</strong></td>
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<td>- P</td>
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<tr>
<td><strong>Student to teacher interaction</strong></td>
<td><strong>[B] REFLECTION</strong></td>
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<tr>
<td><strong>Student to content interaction</strong></td>
<td><strong>[C] TEACHER AND PEER FEEDBACK</strong></td>
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<td><strong>[D] EXPLICIT TEACHING</strong></td>
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<td><strong>[E] PROCESS-RELATED ISSUES</strong></td>
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The success of design- and inquiry-based learning strongly depends on…

**THE TEACHER** who…

…creates **RICH LEARNING UNITS**,

…provides **ADAPTIVE GUIDANCE**,

…continuously **EXPLICATES** learning content

…and **MERGES “KNOWING” AND “DOING”**
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“thank you for your attention :)

https://is.gd/Psf6DB

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