Design Dimensions of Challenge-Based Learning

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Agenda

- Challenge-based learning (CBL)
- Interdisciplinarity
- CBL in TU Eindhoven bachelor curriculum
- Design dimensions
- Examples from education research
- Challenge Based Learning implementations
- Questions and discussion

Definition

Challenge-based learning:

CBL takes places through the identification, analysis and design of a solution to a sociotechnical problem. The learning experience is typically multidisciplinary, takes place in an international context and aims to find a collaboratively developed solution, which is environmentally, socially and economically sustainable (Malmqvist et al, 2015).

Challenge-based learning objectives

Real societal problems are starting point for student team projects

CBL in new TU Eindhoven curriculum: at least two CBL projects per year

Objectives of CBL can be many ……

- Engaging with the complexity of real societal problems
- Personal and professional skills, incl ethical dimensions
- Application and deepening of foundational knowledge and skills
- Design and maker skills
- Interdisciplinary experience
- Learning to apply system engineering
- Self- and team-regulated learning
- Preparing for complexity of professional setting

…. some focus in each CBL project can be helpful

From small to more complex challenges

Design dimensions

- Openness of the task/problem
- Combining different disciplines
- Working with a problem owner
- Involving stakeholders
- Teacher support and coaching
- Assessment format
- Inside or outside curriculum

Solar Car Team Eindhoven [Source: Guardian]
Sun-powered off the road car
Photograph: Bart van Overbeeke

Engineering Design Course

Bart van Esch et al

- Design challenge (CBL)
- Bachelor, 2nd year
  - 1750 students
  - 9 departments, 15 majors
- Group work
  - multidisciplinary groups, 5-6 students
  - meetings 2/wk
  - self-directed, peer-controlled
  - tutor supervision (3rd-yr Ba, or Ma)
- Organization
  - core organizing team
  - 18 teachers, each 4 tutors
  - 72 tutors, each 4 groups
  - 288 student groups
- Tutor tasks
  - coach on process (mainly)
  - Input for assessment

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Tutor training and support

Before : two-day training session

- design methodology and timeline
- group coaching:
  - motivating collaboration and decision-making
  - coaching for learning (ask questions, provide feedback, give clues)
  - preparing and guiding group meetings
  - guiding groups in giving feedback
  - keeping groups on track / on schedule
- individual assessment
  - rubrics
  - FeedbackFruits™
- community building

During : support

- course page for tutors (Canvas)
- discussion forum
- weekly meeting with teacher
- midterm and final assessment, with teacher supervision

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Thermodynamics CBL project

- Cool a can with 2 Bicycle pumps
- Thermodynamics concepts and methods
- Instrumentation, design skills, professional skills
- Introductory lecture thermodynamics & project logistics
- Three introductory experiments:
    1. Thermal insulation
    2. Heat-exchange in circular tube flow
    3. Compression and expansion
- Groups of 5 or 6 students

Source: Marcel ter Brake, Jelle van der Meulen et al 1st yr students Applied Physics & Advanced Technology

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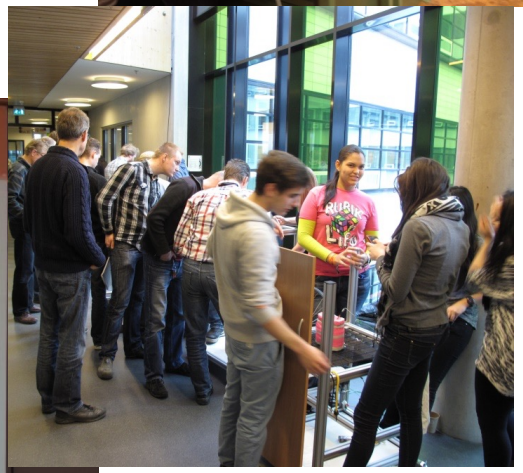
Cooler project at work

- Workplace for constructing, experimenting & team discussions
- Self service workshop: machining, materials & consultancy
- Final event including competition



Student team projects

- Competitions, events
- InnovationSpace facilities
- Workplace, coaching, commercial partners

Credits: Team Polar

Innovation Space facilities

What do they learn in student teams?

Eugenio Bravo, Dury Bayram, Jan van der Veen

- *What do they learn?*
  - Team, leadership and business skills
  - Communication, intra-team and professional
  - How other disciplines work
  - Design and production skills
  - Challenge and role related engineering expertise
- *How do they learn?*
  - By doing, team interactions, previous team input
  - Coaches, TUE and external experts
  - Design, prototyping, test feedback loop
  - Depends on challenge and specialization

SENSUS event:
international biosensor competition

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Challenges for Challenge-Based Learning

- Knowledge acquisition and application, integration with CBL
- Synchronising disciplinary programs: time-slots, credits, numbers of students
- Spaces for the student teams to meet
- Workplace access and maker facilities (incl safety and maintenance)
- Most academic teachers are mono-disciplinary specialists
- Availability of experts from all relevant disciplines
- Teachers and tutors need coaching skills
- Sufficient number of staff to coach all teams
- Assessment format
- Team members tend to specialize >> variation in learning outcomes ok?

Thank you for your attention!

Questions & Discussion