Diagnosing nursing students' errors in medication calculation
Designing a method based on the 4 Cs teaching model for analysing mathematical proficiency

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On February 24th, 2002, a baby was born. The baby showed some signs of seizures, and an anti-epileptic drug was started three days later. The seizures continued, and the drug was changed in May to Xylocard-infusion with the concentration 4 mg/ml. The nurse prepared a new infusion. An error occurred, and the concentration of the infusion was 40 mg/ml. The baby died.
Nursing education

Students from upper secondary school

Bachelor level education

210 ETCS

medication education 9–10 ETCS

New students’ skills in math

Mean grade 7.5

...and from vocational school

medication calculation 2–3 ETCS

varies
Challenges

- Workforce mobility
- Learning difficulties
- Dosage errors on the rise
- Outdated learning materials
- Theory & practice
- Flexible studies
- Proficiency monitoring & certification
Medication calculation process & proficiency in Arcada

4 Cs
Compute
Convert
Conceputalise
Critically evaluate

100 %
The 4 Cs model

Dosage calculation proficiency

Compute

Convert

Conceputalise

Critically evaluate

Student factors

- Basic math skills
- Learning styles
- Motivation
- Anxiety

Program factors

- Teaching methods
- Faculty support
- Curriculum
- Faculty attitudes
Benefits of the 4 Cs model

- **Evaluation**: Critical Eval.
- **Operationalisation**: Calculation process
- **Focus**: Student awareness
- **Assessment**: Errors can be categorised
- **Student**: Feedback
- **Groups, classes**: Assessment
- **Individuals**: Focusing
- **Students**: Teacher

4 Cs
The learning environment Sigma

- Difficulty levels
- Arithmetic categories
- Drug types
- Health care context
- Cases match needs
Authenticity & quality

- Structured to support learning
- Collected from Vnr database
- From real life
- Cases
- Match needs
- Monitored
- Several viewpoints
- Pharmacological
- Recommended practice
- Pedagogical
Harjoittelu - 3/5

Tausta: Keuhkospöytä sairastavan potilaan kivunhoitoon käytetään oraaliiliuosta.
Lääkemääräys: Oraaliiliuos OxyNorm® 15 milligrammaa per os.
Lääke: OxyNorm® 10 mg/ml oraaliiliuos (oksikodonihydraakloridi).
Laskutehtävä: Kuinka monta ml annat potilaalle?

Vastaus: 1,5 millilitraa
Pyöristys: Ei

Laskutoimitus

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<table>
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<tr>
<td>15 mg</td>
<td>10 mg/ml</td>
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<td>15 ml</td>
<td>1,5 ml</td>
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<td>10</td>
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strategy
The project

New learning environment

- Game-like
- More realistic
- Motivating
- HCI
- More interactive
- More authentic
- Guides learning
- Earlier experiences
- Arcada Sigma
- Aalto STACK

Validation & certification

AI
LE guides learning process

- Pedagogical context
- New tasks
- Student

X

- Performs
- Guides
- Effects
Designing the X

1. 4 Cs
   - Learning process
2. Error analysis
3. Test categorisations
4. Teachers’ categorisations consistent?
5. Clusters
6. Hidden variables
7. Can it be done by a computer?
Qs

- Do the 4 Cs work for categorisation
- Modifying categories
- Intersectional classes
Method, $k$-means

Test categorisations → optimal → realistic

$k = 2$

$k = 3$

Iterative process
STACK response tree
Modifications to 4 Cs
Inner hidden variables

reveals