Development and operationalization of learning outcomes in the context of Estonian general education

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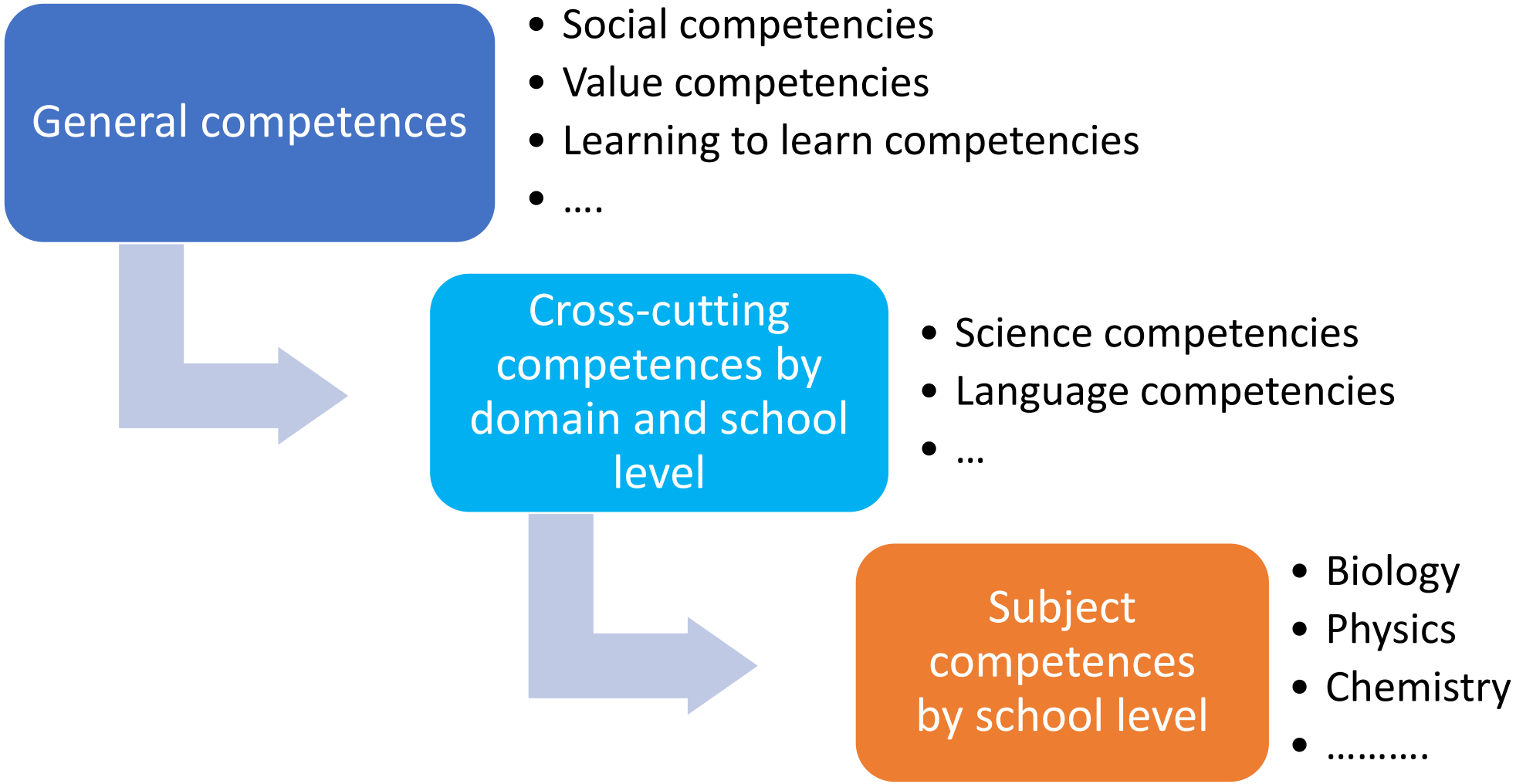
Problems addressed by the last curriculum update process in Estonia (2017- …)

Cross-cutting science competences in Estonian national curricula for general schools

Operationalization of the new directions: development of national science e-test

Hierarchy of competences in the Estonian national curricula (2014) for basic and upper secondary schools



Problems addressed by the last curriculum update

Core values, general competences, cross-cutting topics and domain competences not integrated enough **into subject curricula**.

Learning outcomes: too detailed, too many.

Subject curricula do not support enough the **development of higher order thinking skills** by students.

“Teaching to the test”.

Lack of **horizontal and vertical coherence** in the curricula.

(Suggestions for updating…, 2017)

Cross-cutting science competences in the national curriculum for basic school (1)

Basic school graduates will be expected to possess the capability to be able to:

1) **Show interest** in the environment, and in undertaking studies on the environment and in the field of science and technology, be motivated for **lifelong learning**; undertake a **responsible and sustainable** lifestyle and follow a healthy way of life.

2) Apply the **science knowledge** and **skills** by observing, analyzing and explaining the science phenomena while **using scientific models** and **concepts**, both orally and in written.

3) Identify, formulate and **solve science related problems in every-day life context** while using creative and critical thinking; **make competent decisions**, taking into account **scientific, economic, political, ethical and moral** viewpoints and estimate their impact.

Continues…

Cross-cutting science competences in the national curriculum for basic school (2)

4) Formulate **research questions, plan and conduct experiments** safely, and draw **valid conclusions**.

5) **Use different information sources** to obtain science- and technology related information, analyze and **evaluate the validity of the information** contained.

6) Understand the **nature of science, its importance and limitations**, the relationships between science and technology, and technology related risks.

7) Is aware of **career opportunities** related to science and technology.

Operationalization of cross-cutting competences into subject curricula: Definition of learning outcomes

1) …in **undertaking studies on the environment** and in the field of science and **technology**, ….. undertake a **responsible and sustainable** lifestyle …
3) **solve science related problems in every-day life context** while using creative and critical thinking

EXAMPLE

Science, 2nd school level:
Student is able to:

- plan a greenery in his/her hometown, city of the future, or develop ideas on how to reuse an old mining, etc., in collaboration with his/her classmates.

Science, 3rd school level:

- analyze his/her own energy consumption; suggest ways how to save energy at home, in school, or in his/her hometown.

Assessment has a powerful impact on what and how is taught.

Background of the nation-wide science e-testing

The process was initiated according to the goals of "The Estonian Lifelong Learning Strategy 2020" (Ministry of Education and Research, 2014) to support competence-based teaching and learning in schools:

- "Society places too much emphasis on the **results of national examinations** **when assessing the quality** of education and schools.
- "An **evidence-based approach** in **decision-making** and **in the development of education policy** has not become universal which makes reaching consensus in education policy choices difficult. " (p. 7)

Republic of Estonia
Ministry of Education and Research

Eesti Koostöö Kogu

Eesti Haridusfoorum

Who, when, what, and how are/is tested?

Students are tested **at the beginning of the 2nd, 3rd, 4th school level** and at the end of general education (**grade 12**), incl. VET students.

This **low-stakes test** is based on a set of **contextual** test items, both open-ended and closed cognitive sub-items which included both **subject-specific** (chemistry, physics, biology, geography) and **interdisciplinary** competences.

These competences include:

1. **Scientific content knowledge and skills** (principles, concepts, symbolics, models).
2. **Inquiry skills** (posing problems/hypothesis/questions; planning experiment; interpreting data; making conclusions; evaluating the quality of results and conclusions).
3. **Problem solving skills** (open-ended with every-day-life focus).
4. **Communication skills** (finding relevant information; interpreting information; assessing the reliability of information).

Assessment of problem-solving skills

Most of the information needed to solve a problem, is given to the student.

Types of the problems used in the test items are:

- Trouble-shooting problems
- Decision-making problems
- Diagnosis-solution problems
- Design problems*

Career aspects are integrated with problem solving at the 4th school level

	Urea CON_2H_4	Table salt NaCl	Ammonium nitrate NH_4NO_3	Calcium chloride $CaCl_2$	Sugar $C_{12}H_{22}O_{11}$
Properties	pH=7 in aqueous solution. Breaks slowly down into carbon dioxide and sharply smelling ammonia when in contact with water.	pH=7 in aqueous solution. Chemically stable.	Moderately acidic in aqueous solution. Breaks down into nitrogen, oxygen and water when heated. Explosive in certain conditions.	pH=7 in aqueous solution. Chemically stable.	pH=7 in aqueous solution. Chemically relatively stable, but caramelizes when heated.
Diss. heat	+3.40 kcal/mol	+0.98 kcal/mol	+6,14 kcal/mol	-19.36	l/mol
Uses	For production of fertilizers, plastics, medications and cosmetic products. Additive in chewing gums.	Seasoning and preservation of food. For production of many other chemicals.	For production fertilizers, explo medications, bu methamphetamine		.
ce €/kg	6.50	1.00 (fine) 0.50 (coarce)	10.00	9.50	

“Cold pack”: Example of a decision-making problem

Assessment of science communication skills

Students have to assess the reliability of information (source):

Example

EESTI MAAILM TEADUS TERVIS KEHAKULTUUR ARENG NWO MÜSTIKA

2127 Share | 0 Tweet | 0 Share | 2 Email | 2140 Share

Kommentaare:

Mais 2020 viidi Ecuadoris läbi kliiniline uuring, mille käigus vaadeldi 104 inimest, kes kõik olid saanud positiivse PCR-koroonatesti tulemuse ning kel olid ka mõned COVID-19-le vastavad tüüpilised sümptomid. Asümptomaatilisi patsiente uuringus ei kasutatud.

Foto: kollaaž / Canva

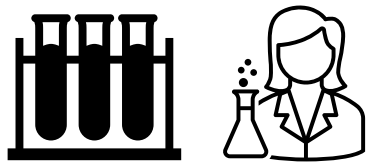
Nendele 104 inimesele ja nende lähikontaktsetele manustati kloordioksiidi lahust

Developing meaningful feedback to students, teachers, schools, educational policy

Based on the **conceptual model** and analysis of students' (pilot) **test results**, we have developed:

- **Descriptions of the levels** (baseline, average, high, top level) with respect to **each competence** (based on IRT and qualitative analysis of the recurrent pilot test results).
- **The format of feedback** to relevant stakeholders (**teachers, students, schools, educational policy**).

Example: taxonomy of inquiry skills



BASELINE

Student is able:

- ✓ to choose suitable research question/hypothesis in a simple every-day situation;
- ✓ to **choose some of the appropriate** experimental tools / activities provided, to conduct an experiment;
- ✓ to choose at least one correct simple conclusion based on a data table or chart.

AVERAGE

- ✓ to define a suitable research question/ hypothesis in a familiar every-day life situation;
- ✓ to **choose appropriate** experimental tools /order activities provided, to conduct an experiment;
- ✓ to choose most of the correct conclusions based on a data table or chart.

HIGH

- ✓ to define a suitable research question/ hypothesis in a novel situation;
- ✓ to **plan an experiment** to solve a science problem and **explain** its conduct;
- ✓ to **analyze the quality** of experimental design and the conclusions made;
- ✓ to choose correct conclusions based on a data table or chart.

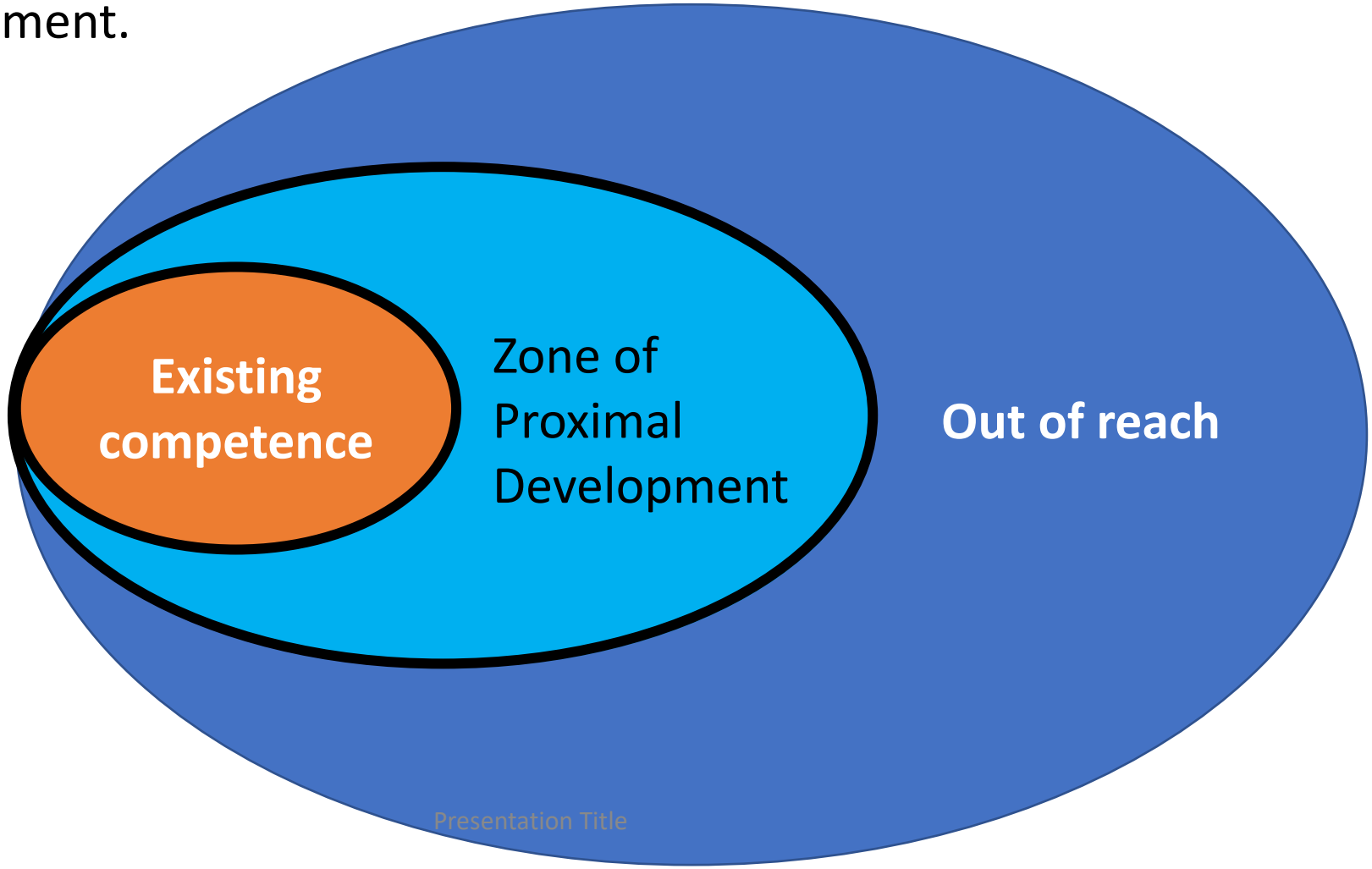
TOP LEVEL

- ✓ to improve the given research question/ hypothesis and justify changes made;
- ✓ to **justify the planned experiment**
- ✓ to **improve the quality** of experimental design and conclusions made;
- ✓ to define appropriate conclusions based on a table or a chart.

Is used to give feedback to teachers and students

Purpose of the feedback to student and teacher

- To diagnose the student's existing competence.
- To suggest ways for improvement that would fit to the student's zone of proximal development.



Format of the feedback

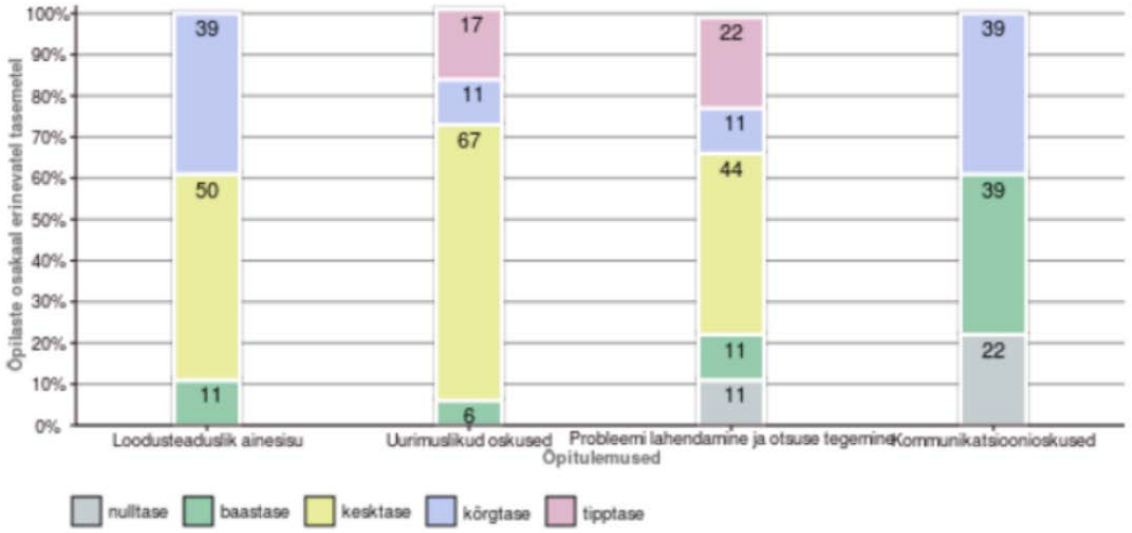
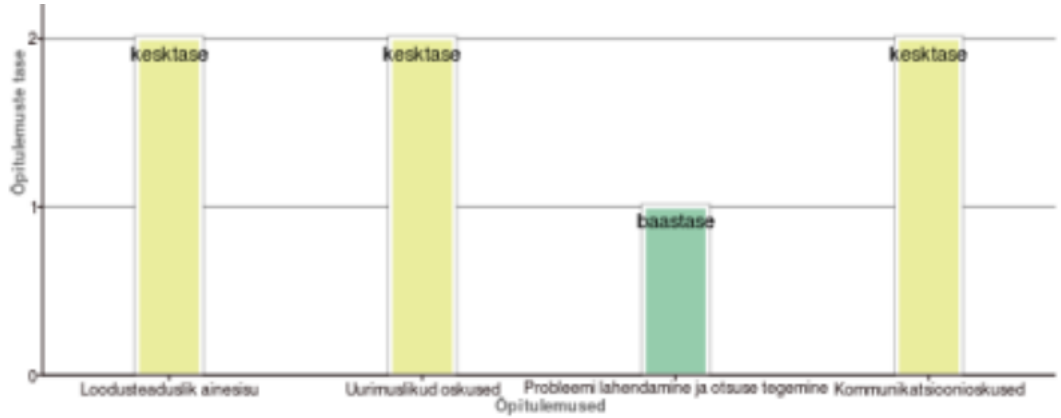


Fig. 1: Part of the feedback to schools and teachers

NB! NOT MEANT FOR SCHOOL COMPARISON



Loodusteaduslik ainesisu

Sa oskad

- selgitada loodusteaduslikku nähtust, tuues välja põhjus-tagajärg seose;
- kasutada korrektselt loodusteaduslikke mõisteid, ühikuid või sümboleid (nt arvutada etteantud seose põhjal vastust);
- selgitada loodusteaduslikku mudelit.

Sinu eesmärkideks on osata

- selgitada interdistsiplinaarses kontekstis esitatud loodusteaduslikku nähtust (nähtus, mis hõlmab mitut loodusainet ning on seotud igapäevaeluga), tuues välja põhjus-tagajärg seose; • kasutada korrektselt keerukamaid loodusteaduslikke mõisteid, ühikuid või sümboleid (nt teisendada ühikut ja arvutada etteantud seose põhjal vastust);
- koostada ise loodusteaduslikku mudelit

Fig. 2: Part of the feedback to the student (parent, teacher)

Expected impact of the implementation of the (science) e-testing

- More school-based **collaboration between teachers**.
- **Less "teaching/learning to the test"** attitude, more attention to the improvement of actual learning.
- Better coherency:
  - ✓between **curriculum core values, general competences,** and **subject competences** (learning outcomes);
  - ✓**between written** and **enacted curriculum**.
- **More meaningful learning**.

References

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“Education starts after mark”

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