

Experimental evaluation of textbooks

Vilnius

December 5, 2014

Jaan Mikk

Aims of the experimental textbook research

- Is the textbook (TB) suitable to achieve the aims of education?
- Is the new textbook better than the textbook in use?
- Which characteristics of textbook are related to the success in learning?

Experimental study of textbooks

- Students learn some parts of textbook independently.
- Students fill in textbook referenced test.
- The students in the study should be representative to the whole sample of students.

Textbook referenced test

- A textbook referenced test controls the acquisition of all the notions and other elements of the textbook in equal probability.
- Textbook referenced test is representative to all questions that can be composed to the TB (or acquiring of which is foreseen in curricula).
- The number of items in TB referenced test should be large (384). Therefore the test is composed in several versions.

Item types

- Multiple choice questions
- Free response questions
- Cloze procedure: every seventh word is deleted in the text and students have to fulfil the blanks.

Is the textbook suitable?

(Optimal results of independent work)

- Comprehension (questions are answered with the usage of TB)
 - Over 75% - suitable after teachers' explanation,
 - Over 90% - suitable for independent learning.
- Acquisition (answering without TB) – over 70%
- Knowledge gain (pre-test subtracted from post-test) 60%.
- If considerable part of students can not acquire TB content then the TB is not suitable

Is the new textbook better than the textbook in use?

- Two groups of students: experimental and control group.
- The groups should be equal in all aspects except textbooks.

Factors of the result of learning

- Students: socio-economic status, abilities, motivation, pre-knowledge, diligence, health, etc.
- Teachers: professional competence, attitudes towards teaching, diligence, etc.
- Textbooks: content, comprehensibility, illustrations, learning methods, etc.
- Tests to measure effects: difficulty of questions, time to answer, etc.

Equalising the groups

- Random selection of students into experimental and control group.
- Measuring prior knowledge on the topic and
 - Relying on the knowledge gain
 - Not considering the results of weaker students in the weak group and and the results of stronger students in the strong group
- Matching students according to SES, prior knowledge etc.
- Experiment of crossing groups.

Outline of an experiment of crossing groups

Part of experiment	Group of	students
	A	B
First	Textbook I	Textbook II
Second	Textbook II	Textbook I

Example of an experiment of crossing groups

- Eesmärk: Kuidas mõjub teksti lihtsustamine õpitulemustele.
- Katsematerjal: VII klassi füüsikaõpiku ja VIII klassi anatoomiaõpiku teine veerand.
- Katseisikud: füüsikas 1300 õpilast ja anatoomias 500 õpilast.
- Ristlevate gruppide eksperiment.
Eksperimentaalgrupile lihtsa keele reeglite järgi ümbersõnastatud õpik.

Results

Näitaja (%-des)	Control group	Experimental group
Comprehension	65	72
Acquering	56	63
Knowledge gain	41	46

Which characteristics of textbook are related to the success in learning?

- If we know the characteristics we can make better textbooks (elaborate rules for clear writing)
- Idea
 - Students learn many passages from textbooks
 - Scientists measure different characteristics of the passages
 - Students average scores on every passages are correlated with the values of the characteristics
- Examples
 - Readability formula development
 - Reading interest formula development

Illustrations

Vilnius

December 5, 2014

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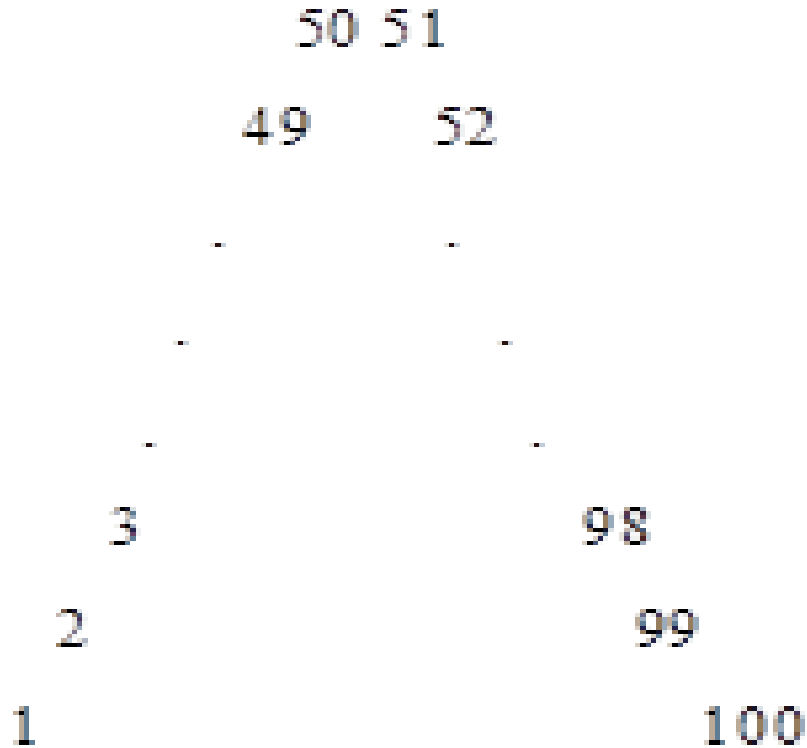
Reaction time in seconds by different representation of stimuli

The mode of stimuli representation	Source of data	
	(Antonov 1988)	(Leppik 1997, 49)
Natural object	0.4	
Illustration	1.2	1.3
Word	2.8	1.8

Acquisition of information depending on its presentation mode

Presentation mode	Source of data	
	(Penner ... 1978)	(Leppik 1992, 32)
Information one has heard	15%	20%
Information one has seen	25%	30%
Information one has seen and heard	65%	70%

Calculating the sum of the numbers from 1 to 100 (Krause 1990)



Types of illustrations (Antonov, 1988)

- 1) **pictographs:**
- a) photos,
- b) blue prints,
- c) draughts,
- d) sketches,
- e) pictograms;
- 2) **ideographs:**
- a) graphs,
- b) histograms,
- c) diagrams,
- d) tables,
- e) formulae,
- f) nomograms.

Compiling illustrations

- Illustrations are needed to depict spacial objects.
- Illustrations are useful for comparison, presenting main idea, for the development of thinking.
- Illustrations should be simple and concrete!
- Illustrations should be related to text!
- Prefer familiar objects on illustrations!

Illustrations motivate learning I

- Illustrations by itself are more interesting than text (Levie 1987, 23).
- Pictures with new and strange content are more affective than pictures with familiar content (Kari 1980).
- Coloured pictures are more motivating and more effective (Hartley 1985).

Illustrations motivate learning II

- Well-designed illustrations are more interesting than poorly designed illustrations with too little detail presentations (Peeck 1987, 12).
- Younger children like to see people in the pictures.
- Funny illustrations make the text more pleasant but they do not influence comprehension (Peeck 1987).
- Illustrations should be simple and concrete.

The efficiency of pictures in prose (Levin, Anglin & Carney 1987)

No	Picture function		Picture in textbook	Instruction to imagine
	Name	Description		
1	Representation	Illustration tells the same story as the text	0.79	0.35
2	Organisation	Instructions in procedural texts	0.76	0.62
3	Interpretation	Pictures clarify difficult passages	0.76	0.90
4	Transformation	Re-coding information, or relating its separate pieces, or	1.60	1.25

Correlates of interest in science texts

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Which texts are more interesting?

I

- Narrative texts are more interesting than expository ones (Alexander and Jetton, 1996).
- Text interestingness correlated strongly with text concreteness (.85), comprehensibility (.85), and familiarity (.71) (Sadoski, Goetz, and Rodriguez, 2000).
- Historical circumstances in chemistry textbook raised the sixth grade students' interest (Baumann, 1980).

Which texts are more interesting?

II

- Pointing out the importance of study material may raise the level of learning up to 45% (Baumann, 1980).
- Vivid anecdotes, lively quotations, etc. raise the students' interest level in the texts, but these elements have a negative effect on the learning of the text content (Alexander and Jetton, 1996).

Human Interest Formula

(Flesch, 1948, 229)

- $HI = 3.635pw + 0.314ps$
- pw — the percentage of personal words (pronouns which refer to people and the nouns with natural gender)
- ps — the percentage of personal sentences (sentences in quotation marks, sentences directly addressed to the reader, exclamations).

Aim and hypothesis

- The aim of the research was to find the features of text in science textbooks, correlated to the interestingness of the texts. The interestingness of biology texts and physics texts was examined.
- The hypothesis was that text interestingness is correlated with the percentage of concrete words, familiar words, short sentences, etc.

Method

in the study of biology texts

- *Subjects.* 124 pupils, 14 – 17-year old in Russian speaking schools in Estonia.
- 48 *texts* from popular-scientific books and papers texts, on one typewritten page.
- *Procedure.* Students took a prior test, studied the texts, filled in a questionnaire and took a post test.
- The average interest ratings were correlated with the text characteristics.

The analysis of texts

- A computer program established the part of speech of the texts' words, the frequency of the words in the spoken language etc.
- Noun terminologicality was assessed according to a three point scale:
 - 1 – the nouns of everyday use, which are not terms,
 - 2 - scientific terms with the same meaning in everyday speech,
 - 3 - professional terms not used in everyday speech.

Abstractness reduced the interest

- The higher the percentage of concrete nouns in the text the higher was the students' interest ($r = .54$). Concrete text evokes images.
- The higher the percentage of abstract nouns in the text the lower was the interest ($r = -.70$). Abstract text is difficult to understand.

Word familiarity should be optimal

- The higher the percentage of rare words (less than 80 times in the spoken language dictionary) the lower the interest ($r = -.64$).
- The higher the percentage of nouns in the text the lower was the interest ($r = -.63$).
- The higher the repeating rate of nouns in the text the lower was the interest ($r = -.48$).

Long words and sentences reduced the interest

- The longer were the words in the texts the lower was the interest ($r = -.75$). Long words are often abstract and unknown.
- The higher the percentage of long sentences (over 110 characters with spaces) the lower was the interest ($r = -.72$).
- The higher the percentage of verbs in the texts the higher was the interest ($r = .49$).

Professional terms and symbols reduced the interest

- The higher the percentage of professional terms in the text the lower was the average interest rating ($r = -.71$).
- The higher the percentage of abbreviations and symbols the lower was the interest ($r = -.33$).

Study of physics texts

- 393 students 16 - 17 year old studied 40 sections from physics textbooks when they reached the section in learning schedule. The study lasted one year.
- The results were similar to the results in biology study: abstract nouns, long sentences, terms and symbols reduced the interest ratings.

Familiar words reduced the interest in physics texts!

- The higher the percentage of the text nouns which were among the 4,000 most frequent Russian words the lower the interest ($r = -.55$).
- The higher the percentage of the nouns outside the spoken language dictionary the higher the interest ratings ($r = .48$).
- The higher the average occurrence of words in the section the lower the interest ($r = -.72$)

Why familiar words reduced the interest in physics texts?

- Because the level of prior knowledge was much higher in the case of physics texts:
 - 26% in physics texts and only
 - 5.5% in biology text.
- Some unknown words in text enhance its interest if the text content is familiar.

Perspectives

- The rules for interesting writing!?
Sometimes effective, sometimes not.
Linguistic features are related to text content.
- Elaborate a new text interest formula. Its validity would be higher than the validity of Flesch formula ($>.70$ versus $.43$).
- The role of illustrations, tasks for students, etc. should be studied also.

Introduction

Jaan Mikk

04.12.2014

Life story I

- Textbooks were too difficult for my classmates
- How to compose better understandable textbooks?
- Readability formulae
- Rules for clear writing
- You make the textbooks too simple!
- Motivating aspects of textbooks
- Value forming aspects of textbooks

Life story II

- Candidate (doctor) degree in Tartu 1970
- Doctor (habil) degree in Moscow 1983
- Different conferences in Europe, Asia and Australia
- Vice-President of IARTEM
- Jury member of BESA
- Now engaged in PISA studies
 - Metacognition
 - PISA results are strongly related to HDI

Textbooks – future of a nation

- Students work most of their study time with textbooks.
- Teachers find in textbooks the content and methods of teaching.
- Textbooks influence the value system of students (Georg-Eckert-Institute).
- Textbooks influence the self-esteem of students.

The usage of textbooks

- In developed countries, the students worked with textbooks 60% of lesson time (Johnsen, 1993).
- Teachers relied on textbooks while planning 90% of lesson time (Honig, 1991).

Importance of textbooks

- Meta-analysis by Gopinathan (1989) (18 studies)
 - 15 studies revealed the importance of textbook
 - 13 studies revealed the importance of teachers
- Too difficult textbooks
 - Destroy the learning motivation
 - Cause underachievement
 - Cause low self-esteem of students.
- The situation may be different in different countries and in different times.

Some contributors to Mathematics results in 8. grade (TIMSS 2003)

Contributor	r
Usage of textbooks	0,49
Teacher education	0,36
Education of parents	0,35

Functions of textbooks

- Motivation of students to learn
- Presentation of study content
- Guiding students in learning
- Enabling differentiation
- Enabling self-assessment

Set of study aids

- Textbook
- Workbook
- Readers
- Vocabularies, maps
- Additional materials (in Internet, on CD)

The aims of textbook research

- To improve the quality of textbooks:
 - content,
 - methods, study skills,
 - layout, illustrations,
 - value forming aspects.

International Association for Research on Textbooks and Educational Media

IARTEM

- Website <http://iartemblog.wordpress.com/>
- IARTEM e-Journal
- IARTEM conference volumes
- IARTEM conferences (2011 in Kaunas).

Georg-Eckert-Institute

- Web-page: <http://www.gei.de/en/the-institute.html>
- Vision: „... we are dedicated to ensuring that future generations are brought up with open minds, able to reflect on their attitudes and beliefs and embrace responsibility and democracy.“
- Journal: [The Journal of Educational Media, Memory, and Society \(JEMMS\)](#).

Questionnaires

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Vilnius December 5, 2014

Areas investigated with questionnaires

- Content and study aims
- Language: vocabulary, concepts, readability
- Feasibility to students
- Design and graphics
- Freedom from bias, human voice
- Teaching methods
- Assignments

Reutlinger Raster I

Rauch & Tomaschewski 1995

- The questions are grouped as follows.
- 1. Bibliography and general impression (12).
- 2. Goals and content (12).
- 3. Teaching methods (15).
- 4. Feasibility to addressees (7).
- 5. Design (42).

Reutlinger Raster II

- 6. Text (25).
- 7. Assignments (15).
- 8. Graphics (32).
- 9. Relationship between text and graphics (9).

Reutlinger Raster III

Examples of questions

- 3.22 The Student edition contains a sufficient number of exercises (0) 1 2 3 4
- 6.7 The text is stylistically clear, simple and comprehensible (0) 1 2 3 4
- 2.19 There are no factual errors (0) 3 6 9 12

Reutlinger Raster IV

- The checklist has special sections for evaluation of a textbook, a teacher's handbook and a student's workbook
- The checklist results have been found to be in good correlation with the results of the field-testing assessment of textbooks

Best European Learning Material Award checklist

- Short version on website <http://www.belma-award.eu/Evaluation-Criteria.html#>
- Full version on CD

BELMA evaluation criteria

- Relevance
- Transparency
- Reliability
- Attractiveness
- Flexibility
- Generativeness
- Participation
- Socialization

Textbook evaluation checklists

- http://www.readingmatrix.com/reading_projects/miekley/project.pdf
- <http://www.project2061.org/publications/textbook/hsbio/report/crit-used.htm>

Representativeness of questions

- The composes of the questionnaire should think about the elements of every aspect of quality and ask questions about them.
- For example.
 - Broad question: text comprehensibility
 - Elements: sentences, terms, new words, symbols, concreteness.

Respondents

- Experts – people who are familiar with the textbook and teaching (experienced teachers, scientists, textbook selecting committees).
- Representative sample of teachers and/or students (random sample, 384 persons).

Formulation of the questions I

- Scientific problem is to be divided into clear and specific questions.
- Do not join two or more questions into one.
- Multiple-choice questions will be preferred if a large number of respondents answer the questionnaire.
- A multiple-choice question should be formulated in the affirmative form.

Formulation of the questions II

- Give only extreme alternatives on the Likert scale!
- Questions must not suggest any answer.
- The questions should be unambiguous, understandable and short.
- The questionnaire should be feasible for respondents.
- The questionnaire should undergo some trials.

Summarising of answers

- Summarising the answers to every question.
- Experts assess the importance of every question.
- Summarising via exploratory factor analysis
 - calculating the values of factors for every respondent.

Reliability and validity of respondent answers

- Reliability – the answers will be stable in time (test-retest reliability)
- Validity – answers reflect real situation (comparison of results received by two methods).
- Reliability and validity of questionnaires was seldom given. The quality of questionnaires was not known.

Establishing reliability

- Field testing of the questionnaire
- Calculate Cronbach α with SPSS
 - Cronbach α for every aspect of quality separately
 - If Cronbach α is below 0.7 try excluding of some questions
- Reliability is obligatory in nowadays research papers.

Establishing validity I

- Expert opinions in the process of composing questionnaire
- The number of questions to every aspects of textbook quality is in accordance with the importance of the aspect.

Establishing validity II

- Comparison of the evaluations received
 - with the evaluations from another questionnaire,
 - with the results of field testing of the questionnaire
- Factor analysis of the results to find the actual structure of the questionnaire

Value forming aspects of textbooks

Jaan Mikk

04.12.2013

What is good in the problem?

- Jonny has worked hard in summer time and earned 1200 crones. He paid 250 crones for his new player, he gave 100 crones to his younger brother Willy, he bought schoolbooks for 220 crones and he consigned in bank the rest of his money. Compose bar chart and block diagram about the earnings and expenditures of Jonny.
 - Veelma (2004, 13). Math 8 grade

Value orientations have big influence on peoples' behaviour

- Fidel Castro had speeches in several hours.
- Georg-Eckert Institut studies the war propaganda in textbooks.
- Entrepreneurs expend a lot of money for advertisement. This is useful for them.
- There are more entrepreneurs among protestants than among Catholics.
- The favoured heroes of children stories in Russia and USA are different.

Teachers' beliefs

(Madis Lepik et al. 2013)

- Teachers' decisions often rely on their beliefs about successful learning and teaching (Calderhead, 1996; Lerman, 2002; Lerman, 2009; Speer, 2005; Thompson, 1992).
- The study revealed positive relationship between constructivist learning attitude and teachers' satisfaction with their work and collaboration.

Main methods to form students' beliefs

- Action
- Persuasion and insinuation
- Example

Action forms beliefs

- Every persons tends to justify his/her actions
- Dr. Allred: positive circle: Thought, action, feeling.
- Work at and then comes love (Tammsaare)
- We have to direct students on positive actions

Assignments in textbooks guide to actions

- M. Kull, K. Part, K. Kõiv, E. Kiive (2012). *Tervis – minu valikud. 8. klassi inimeseõpetuse õpik*. Tallinn: Koolibri.
- Special award of the Best European Schoolbook competition (2013) for value forming aspects.

Think and discuss what might cause the events

- Wind brought light music from party to us. Sun setted on sea and birds song quietly. I intended to kiss her but chuck on her shoes (Kull, 2012, 105)
- What will a person lose if he/she decides to use alcohol before being adult? What will a person lose if he/she decides not to use alcohol before being adult (107)?

Sina koos teistega

Oma valikute ja tegudega saad iga päev mõjutada nii enda kui ka teiste inimeste elus toimuvat. Ühest küljest mõjutavad sinu igapäevased otsused ja nende elluviimine seda, missugune on **sinu enda elu ja tervis** kümne, kahekümne või viiekümne aasta pärast. Teisest küljest saad oma otsustega üsna palju **mõjutada nii üksikuid sind ümbritsevaid inimesi kui ka kogu ümbritsevat**. Näiteks saad olla hea eeskuju ja sõbralik kaaslane väiksematele õdedele-vendadele või nooremate klasside õpilastele. Saad olla hea suhtepartner kaaslastele – alati ei ole vaja spetsialisti nõuannet, vaid piisab hea kaaslase kohalolust ja toest. Kui tunnetad, et sinu arvamus ja mõtted on väärtuslikud, siis kasvab julgus üha **enam osaleda ka ühiskonnaelus**. Selleks on palju võimalusi – näiteks olla tugiõpilane koolis või vabatahtlik abistaja ürituste korraldamisel, abistada loomade varjupaigas, osaleda ümbruskonna ja looduse puhtana hoidmises või noori puudutavate otsuste vastuvõtmises. Iga ühe panus on oluline – sul on võimalik pühendada aega ja kasutada oma võimeid selleks, et **aidata maailma paremaks, hoolivamaks ja turvalisemaks muuta**.



Eestis 2008. aastal vabatahtlike algatusena alguse saanud üle-eestilised prügikoristustalgud „Teeme ära!” on kasvanud ülemaailmseks ettevõtmiseks. 2012. aastal osales ühisaktsioonis „Maailmapuhastus 2012” juba 100 riiki. Ühiskonnaelus vabatahtlikuna tegutsemine on hea eeskuju teistele, annab osalejale hea enesetunde ning aitab muuta maailma paremaks elupaigaks. Pildil on lapsed vabatahtliku tööna Viljandimaal Heimtalis järveäärset koristamas.

Teeme ära!

Persuasion and insinuation

- Persuasion: facts, discussion, conclusion.
- Important facilitators of persuasion are students' prior knowledge, authority of textbook author, clear logic, and students' activity.
- In insinuation, ideas are repeated in different but simple form (without giving any reasons).

Examples of insinuation I

- Very important human values are honesty, caring, responsibility, justice, appreciation of himself/herself and others (Kull, 2012, 122).
- Poverty can be reduced by peace, fair taxes, and right-minded distribution of state income
(Toots, Ühiskonnaõpetus 9,
2003, 145)

Examples of insinuation II

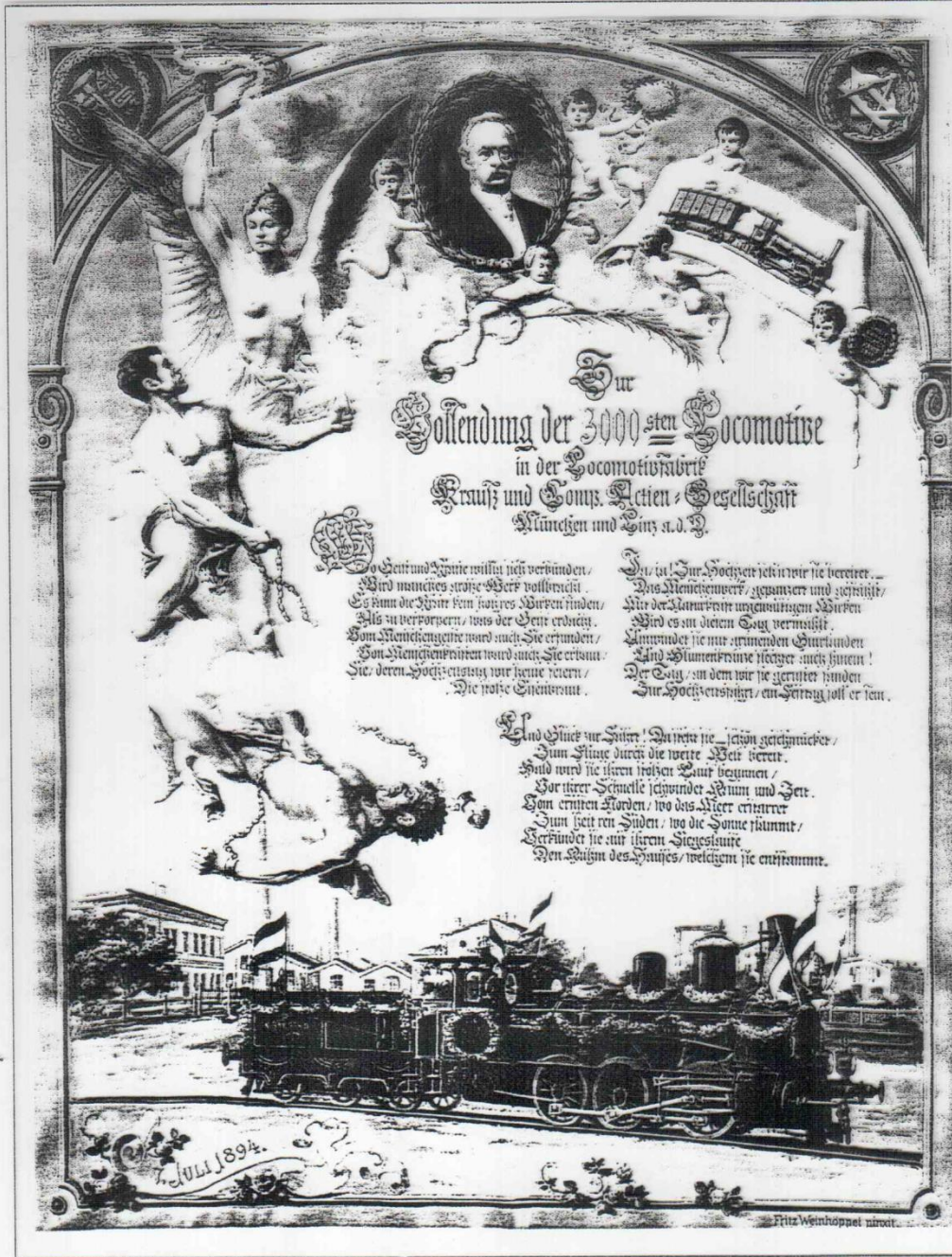
- Gerd Kanter: „Learning is more important than sport. If you prove year by year that you can bring off in school then you are able to accomplish in sport. Who gives up learning in school gives usually up sport as well.
 - Kaasik. Matemaatika 4. klassile, I.
 - Avita 2009, 114.

Evaluative aspect of words is important

- Negatiivse tähendusega sõnad on näiteks joodik, varas, kommunist jne.
- The word “negro” should not be used
- The words with positive meaning are democracy, freedom, education, university, etc.
- The words with negative meaning are murderer, drunkard, skiver, etc.

Evaluations can be given by illustrations

- Example from history textbook. There was a text about industrial revolution in 18. sajandil (James Watt, spinning machine, steamships, locomotives, etc.).
- Two different illustrations can be added.

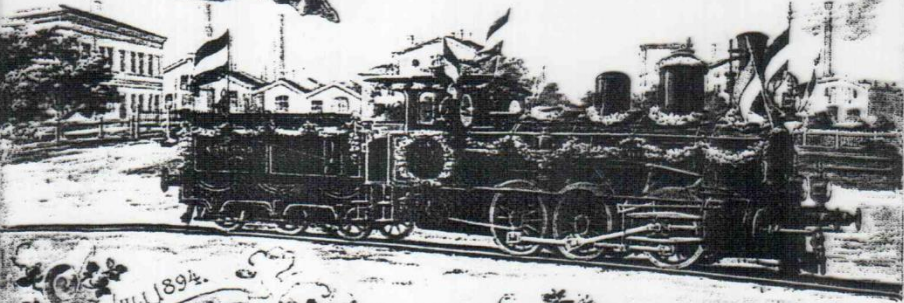


Zur
Vollendung der 3000^{sten} Locomotive
 in der Locomotivfabrik
Krauß und Sons. Actien-Gesellschaft
 München und Linz a. d. D.

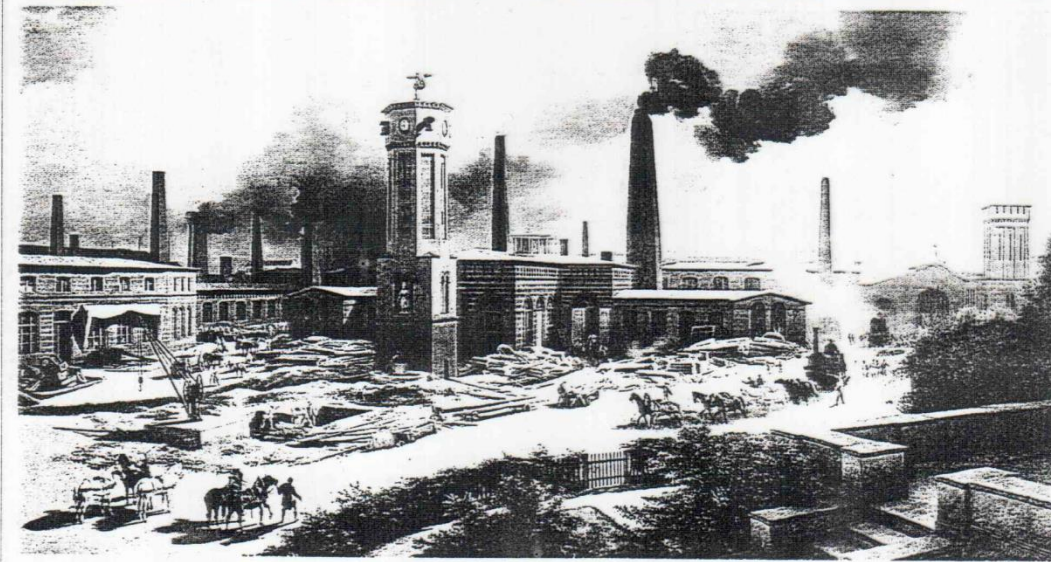
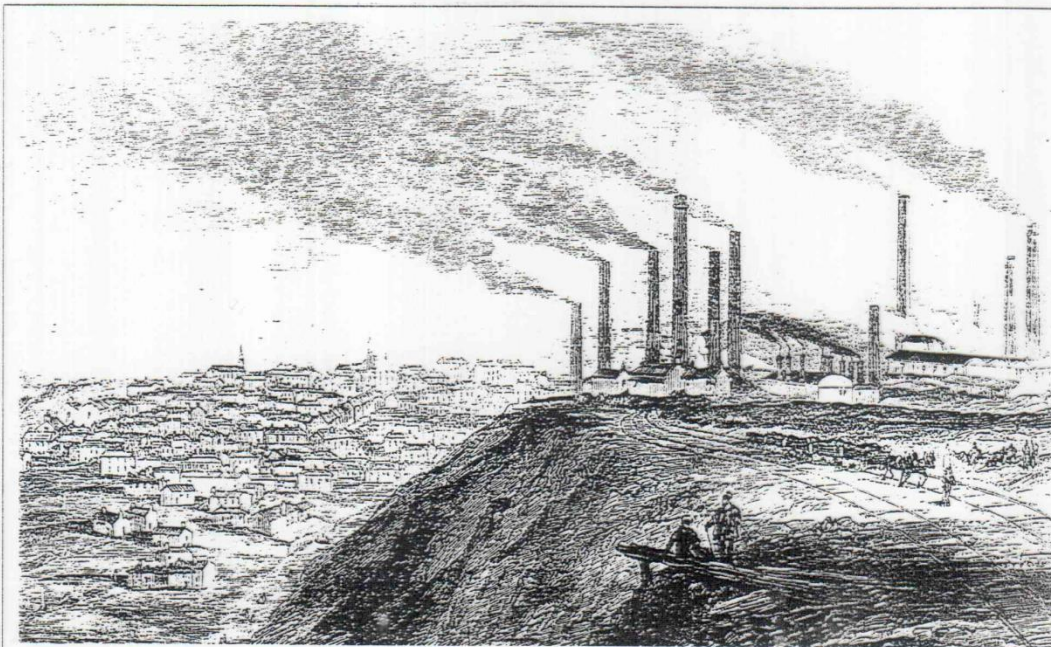
So Zeit und Raum nicht zu verbinden,
 Wird manches stolze Werk vollbracht.
 Es kam die Zeit dem kühnen Bärenfinden,
 Als zu verpöppeln, was der Gott erdicht.
 Dem Menschengeiste ward auch Sie erfinden,
 Dem Menschenreichtum ward auch Sie erbaut.
 Sie, deren Hochgeistes sich kein Feind
 Die stolze Eisenbahn.

So ist die Hochzeit nicht wie Sie bereitet,
 Das Menschenwerk, gesamt und geistlich,
 Für der Natur im ungenutzigen Sturben
 Wird es an diesem Tag vermählt.
 Umarmet sie nur, trübenden Sturmländen
 Und Blumenkränze stöcket auch hinein!
 Der Tag, an dem wir sie gerühmt haben
 Zur Hochzeitstag, ein Festtag soll er sein.

Und Glück ihr Glück! Da regnet sie schon gleichmücker,
 Dem Flug durch die weite Welt bereit.
 Bald wird sie ihren trüben Lauf beginnen,
 Vor ihrer Schnellleisenden Raum und Zeit.
 Dem ersten Norden, wo das Meer erhitzt
 Dem heitren Süden, wo die Sonne stammt,
 Verkündet sie mit ihrem Siegeslaute
 Den Ruhm des Hauses, welchem sie entstammt.



JULI 1894.



On illustrations

- Above is ideal, below is real.
- Left is familiar, right is unfamiliar.
- Near is our, far away is strange.
- Looking from above insinuates that viewer is important.
- Active person is more powerful than passive one.

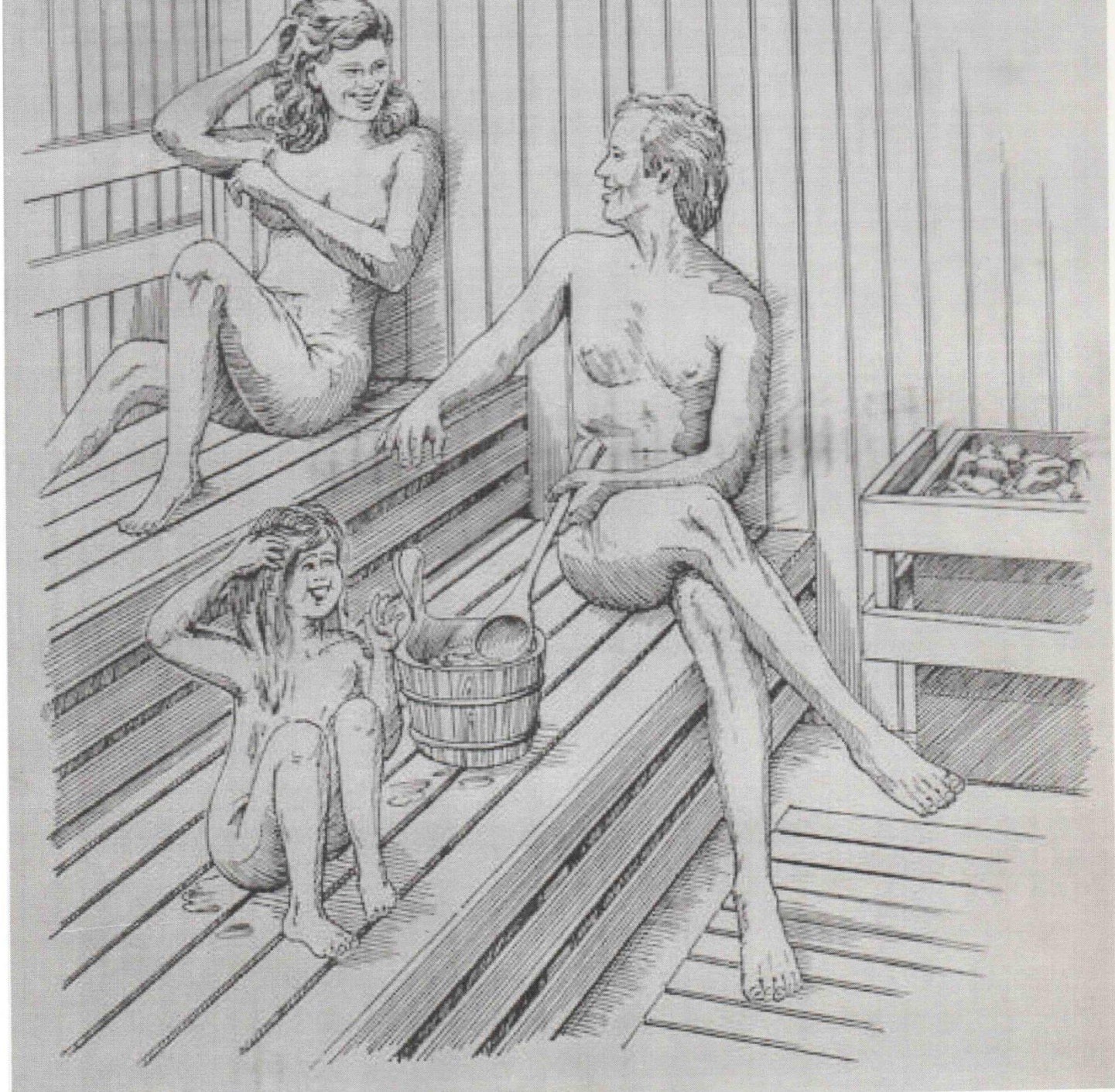
Eesti Päevaleht

11.09.2014

Arvamus



Ei ole kiit!



Example

influences always

- All that is presented in textbooks is an example for students.
- It is important
 - what is depicted in textbooks,
 - What is stressed and repeated,
 - Which assessments are given
- Punished example influences as well.

- Kalle planted 48 plants of turnip and 37 plants of cabbage in spring. How many turnips and cabbages will kalle have in spring if 80% turnios will grow and 85 % cabbages?
 - (Veelma, 2004, 7)

Value forming aspects will be often introduced into textbooks unintentional

- Example: A girl came from house outside and said to mother “My bird disappeared! He flied out of door”.

A little girl ran out of a white house into a big yard. "Mother," she said, "my pet bird is gone. It went out of the open door."

Mother laughed and said, "Look on the steps." When the girl looked she had a big surprise. A yellow bird with blue wings was sitting on the steps. Then the bird started to sing. It was the bird that had flown away.

The little girl carefully put the bird in her pocket and took it back into the house. She made sure that she closed the door behind her.

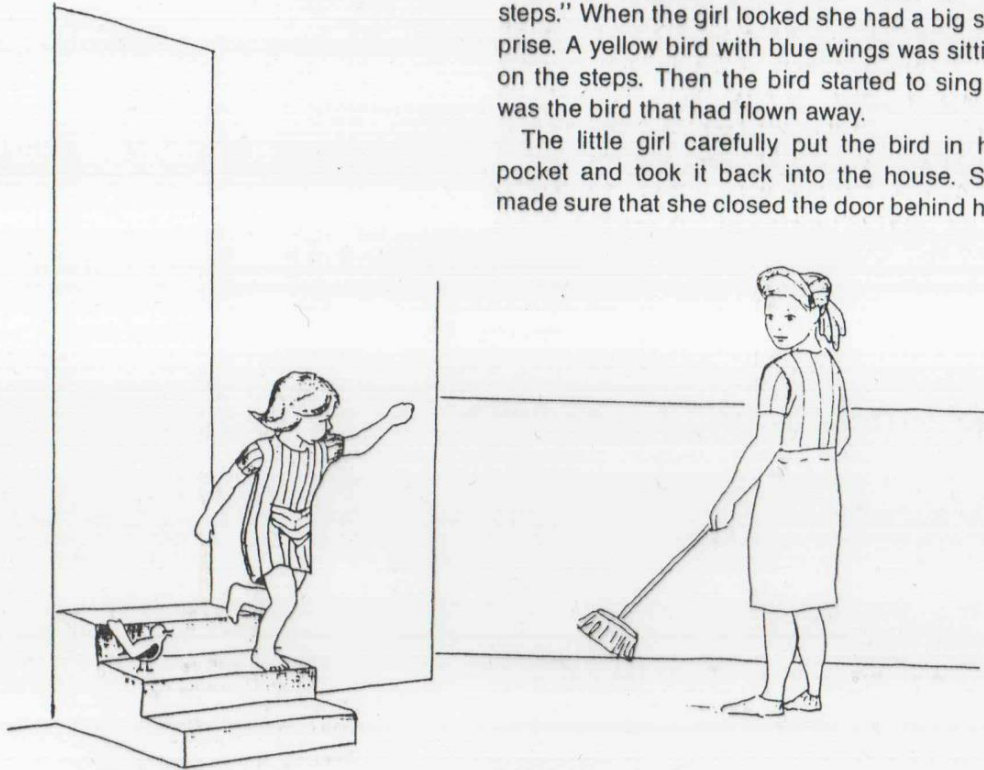


FIGURE 4.1. *Continued.*



A little girl ran out of a white house into a big yard. "Mother," she said, "my pet bird is gone. It went out of the open door."

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The little girl carefully put the bird in her pocket and took it back into the house. She made sure that she closed the door behind her.

FIGURE 4.1. Children's story used by Willows with (a) the original illustration and (b) another illustration that depicts largely the same text content. From *Reading Comprehension of Illustrated and Nonillustrated Aspects of Text* by D. M. Willows, 1979. Paper presented at the annual meeting of the American Educational Research Association, San Francisco. Reprinted and adapted by permission.

Optimal presentation of values in textbooks

- Textbooks should depict life as it is.
- Textbooks should depict more often the aspects of life we wish to develop for better future.

Calamity to the generation
which has acquired from ABC book
nothing
besides mechanic reading skills!

Kalju Leht



