Course Specific Adaptation of Competences of an Education for Sustainable Development

Design of Learning Outcomes and a Subsequent Course Evaluation

André Baier
PostDoc at the Chair of Machinery Systems Design
Coordinator of the Sustainability Certificate for Students
HRK nexus Workshop in Cologne | 26. February 2019

Technische Universität Berlin

Overview

Problem Area - Design of the Blue Engineering Course

Analysis - Learning Outcomes and their Frameworks; Key Competences

Design - Designing Down Learning Outcomes for the Blue Engineering Course

Evaluation - Evaluation of the Blue Engineering Course

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Origin of the Blue Engineering Course

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“We need more social and ecological responsibility
within engineering education and within the engineering profession.
This is our idea…”

Winter Semester 2008/2009
student group in the course Sociology of the Engineering Profession

Three Guiding Principles for the Design of the Blue Engineering Course

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social and ecological responsibility
to foster discussion about social and ecological responsibility of engineering which is to be seen differently on the individual level and on the societal level

student-driven character
to handover the responsibility to the students by letting them co-conduct and co-create the course

TINS-D Constellation
to understand and analyze the reciprocal relations of technology, individuals, nature, society and democracy (TINS-D)

“Hard Facts” of the current Blue Engineering Course

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14 weekly lessons for 3 hours - 6 Credit Points

compulsory elective course in five Bachelor study programs
Mechanical Engineering - Industrial Engineering - Transport Systems Engineering
Sustainable Management - STEM Orientation Study Program (MINTgrün)

capacity of 75 students each semester
sometimes they are all together in one room and sometimes split up in 3 rooms

student tutors’ role / lecturer’s role
three student tutors conduct the entire course, the lecturer supports them

Building Blocks

over 150 interactive teaching/learning units
15 to 90 minute long sessions on a complex topic

combination of different methods and broad variety of topics
role playing, educational games, case studies, station learning, learning…
pre-implementation diagnostics, fracking, food ethics, cooperatives…

no expert knowledge necessary, instead the facilitation of a group process
the participants drive their own learning which is only facilitated

well documented, easy to use manuals
little preparation is needed to conduct a building block

Three Parts of the Blue Engineering Course Plan

core building blocks conducted by tutors
Plastics - Technology as Problem-Solver!? - Responsibility and Ethical Codes...

conduction of existing building blocks conducted by student groups
Two fixed topics: Gender, Diversity & Technology - Work and Labour Unions

conduction of newly created building blocks by students groups
developed over the whole semester and documented for further use

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Characteristics of an Outcome-Based Education

definition of learning outcomes
Learning results that are clearly demonstrated at or after the end of an instructional experience. (Spady 1994b, 194))

a shift from teaching to learning and from teacher- to student-centered

foster communication between everyone who is involved in education

alignment of outcomes, activities and assessment

learning outcomes usually comprise two distinct components
a verb referring to the intended behavior, performance or competence
a noun, referring to content, subject matter or context

Common Frameworks of Learning Outcomes

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Ralph Tyler - Basic Principles of Curriculum and Instruction - 1949
a seminal book which influenced the concept of an outcome-based education

Bloom et al. - Taxonomy of Educational Objectives. The Classification of Educational Goals - Cognitive Domain - 1956 / Affective Domain - 1964
Bloom's Taxonomy ignited the systematic description of learning outcomes

Anderson and Krathwohl et al. - A Taxonomy for Learning, Teaching and Assessing: A revision of Bloom's Taxonomy of Educational Outcomes - 2001
switching from a one dimensional table to a two dimensional table

Schaper et al. - Umsetzungshilfen für kompetenzorientiertes Prüfen (Implementation Guide for Competence-Oriented Assessment) - 2013

Schaper Taxonomy Table

Schaper, Hilkenmeier and Bender 2000, 56

		Process dimension			
		Remember and Understand Knowledge and Skills	**Apply Knowledge, Skills and Attitudes**	**Analyze and Evaluate of Knowledge, Skills and Attitudes**	**Create and Extend Knowledge, Skills and Attitudes**
Content Dimension		Remember and Understand	Apply	Analyze and Evaluate	Create
Factual Knowledge and Procedures	Factual Knowledge Conceptual Knowledge Procedural Knowledge	A1	A2	A3	A4
Values, Attitudes and Beliefs		B1	B2	B3	B4
Interdisciplinary Skill and Knowledge	Metacognitive Knowledge Social and Communicative Knowledge and Skills	C1	C2	C3	C4

Definition of Competences

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Competences are **the proven ability to use knowledge, skills and personal, social and/or methodological abilities,** in work or study situations and in professional and personal development

European Qualifications Framework for Lifelong Learning
European Commission 2008, 11

Key Competences (of an Education for Sustainable Development)

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Key competences are transversal, multi-dimensional competences which are relevant across academic subjects to handle complex and often unpredictable problems/situations *OECD 2005*

convergence of key competences (for a sustainable development)
the differences between the different concepts invite to one's own adaptation
Svanström et al. 2008 ; Voogt and Roblin 2012

domain- or course-specific adaptations of key competences necessary
key competences have to be acquired in domain-specific circumstances through situational learning as this guarantees the transferability to other situations
Weinert 2001

Concept of Gestaltungskompetenz

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definition of Gestaltungskompetenz
Gestaltungskompetenz describes the competence to modify and shape the future of society and to guide its social, economic, technological and ecological changes along the lines of sustainable development. (Haan 2006, 2009, 2010)

part of the UNESCO Decade of Education for Sustainable Development
developed in an iterative process to be used in German secondary schools
adopted and adapted by other to be used in the context of higher education

12 sub-competences of Gestaltungskompetenz
adopts the OECD categories for key competences
4 sub-competences of Gestaltungskompetenz for each of the
3 OECD Categories Tools - Cooperation - Action of the DeSeCo Project

Sub-Competences of Gestaltungskompetenz OECD Tools Category

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T1 - Perspective-Taking
to gather knowledge in a spirit of openness to the world, integrating new perspectives

T2 - Anticipating
to think and act in a forward-looking manner

T3 - Gaining Interdisciplinary Knowledge
to acquire knowledge and to act in an interdisciplinary manner

T4 - Dealing with Incomplete and Overly Complex Information
to deal with incomplete and overly complex information

Sub-Competences of Gestaltungskompetenz OECD Cooperation and Action Category

C1 - Cooperating
C2 - Coping with Dilemmas of Decision-Making
C3 - Participating
C4 - Motivating

A1 - Reflecting Principles
A2 - Acting Morally
A3 - Acting Independently
A4 - Supporting Others

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Design Down Process

iterative participatory process to describe the learning outcomes
starting in spring 2013 and finishing in spring 2015
two lecturers of the Blue Engineering Course facilitated the process
experts: student tutors, course alumni, strategic controlling of TU Berlin...
presentation and discussion at three international conferences

levels of the design down process
General Framework
2 Learning Outcomes on General Level
12 Specific Learning Outcomes on Module Level
48 Learning Outcomes on Block Level
Learning Outcomes on Activity Level

the General Framework of the Blue Engineering Course

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Berliner Hochschulgesetz [Law on Higher Education Institutions in Berlin]
no direct reference to sustainability, nonetheless a strong call for sustainability

guidelines of the responsible accreditation agencies
no concrete reference to sustainability in the guidelines of ASIIN and EUR-ACE, however there are several indirect references to aspects of sustainability

regulations at Technische Universität Berlin
overall strong focus on sustainability in all central guidelines, regulations etc.

the design of the Blue Engineering Course
social and ecological responsibility, TINS-D Constellation, student-driven design

Two Learning Outcomes on General Level

The prospective engineers **analyze and evaluate the present reciprocal relations** of technology, individuals, nature, society and democracy by taking different perspectives. Based on this analysis and evaluation, they are able to **state their personal perspective and values of the reciprocal relations and act accordingly**.

The prospective engineers **cooperate with others to analyze and evaluate in a democratic process the present reciprocal relations** of technology, individuals, nature, society and democracy. Based on their analysis and evaluation, **they are able to work out a collective understanding with regard to their collective values and to democratise the reciprocal relations.**

4 Key Aspects of the Learning Outcomes on General Level

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to **identify their values on an individual level as well as group level**

to **analyse and to evaluate the reciprocal relations** between technology, individuals, nature, society and democracy (**TINS-D**)

to **act according to their values**

to **democratise group-processes**

12 Course-Specific Learning Outcomes on Module Level

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Merging the two general learning outcomes with Gestaltungskompetenz leads to a course-specific adaptation of the 12 sub-competences.

C4 - Motivating
to motivate oneself as well as others to become active

C4 - BE - Motivating
Students **motivate** oneself and others **to democratize the reciprocal relations** between technology, individuals, nature and society.

Designing Down the Learning Outcomes on Activity Level

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Block Level - one concrete teaching/learning unit or lesson or assessment

Merging the 12 learning outcomes on module level with the Schaper Taxonomy Table leads to a set of 48 learning outcomes that are course-specific and describe what the students may learn in a lesson/building block/assessment.

48 Learning Outcomes of the Blue Engineering Course on Block Level

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Content dimension		Process dimension			
		Remember and understand knowledge and skills	Apply knowledge, skills and attitudes	Analyze and evaluate of knowledge, skills and attitudes	Create and extend knowledge, skills and attitudes
Factual knowledge and procedures	**T1-BE - Perspective Taking**	T1-BE-1	T1-BE-2	T1-BE-3	T1-BE-4
	T2-BE - Anticipating	T2-BE-1	T2-BE-2	T2-BE-3	T2-BE-4
	T3-BE - Interdisciplinarity	T3-BE-1	T3-BE-2	T3-BE-3	T3-BE-4
	T4-BE - Complexity	T4-BE-1	T4-BE-2	T4-BE-3	T4-BE-4

A2 - BE - Acting Morally
Learning Outcomes on Block Level

A2-BE-1 - Students ***know methods*** to identify the underlying values which shape the reciprocal relations of technology, nature, individuals and society and to use them to act morally.

A2-BE-2 - Students ***apply methods*** to identify the underlying values which shape the reciprocal relations of technology, nature, individuals and society and to use them to act morally.

A2-BE-3 - Students ***analyze and evaluate methods*** to identify the underlying values which shape the reciprocal relations of technology, nature, individuals and society and to use them to act morally.

A2-BE-4 - Students ***create methods to identify*** the underlying values which shape the reciprocal relations of technology, nature, individuals and society and to use them to act morally.

Designing Down the Learning Outcomes on Activity Level

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Using the 48 learning outcomes on block level to describe what the students may learn in a concrete activity.

C1 - BE-1 - Students **know one method** to structure an open discussion less hierarchical, e.g. by letting the last person who spoke decide who will speak next.

C1 - BE - 2 - Students **apply one method** to structure an open discussion less hierarchical, e.g. by letting the last person who spoke decide who will speak next.

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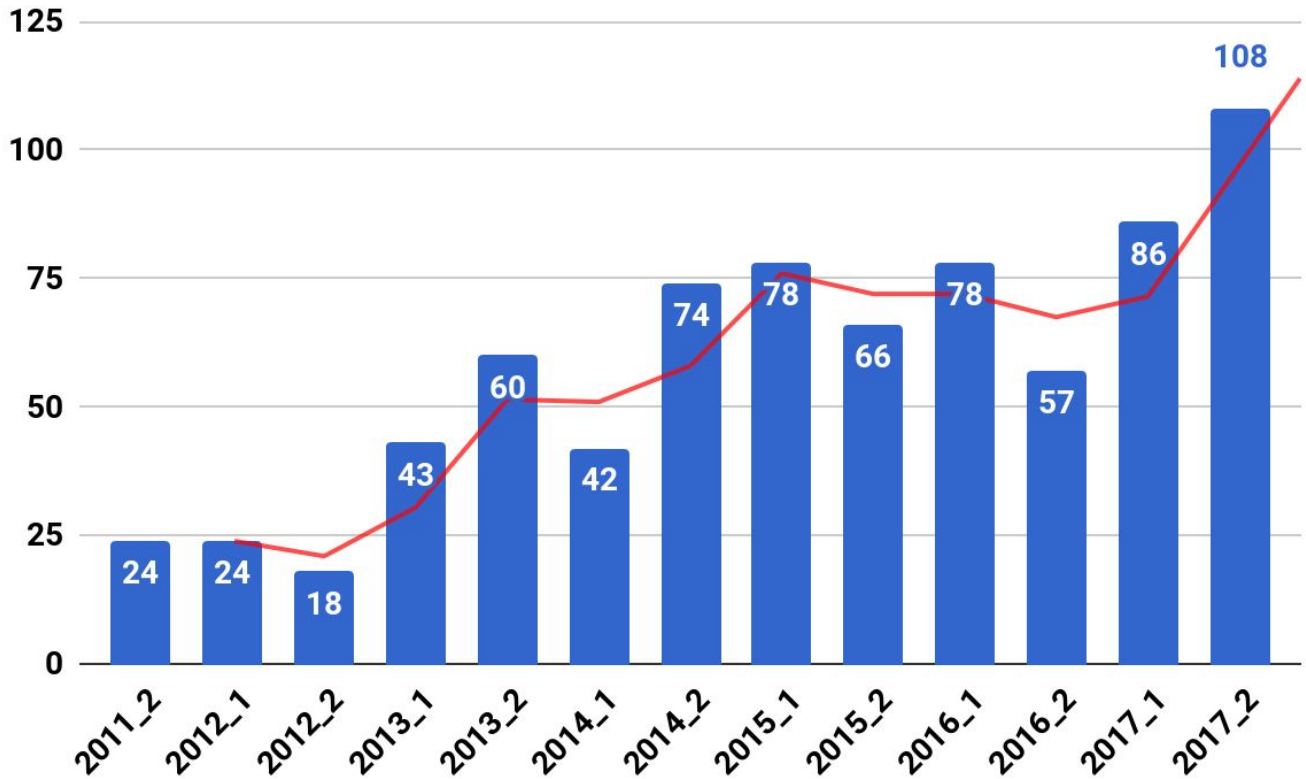
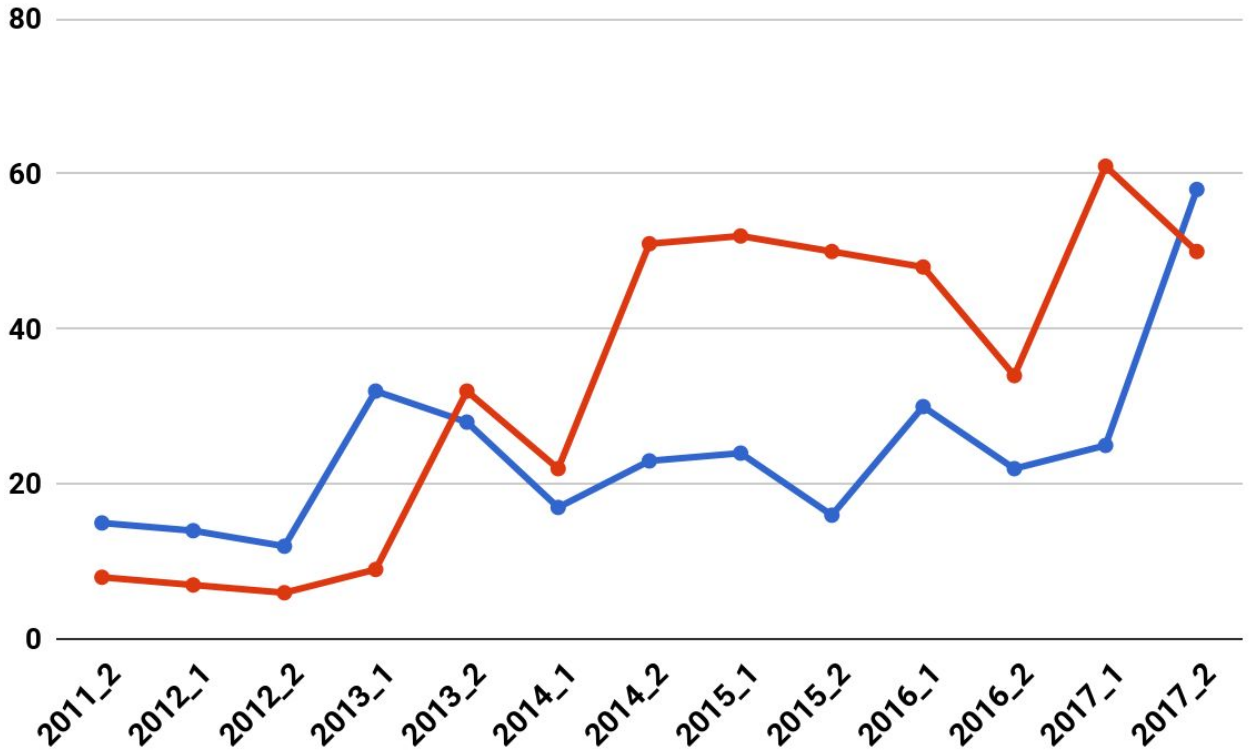
Number of Examination

blue bar - number of examinations for each semester / red line - moving average

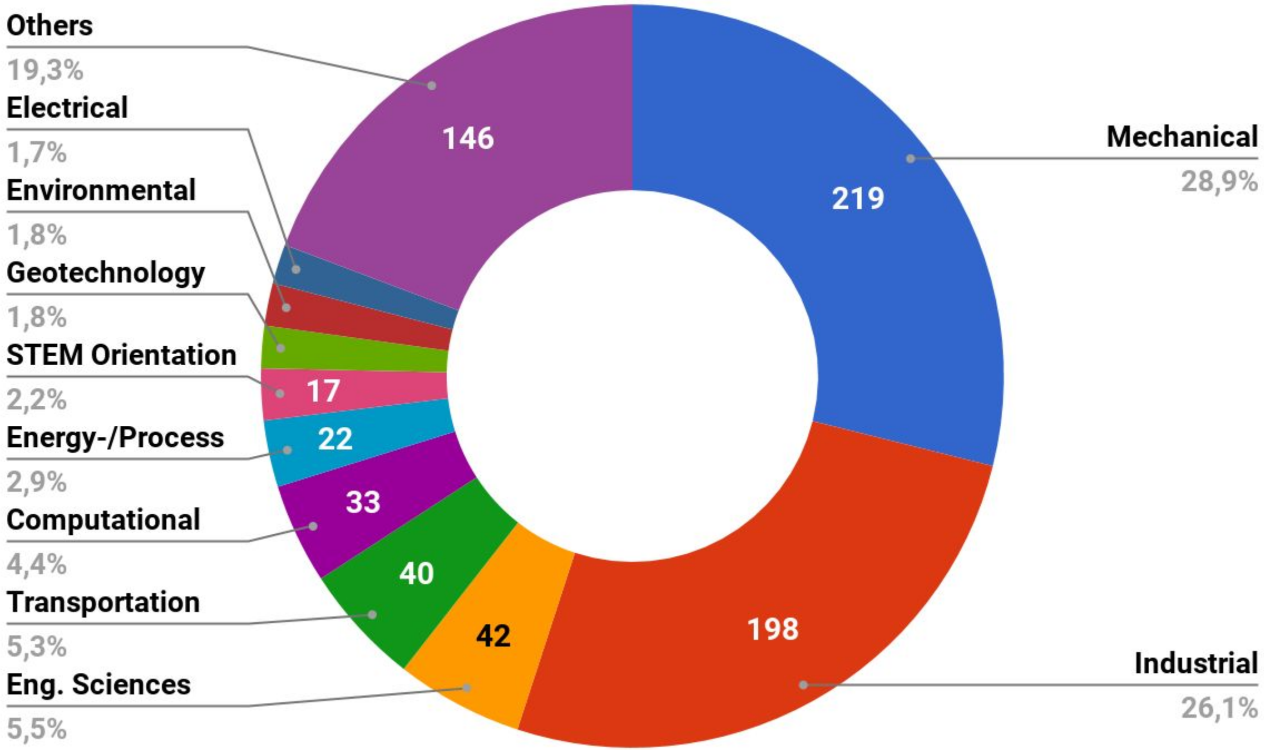


Bachelor Studens / Master Students

blue dots - Bachelor Studens / red dots - Master Students



Study Programs of Participants



Comparative Self-Assessment Test

object of the evaluation
the self-assessed competence gain of the students
comparing the beginning (pre) of a semester with the end (post) of a semester

design of the questionnaire
learning outcomes on module level are the basis for test items
6 Point Likert-Scale - 1 - Low Agreement - 6 - High Agreement

data collection
3 semesters - at the beginning and at the end (prepre/postpost)
3 semesters - at the end and looking back at the beginning (then/postthen)

data analysis
comparison of means, t-test, CSA Gain, Cronbach's Alpha

Data Analysis
Comparative Self-Assessment Test

participants and return rate

participants		439		
returned tests	pre	365	post	279
return rate mean	pre	83%	post	64%

two-tailed t-test

almost all items across all semesters have p < 0,01

Cronbach's Alpha

all 12 tests yield a Cronbach's Alpha Value > 0,76

Mean of Cronbach's Alpha Across all Tests 0,84

Comparative Self-Assessment
Comparison of Aggregated Means

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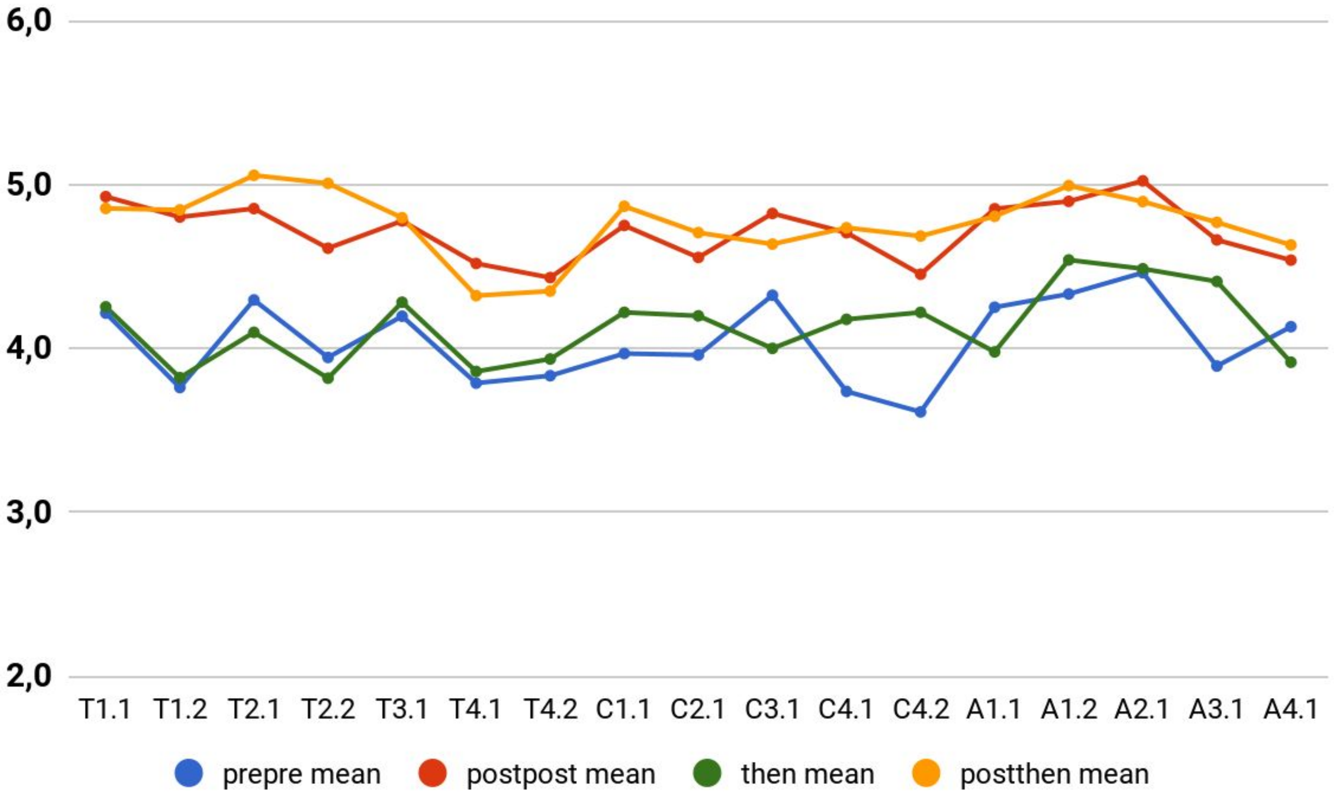
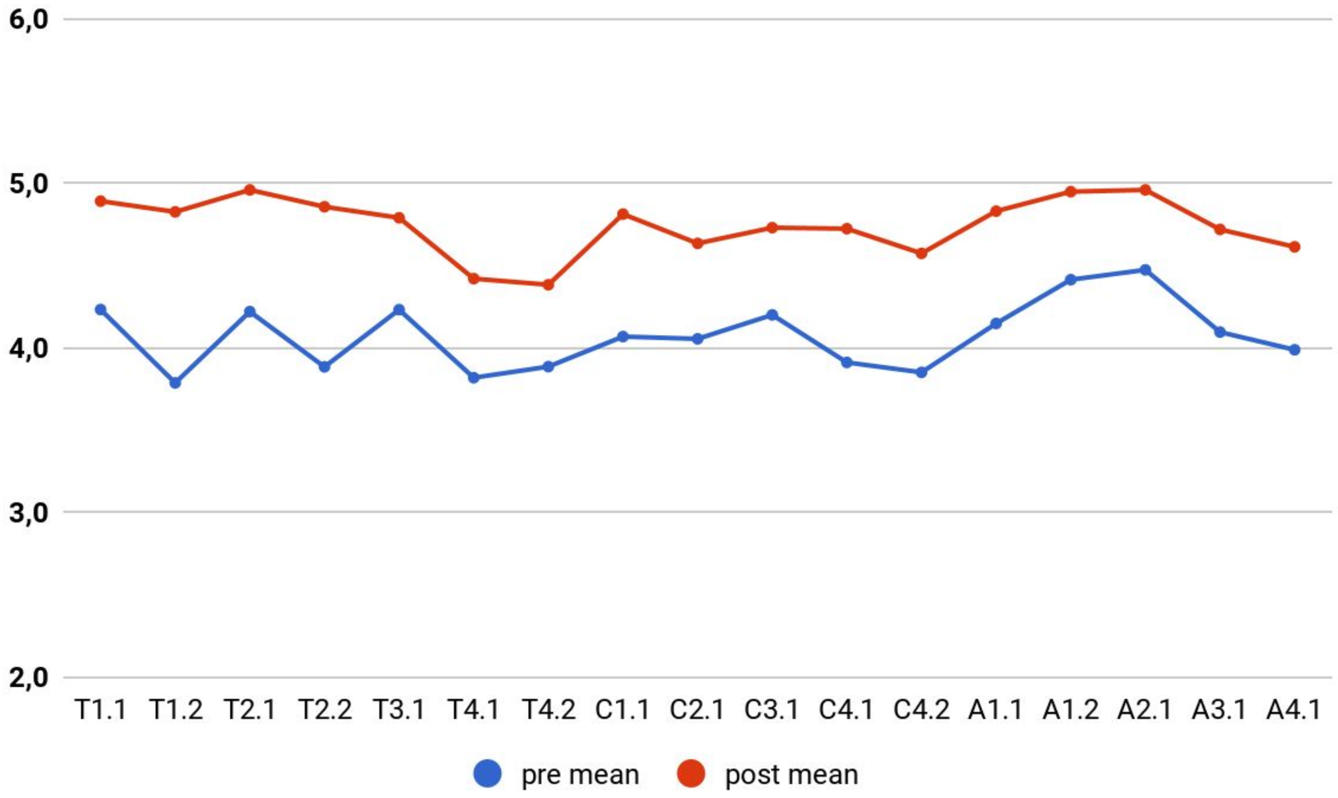


Comparative Self-Assessment Comparison of Aggregated Means



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Design Principles
Learning Outcomes

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analysing of the regulatory context of the course

describing two learning outcomes on general level

merging the two course-specific learning outcomes on general level with the 12 rather general sub-competences of Gestaltungskompetenz

merging the 12 learning outcomes with the Schaper Taxonomy Table

adapting the 48 learning outcomes on block level for the activity level

thank you

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