Curricular development focusing on competences and leaning outcomes

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Student-Centered Learning

- Higher education is meant for students, not for teachers
- HE should be student-centered, not teacher-centered
- Teacher-centered teaching emphasizes the interests and expertise of the teachers
- Student-centered learning focuses on what competences students need for future professional life
- Change of philosophy: from passive **teaching by teachers** to **active learning by students**

Aims/Objectives vs Learning Outcomes

- **Aims/objectives** of a course
  - A statement of what topics the course will cover or what the teacher wants to teach
  - *Teacher-centered, process-centered*
- **Learning outcomes** of a course
  - A statement of what students will know, understand and be able to do after the course
  - *Student-centered, output-centered*

Competences and Learning Outcomes

- Basic parameters to compare education
- A reference of transparency for students/stakeholders
- A tool for better communication with employers and stakeholders - employability
- Benchmark for quality assurance & accreditation

What is competence ?

- A combination of knowledge, understanding, skill, capability and attitude that enables an individual to perform certain *professional* tasks
- Competences deals with "what is expected in a *professional* workplace."
- Emphasis on **performing an actual job**, not gaining knowledge/skills for their own sake or as a hobby.

Competences vs Learning Outcomes

- Competences concern a study programme, while LOs address individual courses (subjects)
- Desired competences are defined on the basis of input from internal and external stakeholders (e.g. employers)
- LOs are statements of what a student is expected to know, understand and be able to do after completion of a course
- LOs are mostly formulated by the teaching staff, taking into account the programme's desired competences

Competences and Learning Outcomes

- Learning/teaching activities help students to learn
- Assessment activities make sure that students have achieved the stated **Learning Outcomes**
- **Learning Outcomes** lead to skills/**Competences**
- **Competences** make graduates employable and useful for the society

Competences of a study programme

(LOs at programme level)

- Knowledge and understanding of the subject
- Practical skills
- Intellectual skills required to make use of existing knowledge and create new knowledge
- Generic (transversal/transferable) skills

Competences for MSc in *Geodesy and Geoinformatics*

1) Broad knowledge in land survey, mapping and GIS
2) specialised knowledge in certain areas and current research topics

3) Practical skills to do measurements, process field data and evaluate the results
4) Practical skills to structure, visualize and analyze spatial data using GIS software

5) Ability to choose proper methods for speicifc conditions and requirements
6) Skills to evaluate possibilities and limitations of existing geodetic methods
7) Insight on the needs of new technologies/solutions in geodesy/geoinformatics

8) Be able to communicate effectively and present scientific work in oral/written form
9) Project management skills and ability to work in group and in project form
10) Insight on ethical, environmental and sustainable development issues and their relevance in professional work

MSc in *Geodesy and Geoinformatics*

1)	Adjustment theory	(7,5c)
2)	Map projections & reference systems	(7,5c)
3)	Global Navigation Satellite Systems (GNSS)	(7,5c)
4)	Physical geodesy	(7,5c)
5)	Laser scanning technologies	(7,5c)
6)	Integrated navigation	(7,5c)
7)	Spatial databases	(7,5c)
8)	Geovisualization	(7,5c)
9)	GIS architecture	(7,5c)
10)	Spatial analysis	(7,5c)
11)	Remote sensing and image processing	(7,5c)
12)	GIS project	(7,5c)
13)	MSc thesis project	(30c)

The Competence Matrix for *Geodesy and Geoinformatics*

COMPETENCES / COURSES	01. Adjustment theory	02. Map projections & RS	03. GNSS	04. Physical geodesy	05. Laser scanning	06. Engineering geodesy	07. Spatial databases	08. Geovisualization	09. GIS architecture	10. Spatial analysis	11. Image processing	11. GIS project
broad knowledge in land survey, mapping and GIS	X	X	X	X	X	X	X	X	X	X	X	X
specialized knowledge in some areas and current research topics	X	X	X	X	X	X	X	X	X	X	X	X
practical skills to carry out measurements, process field data and evaluate results	X	X	X		X	X						
practical skills to structure, visualize and analyse spatial data using GIS					X	x	X	X	X	X	X	X
ability to choose proper methods for specific conditions and requirements		X	X		X	X		X		X		X
ability to evaluate possibilities and limitations of existing geodetic methods		X	X		X	X						X
insight on needs of new technologies and new solutions in geodesy and geoinformatics			X	X	X	X	X	X	X	X	X	X
skills to communicate effectively					X	X				X	X	X
ability to manage project and work in groups & project form					X	X				X		X
awareness on ethnical issues as wel as climate change + sustainable development				X	X	X	X			X		X

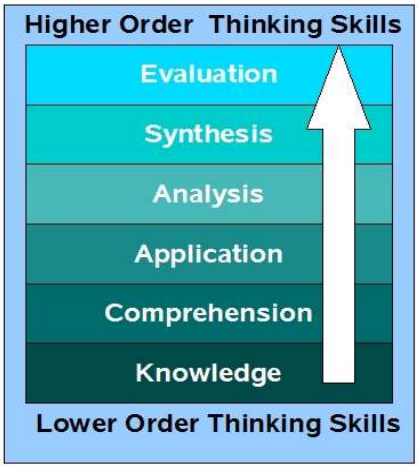
Learning outcomes

- In a learning process, learning/teaching activities (lessons) are input, while LOs are the expected outputs.
- LO are not a repeat of titles of lessons in a course, rather **what student should know, understand, be able to do** after the lessons.
- It should be possible to assess if a student has achieved the stated LOs or not.
- Course with the same name but at different levels (BSc, MSc) can/should have different LOs
- LOs can be formulated using active verbs, from Bloom's taxonomy

Bloom's Taxonomy (1956)

Higher order thinking skills

Lower order thinking skills



13

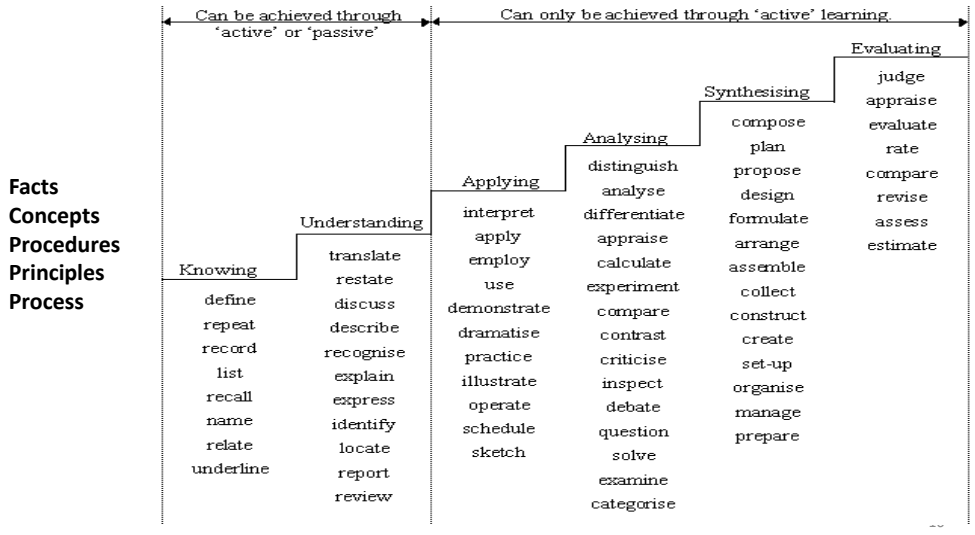
Bloom's Taxonomy (1/2)

1. **Knowledge** (*recalling important information*) – e.g. define, repeat, record, list, recall, name, relate, underline.
2. **Comprehension** (*explaining important information*) – e.g. discuss, describe, recognize, explain, identify, locate, report, review, tell
3. **Application** (*solving close ended problems where there is a clear answer*) – e.g. interpret, apply, employ, use, demonstrate, dramatize, practice, illustrate, operate, schedule, sketch.

Bloom's Taxonomy (2/2)

4. **Analysis** (*solving open problems where there is no single clear answer*) – e.g. distinguish, analyse, differentiate, appraise, calculate, experiment, test, compare, contrast, criticize, diagram, inspect, debate, question, relate, solve, examine, categorize
5. **Synthesis** (*creating unique answers to open problems*) – e.g. compose, plan, propose, design, formulate, arrange, assemble, collect, construct, create, set up, organize, manage, prepare.
6. **Evaluation** (*making critical judgements based on sound knowledge base*) – e.g. judge, appraise, evaluate, rate, compare, revise, assess, *estimate*

Bloom's taxonomy



Bloom's Taxonomy (revised)

Higher order thinking skills

Create

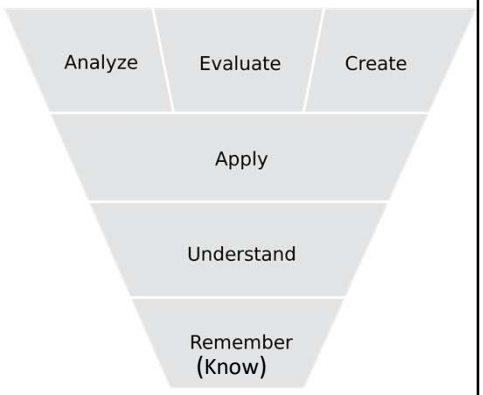
Evaluate

Analyze

Apply

Understand

Know



Lower order thinking skills

17

Syllabus of one course

Course code	AH2922
Course name	**Map projections and reference systems**
Semester / year	1 / 1
ECTS credits	7,5c
Language of instructions	Swedish or English
Study hours	Lecture: 28 hours Exercise: 36 hours Project: 24 hours Self-study: 112 hours Total: 200 hours (27 hours per ECTS credit)
Learning outcomes	After completion of this course, students should be able to 1) describe the geometry of the reference ellipsoid 2) computer geodetic lines on the reference ellipsoid 3) analyse, compare and select map projections for different applications 4) calculate projection coordinates for commonly used map projections 5) understand how astrogeodetic networks, height systems and modern 3D reference systems are constructed 6) understand astro-geodynamic phenomena and their influences on celestrial and terrestrial reference systems 7) transform coordinates between different reference systems.
Syllabus (contents, lessons)	List of lectures (2h each): 1. Geometry of the earth sphere and earth ellipsoid 2. Coordinate systems on the ellipsoid 3. Geodetic lines and basic geodetic problems 4. Classification of map projections. General projection theory. 5. Azimuthal projections. Conical projections 6. Cylindrical projections. Gauss-Kruger projections. UTM. 7. Spherical astronomy 8. Astro-geodetic triangulation. Geodetic datums. 9. Gravity, geoid and height systems 10. Geodynamics: plate tectonics, land uplift, earth tide, sea level change 11. Earth rotation: polar motion, precession and nutation. Earth orientation parameters (EOP). 12. Celestial vs. terrestrial reference systems (ICRS, ITRS) 13. Existing reference frames: ITRF 2005, WGS 84, EUREF 89, SWEREF 99, RT 90, RH 70, SWEN08LR. 14. Transformation between 3D coordinate systems. Estimation of 3D Helmert transformation parameters.

Syllabus of a course

	List of exercises (assignments) (4h each): 1. Computation of geodetic coordinates 2. Computation of geodetic lines 3. Deformation of map projections 4. Azimuthal, conical and cylindrical map projections 5. Geodetic astronomy 6. Transformation between triangulation system and WGS84 7. Height systems 8. Earth rotation parameters. Transformation between ICRF and ITRF 9. Estimation of Helmert transformation parameters List of project topics (to be announced at course start)
Prerequisite	AH1812 Geodetic surveying, AH2921 Adjustment theory.
Follow-up	AH2925 Global Navigation Satellite Systems (GNSS)
Course literature	Required reading: Fan, H. (2012). *Theoretical geodesy*. KTH. Optional literature: Wellenhoff, et.al. (2005). *GNSS – theory and practice*. Springer Verlag.
Assessment	Written examination: 4,5c Approved exercises: 3c
Grading	Written examination: A (best), B, C, D, E or F (fail) Approved exercises: P (pass) or F (fail)
Course co-ordinator	Huaan Fan, 08-790 7340, huaan.fan@abe.kth.se
Examiner	Huaan Fan, 08-790 7340, huaan.fan@abe.kth.se

Summary

- Curricular design should be based on the needs of the society in general and the industry / labour market in particular
- Competences of a study programme should be formulated by academical staff **and** stakeholders together
- All courses in the programme should address different types of competences to create a full competence matrix
- Learning/teaching should focus on LO, with the aim to provide students with the necessary competences
- Bloom's taxonomy can be used to formulate proper LOs and facilitate active learning in a progressive way