Co-funded by the
Erasmus+ Programme
of the European Union

University of Belgrade
Faculty of Civil Engineering

**Modernizing geodesy education in Western Balkan with focus on
competences and learning outcomes - GEOWEB**

CURRICULUM DEVELOPMENT
NEW FCE COURSES

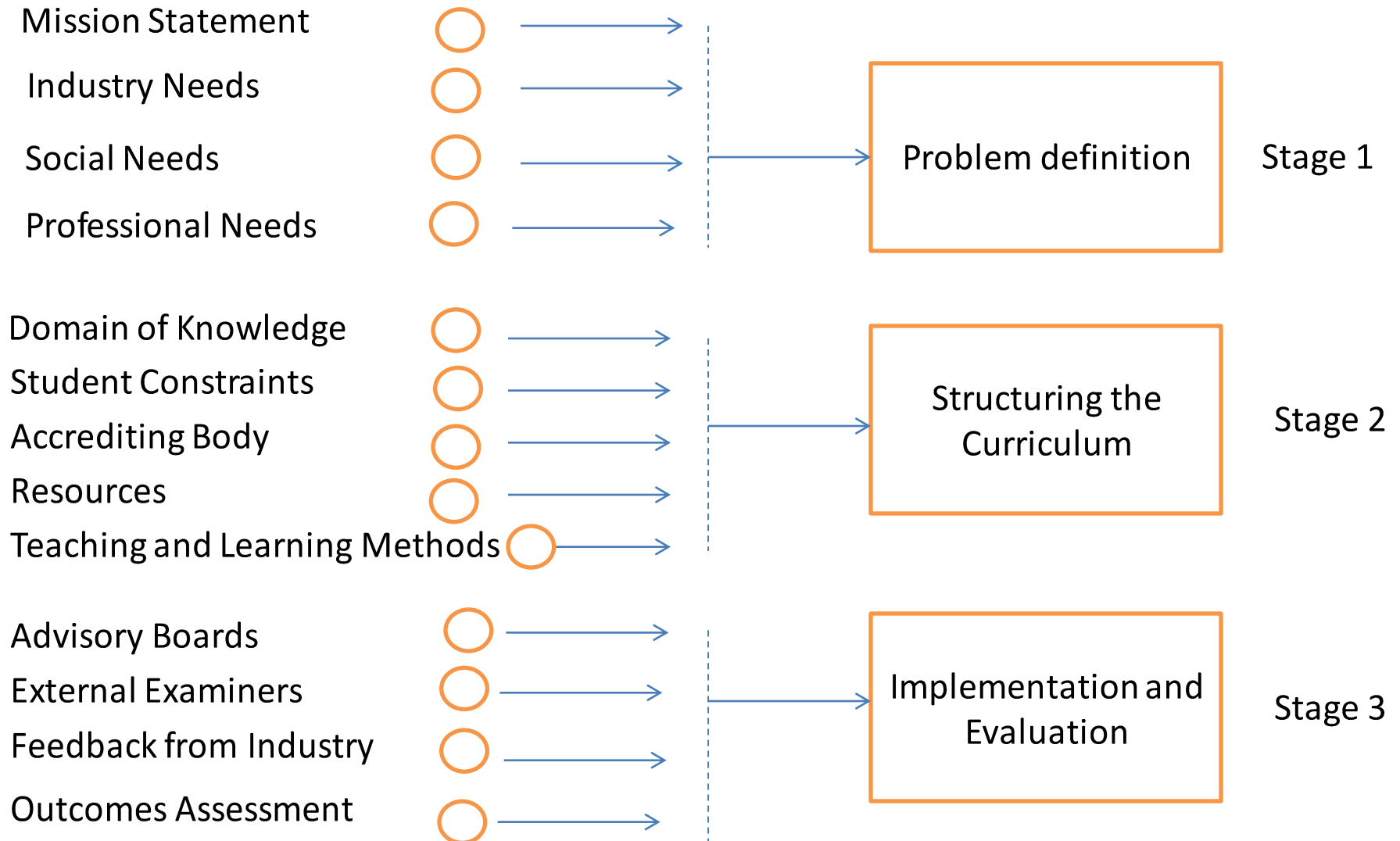http://osgl.grf.bg.ac.rs/survey/accounts/login/

Branko Bozic, PhD

PBL meeting – Stockholm 20-24.06.2017

Specific questions

- **Stages in CD**

- **EQF and QF EHEA**

- **National Qualification Framework**

- **Sectoral Qualification Framework**

Stages of CD (Grayson, 1978)

Mission Statement ⃝ ⟶

Industry Needs ⃝ ⟶

Social Needs ⃝ ⟶ **Problem definition** — Stage 1

Professional Needs ⃝ ⟶

Domain of Knowledge ⃝ ⟶

Student Constraints ⃝ ⟶

Accrediting Body ⃝ ⟶ **Structuring the Curriculum** — Stage 2

Resources ⃝ ⟶

Teaching and Learning Methods ⃝ ⟶

Advisory Boards ⃝ ⟶

External Examiners ⃝ ⟶

Feedback from Industry ⃝ ⟶ **Implementation and Evaluation** — Stage 3

Outcomes Assessment ⃝ ⟶

Problem definition – stage 1

		The outputs:
Mission Statement	Part of the strategic planning and quality management procedures of the Department	
Industry Needs	Measure of manpower requirements and the skills, knowledge and competences employers expect of graduates	A broad statement of the educational objectives
Social Needs	The role the engineer The engineer's responsibility to society's expectations Impact of technology on society	A qualifications profile – list of knowledge, skills and attitudes
Professional Needs	Criteria set for the initial registration of professional engineers Criteria for continued registration Criteria for educational program set by professional societies	

Evaluation of an existing curriculum – feedback from the existing curriculum – how well existing curriculum satisfies the education goals

Structuring the Curriculum – stage 2

Domain of knowledge	Area of knowledge as being fundamental to the discipline, including basic sciences and math., engineering sciences, design,…
Student characteristics	Prior education, experiences, learning habits, motivation and number of students
Accrediting body	The criteria, accrediting procedures, topics, time, minimum length of course, staff qualifications
Resources	Library facilities, PC labs, PC, Staff qualifications, funding, classrooms, access to resources outside
Teaching and Learning Methods	Teaching methods, assessment procedures, technology to be used,

The outputs:

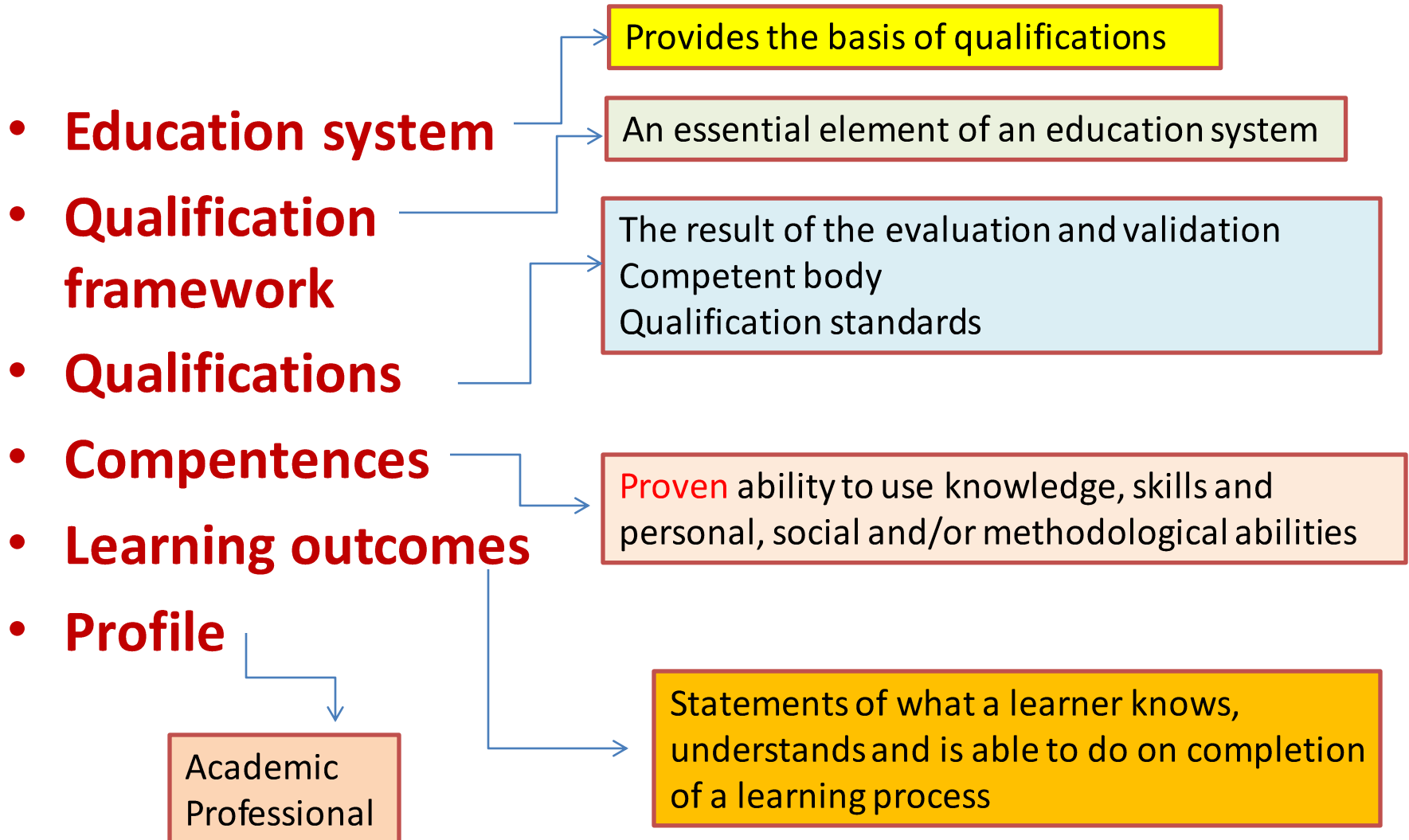Validation at the Faculty level
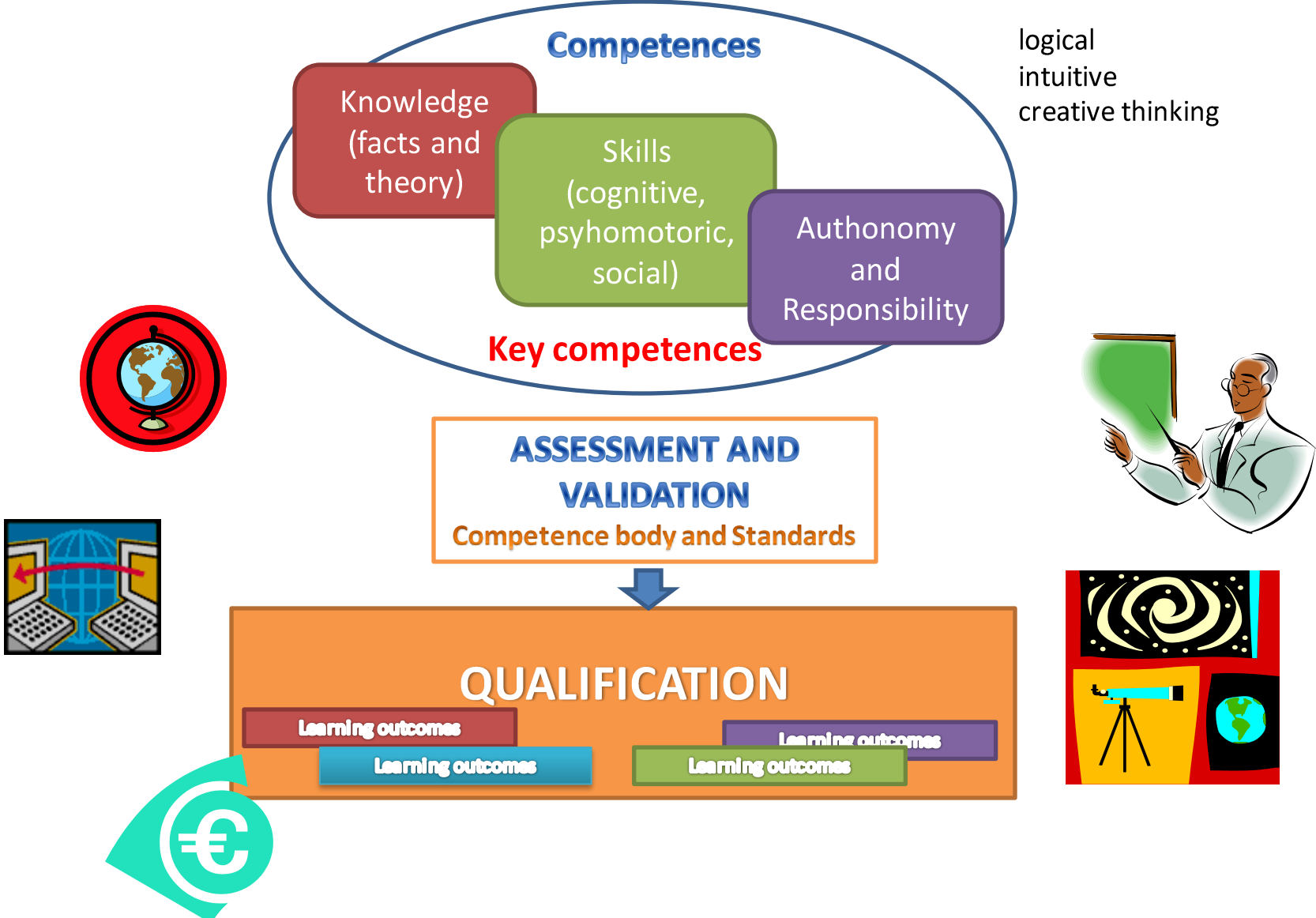
Implementation and Evaluation - stage 3

- Departments should have a documented assessment process which demonstrates that the objectives of the program are being measured and achieved, and that the results of this outcomes assessment are being applied to the continuous improvement of the study program

- Evidence that could be gathered as part of this assessment process would include: students' results, students' project and design outputs, nationally (or internationally) referenced subject content examinations, alumni surveys, career developments of former students, graduate employment, employer satisfaction surveys and program accreditation results

- Individual subjects can be evaluated by getting feedback from students, by observing the quality of students' output in designs, tests or examinations, by observing student performance in subsequent courses and by comparing class performance with that in previous years or for similar courses

It takes time to build up a full evaluation process as inputs to the assessment framework are accumulated over the years that the curriculum is in operation
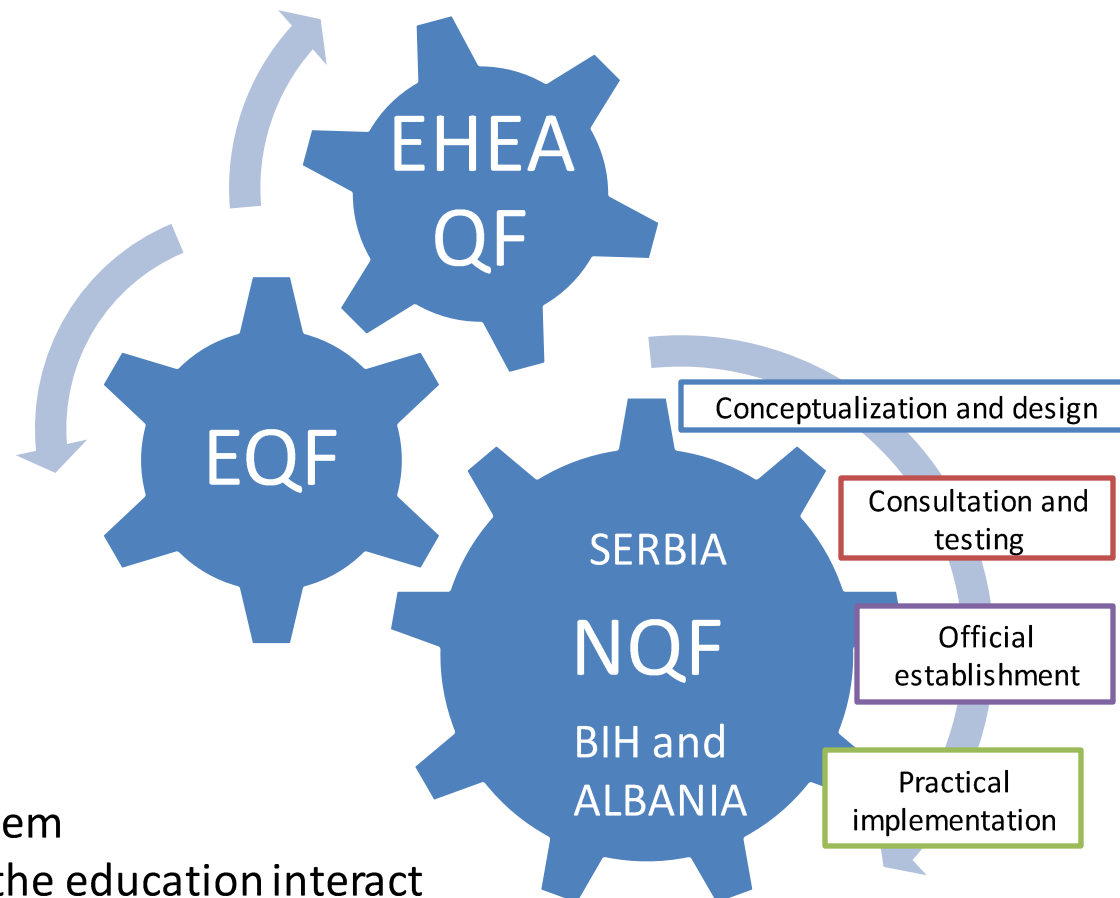
The basic terms related to QF

- **Education system**
- **Qualification framework**
- **Qualifications**
- **Compentences**
- **Learning outcomes**
- **Profile**

Provides the basis of qualifications

An essential element of an education system

The result of the evaluation and validation
Competent body
Qualification standards

Proven ability to use knowledge, skills and personal, social and/or methodological abilities

Academic
Professional

Statements of what a learner knows, understands and is able to do on completion of a learning process

WHAT DOES THE QUALIFICATION MEAN?

Competences

Knowledge (facts and theory)

Skills (cognitive, psyhomotoric, social)

Authonomy and Responsibility

logical
intuitive
creative thinking

Key competences

ASSESSMENT AND VALIDATION
Competence body and Standards

QUALIFICATION

Learning outcomes

Learning outcomes

Learning outcomes

Learning outcomes

Qualification Framework Types

- **Level**
- **Workload**
- **Learning Outcomes**
- **Profile**

EHEA QF

EQF

SERBIA

NQF

BIH and ALBANIA

Conceptualization and design

Consultation and testing

Official establishment

Practical implementation

All qualifications in education system

How the various qualifications in the education interact

What a learner knows, understands and is able to do on the basis of a given qualification

How learners can move between qualifications

QF focus on outcomes more than on procedures and several learning paths – including those of lifelong learning – may lead to a given qualification

Serbian NQF – Basic Structure

EQF	EHEA QF	Academic studies					Applied studies	ECTS
8	3	Doctoral	Speciali-sation			Medicine		180
7	2	Master	Master	Integrated Studies			Speciali-sation	60-120
6	1	Bachelor	Bachelor with honour				Bachelor	180 -240

1. Decision to start: 2008
2. Setting the agenda
3. Organising the process
4. Design Profile: Level structure, Level descriptors (learning outcomes), Credit ranges
5. Consultation - National discussion and acceptance of design by stakeholders
6. Approval - According to national tradition by Minister/Government/legislation
7. Administrative set-up - Division of tasks of implementation between HEI, QAA and other bodies
8. Implementation - At institutional/programme level;
9. Reformulation - Learning outcome based approach
10. Accreditation – Responsible body/Commission

Levels Connections

EHEA QF	ECTS	Academic studies					Applied Studies
3	180			Specialist	Doctoral		
2	60 - 120	Medicine	Integrated Studies	Master	Master		Specialist
1	180 -240			Bachelor with honour	Bachelor		Bachelor
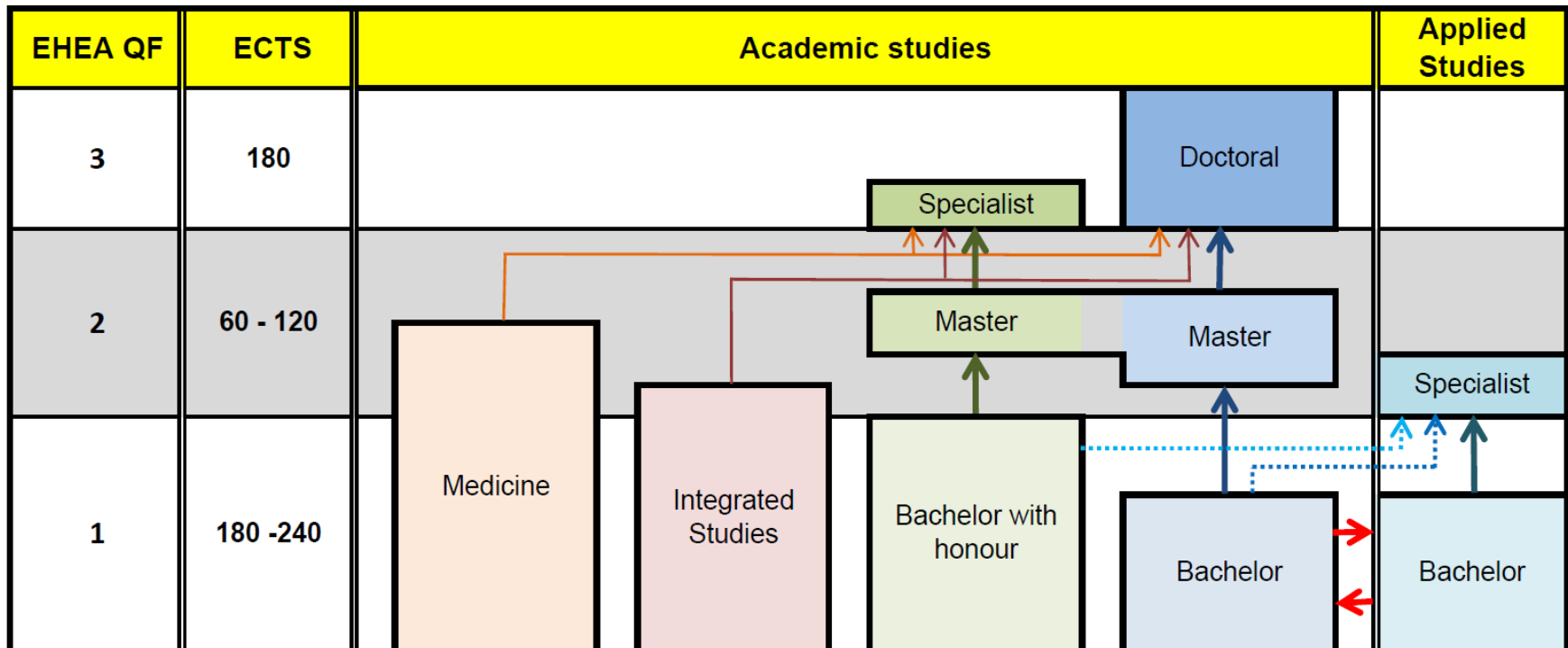
Sectoral QF – Curricula development

- **Subject knowledge and understanding**

- **Subject-specific skills**

- **Types and methods of teaching, learning and quality assessment**

- **Benchmark standards**

By programme we mean a coherent set of courses, leading to a certain degree.
In a programme we can distinguish a core curriculum and optional courses, together making up the different ways a student can choose to arrive at the degree. (Vroeijenstein: 1995)

Key elements and relationships in the curriculum
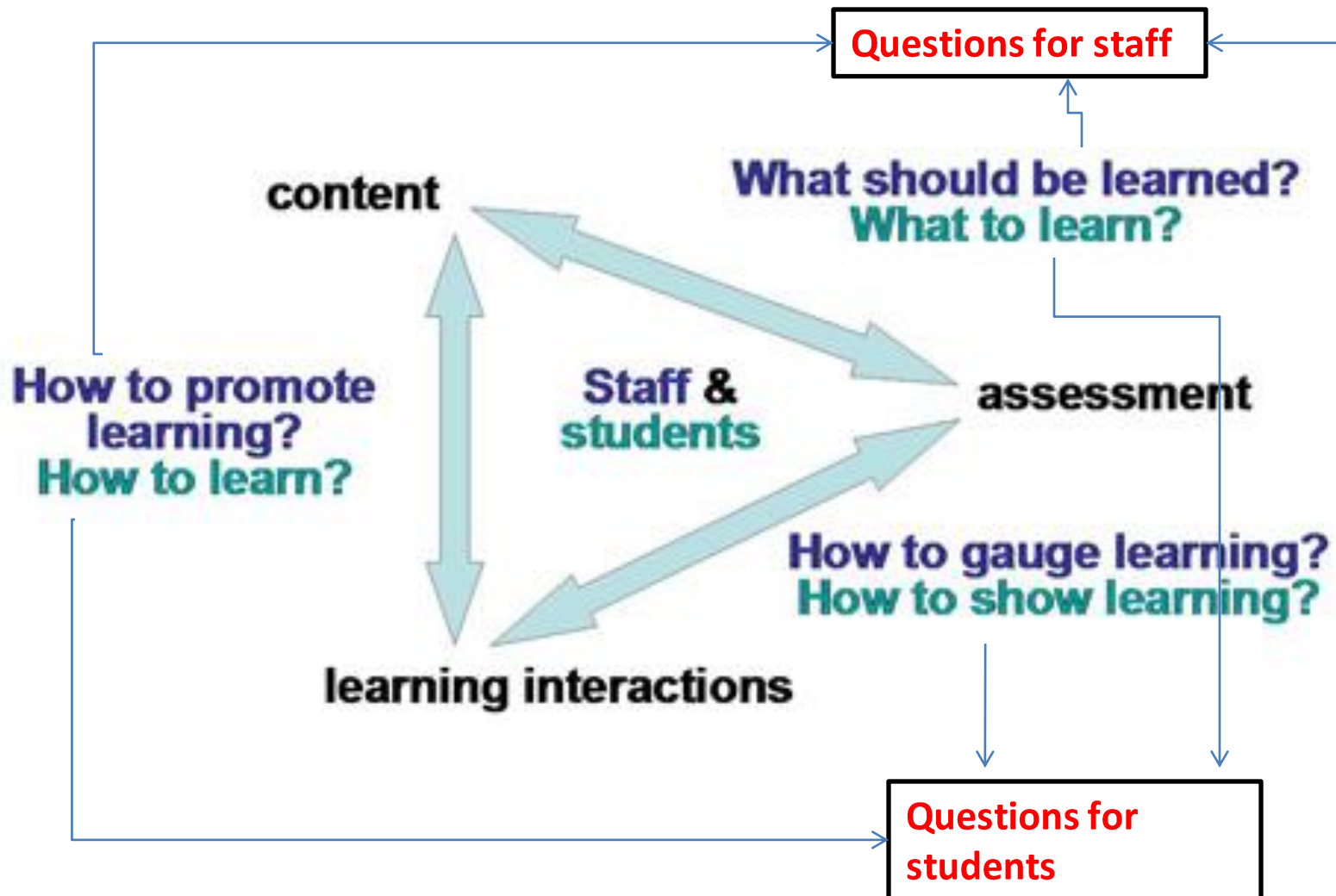
Learning Outcomes Descriptors

Level	Level descriptors
ECTS 180 **EHEA QF** **Level 3** **EQF** **Level 8**	Demonstrated a systematic understanding of a particular field study
	Mastered the skills and methods of research in this field
	Demonstrated the ability of conceiving, designing and application
	Demonstrated ability to adapt to the process research with the necessary level of academic integrity
	Make original research and the work accomplished achievement that expands the boundaries of knowledge, which is published and by reference to national and international levels
	Capable of critical analysis, valuation and synthesis new and complex ideas
	To bring expertise and ideas of colleagues, wider academic community and society at large
	Capable of academic and professional environment to promote technological, social or cultural progress

Level	Level descriptors
ECTS 120 **EHEA QF** **Level 2** **EQF** **Level 7**	Demonstrated knowledge and understanding in the field of study, that complements the knowledge gained at undergraduate studies and the basis for the development of critical thinking and application of knowledge
	Able to apply knowledge in solving problems in new or unfamiliar environment or the wider multidisciplinary areas within the educational scientific or educational and artistic fields of study
	Ability to integrate knowledge, solve complex problems and make judgments based on available containing information on social thinking and ethical responsibilities associated with the implementation of their knowledge and judgments
	Able to clearly and unambiguously convey knowledge and professional way of reasoning
	Ability to pursue studies in a way independently selected.

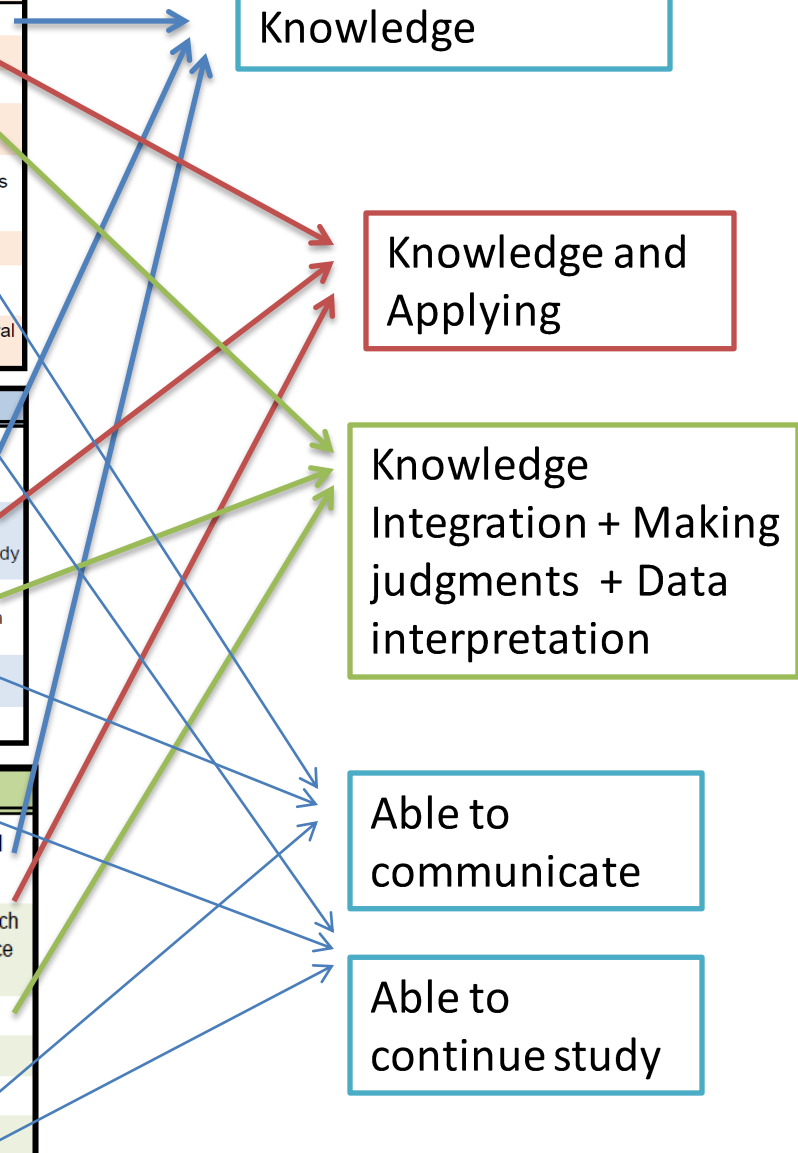| Level	Level descriptors
ECTS 180 **EHEA QF** **Level 1** **EQF** **Level 6**	Demonstrated knowledge in the field of study that is based on previous education at a level that allows use and includes some aspects that rely on key knowledge of the field of study
	Apply the knowledge and understanding of the manner that indicates a professional approach to or profession and who have skills that are commonly reported coming up with the defence arguments and solving problems within the field of study
	Ability to collect and interpret the necessary data
	Ability to discuss the relevant social, scientific or ethical issues
	Able to discuss their work and inform the professional and general public
	Developed the skills necessary to continue study

Knowledge

Knowledge and Applying

Knowledge Integration + Making judgments + Data interpretation

Able to communicate

Able to continue study

FCE - BSc study - Geodesy

Level	BSc course-specific descriptors	
	Existing model	**New model proposal**
ECTS 180	Apply geodetic measurements to establish a geodetic reference network and reference surface	Explain the principles, theories, tools, and techniques of surveying and land information
	Apply the ground for aerial photogrammetric surveying	Appropriately apply specialised knowledge in land surveying and land information management and other transferable skills appropriate to a wide range of disciplines
	Apply different methods of geospatial data gathering	
EHEA QF Level 1	Taking part in digital geospatial data bases creation and maintenance	Use the skills required to work independently and as a member of a team
	Topographic maps preparation	Critically examine land surveying and land information management problems and develop solutions within the context of given specifications and standards
	Taking part in Land consolidation and expropriation works	
EQF Level 6	Management, development and maintenance of real estate and utility cadastres	Confidently develop and effectively communicate professional opinions on topical issues
	Cartographic works on the development of topographic maps and maps for special purposes	
	Surveying engineering works	Establish a sound basis for lifelong, self-motivated academic and professional studies
	Works on geodetic technical documentation	

SKILLS

Knowledge

Knowledge Apply

Skills –
Team work,
Critical thinking
Making judgment,
Communication
LLL

FCE – MSc study – Geodesy

Master Level	MSc course-specific descriptors
ECTS 120 **EHEA QF Level 2** **EQF Level 7**	Surveying work on the establishment of geodetic reference network geodetic reference surface and determining the external gravitational field
	Apply knowledge in geodetic metrology work
	Research and geodynamic monitoring of spatial displacement
	The field preparation for the air and terrestrial photogrammetric work
	Work on the designing and maintaining the digital geospatial data bases
	The state survey and establishment and maintenance of real estate cadastre
	Geodetic-technical works in the land consolidation and expropriation
	Cartographic works on the development of topographic maps and maps for special purposes
	Works in surveying engineering
	Implementation of scientific research projects
	The lower education level teachers training
	Carrying out the real estate valuation
	Management works in the real estate market designing
	Development and maintenance of geospatial information systems
	Perform a variety of analysis and interpretation of geospatial data

Small research

Applied oriented

- *No principles and theory*
- *No creative thinking*
- *No communication*
- *No team work*
- *No integrative components*
- *No judgement and social components*
- *No LLL*

Interior oriented

Management in Real Estate only

Sectoral QF
FCE – MSc LM - Proposed

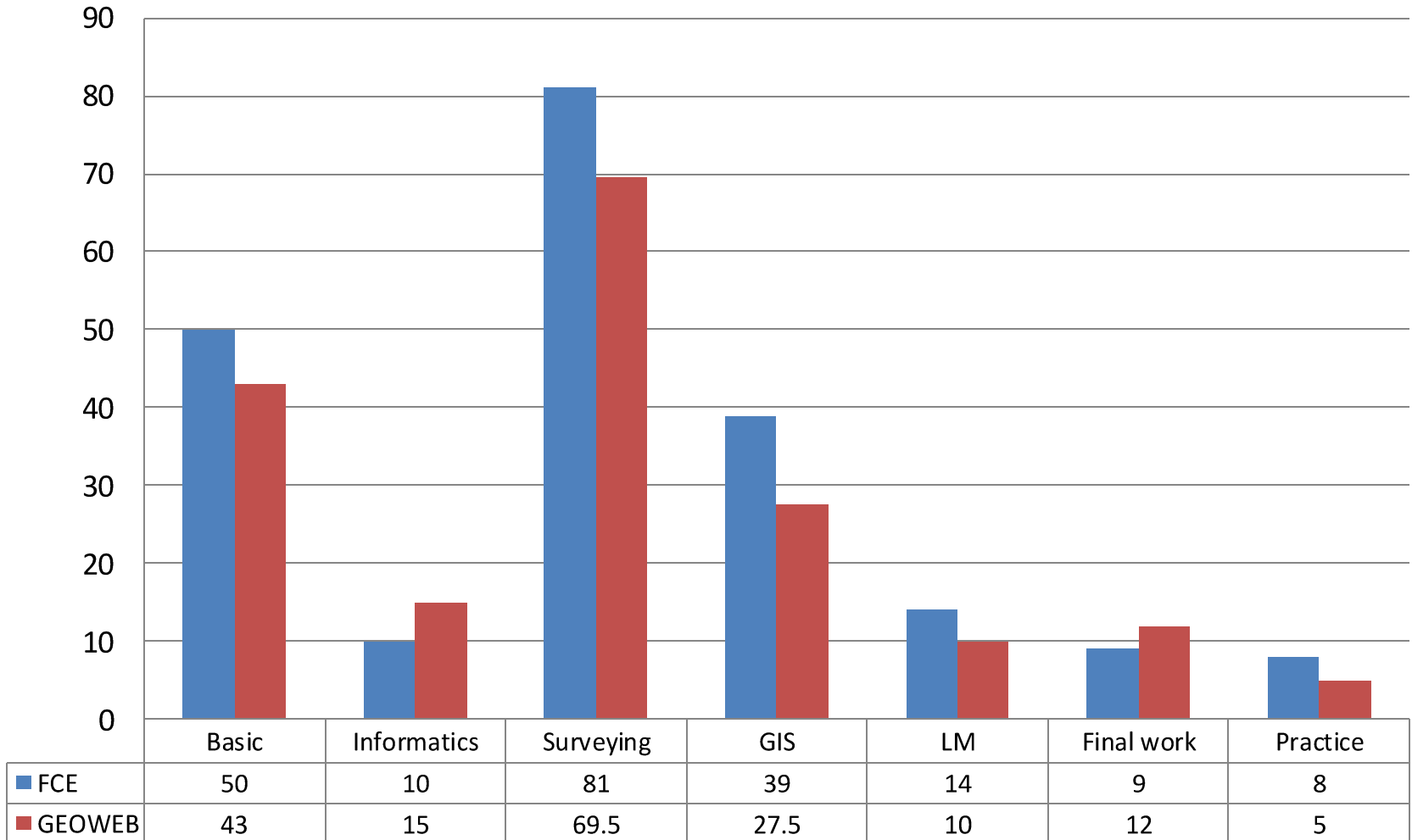|			
Domain specific Learning Outcomes	1	Explain the basic theories, concepts and methods in the field of Land management (land surveying or geoinformatics)	K&U
	2	Apply the knowledge and tools for the acquisition, storage, analysis, visualisation and dissemination of geo-spatial data	Applying K&U
	3	Investigate the usability of Land management (land surveying or geoinformatics) in geo-spatial problems	Applying K&U
	4	Create Land management (land surveying or geoinformatics) solutions for an application domain	Applying K&U and making judgements
Scientific specific Learning Outcomes	5	Analyse concepts, approaches and methods and reflect upon scientific literature, with special reference to the field of Land management	Applying K&U and making judgements
	6	Design a research plan in the field of Land management (land surveying or geoinformatics) and critically reflect (under supervision) on the phases of a scientific research process	Applying K&U and making judgements
	7	Carry out a research in the field of Land management (land surveying or geoinformatics) by using adequate methods and techniques to collect and interpret data	Applying K&U and making judgements
General academic Learning Outcomes	8	Communicate clearly - both orally and in writing – to present the outcomes of their research and design projects and discuss these results with specialists and non-specialists	Communication
	9	Function effectively in international multidisciplinary teams	Applying K&U
	10	Respond to social, organizational, scientific and ethical issues that are encountered in the field of Land management (land surveying or geoinformatics)	Making judgements
	11	Reflect critically on their performance and results, as well as on those of colleagues	Making judgements
	12	Design and plan their own learning processes in the domain of Land management (land surveying or geoinformatics) based on experiences from working in this domain	Learning skills

Theory
Tools
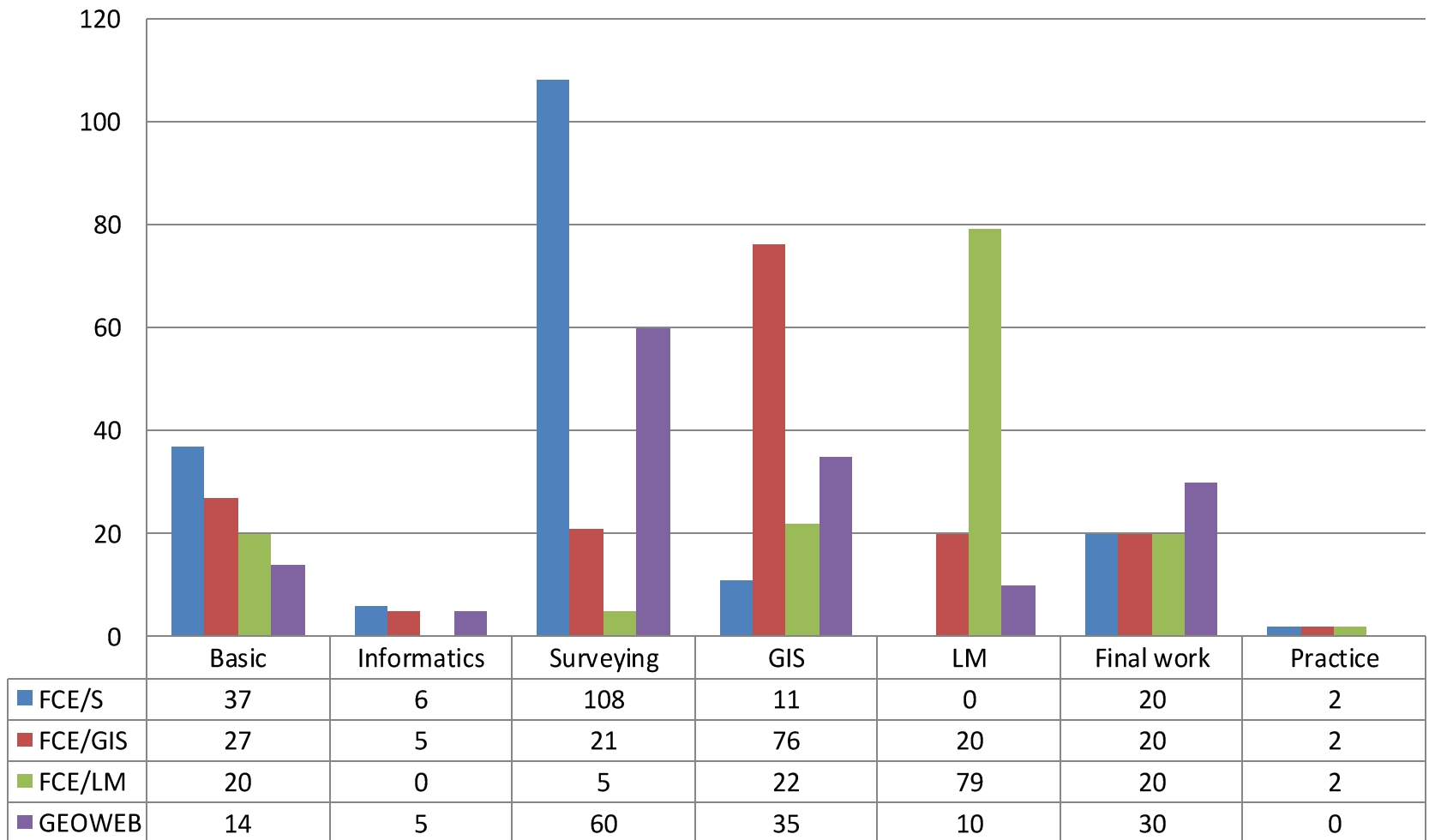Usefulness
Problem solving

Analysis
Designing
Carry out

Communication
Team work
Social components
Critical thinking
Work based learning

FCE – GEOWEB similarities and diffrerences

BSc :FCE=GEOWEB

	Basic	Informatics	Surveying	GIS	LM	Final work	Practice
FCE	50	10	81	39	14	9	8
GEOWEB	43	15	69.5	27.5	10	12	5

MSc : FCE≈GEOWEB

	Basic	Informatics	Surveying	GIS	LM	Final work	Practice
FCE/S	37	6	108	11	0	20	2
FCE/GIS	27	5	21	76	20	20	2
FCE/LM	20	0	5	22	79	20	2
GEOWEB	14	5	60	35	10	30	0

NEW FCE courses

NEW FCE courses

- **Global geopotential models (GGM)**

- **Precise GNSS Point Positioning**

- **Laser Scanning**

- **Geovisualization**

Global geopotential models (GGM) – 5ETCS

- Boundary value problem (BVP). Dirichlet's problem.
- Solution of BVP by means of spherical harmonics.
- Zonal harmonics. Tesseral harmonics. Sectorial harmonics. Surface harmonics.
- Satellite orbits and spherical harmonics.
- Determination of geopotential coefficient by terrestrial measurement.
- Determination of geopotential coefficient by satellite measurement.
- Determination of geopotential coefficient by combination of terrestrial and satellite measurement.
- Other BVP of potential theory (Neumann's problem, third boundary value problem,…)
- Global Geopotential Models (GGM).
- Dedicated satellite missions.
- Determination of free air anomaly by GGM.
- Determination of height anomaly by GGM.
- Use of GGM in the process of determining the geoid by Remove-Compute-Restore method. Combination of GGM, gravity measurements and Digital Terrain models.
- Degree Variances and Error Degree Variances and their usages.
- Tailoring of GGM

Precise GNSS Point Positioning – 6ETCS

- GNSS architecture: space segment, control segment, user segment
- Principle of GNSS positioning. Satellite navigation systems: GPS, GLONASS, GALILEO, BEIDOU, QZSS.
- Basic PPP model
- Functional PPP model: classic model, UoC model.
- Modelling of geometric range. Correction due to Earth rotation. Basic stochastic model.
- PPP error sources
- Satellite error sources: satellite ephemeris and clocks, satellite orientation, antenna phase center, differential code biases.
- Receiver error sources: receiver clock, antenna phase center, differential code biases, cycle slips.
- Environmental error sources: troposphere delay, ionosphere delay, multipath. 8 Tidal and loading error sources: earth body tide, ocean tide loading, atmospheric pressure loading.
- Other error sources: relativistic effects, phase windup.
- PPP estimation
- Least squares method. Kalman filter. The state vector. Calculating the expected observations. Design matrix.
- Observation stochastic modelling. Parameter stochastic modelling. 12 Quality control and outlier detection. Feasibility of PPP.PPP applications
- Static and kinematic positioning, possibilities and accuracy.
- Atmospheric research, weather forecast, ionospheric studies.
- Time transfer.

Laser Scanning – 5ETCS

- Basic measurement principles and components of laser scanners.
- Airborne laser scanning (basics, ALS systems, operational aspects).
- Terrestrial laser scanning (basics, terrestrial laser scanners, operational aspects).
- Mobile mapping.
- System calibration.
- Basics of LiDAR data processing and management.
- Point cloud structuring and visualisation.
- Registration and georeferencing of point clouds.
- Point cloud data formats and software tools.
- Accuracy, quality assurance and quality control of LiDAR data.
- Filtering of point clouds and DTMgeneration.
- Feature extraction from LiDAR data (roads, buildings, vegetation, etc.).
- Integration with other sensors.
- Laser scanning applications (forestry, engineering, cultural heritage, etc.).

Geovisualization – 5ETCS

- Cartographic fundamentals.
- Visual variables: spacing, size, orientation, shape, arrangement, height, hue, value, saturation.
- Mapping discrete features.
- Treatment of continuous surfaces.
- Introduction to thematic mapping.
- Statistical mapping.
- Space-time visualization and 3D visualization
- Introduction to multimedia and web cartography.
- Data models and data formats; Model based visualization
- Standardization and formats KML, VRML, GEOVRML, CITYGML; WEBGL, glTF
- Cartographic visualization for Web, SLD ;
- Virtual globes.
- Virtual reality - VR and augmented reality - AR
- Smart cities.
- Map mashups.
- Volunteered geographical information.