ASSESSMENT OF LEARNING OUTCOMES IN HIGHER EDUCATION

-Assessment guides learning -

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Introduction

• What underpins effective teaching? Main forms are related to
  – the subject
  – teaching methods
  – the ways in which students develop and learn (Calderhead, 1996)
  – awareness of the relationship between learning and teaching („learning moments”) (Entwistle, 2000)

• Students testify and teachers witness:

Assessment guides learning
Motivation

• The most prominent goals of higher education
  – providing students with knowledge skills and competences (employability)
  – develop critical and abstract thinking, metacognitive skills...

• Assessment guides learning

• Therefore:
  – Teaching should encourage deeper learning (Entwistle, 2000)
  – Take into account real life authentic situations and problem solving (Poya, 1945; 1985)
  – Give students opportunity to inquire (Dewey, 1938), (Freudenthal, 1991; Brousseau, 1997; Schoenfeld, 1992)
  – Assessment criteria aligned with intended learning outcomes (Biggs 2000, ESG 2015)
  – Assessment methods should be carefully chosen and implemented in concrete learning context within the subject (Divjak, 2015)
Content

• Assessment of LO
• Critiques of LO approach
• Constructive alignment
• Assessment methods
• Assessment criteria and rubrics
• Two case studies:
  – Problem solving
  – Peer assessment
• Learning analytics as an indirect assessment toolkit
• External evaluation of LOs – qualification frameworks
• Discussion and conclusions
Questions to be asked

How to ensure that LOs, instructions and assessment are consistent? – evaluation

What is important for students to learn? – learning outcomes

What assessment methods to choose to get reliable and meaningful information about students' achievement of intended LOs? – assessment

How to organize teaching and learning that the majority of students achieve LOs? – design of instruction
Learning outcomes – COVERED BY D. KENNEDY

• are statements of what a learner knows, understands and is able to do on completion of a learning process (EQF)

• are defined in terms of knowledge, skills and competence
  – Knowledge - facts, principles, theories & practices related to a field of work or study
    • theoretical and/or factual knowledge
  – Skills - ability to apply knowledge and know-how to complete tasks & solve problems
    • cognitive (logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments)
  – Competence - proven ability to use knowledge, skills and personal, social and methodological abilities in work or study & in professional and personal development
    • responsibility and autonomy

• are used as a basis for credit transfer and accumulation as well in qualification frameworks

• can be achieved in
  – formal, non-formal and informal learning environment
  – f2f or ODL environment
Learning outcome based assessment

Benefits

• Student-centered learning paradigm
• Solid bases for building assessment criteria on and focus teaching, learning and assessment
• Connect different levels: qualifications, study program, courses, learning units (chapters)
• Understandable to employers
• Transparent to students
• In line with EQF, Bologna process recommendations and national regulation

Questions?

• Are all LOs measurable?
• How to capture implicit or tacit knowledge or process of learning?
• Can generic (transferable) skills be separated from subject-specific and assessed?
• How to guarantee achievement of LOs in big learning groups?
• Assessment task should promote deeper approach to learning – how to translate IBL in LO?
• How to translate values and attitudes in LOs (Affective Domain) as well as Psychomotor skills? DK
Learning outcomes accompanied

• What to expect from students?
• In which context?
• How to assess that?

*Example:*

*student will be able to*

• ‘apply algorithms of the graph theory to solving problems with use of the algorithms by herself or in a team (which performance will be assessed by grading rubrics...)’

• ‘define (and present) basic notions of learning outcomes in a way to prepare material and present in 20 min (that will be peer assessed...)’

• Usually we omitted assessment but keep it in mind all the time
Constructive alignment

- aligning LOs with teaching and learning and with assessment
- term coined by John Biggs (Biggs, 1999, 2003)
- intended LO and assessment criteria, and the use of criterion based assessment
- tasks and experiences which are
  - authentic, real-world and relevant
  - constructive, sequential and interdisciplinary
  - require students to use and engage higher order cognitive processes
  - aligned with each other and the intended learning outcomes
  - provide challenge, interest and motivation to learn
Assessment is the systematic collection and analysis of information to improve student learning and to evaluate achievement of intended learning outcomes.

MAIN STEPS to start with:

• Rethinking existing practice and connect it to LOs
• Selecting when and how often to assess
  – Formative and summative assessment
  – Take into account student group size, pre-knowledge, conditions
  – Use of technology enhanced assessment
• Selecting assessment methods
• Construction assessment and planning associated feedback...
• ...

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Assessment methods

Direct

– Tests, standardized exams
– Writing essays
– Presentations: oral, poster, exhibition
– Self-evaluations, peer-evaluations
– Case studies
– Critics, debates
– Problem solving
– Lab measurements, practicums
– Projects
– Discussion, participation marks
– Business plan
– Prototype
– Software developed
– Portfolio
– Research paper...

Indirect

– Survey
– Job placement
– Employer survey
– Focus group discussion
– Exit interviews
– Alumni tracking surveys
– Learning analytics
– Graduation and retention rates
– Acceptance rate in further education
– External and internal curriculum and study program evaluations
– Study program rankings
– ...

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# Tool for assessment planning at the course level – based on constructive alignment

<table>
<thead>
<tr>
<th>Study program LO</th>
<th>Course specific LO</th>
<th>Student activity – T&amp;L method</th>
<th>Assessment method</th>
<th>Student workload (ECTS)</th>
</tr>
</thead>
<tbody>
<tr>
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## Tool for constructive alignment

<table>
<thead>
<tr>
<th>Study program LO</th>
<th>Course specific LO</th>
<th>Teaching and learning method</th>
<th>Assessment method</th>
<th>Student workload /ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>apply for R&amp;D grants</td>
<td>use of methods and techniques of project management when writing applications for international project in the field of higher education</td>
<td>team work in (virtual) teams – preparing concrete R&amp;D project application following set-up procedure</td>
<td>project application posted in a LMS and assessed according to predetermined criteria (rubric)</td>
<td>40 hours = 1.5 ECTS</td>
</tr>
</tbody>
</table>
## Tool for constructive alignment – Case study I (DMGT)

<table>
<thead>
<tr>
<th>Study program LO</th>
<th>Course specific LO</th>
<th>Teaching and learning method</th>
<th>Assessment method</th>
<th>Student workload /ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>apply mathematical methods, models and techniques appropriate for solving problems in the field of information and business systems</td>
<td>solve real world problems in ICT with methods from graph theory and discrete maths (individually and in teams)</td>
<td>team work in (virtual) teams – Defining/solving practical problem implemented in wiki</td>
<td>Teacher assessment + peer assessment of two stages of problem formulation and problem solving</td>
<td>55 hours = 2 ECTS</td>
</tr>
</tbody>
</table>

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Assessment criteria - rubrics

- A rubric is a grading tool used to describe the criteria used in grading the performance of students.
- A rubric consists of a set of criteria and marks or grades associated with these criteria.
- Rubrics help to:
  - Define the assessment criteria
  - Describe performance
  - Establish a rating scale (weights – AHP!)
  - Communicate to students – support learning
  - Assure consistency between teachers
  - Organize feedback (LMS!)
  - Engage students into assessment design and in assessment
## Assessment criteria – rubrics – Example 1

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Levels of achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic covering, mathematical soundness</strong></td>
<td></td>
</tr>
<tr>
<td>Topic is not covered or the essay is partly</td>
<td>Topic is partly covered but not deeply understand it is not mathematically sound (1)</td>
</tr>
<tr>
<td>copied (0)</td>
<td>Topic is partly covered and mainly deeply understand but mathematical rigor is missing. (2)</td>
</tr>
<tr>
<td></td>
<td>Topic is covered, well understand and mathematical rigor is present. There is no innovative elem. (3)</td>
</tr>
<tr>
<td></td>
<td>Topic is covered, well understand and mathematical rigor is present. There is innova. (4)</td>
</tr>
<tr>
<td><strong>Text formatting, pictures, graphs</strong></td>
<td></td>
</tr>
<tr>
<td>Essay is not structured according to given</td>
<td>Essay is structured according to given rules, but no additional elements or it is not written in prescribed length (1)</td>
</tr>
<tr>
<td>rules or the essay is partly copied (0)</td>
<td>Essay is structured according to given rules, there are justified additional elements (2)</td>
</tr>
<tr>
<td></td>
<td>Essay is structured according to the given rules, there are justified additional elements prepared by student. (3)</td>
</tr>
<tr>
<td><strong>Citations, literature, language</strong></td>
<td></td>
</tr>
<tr>
<td>No reference list or it is not written in</td>
<td>It has reference list with correct citation but mainly web references. Language is acceptable. (2)</td>
</tr>
<tr>
<td>standard language or it is partly copied (0)</td>
<td>It has reference list with different sources (web sources, books, articles) &amp; correct citation. Good use of language. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case study 1: Non-structured mathematical problems and their assessment

- **Discrete Mathematics with Graph Theory** (DMGT)
- 1st year master level of study programs Information Systems and Software Engineering at the Faculty of Organization and Informatics, University of Zagreb
- Blended learning course
- Sylabus: discrete mathematics & graph theory and its applications
- 120 + students
- 1 professor + 2 teaching assistants
## Constructive alignment on the course DMGT

<table>
<thead>
<tr>
<th>Study program learning outcome - relevant for the course</th>
<th>Course specific learning outcome related to the study programme learning outcome</th>
<th>Teaching and learning method</th>
<th>Assessment method</th>
<th>Student workload - ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply mathematical methods, models and techniques appropriate for solving problems in the field of information and business systems</td>
<td>Solve real world problems in ICT with methods from graph theory and discrete maths (individually and in teams)</td>
<td>Students work in teams of three on posing and solving authentic problems – online work</td>
<td>Teacher assessment and partially peer assessment of two stages of problem posing and problem solving based on prepared criteria and scoring rubrics</td>
<td>40 hours = 1.5 ECTS (approx. 20% of the course 7 ECTS)</td>
</tr>
</tbody>
</table>

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Phases in problem solving on DMGT

I. phase: problem recognizing and posing

evaluation of phase I and redistribution of problems

II. phase: problem solving and presenting

evaluation of phase II by peers and teachers

... a problem is only a problem if you don’t know how to go about solving it. A problem that has no “surprises” in store, and can be solved comfortably by routine or familiar procedures (no matter how difficult!) it is an exercise. (Schoenfeld A., 1983.)
Assessment criteria

I. Phase:
1. Problem relevance
2. Problem description
3. Characteristics of solution

II. Phase:
4. Linking given problems with theory of DMGT (modelling)
5. Strategy of solving
6. Characteristics of the solution
7. Implementation of the solution and interpretation
8. Written and oral presentation
9. Teamwork

Rubrics

AHP group decision making on weights

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Benchmark for students - feedback
Students’ perspective

What was difficult for you?

- Posing problem: 35
- Solving problem: 1
- Implementation of solution: 7
- Presentation and writing: 1
- Nothing: 13

No. of students
Student’s comments

• „Idea of project work is ingenious and it is obvious which teams really work hard on it, show mathematical knowledge but also can solve real problems. This kind of approach is missing generally in mathematics.”

• “I think it should be more clearly defined what is being asked in this task, put 2-3 good examples on the Moodle to give us a clue what is expected.”
Case study 2 – learning enviroment & RQs

• The course Project Management
  – Master Level of Entrepreneurship Study Programme
  – Action research during three years period
  – 131 students were enrolled in 3 years
  – First two years all students’ tasks were assessed only by teachers based on scoring rubrics

• Research questions:
  1. How to prepare peer assessment to be reliable and valid and at the same time enhance mutual learning?
  2. What is student perception about peer assessment, assessment standards and criteria and mutual learning activity?
  3. Is deeper learning approach encouraged by peer assessment?
Peer assessment

Advantages:

(1) *Logistical* - saves teachers time
(2) *Pedagogical* - additional opportunity for students to deepen their understanding about a topic deeper learning, student active learner
(3) *Metacognitive* - demystify testing and students become more aware of their own strengths, progress and gaps in knowledge and skills – increase student autonomy; better understanding of own subjectivity and judgement
(4) *Affective* - make students more productive and cooperative, build greater sense of shared ownership for the learning process - increase responsibility


Disadvantages:

(1) *Logistical* - additional briefing time – plan extra time
(2) *Reliability* - risk with respect to reliability, students assessing their peers – anonymized tasks, LA check
(3) *Equalizing* - tendency to award everyone the same mark – LA check on patterns
(4) *Metacognition* - not all students are well quipped to undertake the assessment – LA analysis on reliability, start with low stake tasks

– Source: B. Divjak, M. Maretić, 2015
Scoring rubrics in Moodle Workshop

• Essay grading by the following criteria (weight of criteria):
  – C1 - Topic covering, soundness (3)
  – C2 - Essay structure (2)
  – C3 - Text formatting, pictures, graphs, examples (2)
  – C4 - Language and grammar (1)
  – C5 - Referencing (1)

• Criteria and levels described in details

• Implemented in the Moodle Workshop assessment package
  – Students submit their work during the Workshop activity
  – Submissions assessed by teachers, students and their peers
  – Workshop allows multi-criteria assessment based on scoring rubrics
  – Students obtain two grades in a single Workshop activity
    • grade for their submission
    • grade for assessment
  – Great source of data for LA
Evaluation of peer assessment by LA

Analysis of criteria
Benchmark for a student

Reliability of peer assessment

<table>
<thead>
<tr>
<th>Academic year</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>2014/15 (n=62)</td>
<td>6.40/9</td>
</tr>
<tr>
<td>2013/14 (n=34)</td>
<td>(5.62/10) = 6.24/9</td>
</tr>
<tr>
<td>2012/2013 (n=35)</td>
<td>(6.11/10) = 6.79/9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of grades within the 2-point span</th>
<th>Number of grades that equal or exceed the 2-point span</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>85%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Average grade
Peer assessment – student perspective

Agreement with the claim:

**Peer assessment of essay and projects motivated me on new way of thinking and learning**

Source: anonymous questionnaire at the end of the course; total no of answers 45 - out 62 that attend the class
Conclusions

• Assessment as a teaching tool
• LOs are important but also teaching and learning process matters
• Helpful tools: rubrics, learning analytics, e-assessment
• Formative and summative assessment task that promote learning
• Give feedback to students on achievements and ways to improve
• Encourage higher cognitive skills and creativity
• Check regularly on student workload
• Assessment tasks to accommodate the needs of different students
• Be aware strengths and limitations of particular assessment method
• Goal: students as self-reflective and self-regulated learners
References

- Divjak, B. Assessment of complex, non-structured mathematical problems. IMA International Conference on Barriers and Enablers to Learning Maths: Enhancing Learning and Teaching for All Learners M.A. Hersh and M. Kotecha (eds.), 2015.
- Divjak B., Chapter: Implementation of learning outcomes in mathematics for non-mathematics major by using e-learning in the book: Teaching Mathematics Online: Emergent Technologies and Methodologies; Editor(s): A. A. Juan; M. A. Huertas; S. Trenholm; C. Steegmann; IGI Global. 2012.


If we teach today’s students as we taught yesterday’s, we rob them of tomorrow.

- John Dewey -

Discussion

THANK YOU

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