

Assessment for problem-based learning

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ABSTRACT: When designing a new educational unit on organisational behaviour, special attention was paid to the constructive alignment of the assessment procedure with the learning outcomes and educational concept. In order to optimise the fit with the principles and philosophy of problem-based learning, the assessment was designed to support the process of constructive, collaborative, contextual and self-directed learning. In a final two-hour session, each problem-based learning team is required to analyse a case study and report their diagnosis and suggested interventions in a case study paper with an accompanying set of PowerPoint™ slides. Design and delivery of this innovative approach to summative team performance assessment are reported and results show that students appreciate the educational value of the approach and consider it enhances their conceptual skills and competence in contributing to constructive teamwork.

KEYWORDS: assessment design, assessment for learning, assessment mix, assessment session, constructive alignment, problem-based learning (PBL)

Introduction

Assessment for learning

Assessment is one of the major drivers in students' study activities (Gijbels, Dochy, Van den Bossche & Segers, 2005; Gijbels, Van de Watering & Dochy, 2005; Boud & Falchikov, 2007). The first thing students do when entering a new module or unit is figuring out how they will be graded and what case studies, assignments, tests and performances are most critical for passing. Students will check the relevant parts of the syllabus for information about assessment and grading, and will consult their fellow students for tips and tricks to improve their chances of success. The better informed they are, the better they can design an optimal strategy for success that would meet their preferred level of effort and output (Schuwirth & Van der Vleuten, 2011a; Cilliers, Schuwirth, Herman, Adendorff, & Van der Vleuten, 2012).

While students consider assessment as a hurdle that they need to take in order to pass a module, schools need tests and assessments to assure whether participants have obtained the necessary skills, knowledge and attitudes — together referred to as competencies — to warrant a particular qualification, certificate or diploma. In order to be able to make valid judgments about competence mastery of participants, the school uses tools and instruments with proven quality. In the context of assessment, quality is generally measured and expressed in terms of validity, reliability, utility and acceptability (Ebel & Frisbie, 1991).

During the latter decades, the focus of assessment has shifted from assessment *of* learning to assessment *for* learning (Boud & Falchikov, 2006). Assessment for learning is "an approach in which the assessment process is inextricably embedded within the educational process, which is maximally information rich and which serves to steer and foster the learning of each individual

student to the maximum of his/her ability" (Schuwirth & Van der Vleuten, 2011a, p. 478). Assessment for learning provides information about the competency level and competence development of a student, obtained with various instruments at different assessment moments (Schuwirth & Van der Vleuten, 2011b). Peer and self-assessment is considered to be an essential element in the process of problem-based learning (Dochy, Segers, & Sluijsmans, 1999; Segers & Dochy, 2001; Gielen, Dochy, & Onghena, 2010; Sridharan & Boud, 2019).

When teamwork and collaboration are key elements in the learning process, collaborative assessment seems the appropriate approach to enhance educational alignment (Sandahl, 2009; 2010; Bloom, 2011; Vogler & Robinson, 2016; Efu, 2018; Schmulian & Coetzee, 2018).

This article reports on the construction and implementation of an assessment format that was designed to be optimally aligned with the principles of problem-based learning (PBL), demonstrating the idea of constructive, collaborative, contextual and self-directed assessment for learning.

A case study in educational design

In the academic year (2013/2014), a new third-year unit was developed as part of a four-year Bachelor in Business Administration programme at a Dutch hotel school. The hotel school uses problem-based learning (PBL) as the primary educational approach. The main subject areas which had to be addressed in the new unit were "psychology of management" and "organisational behaviour", so the unit was called "Psychology of Management and Organisation" (PMO). The unit is scheduled as a four-week course for three European Credits. Each week, one key driver of organisational performance is addressed. In week 1, the impact of individual behaviour on organisational performance is studied; in week 2, the impact

of team behaviour; in week 3, managerial behaviour; and in the fourth week, the topic is the impact of systemic factors on organisational performance. Every week two PBL sessions are scheduled (see Table 1). The first PBL session each week takes 90 minutes and is devoted to discussing some designated chapters of the required textbook. This can be considered to be a study task. Theories and concepts from the book are summarised, discussed and evaluated using different methods like concept mapping, mini-lectures, discussing own work experiences and mutual testing. The second PBL session each week is a 135-minute trial of the final assessment session (referred to as the "Assession") that will take place in week 9 of the module.

Constructive alignment

When designing the unit, attention was given to constructive alignment (Biggs, 1996) between the three components of the educational configuration: (1) learning outcomes; (2) teaching and learning activities; and (3) assessment.

Learning outcomes

The unit's learning outcome was formulated as follows:

Upon successful completion, the student is able to describe, analyse, conceptualise, and explain organizational behaviour using appropriate theories that help generate viable and feasible interventions to enhance the organizational performance at individual, team and managerial level (Unit syllabus PMO, 2018).

More specifically the following set of unit objectives were included:

Students are able to...

- analyse a problem with sufficient depth and breadth;
- identify and describe the issues to be addressed;
- construct a conceptual representation of the key issues, concepts and mechanisms;
- make an informed choice of theories to be applied to the case study;
- suggest viable, feasible and suitable interventions;
- outline the implementation plan;
- use key performance indicators and decide about contingency plans;
- produce a professional case study paper;
- prepare a professional PowerPoint™ presentation; and
- manage teamwork and deal with group dynamics.

TABLE 1: A regular week in the PMO unit

Day	Activity
Monday	Study indicated chapters of the textbook (read, summarise, analyse, explain, relate, compare, criticise, illustrate, apply). (Output: individual written summary reflecting a thorough and critical analysis as outlined above)
Tuesday	PBL1 Discuss the theory. (Input: individual written summary of the designated chapters)
Wednesday	Apply diagnostic approach to the case. (Output: individual written case paper)
Thursday	PBL2 Trial assessment session. (Output: Case study paper and PowerPoint™ presentation)
Friday	Start preparation for next week.
Weekend	Study indicated chapters of the textbook.

Teaching and learning activities

The hotel school where the unit was developed has used problem-based learning as their leading educational concept for more than 30 years (Zwaal & Otting, 2015). The core characteristics of PBL are:

1. Learning is student-centred;
2. Small group, constructive, collaborative and competence-based learning;
3. A tutor is present as a guide;
4. Real-world contextualised problems are presented as the trigger for learning;
5. The problems are used to achieve the required knowledge and problem-solving skills; and
6. New information is acquired through self-directed learning (Barrows, 1996; Schmidt, Van der Molen, Te Winkel, & Wijnen, 2009; Van Berkel, Scherpbier, Hillen & Van der Vleuten, 2010).

The total study load of the unit is three European credits (84 hours), or approximately 20 hours for each of the four weeks. The two PBL sessions per week will take up about four hours, leaving 16 hours for self-study and preparation for the PBL sessions. In order to keep up with reading the indicated chapters of the book, we assumed students should be able to read 10 pages per hour, considering the length and level of the textbook.

Assessment

As part of the educational design process, an approach to assessment was constructed that would support attaining the learning outcomes, match and enhance the principles of PBL, and satisfy psychometric standards. When, in the six characteristics of PBL listed above, the word "learning" is replaced with "assessment", an interesting set of potential criteria for assessment in PBL occurs:

- Assessment is student-centred;
- Small-group, constructive, collaborative and competence-based assessment;
- A tutor is present as assessor;
- Real-world contextualised problems are presented as the trigger for assessment;
- The assessment task enables students to demonstrate their mastery of required competences; and
- The assessment session might raise issues and interest for further self-directed learning.

These guidelines have all been included in the design of a new assessment method, called the assessment session or, shorter, the "Assession".

Assession

The assessment session or "Assession" is a summative team performance assessment that takes 135 minutes and includes the following activities.

Assessment case study

A case study is provided at the start of the session. Every module period, two new assessment case studies are constructed by members of the tutor team, one for the "assession" on Tuesday for the groups who had "Psychology of Management and Organisation" (PMO) in weeks 1 to 4, and another one for the "assession" on Thursday for the groups who do the unit PMO in weeks 5 to 8. Case studies can cover any mix of levels

(individual, team, managerial, systemic) and combination of topics and chapters from the mandatory textbook by Robbins and Judge (2018).

Guidelines for the construction of assessment case studies are:

- The case study includes three to five key issues;
- The case study covers at least two of the four levels of organisational behaviour (individual, team, managerial, systemic);
- The case study is two to four pages long;
- Exhibits are always included with a purpose; and
- The case study should be about an organisation from the hospitality industry.

Assessment case studies are always screened, reviewed and edited by two members of the PMO tutor team. An excerpt from an assessment case is shown in Box 1.

Case study paper and PowerPoint™ slides

The team has two hours to produce a case study paper of

approximately 1 500 words, using a framework called the diagnostic approach (Gordon, 2001). This approach consists of eight parts, which also determine the sections of the case study paper (Figure 1): (1) Description; (2) Key Issues; (3) Diagnosis; (4) Conceptual model; (5) Interventions; (6) Informed choice; (7) Implementation plan; and (8) Contingency plan. Additional to the case study paper, the team has to prepare a set of PowerPoint™ slides that could be used for a presentation.

When writing the case study paper students can apply the set of guidelines shown in Box 2.

Script

In order to manage the task dimension as well as the team dimension of the process, students develop a script for the two-hour assessment session. This script includes the distribution of roles, a timeline, some rules of engagement and it is adapted, if necessary, after every trial assessment session (Table 2).

BOX 1: Excerpt from a case study

9 July 2014, a sunny Wednesday, early in the morning, Ellen and Louis, along with some other colleagues, were waiting for the meeting to start. The meeting was supposed to shed light on why their fellow sales rep, George, had been absent from work for a couple of days. A few moments later, Eddie, the manager of the sales team, walked in, along with Dianne, the secretary.

Eddie greeted everyone cheerfully. After a few polite exchanges concerning the weather, he said, "George is not with us anymore, we had to let him go. He was not making his sales numbers and things were simply not working out. It is the best for everybody this way. But I have good news as well. We have hired a new sales rep to replace George, his name is Jerry. He will be starting on Monday."

Some in the meeting seemed surprised by the news, but not Ellen and Louis. They had long known that Eddie did not like George and thought someday, given the opportunity, Eddie would try to get rid of George. But still, they felt upset that their teammate and friend George had been fired, and they were angry that Eddie tried to make it appear that it was the best for all involved. What made them even angrier was that in the same breath, Eddie announced that Jerry, the replacement for George, was starting the following Monday.

The way Eddie saw it...

Eddie was 33 years of age, single, holder of an MBA degree from a respectable business school. In early 2012, Eddie started working as the sales manager in this hotel and he hired Ellen, Louis, and George shortly thereafter. This was the first time he directly managed a group of employees. He was pleased to see that the team was functioning quite well initially. But gradually, he sensed that there was some tension and dissatisfaction in the team. Eddie attributed these negative emotions to George because it was usually George who would bring up complaints about sales policies or team management, and the team would normally back him up. George also often played the role of the devil's advocate. In Eddie's view, many group discussions were interrupted because of George's questions and remarks. George created a disruptive atmosphere within the sales team, Eddie thought.

By mid-2014, it seemed George would not be able to meet his seasonal revenue targets. Upon consulting with his supervisor, Eddie decided that this would be the right time to terminate George's contract. He had never fired an employee before and was therefore somewhat nervous about the thought. But Eddie believed that this was the best way to solve his problem. Although this would be a relief to him personally, he was concerned about how the team would take it. Based on what he had heard from other employees, Ellen, Louis, and George not only had a good business relationship, but were also friends outside the confines of the office. Eddie did not want the firing of George to negatively impact the morale of the sales team. But he still thought, for the long run, this was the right decision. He was just unsure how the team would react to his decision of letting George go.

<p>1.1 Description</p> <ul style="list-style-type: none"> • Company characteristics • Key stakeholders • Facts & figures 	<p>2.1 Diagnosis</p> <ul style="list-style-type: none"> • Apply theories & concepts from the book to explain key issues • Use contemporary theories • Don't use too many theories 	<p>3.1 Interventions</p> <ul style="list-style-type: none"> • At least 10 interventions • Some radical solutions could be included 	<p>4.1 Implementation plan</p> <ul style="list-style-type: none"> • What • Who • How • When • KPI
<p>1.2 Key issues</p> <ul style="list-style-type: none"> • 3 to 5 • Formulated as problems 	<p>2.2 Conceptual model</p> <ul style="list-style-type: none"> • Max 10 concepts • Use neutral concepts • Clearly distinguish (in) dependent variables • Indicate the mechanisms involved 	<p>3.2 Informed choice</p> <ul style="list-style-type: none"> • Select the 3-5 most promising interventions • List the criteria used • Score the interventions on the criteria • List your selection rule 	<p>4.2 Monitoring & contingency plan</p> <ul style="list-style-type: none"> • Clearly state the decision rule • Formulate plan B

FIGURE 1: The Diagnostic Approach Matrix

BOX 2: Guidelines for the case paper

1. Title page including group-code, names and student numbers, tutor, title of the case study, date.
2. The Description generally covers 200–300 words and can include a table with relevant facts & figures.
3. Most cases contain 3–5 Key Issues, which should be formulated in a concise but clear way as a problem to be solved.
4. The Diagnosis will cover about 800 words and contains 4–5 theories that are applied to explain the phenomena in the case and address the key issues.
5. The Conceptual Model includes a maximum of 10 key concepts, that are formulated in a neutral way, with the independent variables (drivers, causes, input) on the left side and the dependent variables (outcome, effects, output) on the right side. The CM is expected to cover the key issues and is the link between diagnosis and interventions.
6. The long list with Interventions should contain between 10–15 potential solutions, possibly including a few wild or radical ideas.
7. Informed choice. Students should explicitly and clearly list the criteria they applied when making a selection from the long list. The selection process should lead to 3–5 most viable or promising solutions. A justification should be provided as well.
8. For the Implementation Plan a table can be used with the following columns: What, How, Who (is involved (1) and responsible (2)), When, and a (measurable and quantified) KPI. If text does not fit into the table, it can be written below the table.
9. The Contingency Plan (also referred to as Plan B). If the interventions happen to be unsuccessful (include the decision rule), what alternative plan will be considered or implemented?

TABLE 2: Example of a script

Time	Action	Who	Typist 1	Typist 2	PP
12:30–12:40	Reading the case study	Group			
12:40–12:45	Description	Group	Description		1
12:45–12:55	Key issues	Group		Key issues	2
12:55–13:20	Diagnosis	Subgroups	Diagnosis (1, 3, 5)	Diagnosis (2, 4)	3
13:20–13:30	Conceptual model	Two specialists present it to team		Conceptual model	4
13:30–13:40	Interventions	Group; brainstorm	Interventions		5
13:40–14:00	Informed choice	Group		Informed choice	6
14:00–14:15	Implementation Plan	Subgroups	Implementation plan	7	
14:15–14:25	Plan B	Group	Plan B	Finalise PowerPoint™ slides	8
14:25–14:30	Review/editing	Together	Review and edit	SAVE FILE!	

Peer and self-assessment

The last 15 minutes of the assessment session are spent on peer and self-assessment, and completing an evaluation form about the unit. For the peer and self-assessment procedure, every student receives a form with the names of all students of their PBL group. All students score all team members (including themselves) with an A, B or C, according to the following condition: exactly one third of the team members should be categorised in A or C. That would imply that in a team of 12 students, four students (no more, no fewer) should be assigned to category A or C. This could be any combination of As and Cs as long as their sum is four. Peer and self-assessment scores are assigned anonymously and are further processed by the unit coordinator. They combine all scores (as shown in Table 3) and identify the (one-third of team size) highest numbers in A or C. The students that end up in category A will receive 80% of the team score, the ones in B 100%, and the ones in C will have the team score weighted (multiplied) by 120%.

Tutors will not interfere with the peer and self-assessment scores assigned by the students. Earlier research has shown very high agreement between student and tutor ratings. It is a powerful and consequential tool for students for mastering an important managerial skill: evaluating the performance of one's colleagues and oneself (Falchikov, 2005).

At the moment, there is no requirement to use both category A and C, so we often see that one third of the team is assigned to C and no one ends up in A. Since that is statistically and psychologically almost impossible, we are considering adding

the extra condition to use both A and C when scoring the team members.

Grading

The case study paper and PowerPoint™ slides are independently graded by the assessor and the tutor. The average of their scores determines the team score.

The case study paper is graded with ten different criteria, as shown in Table 4. Each of the four steps in the diagnostic approach (description, diagnosis, interventions, implementation) is divided into two sections, representing the first eight grading

TABLE 3: Results of peer- and self-assessment and final individualised scores

PMO Group K						Team score: 6.1
Name	Number	A	B	C	w	
1 Peter	1234		10		1	6.1
2 Marian	2341		12		1	6.1
3 Felix	3412	4	8		0.8	4.9
4 Jenny	4123		7	5	1.2	7.3
5 Hanliu	2134		4	8	1.2	7.3
6 Petra	3241		9	3	1	6.1
7 Jon	4312	2	10		1	6.1
8 Lesley	1423		10	2	1	6.1
9 Vasilev	2143		5	7	1.2	7.3
10 Bart	3214		10	2	1	6.1
11 Shannon	4321	1	11		1	6.1
12 Tatiana	3124		12		1	6.1

TABLE 4: Assessor scores and inter-rater agreement

	Group A		Group B		Group C		Group D		Group E		Group F	
	Tutor	Assessor	Tutor	Assessor	Tutor	Assessor	Tutor	Assessor	Tutor	Assessor	Tutor	Assessor
	A	B	C	D	D	C	B	E	F	A	E	F
Description												
Problem analysis	7	7	5.5	5	6.5	6.5	8	8	7.5	6	7	7
Key issues	7	5	6	5	6.5	6.5	7.5	6	7.5	7	5	7.5
Diagnosis												
Concepts & theories	6	5.5	4	5	6.5	4	4.5	6	6	6	7	6.5
Conceptual model	6	6.5	5	5	6	5	6	6	5.5	6	5	5.5
Interventions/solutions												
Interventions (longlist)	8	6.5	5.5	5	6	6.5	7.5	7	7.5	7	7	6
Informed choice	7	7	4	5	5.5	3	5.5	5	7.5	7	6	7.5
Implementation												
Implementation plan	7	7	6	5.5	6	7	5	3	6.5	6	6	6.5
Evaluation & plan B	7	6	5	5.5	6	5	5	5	4.5	6	4	5.5
Reporting												
Academic writing	6	7	5	5	6	7	6	6	8	7	7	8
PP-slides	7	8	6	6	7	6	7	6	7	7	6	7
	6.8	6.6	5.2	5.2	6.2	5.7	6.2	5.8	6.8	6.5	6.0	6.7
Difference	0.2		0		0.5		0.4		0.3		0.7	
Groupscore:	6.7		5.2		5.9		6.0		6.6		6.4	

criteria. Two further criteria are added: Academic writing and the PowerPoint™ slides. For every one of the ten criteria, a score between 1 and 10 is assigned by two independent raters: the assessor who was supervising the team during the assessment session, and the tutor who coached the team in the regular eight PBL sessions during the four weeks of the unit. The average of their grades is the team score, which is used as the point of reference when calculating the individualised final score.

The assessor scores (Table 4) are not shared with students, but are used to monitor the inter-rater agreement. If the difference in the final case study paper mark between two graders is 1 point or more, the unit coordinator will arrange for a third assessment to bring the difference within the set margin. To prevent substantial differences between assessors, calibration sessions are arranged for tutors several times a year to discuss the different grading criteria of the case study paper.

Individualised final score

An individualised score is subsequently calculated using the peer and self- assessment ratings of all members of the PBL group.

As shown in Table 8, the four highest numbers in columns A and C are linked to Jenny, Hanliu, Vasilev, and Felix. The first three will be awarded 120% of the team score, while Felix will end up with 80% of that team score, causing him to fail the unit, the only one in his team.

The example shows the potentially serious consequences of the peer and self-assessment procedure. To avoid the score coming as a surprise, the procedure is also used in the trial "assessments" in the four weeks of the unit. Should students receive As in that period, they can ask their peers what they could or should do to improve their performance.

Conclusion: Does the procedure meet the assessment criteria?

When looking at the desired constructive alignment between educational concept (PBL), learning outcomes, educational activities and assessment, the procedure satisfies many

criteria. The assessment session is collaborative, constructive, contextual, student-centred and supportive of competence development (Segers & Dochy, 2001; Boud & Fachikov, 2007; Kemp, Atfield & Tong, 2010).

When looking at the psychometric criteria, the method scores very well on transparency, since not only are all grading criteria available from the start of the unit, but their application and interpretation is actively practised by having students grade their own case study papers four times, after every second PBL session in the unit. Students are even encouraged to compare their scoring with that of their tutor, all in an effort to generate better grading and a better grade.

Another great benefit of the method is the built-in veracity of the final products (case study paper and PowerPoint™ slides). Since all output is produced on the spot in the two-hour session, no further checks are needed to verify whether the work was done by the ones listed on the title page of the case study paper. And with no internet connection allowed during the assessment session, both plagiarism and ghost-writing can be firmly excluded.

To test validity and reliability of the method, additional research is needed in which a team should preferably participate in two assessment sessions, in order to measure the stability (test-retest) and transferability (domain-specificity) of their performance.

The assessment session approach is generally evaluated quite positively by students ($M > 7$ out of 10), although they sometimes express some resistance regarding the peer and self-assessment procedure. The two-hour high pressure assignment is appreciated and considered valuable for future real-world teamwork.

What is considered the strongest asset of the approach is what could best be referred to as its educational value or "educativity". The "assessment" tests and trains students in essential competencies like managing teamwork, communication, planning, organising, academic reading and writing, conceptual thinking, practical acting, but most of all in

mastering the quintessential competency of assessing your own and other people's performance, whether using an absolute, relative or intra-individual standard.

Although team-testing has been applied in several formats before, like collaboratively answering multiple-choice tests, doing project work, or making group assignments, the current approach is different in several respects. Students do not have to choose a consensual answer to a multiple choice item (convergent), but are expected to choose relevant theories and concepts from the textbook to describe and explain what is happening in the case study, followed by an informed choice of interventions that may solve the key issues in the case study (divergent). Contrary to project work or group assignments, which are generally scheduled for an extended period of time, the assessment session is limited to two hours in an allocated room. The restriction in time and the fixed location most closely resembles the assessment centre approach. The difference with the group assignment in an assessment centre is that participants in an assessment centre have not met before and have had no opportunity to practise team and task management in advance.

All in all, we think that a summative PBL session where performance is dependent on managing both the team and task dimensions might be a promising innovation in assessment for learning in higher education.

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