

Towards skill-based evaluation in a hybrid learning context: an experience in Aircraft Maintenance

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Abstract

COVID19 forced Higher Education to take place virtually. The evaluation process was particularly sensitive, mostly if it involved written tests. Still, it posed an opportunity to revise learning activities and evaluations. The Aircraft Maintenance course at UPV was driven from a content-based evaluation toward a skill-based one, replacing an open answer test with a thorough assignment. Student grades and surveys motivated the perpetuation of the activity once students were back in a classroom.

Keywords: skill-based evaluation; hybrid learning; aircraft maintenance; written reports.

Resumen

La COVID19 obligó a la Educación a tener lugar virtualmente. El proceso de evaluación se vio afectado, máxime si consistía en pruebas escritas. Pero fue una oportunidad para revisar actividades de aprendizaje. La evaluación de la asignatura Mantenimiento de Aeronaves de la UPV viró de centrada en contenidos a centrada en competencias, reemplazando una prueba escrita por un trabajo académico intenso. Las calificaciones y sondeos motivaron que este enfoque continuara de vuelta a la presencialidad.

Palabras clave: evaluación centrada en competencias; aprendizaje híbrido; mantenimiento de aeronaves; informes escritos.

INTRODUCTION AND OBJECTIVES

As opposed to the traditional content-based learning methodologies, skill-based learning aims at building knowledge by developing practical expertise in a particular area. This learning method and the use of active methodologies end up relating to the so-called *deep learning* in contrast to *surface learning* (Baeten, 2010), allowing students to think critically and communicate effectively with others as well as developing them as lifelong learners. Some authors found the assessment methods have a strong impact on the approaches taken by students to a subject, with multiple choice examinations encouraging surface learning and assignment essays assessing higher levels of cognitive processing (Scouler, 1998). The present work depicts an experience of replacing an open answer test by a thorough written assignment in search of deep learning in an Aircraft Maintenance course.

The Aircraft Maintenance course at Universitat Politècnica de València (UPV) belongs to the 4th year (8th semester) of the "Aircraft" speciality with an enrolment rate of 45-50 students per year. It is conceived to provide students with knowledge of defining maintenance in design and to develop the ability to maintain the airworthiness of an aircraft fleet. It is therefore linked to several learning outcomes such as the fundamentals of maintainability of a design; the maintenance of existing aerospace vehicles, powerplants, systems and facilities; and the ability to apply regulations in the exercise of the professional duties of an aerospace engineer. To this end, two main modules are proposed: a) Fundamentals of Maintenance Engineering; and b) Aircraft Maintenance Management. Additionally, the course works as a *control point* for three soft skills of the UPV institutional project (UPV, 2020): a) Effective communication, b) Knowledge of current issues and c) Planning and time management. Each of these is worked on in relation to demonstrating an understanding of the legislation applicable to European airline maintenance policy, to decision-making in maintenance engineering, to the day-to-day problems of aircraft maintenance management and, finally, to the complexity of scheduling the maintenance of an air fleet for a company.

Assessments are an important point in demonstrating whether a learning outcome has been achieved. On the one hand, a good assessment system allows students to have confidence on the quality of their training. On the other hand, it encourages employers to have confidence in accredited students. Until the 2018/19 academic year, learning outcomes in the Aircraft Maintenance course were mostly assessed through multiple-choice tests (40% of the course) for each module, a problem-based test for the first module (25%) and an open-response test for the second module (25%). Active methodologies were only used in the lab session reports (10%) (García-Cuevas, 2016) and most learning and assessment activities were content-based. The COVID-19 pandemic forced a virtual environment by the time the second module was developed in the 2019/20 academic year. This context did not encourage assessment through an open-ended test. Far from being a problem, shifting from face-to-face activities to remote or hybrid learning contexts was perceived as an opportunity to review the course activities and begin to steer them towards skills-based tasks and assessments, as it happened elsewhere (Ayuningtyas, 2020). Hence, the second open response test was replaced by a written task that would force students to train and develop the ability to understand and apply continuing airworthiness regulations.

The ultimate objective of the investigation is to assess whether the implemented methodology forces students to adopt a *deep learning* approach towards the course rather than a *surface-based* one, allowing them to attain a lifelong learning skill related to United Nations Sustainable Development Goal (UN SDG) 4. Hence, the specific objectives are:

- To propose a methodology that allows steering a course towards active learning.
- To gather evidence about the impact of the activity on student performance and opinion.
- To analyze the results to an extent that confirms if the proposed activity can be considered as a skill-based learning methodology rather than a content-based methodology.
- To develop a student's lifelong learning attitude towards aircraft maintenance that raises awareness on the opportunities of these disciplines in terms of UN SDGs 8 (Decent Work and Economic Growth) and 13 (Climate Action).

METHODOLOGY

The aforementioned module of Aircraft Maintenance Management is built around EU regulations 748/2012 (airworthiness certification) and, especially, 1321/2014 (continuing airworthiness). Considering how important but challenging is to teach technical regulations in engineering, this module is considered as ideal to shift the assessment from an exam with open-ended questions to a written task and thus promote students deep learning in this matter, which is the objective of this investigation.

The new written assignment for the course of Aircraft Maintenance was defined following the guidelines of other successful experiences (Carreres, 2019) in the framework of the Aerospace Engineering BSc. In this way, the statement of the assignment was provided two months before the deadline. There are 13 topics about aircraft maintenance that are randomly assigned to the students on the day that the assignment is described in class. Each student should upload in due time a report about a one of these contents: EASA vs FAA regulations, initial vs continuing airworthiness, Part M Subpart G vs Part M Subpart F vs Part 145, requirements for the update of Part M organizations, aircraft maintenance records, quality system, aircraft reliability program, personnel training requirements, line vs base maintenance, material support, component maintenance, design for maintainability and design and programming of maintenance checks. The assignment is therefore an opportunity for the students to dive deep into topics addressed in the theory lessons that would be of importance for a future career in aircraft maintenance.

For instance, regarding the topic of aircraft maintenance records, the assignment statement specifies the questions that a student report should answer on the basis of the corresponding regulations:

- Which type of tasks require maintenance records to be kept?
- Indicate which records should be kept by each type of organization involved in continuing airworthiness maintenance, emphasizing the differences.
- Specify for how long, where and under what conditions maintenance records must be kept by each organization involved.
- Analyze what happens if an airline buys a used aircraft from another operator and when a private individual buys a used aircraft from another private individual.
- Show an example of a maintenance record, analyzing the information it contains.

The statement of the assignment includes recommendations about the contents (as aforementioned) and the approach of the report, although the students are encouraged to ask the teacher for support whenever is required. In any case, an intermediate delivery of an unfinished version of the report is welcome by the teacher so as to provide feedback before the deadline, as it has shown to improve the result of the final report (Carreres, 2019). Besides, the scoring rubrics that will be used for evaluating each work are provided in advance, to encourage student self-assessment. The dimensions of these rubrics are: development of the assigned contents, identification of relevant regulations, identification and interpretation of relevant Acceptable Means of Compliance (AMCs), ability to relate the work with the course

contents, usage of real cases as examples, readability and usage of technical terms. For instance, relevant regulations can be identified in 4 levels: perfectly, well (with a slight omission or misinterpretation), fairly (only a small portion of the relevant regulations identified) or inadequately (irrelevant regulations identified and/or with conceptual mistakes). Please note that the academic assignment trains the students not only in the technical aspects of a course in aircraft maintenance but also in the soft skill of effective communication. For the later, the students are provided with a set of guidelines for written reports.

RESULTS

The implementation of the new learning methodology is evaluated from two different points of view. On the one hand, the results obtained by the students using the proposed learning methodology are compared with those obtained using the traditional one. On the other hand, the students' opinion is also analyzed with the objective of identifying whether the new methodology motivates and encourages an active student participation towards *deep learning*.

Students' evaluation results

Results obtained by the students after the evaluation process are analyzed in Fig. 1. Here, a comparison between the conventional methodology -based on open answer tests- and the proposed method is shown. The graph on left hand side shows the marks distribution obtained by the students for the second module evaluation. Inspection of the distribution itself does not seem to help to understand whether the methodology helps to improve the students' marks. However, the average value of the rates slightly increased with the new method (0.22 points), whereas the success percentage raised up to 98% (around of 9% of improvement). To quantify the impact of these results on all subject skills, the graph on the right shows the results of the complete evaluation process. Similarly, the average rates increased, improving the percentage of success from 95.7% to 98.0%.

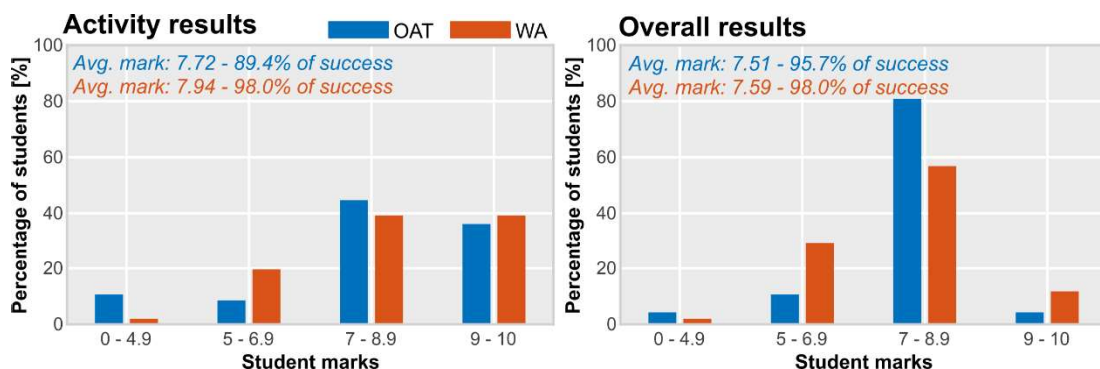


Figure 1. Results of the second module (left) and overall (right) evaluation procedures.
Legend: Open Answer Test (OAT), Written Assessment (WA).

These results may not be conclusive, as raw data of two different courses is being compared. In the long term, the impact of the assessment shift will be determined based on data from subsequent years. In any case, Fig. 1 shows a small improvement in the results, suggesting that the methodology contributes to a better acquisition of content and skills by the student

Subjective students' opinion

The subjective feedback from the students is ranged by a survey in which their perception about different aspects of the learning methodology is assessed. Student opinions were gathered at the end of the course through an anonymous poll, in which they are asked about key aspects related to the application of the learning methodology. Out of the total 8 poll questions, a subset of 4 is extracted due to its relevance on the learning objectives (Table 1).

Table 1. Selected poll questions.

Question #	Statement
Q.2	The methodology contributed to my achievement of the learning outcomes to a greater extent than an open answer test.
Q.4	I devoted more time to the report elaboration than I would have had to devote to an open answer test.
Q.6	I feel that I received a higher grade than I would have received on an open answer test.
Q.8	Overall, I liked the experience of this methodology.

In Fig. 2 the student percentage that agrees with the specific statements is shown, demonstrating a high degree of satisfaction with the new methodology environment. The high percentage of satisfaction is evident, evincing that the proposed methodology is well received by the aerospace engineering students. For instance, results of question Q.2, which focus on the skills acquisition, show remarkable high rates (above 75%), highlighting that the methodology helps students in the learning process.

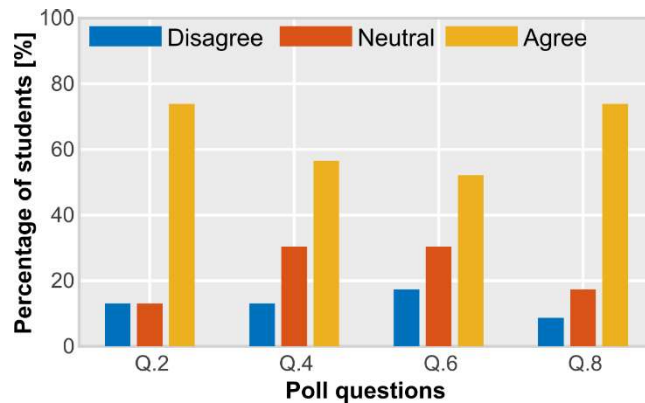


Figure 2. Anonymous poll results.

CONCLUSIONS

The present work attempted to investigate the effect of steering the evaluation from content-based (open answer test) to skill-based (written assignment forcing to navigate and integrate regulation text) on the acquisition of learning outcomes by students. The new assignment is a more remote and digital-friendly activity, as it was motivated by the shift from on-site teaching to virtual or hybrid learning contexts due to COVID-19 pandemic.

The discussed evidence is based on comparing the grades achieved by the students through both evaluations on the one hand, and analyzing their responses to a student survey about the topic on the other hand.

Results show that the average assignment grades were only slightly greater than their open answer test counterpart, although the success rate was improved. Anyway, the student opinion strongly reinforces the idea that skill-based evaluation was achieved, encouraging deep learning to a higher extent as suggested by the literature (Scouller, 1998).

It is important to note that the presented methodology is not restricted to *replacing a test by an assignment*, but is rather based on designing an activity that demands students to demonstrate their skills on the course through reflection and synthesis, in a process in which the teacher must accompany the student providing help and regular feedback.

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