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Approaching advanced alloys from a different perspective: from knowledge to practice

Abordando las aleaciones avanzadas desde otra perspectiva: del conocimiento a la práctica

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Abstract- In this study an evaluation method based on oral presentations is implemented over traditional written reports. The approach integrates collaborative learning and oral communication to improve soft skills development useful for the students' future professional career as well as enhanced learning and motivation. This approach has been implemented during the evaluation of laboratory sessions in advanced metal alloy courses at Universidad Politécnica de Madrid. The result of the method was assessed by a student survey, which is presented in this manuscript. Results indicate that 59% of the students agree with the adoption of this methodology based on the improved soft skills and knowledge retention. Nevertheless, some students prefer written reports given a higher flexibility and familiarity of this method. The findings open opportunities to improve the way of evaluation to facilitated deeper learning while enhancing the acquisition of professional skills during university studies.

Keywords: Collaborative learning, Evaluation, Active learning, Professional development.

Resumen- En este estudio se muestran los resultados de implementar un nuevo método de evaluación basado en presentaciones orales, en lugar de informes escritos. Este enfoque integra el aprendizaje colaborativo y la comunicación oral para mejorar el desarrollo de habilidades útiles en la futura carrera profesional de los estudiantes, así como para potenciar el aprendizaje y la motivación. La metodología se implementó en la evaluación de sesiones prácticas en cursos de aleaciones metálicas en la Universidad Politécnica de Madrid. Su efectividad fue evaluada mediante una encuesta estudiantil cuyos resultados se presentan en este manuscrito. Los resultados indican que el 59 % de los estudiantes apoya esta metodología debido a la mejora en la retención del conocimiento y el desarrollo de habilidades. Aunque algunos prefieren los informes escritos por su flexibilidad y familiaridad. Estos hallazgos abren oportunidades para mejorar la evaluación, favoreciendo un aprendizaje más profundo y el desarrollo de competencias profesionales.

Palabras clave: Aprendizaje cooperativo, Evaluación, Aprendizaje activo, Formación para el empleo.

1. INTRODUCTION

The enormous technological development in the twenty-first century requires the educational system to enhance certain skills among students, such as the development of creative thinking, the ability to solve problems, and collaborative work, which are key to the development of humanity (Martin, 2018; Pérez et al. 2005).

Skills included in critical thinking allow students to address a topic in depth, find relevant information, and make decisions with reasoning (Febri et al., 2019; Eryandi et al., 2020). In addition, critical thinking involves a series of attitudes and motivations, such as doing things well and making informed decisions considering the opinion of others. On the other hand, one of the main objectives of teaching is to capture the student's learning interests. In this sense, gamification is presented as a powerful tool, where this time the tools of the game are used to motivate and improve the participation of students in their learning process (Deterding et al., 2011; Ortiz-Rojas et al., 2025).

Students must maintain motivation for their own learning throughout their lives. In this sense, self-regulated learning is considered one of the key factors in lifelong learning (Dent and Koeka, 2016). The acquisition by students of self-regulatory learning skills increases the potential to improve both cognitive and self-cognitive skills. According to Zimmerman (2000), the self-regulated learning process goes through three stages: the planning phase, the execution phase, and the self-reflection phase. In the planning phase, the student analyses the difficulty of the task, considers his or her abilities, and establishes goals and strategies. In the execution phase, the student performs the activity. Finally, in the self-reflection phase, the student evaluates his or her work and analyses the relationship between the strategies used and the results obtained.

In this scenario, this work aims to increase the efficiency of the learning of metallic materials by undergraduate students. To this end, a strategy is designed that is instrumentalised in that students contextualise the experimental work they do in the laboratory in a broader scope, which they will find in their professional lives. This task, which is presented as a challenge, allows them to promote their motivation. The proposed challenge is faced through teamwork, which allows the development of their self-regulatory skills to be encouraged. The defence of a position and self-reflection are also encouraged. The ultimate goal is to evaluate the impact that the proposed strategy has on the efficiency of their learning process.

2. CONTEXT & DESCRIPTION

A. *Objectives*

The goals of the presented approach are directed to contribute to the improvements of lecturing in the following aspects:

1. Higher participation of the students in the learning process contributing to increase in their motivation by the application of "real" societal challenges in materials science.
2. Bringing the students closer to the research activities to better relate to the lecturers in their role as academic researchers.
3. Practical application of the theoretical knowledge, leading to a deeper understanding of the concepts studied in class.
4. Improvements in the use of soft skills such as: communication, oral presentation, teamwork, planning and leadership very important in their future professional life.
5. An opportunity to explore the research role as a professional alternative.

B. *Methodology*

The practical lectures performed in courses of advanced metal alloys focus in providing the students with applied knowledge to understand better the theory and to take a more active role in learning. These practical lectures study a variety of advanced alloys and their heat treatments for engineering applications. At the end of each session the students must collect the results and write a report in teams. The drawback of this approach is that the knowledge is acquired unevenly between the different group members. Additionally, this evaluation method has been the most used in other courses. Since the rise of artificial intelligence (AI) technologies theoretical knowledge is fully accessible for consultation and use in written reports. This is why a more dynamic project, with equal participation from all group members, would strengthen the acquisition and practical application of knowledge. The implementation of a new evaluation method will enable research-based-learning in which the causes and effect of the behaviour of the studied materials will be analysed by the students, leading to a comprehensive evaluation of the experiments. The results and discussion were presented orally by the students with equal participation by each team members. A brief written report was also handed in. This approach supports cognitive abilities and soft skills reaching higher levels in the Bloom´s Taxonomy pyramid according to Anderson et al. (2001).

The assessment criterion for the results and discussion presented by the students assigns 60% of the mark to the report, distributed equally between aspects such as structure and design, comparison of experimental data from other working groups and validation of data obtained in the laboratory. The remaining 40 % corresponds to the oral presentation, assessing aspects such as clarity, synthesis capacity and originality. The evaluation method presented in this study has been implemented partially in the first semester of 2024 – 2025 in the course "Aleaciones Aeroespaciales – Aerospace alloys" in the 3rd year of the bachelor's in aerospace engineering taught at the at the E.T.S. de Ingeniería Aeronáutica y del Espacio in Universidad Politécnica de Madrid. Furthermore, it is currently being implemented fully in the second semester of the same academic year in the course "Materiales Metálicos II – Metal Materials II" in the 2nd year of the bachelor's in materials engineering taught at the at the E.T.S. de Ingenieros de Caminos, Canales y Puertos, also, in Universidad Politécnica de Madrid. In total, 430 students were matriculated in the first course (I) and 85 students in the second course (II). In this article, the results of the first phase consisting of the partial application of this approach in course (I) will be presented. In course (I) the students are divided into three specialization groups. The sample of 46 students represents more than 10% of the student population. Students agreed to the survey on a voluntary basis, which could lead to a bias in favour of the proposed methodology. However, the total sample comes in a balanced way from the three existing specialisations, which reduces the chance of bias in the conclusions. However, we consider extending the analysis in future publications, incorporating a larger number of participants and a longitudinal evaluation to observe the impact in the medium and long term.

3. RESULTS

At the end of the course (I), the students were asked to answer a survey. The content of the survey was validated by the judgment of other lecturers. Furthermore, its reliability was validated by assessing the consistency of the student responses to the questions. The results of the survey are presented in this section which were also compared to the university student satisfaction evaluation survey at the end of the courses. Additionally, it was noted that the general marks obtained by the students in the practical's lessons were not largely impacted by this new evaluation methodology, which shows that even when it was a novel approach they adapted rapidly and delivered high quality oral presentations. A total of 46 students from three different specialization groups participated in the survey. The distribution of respondents was as follows: Ciencias y Tecnologías Aeroespaciales (CTA) accounted for 33.3%, Propulsión Aeroespacial (PA) comprised 20.5%, and Vehículos Aeroespaciales (VA) made up 46.2%.

Question 1: Do you think that evaluating the practices through oral presentations helped you assimilate the technical content of the course more effectively than through traditional written reports? (With 5 being the highest score)

With an average rating of 3.7, the results in Figure 1 show that 69.6% of the participating students are in favour (scoring 4 or more) of the usefulness of the methodology to assimilate technical concepts to a high degree. In fact, only 17.4% (scoring 2 or less) did not agree with the positive impact of this evaluation method in their learning process.

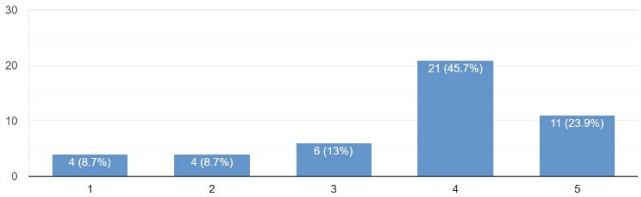

Figure 1. Results of the question 1 to the evaluation of this methodology.

Question 2: I would like to have a similar evaluation method (through oral presentations) in other courses about metallic materials.

According to the survey, 58.7% of the students are in favour of implementing the evaluation method based on oral presentations. This highlights the great support of students in favour of the use of collaborative tools and oral communication in the classroom. However, the results show the need to also

consider the skills traditionally developed by students when implementing teaching innovation. In fact, 41.3% of the participating students disagree with implementing the new methodology in the future, claiming a longer time spent in the laboratory work. This shows that they have difficulties in the use of social, organizational and oral communication skills, skills required in this evaluation method, as shown in Figure 2.

Question 3: Preparing and discussing the presentations for practices P2 and P3 helped me improve the following skills: Teamwork; Oral communication; Leadership skills; Organization and planning; I believe none; Other.

On the other hand, most of the students in favour with this new evaluation method, recognized the development of at least one of the soft skills presented in question 3. Only a small number of students (3 students) did not see the acquisition of the proposed soft skills set. The most recognized skill was the teamwork followed by organization and planning due to the higher effort and more interactions forced by this new evaluation in comparison to more traditional methods as written reports.

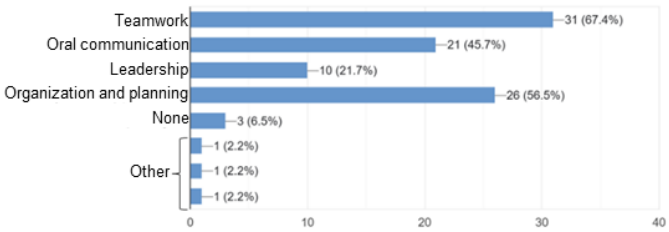

Figure 2. Results of the question 3 regarding the improvement of soft skills.

Question 4: Explain two positive aspects you have found in written reports in other courses compared to reports through oral presentations.

Question 5: Explain two positive aspects you have found in preparing reports through oral presentations compared to written reports.

In the last questions number 4 and 5 the survey allowed the students to freely mention the main advantages of the evaluation by the most traditional evaluation method to this new method by oral presentations and *vice versa*. When asked about the advantages of each method, some students were inclined to prefer one method to the other. Therefore, some of the advantages are found in both methods due to the preference of the students for each one.

Table 1. Student feedback on written reports *versus* oral presentations.

A-Written report	B-Oral presentation
A.1. Detailed	B.1. Enhanced learning
A.2. Simple development	B.2. Efficiency
A.3. Flexibility	B.3. Collaborative
A.4. Technical feasibility	B.4. Communication skills
A.5. Reference material	B.5. Professional development

In general, since the oral presentations were delivered as recorded videos, a group of students mentioned the difficulty in having to create and edit the videos in comparison to the written reports. Another group, on the other hand, mentioned that it was easier to create visual content that they enjoy more to develop together, and it is novel. The main ideas elaborated by the students regarding the written reports to oral presentations are presented in Table 1 and elaborated in the Discussion section. However, among the students in favour of implementing the new methodology, 80% consider that collaborative work and oral expression, when applied together, are valuable tools to achieve more meaningful learning. This highlights the positive benefit of the proposed methodology.

4. DISCUSSION

4.1 Impact in the learning environment of the students

- Detailed *versus* Enhanced learning (A.1./B.1.)

From the key points answered by the students in the open survey and summarized in Table 1, the main points of difference between the written reports and the oral presentations were that the first allows to elaborate more the written explanations (no size limit), while the oral presentations gave them the opportunity to better understand the contents preventing memorization and promoting knowledge retention. In Figure 3, the results were broken down by student group in which more of 50% of the students in CTA and VA recognize the benefits of the written reports on being able to add more content to the report but on the other hand the effectiveness of the preparation for the oral presentation in acquiring the theoretical knowledge. The PA students have a clear preference for the Oral presentations over the written reports. The VA students compose the group with the least preference for the new evaluation method or at least have not emphasized the capacity of the increased learning in their answers as the other two groups.

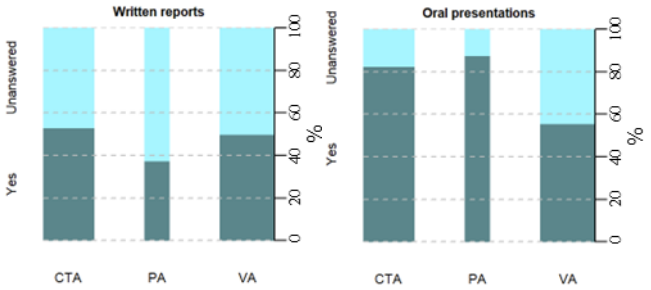

Figure 3. Comparison of written reports and oral presentation on the capacity of increasing learning.

- Simple development *versus* efficiency (A.2./B.2.)

A group of students recognized the benefits of the written reports in the simplicity of its development in addition to being the most common way of evaluating and therefore having more experience in the written communication. On the other hand, the students that preferred the oral presentation format claimed that even when the video recording meant another technical complexity, this way of evaluation was overall more efficient for knowledge acquisition. Additionally, they pointed out other advantages over the written format as it prevents plagiarism and writing a lengthy report also takes time. In Figure 4 the open survey data was analysed by group of students. In general, all groups recognized both ways of evaluating having as advantage regarding time spent.

Other aspects mentioned by the students were the flexibility of the written reports over the collaborative nature of the oral presentation. The first one requires less effort in planning and coordination, while the second one requires more team effort and results in higher quality of the final work.

While the written reports mean fewer technical difficulties than the oral presentation format due to the need for recording and video editing, the oral presentations improve the development of the communication skills of the students which is a positive skill in their future professional life. Finally, the students also point out that the oral presentation enhances their planning and coordination abilities which is associated to the teamwork. On the other hand, the written report serves as useful study resources.

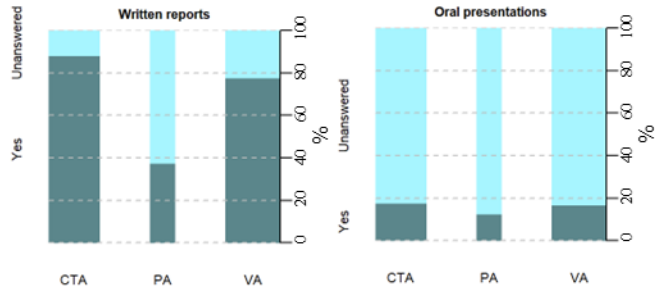

Figure 4. Comparison of written reports and oral presentation on the effort and efficiency.

4.2 Adoption of the evaluation method based on oral presentation

According to the survey, close to 59% of the students preferred the new method. Analysing and correlating the data in this graph with the results of the open questions 4 and 5, some conclusions were draft. From the students pro-oral presentation, they recognize in the majority that the oral evaluation is more effective in enhanced learning, however they sill recognize some benefits in the written reports. All the students recognize the simplicity of the written reports as a strong benefit independently on their preferences in evaluation method.

However, the oral presentation is not recognized for its simplicity but other benefits as acquiring important soft skills for professional life and consolidating better the theoretical knowledge. The student's pro-oral presentation don't see the lack of simplicity in the oral reports as a barrier for its adoption. On the other hand, students that vote against the adoption of the new method still recognize as an advantage the improvement of soft skills. Students recognise that, in the proposed methodology, individual participation within the group is more equal. This is reflected in the oral presentation. They reported no particular difficulties in recording and editing videos. However, written reports are reported to be more extensive content-wise than the brief presentation handed in by the students. The research indicates that some students prefer written reports because they are more used to them. Additionally, the students state that the written reports allow them to provide more detailed details of their findings. They also believe that completing these reports takes less time. Therefore, to improve the suggested methodology, it is recommended that students in the written report deepen the key results and incorporate the challenges faced, particularly with audiovisual tools and task allocation. This report aims to refine the evaluation process by integrating elements in terms of learning and teamwork.

5. Conclusions

This study presents an evaluation method of the practical sessions (laboratory) based on oral presentation in video recordings developed by the students. This method combines the joint application of collaborative and oral communication tools, to contextualize the technical concepts learned in the classroom in the professional world. The aim of this method is for students to achieve a more meaningful learning and retain more knowledge limiting the use of AI tools to develop written reports. The results show a good reception by the students in which up to 59% agrees to change the evaluation method to the one presented in this study for future courses. The results also highlight the need to consider the skills traditionally used by students to optimize the proposed methodology in the future. The suggested approach might be applicable to various educational settings. However, the extension of this approach to other subjects with larger number of students can present some challenges. For example, the correction of a large number of videos can be challenging with the current number of lecturers. This could be overcomed by reducing the length of the videos or incorporating the students in the correction of their colleagues (as a peer review exercise).

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