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CAPRAM and ClassTrack: Progressive learning management tools in mass groups

CAPRAM y ClassTrack: Herramientas de gestión del aprendizaje progresivo en grupos masivos

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Abstract- The increasing student-to-teacher ratio in higher education presents a challenge for maintaining personalized learning and effective assessment processes. This study introduces two technological solutions, CAPRAM and ClassTrack, designed to enhance progressive assessment in large student groups. CAPRAM automates grading and feedback through barcode/QR-based evaluation, while ClassTrack ensures academic integrity by verifying student attendance and test authorship. The study evaluates the impact of these tools in three courses with different methodological approaches, demonstrating a significant reduction in grading time and faster feedback delivery. Results highlight the effectiveness of these technologies in improving the learning experience and instructional efficiency. Furthermore, the study reflects on the necessity of such digital solutions in massified educational environments, emphasizing that while increased faculty availability would lessen the need for automation, current constraints make these innovations essential for sustaining high-quality education.

Keywords: ICT development, Progressive assessment, Large student groups, Learning management systems (LMS), Learning analytics

Resumen- El aumento de la proporción de estudiantes por docente en la educación superior representa un desafío para mantener la personalización del aprendizaje y la eficacia de los procesos de evaluación. Este estudio presenta dos soluciones tecnológicas, CAPRAM y ClassTrack, diseñadas para optimizar la evaluación progresiva en grupos numerosos. CAPRAM automatiza la calificación y retroalimentación mediante códigos de barras/QR, mientras que ClassTrack garantiza la integridad académica verificando la asistencia y autoría de pruebas. Se evaluó el impacto de estas herramientas en tres asignaturas con diferentes metodologías, evidenciando una reducción significativa en los tiempos de corrección y una entrega más ágil de retroalimentación. Los resultados subrayan la efectividad de estas tecnologías en la mejora del aprendizaje y la eficiencia docente. Además, se reflexiona sobre la necesidad de estas soluciones digitales en entornos masificados, señalando que, aunque una mayor disponibilidad de profesorado reduciría la necesidad de automatización, las restricciones actuales hacen que estas innovaciones sean fundamentales para mantener la calidad educativa.

Palabras clave: Desarrollo de TICs, Evaluación progresiva, Grupos numerosos de estudiantes, Sistemas de gestión del aprendizaje (LMS), Analíticas de aprendizaje

1. INTRODUCTION

Higher education institutions face the challenge of maintaining high-quality learning experiences in large student groups, particularly in technical or practical disciplines. According to data from the Spanish Ministry of Science, Innovation, and Universities (2024), the average number of engineering students enrolled at Escuela Superior de Ingenieros de Minas y Energía - Universidad Politécnica de Madrid (ETSIME-UPM) between 2015 and 2024 was 1,442. This large student body necessitates innovative approaches to address the difficulty of personalized learning and timely feedback. Traditional methods struggle to provide individual attention in such contexts, which can contribute to bottlenecks in students' progress (Sturts & Mowat, 2012).

This study proposes a novel system to support the process for progressive evaluation aimed at improving learning outcomes in large student groups by leveraging cutting-edge technologies, including barcode/QR-based rapid feedback and integration with Moodle. The project addresses critical challenges in learning progression monitoring and avoid fraudulent practices (taking of assessment tests by non-students) during Moodle tests that could be taken remotely (outside the classroom without the teacher's control). The system's development introduces a quick-feedback mechanism that ensures efficient tutorial interventions, thereby advancing the state of the art in personalized education. Additionally, the implementation of active methodologies such as flipped teaching (Sánchez-Palencia et al., 2019) positions this initiative as a cornerstone in adapting traditional pedagogical models to the demands of contemporary educational environments.

2. CONTEXT & DESCRIPTION

A. Need for the Project

Large student groups present a significant challenge in terms of personalized teaching, effective monitoring, and timely feedback on academic performance. The proposed system addresses the critical need for scalable solutions that ensure efficient assessment and support individualized student

progress in these settings. By doing so, it directly improves both the learning experience and teaching efficiency.

B. Objectives

The project aims to achieve the following:

- Enhance student learning outcomes by implementing a progressive evaluation system that delivers immediate feedback on performance.
- Optimize the assessment process for instructors, particularly in large groups, through the deployment of an automated tool capable of classifying test results efficiently.
- Facilitate in-class tutorial interventions by enabling instructors to quickly identify and address common areas of difficulty during lessons.
- Promote active learning methodologies such as flipped teaching, fostering a more meaningful and practical educational experience.
- Prevent academic fraud by using barcode-based identification systems for secure identification of students during evaluation processes using telematic methods (Moodle).

C. Target Audience

The system is designed for first-year engineering students at the ETSIME-UPM, as these cohorts typically represent the largest and most heterogeneous groups. It also serves faculty members by equipping them with tools to streamline assessment and enhance their capacity for individualized instruction.

D. Activities and Resources

The project involves several key activities and methodologies, including:

- Development of a Rapid Feedback Tool: A software system capable of categorizing in-class assessment results and linking them to individual student profiles via QR/ barcodes. This facilitates quasi-real time monitoring of student progress and identifies bottlenecks (Sturts & Mowat, 2012).
- Integration with Moodle: The system is designed to work seamlessly with Moodle for conducting secure in-class tests, where barcodes ensure rapid student identification and enable automated feedback delivery.
- Implementation of Active Methodologies: The flipped teaching methodology (Sánchez-Palencia et al., 2019) is adopted to prioritize practical and collaborative activities during class time. The tool supports this by providing real-time feedback on in-class tasks, allowing instructors to resolve doubts and reinforce complex concepts effectively.
- Use of Heterogeneity to Enhance Learning: Drawing on prior innovations (Barrio-Parra et al., 2019, Fernández-Gutierrez del Álamo et al. 2018, 2019), the system incorporates multilevel collective intelligence strategies to harness the diverse prior knowledge levels of students in large groups.

E. Technologies and Techniques

This work proposes the development of software tools (computer programmes and smartphone applications) to facilitate the monitoring and management of large groups of students by teachers.

3. Results

A. Software Tools Developed

As part of this project, two software tools were developed: a desktop program named CAPRAM and a mobile application called ClassTrack. These tools were designed to address the challenges of managing large student groups while supporting the objectives of efficient assessment, personalized feedback, and academic integrity outlined earlier. CAPRAM addresses administrative challenges, such as tracking enrolment changes, automating grading processes, and efficiently organizing assessment data. ClassTrack complements this by ensuring academic integrity and simplifying attendance tracking, thereby reducing logistical burdens and fostering a controlled assessment environment. The CAPRAM software is an extended version of a previously developed programme (ECAM) (Barrio-Parra et al., 2018) applied to adaptive and cooperative learning systems in large groups of students and heterogeneous in terms of their initial level of expertise [6]. The CAPRAM software offers multiple functionalities for managing evidence of learning progress, as well as database utilities for student management. Its key features include:

- Identification of Repeating Students: CAPRAM enables the upload and comparison of multiple student databases across different academic years using unique identifiers (e.g., Moodle user IDs, email addresses, or QR/barcode identifiers). This feature allows educators to identify students who have previously completed non-recoverable mandatory activities, such as laboratory practices. This information is critical for planning and optimizing the use of educational spaces dedicated to such activities.
- Tracking Enrolment Changes: Given that academic courses often begin with an initial enrolment list that may change over time due to withdrawals or new registrations, CAPRAM allows for the detection of these modifications. By comparing updated lists, the tool identifies students who have dropped out or joined after classes have started.
- Automated Grade Input: CAPRAM facilitates the assignment of assessment grades to students by integrating barcode or QR code reading. These codes, generated using unique identifiers that are affixed to evaluation submissions by students. Educators can scan these codes with an optical reader (or ClassTrack App) to record grades directly into a database. Additionally, the tool provides the student's position within the roster, simplifying the organization of evaluated materials. This feature is particularly beneficial for reviewing assessments with students during feedback sessions.

ClassTrack is a mobile application compatible with Android devices, designed to scan barcodes and QR codes using smartphones or tablets. Its primary applications include tracking class attendance and managing progressive assessments in large student groups. The most significant feature of ClassTrack is its ability to verify the authenticity of in-class assessments conducted traditionally or via Moodle. By

enabling faculty to monitor and control the classroom environment, the tool ensures that assessments are completed by the appropriate students, minimizing opportunities for academic misconduct. For instance, it prevents students from completing Moodle-based tests outside the classroom or delegating tasks to others. ClassTrack employs the device's camera to scan codes and generates an Excel file containing attendance or evaluation data. This file can then be seamlessly integrated with the CAPRAM software to cross-reference attendance records with grades, further supporting efficient monitoring and evaluation processes.

B. Evaluation of the Utility of the Developed Tools

To assess the utility of the developed software tools, data were compiled regarding the time required for grading progressive assessment tests, recording grades, and providing feedback in courses employing different teaching methodologies.

Case Study 1: Chemistry

The progressive assessment in the Chemistry course, conducted in groups of approximately 90 students, involves written tests that combine theoretical questions and practical problems. These tests are administered at the end of each of the four laboratory sessions, which are spaced throughout the semester, with a duration of 20 minutes each. The teaching methodology is based on flipped classroom principles, wherein theoretical and practical content presented during lectures is complemented by illustrated guides and instructional videos hosted on dedicated YouTube channels (Sánchez-Palencia et al., 2019). Grading is performed manually, assigning numerical scores on a 0–10 scale. Grades are then entered manually into a shared Excel spreadsheet stored in a cloud repository. None of the software tools proposed in this project were used for these processes. Feedback is provided during two collective review sessions, where students are allowed to examine their evaluation tests in pairs. One session covers the first two laboratory practices, and the second covers the remaining two.

Case Study 2: Environmental Risk Assessment

The Environmental Risk Assessment course is delivered to a single group of approximately 60 students. Throughout the course, students are assigned tasks involving practical problems related to the thematic blocks of the syllabus. To monitor student progress, assignments are submitted through the Moodle course page, where the Turnitin tool is applied as a deterrent against plagiarism. Once submitted, assignments are reviewed by the instructor, and common doubts arising during the students' problem-solving process are addressed during dedicated sessions. These sessions also allow students to revise their own work under the instructor's guidance. Comprehension of the content within each thematic block is evaluated through Moodle-administered tests conducted in the class following the revision session. These tests, lasting approximately 10 minutes, combine multiple-choice and calculated-response questions. Students are required to use specially designed spreadsheets to solve the problems, which must also be submitted through Moodle to prevent plagiarism. The feedback is automatically generated, providing an explanation of the correct solution to each exercise. Attendance and authorship are monitored using the ClassTrack application, and results are subsequently integrated into the gradebook generated by Moodle using the CAPRAM software.

Case Study 3: Graphic Expression

In the Graphic Expression course, progressive assessment is conducted through individual submissions in two thematic blocks: "Visualization" and "Contour maps." The course is taught in groups of approximately 20 to 70 students. Due to the graphical nature of the exercises, students submit their work on paper, attaching a sticker with a barcode/QR code to identify themselves. The teaching methodology uses student monitors and group work, making use of the heterogeneity in the initial level of the students in a multilevel collective intelligence system that allows students to resolve doubts between groups during the course of the classes. The practical contents are complemented with audio-visual material and resolution guides that can be consulted within the flipped classroom methodology (Barrio-Parra et al., 2019, Fernández-Gutierrez del Álamo et al. 2018, 2019). Solutions to the exercises are published on Moodle, and the instructor evaluates the submissions, categorizing them into two levels: "good" and "poor." Grades are recorded using a barcode scanner integrated with the ClassTrack app and linked to the student profile through CAPRAM software. Feedback is provided to students during the following session. Students are encouraged to identify their errors by comparing their graphical results with the solutions published by the instructor on Moodle.

Summary of Findings

Table 1 provides a summary of the number of corrected examinations per assessment test per study case, the time spent in grading, the time required to transcribe grades into student rosters, and the delay between test completion and feedback delivery to students.

Table 1. Summary of results per case study: (a) Number of average tests corrected by teacher. (b) Time spent on correction (hours). (c) Time spent on transcription of marks (hours). (d) Time taken to obtain feedback (days). T#1, T#2 and T#3 correspond to the answers given by three teachers of the same subject. The numerical values correspond to the averages obtained considering all the progressive assessment tests carried out on the subject.

Case Study	(a)	(b)	(c)	(d)
1	54 T#1 90 T#2, T#3	6 T#1 10 T#2, T#3	0.25 T#1 1 T#2, T#3	15 T#1 15 T#2, T#3
2	60	0	0.5	0
3	80	2	0.25	1

The results indicate that in Case Study 1, the time spent by instructors on grading is the highest among the three cases. Additionally, the time required for grade transcription exhibits a non-linear increase as the number of records to be transcribed grows. This phenomenon is likely associated with the need to review large student rosters and correct errors introduced during manual transcription. These times could have been significantly reduced by implementing barcode/QR code scanning and the CAPRAM software. Furthermore, the time elapsed between test completion and feedback delivery is, by far, the longest in Case Study 1. This delay negatively impacts students' ability to track their progress and prevents instructors from identifying areas of misunderstanding in a timely manner. As a result, students may

struggle to keep up with the course content, potentially leading to disengagement and learning gaps.

In contrast, the methodologies applied in Case Studies 2 and 3 demonstrate a substantial reduction in grading time, grade transcription, and feedback turnaround compared to Case Study 1. In Case Study 3, the graphical nature of the assessment requires manual grading, yet the classification into two performance levels significantly streamlines the evaluation process. This not only reduces grading time compared to Case Study 1 but also drastically shortens the feedback delay, allowing students to quickly assess their performance. In Case Study 2, the theoretical-practical (non-graphical) nature of the assessments enables the automation of evaluations through Moodle. As a result, grading time for instructors is reduced to zero, and both students' feedback and instructors' insights into overall group performance are obtained instantaneously. This immediate feedback allows the instructor to reinforce concepts or clarify misconceptions in the same or subsequent class sessions, a strategy that can also be extrapolated to Case Study 3. However, in Case Study 2, the grade transcription time is slightly higher than in Case Study 3 due to the dual transcription process required when using the developed software tools. On one hand, ClassTrack is used to verify students' attendance in the classroom; on the other, results stored in Moodle must be transferred to the final gradebook. Overall, in Case Studies 2 and 3, the time required for instructors to monitor and assess student progress in large groups is drastically reduced compared to Case Study 1. This suggests that the proposed software tools and pedagogical strategies offer high utility in optimizing assessment and feedback processes in mass education settings. It should be noted that the comparison between case studies illustrates diverse scenarios and does not allow for direct causal inferences regarding learning outcomes, due to differing methodologies, assessment types, and prior levels of automation; however, the analysis remains relevant for evaluating differences in feedback delivery times.

4. Conclusions

The results obtained in this study underscore the effectiveness of the proposed tools and methodologies in optimizing the assessment and feedback processes within large student groups. The CAPRAM and ClassTrack systems have demonstrated their ability to significantly reduce grading times, streamline grade transcription, and enhance feedback efficiency. This improvement not only benefits students by providing timely insights into their progress but also alleviates the administrative burden on instructors, allowing them to allocate more time to personalized tutoring and content reinforcement. The sustainability of this initiative is reinforced by its scalability and adaptability to different educational contexts, particularly in disciplines with high enrolment and intensive assessment demands. The transferability of the proposed tools to other institutions and subject areas is straightforward, given their integration with widely used platforms such as Moodle and their reliance on standard barcode/QR technology. However, it is essential to recognize that the need for such digital solutions arises primarily from the challenges posed by massified educational environments. In an ideal scenario where higher education institutions could afford smaller class sizes and increased faculty resources, the necessity for automated assessment tools would be significantly diminished. In reality, however, the persistent shortage of faculty and growing student numbers make the implementation of such technology-driven solutions crucial for maintaining educational quality. The findings of this study suggest that the integration of these tools into mainstream academic practices can substantially enhance the efficiency and equity of assessment in large classrooms, providing a model for improving learning outcomes in resource-constrained settings. The developed tools could be used to track student attendance and assignment submissions, providing valuable data for analysing course engagement. This information could contribute to the evaluation of key indicators used in degree program reports, supporting data-driven decision-making in academic performance assessment.

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