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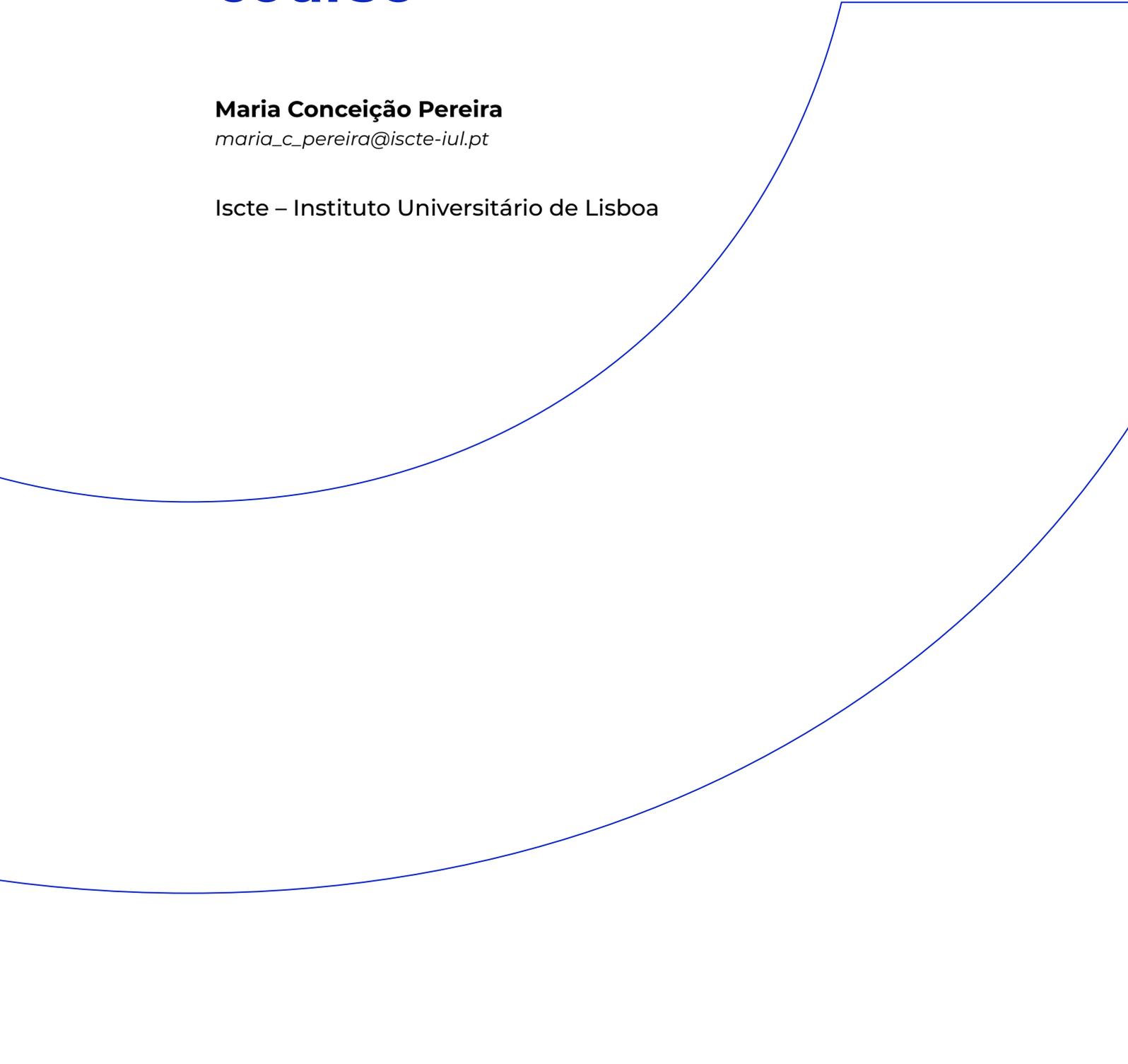
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Flipped learning and eduScrum in an Operating Systems and Virtualisation course

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ABSTRACT

We live in an era of digital technologies evolving rapidly and in extraordinary ways. Teaching a highly technological course in this era entails teaching students to actively seek out, stay current, and be autonomous in their studies. This is already provided for in Iscte's pedagogical model, centring on active learning. Keeping up to date is time-consuming and requires good time and task management. Flipped learning promotes active learning, and eduScrum provides mechanisms for managing tasks and time productively.

This paper details adapting those methodologies to an Operating Systems and Virtualisation course delivered in the first semester of the first year at Iscte's Higher Education School in Sintra, Portugal, in the 2024–2025 academic year. This year, 95% of students completed the course criterion, with a mean of 16 and a standard deviation 2.

Keywords: Flipped learning, eduScrum, active learning, numbering systems, hardware, operating systems, virtualisation

INTRODUCTION

Operating Systems and Virtualisation (SOV) [1] is a course designed to provide students with a foundational understanding of digital technology and computer science. Topics covered include numbering systems, computer hardware, operating systems (OS), and computer virtualisation.

SOV has been taught since the 2022-2023 academic year. For two years, SOV was implemented using a combination of project-based learning and other active learning strategies, such as constructivism and connectivism [1]. In 2022-2023, 91% of students completed the course, with a mean of 14 and a standard deviation of 2. Given that we kept almost all the methods used, introducing only minor changes to the assessment components, depending on the results of the 2022-2023 academic year [1]. In the 2023-2024 academic year, the pass rate dropped to 70%, with an average of 13 and a standard deviation of 3, respectively. The worst results were recorded in research assignments, as students exclusively used AI chat services with poorly formulated questions and relied entirely on the answers. One difficulty we noticed in the students in both academic years was managing the time needed to complete tasks and

subdividing and sequencing large tasks into smaller parts. In the 2022-2023 academic year, we had 53 students in SOV; in the 2023-2024 academic year, we had 57 students in SOV; and in the 2024-2025 academic year, we had 89 students. There was only one teacher in all three years.

In the 2024-2025 academic year, we restructured the teaching-learning format, introducing flipped learning and eduScrum. This paper presents the details and results of applying this new format.

In the following sections, I will present the background literature, followed by the pedagogical methods implemented in the SOV curriculum and their results, and discuss future directions for improvement.

BACKGROUND

Over the last two to three decades, diverse student-centred teaching-learning approaches, such as problem-based, project-based, and, more recently, flipped learning, have emerged to promote active learning [2]. The flipped learning methodology is a teaching and learning method that reverses traditional teaching sequences. Students learn material at home using the teacher's resources, such as slides, book chapters, articles, and videos. In-class activities involve practical applications, including presentations, discussions, and problem-solving. This approach places students at the centre of the learning process, promoting autonomy, engagement, and responsibility for their education [2 – 7]. Flipped learning enables the application of active learning, where the development of competencies in students is naturally promoted, and the teacher helps students consolidate and place value on the knowledge they have learned [5]. Research indicates that the flipped learning approach enhances learning outcomes, fosters a more positive attitude towards the subject matter, increases engagement with learning, and improves metacognitive skills. It enhances students' critical thinking, creativity, problem-solving skills, socialisation and communication [5], [8]. The most common and innovative teaching strategy in flipped learning utilises technology, such as LMS (learning management systems) [2], [6], managed by instructors, to provide instructional materials and facilitate students' online learning [8].

Studies show that the flipped learning methodology challenges teachers by significantly increasing their teaching dedication, requiring them to prepare teaching materials differently than they are accustomed to. This also challenges students, who must prepare for classes by engaging in prior activities [5], [6], [8]. Students should demonstrate a greater sense of responsibility in controlling and monitoring their learning [5], [6], [8].

Bearing in mind the need to guide students on time management when carrying out tasks, as well as the subdivision and sequencing of tasks, I researched what other teachers are doing in this area and found eduScrum, first introduced in 2013 in secondary schools in the Netherlands [9], [10]. eduScrum is an adaptation of the agile Scrum methodology [10–13], used in software development. Transparency, inspection, and adaptability are the three pillars that comprise eduScrum, just as Scrum [14–16]. eduScrum organises the learning process in short, iterative cycles, known as Sprints, in which students work in groups to plan, execute, and revise their tasks continuously. The teacher is responsible for setting learning objectives, monitoring student progress, and assessing their performance. The professor provides recommendations for learning materials, answers questions, and guides the learners to a solution. eduScrum aims to enhance soft skills, including communication, teamwork, presentation, and self-reflection, by providing team members and teachers a comprehensive overview of project status. eduScrum defines several cornerstones in the process, including three roles, three artefacts and four ceremonies [9], [10], [15 – 18].

eduScrum roles – Students work in teams of four or more members. One member is the Scrum Master, responsible for maintaining the task board (Flipboard), motivating the team, and collaborating with the teacher. The teacher, as the Product Owner, sets learning objectives, monitors progress, and assesses students, offering guidance without providing direct solutions [9], [10], [15 – 18].

Artefacts – Product Backlog (a document listing learning objectives and working methods); Flipboard (a physical or digital task board that helps teams track progress and allows the Product Owner to assess their work); Definition of Completeness (criteria set by teams in Sprint Planning to determine when work is finished) [9], [10], [15 – 18].

Ceremonies – eduScrum follows structured, time-bound cycles called Sprints. Key events in each Sprint include: Sprint Planning (teams are formed, learning objectives introduced, and tasks divided on the Flipboard); Stand Up (a brief, regular check-in where students update the Flipboard and discuss their progress, plans, and challenges); Sprint Review (teams present their solutions, and the Product Owner evaluates if objectives were met); Retrospective (after each Sprint, students reflect on what worked well, what could be improved, and how to enhance the next Sprint) [9], [10], [15 – 18].

Even though eduScrum is straightforward to understand, it can be challenging to master, as it places primary responsibility for learning on student teams [10]. Lack of assistance for students implementing agile principles is a frequent problem [10]. They require guidance in managing cooperation, overcoming obstacles, and understanding the principles of eduScrum [10]. eduScrum ceremonies demand work, particularly the Sprint retrospectives and

daily meetings that emphasise peer review and process assessment. Although it might be exhausting, this encourages collective self-control [10]. Teachers must be precise in meeting the “ready” criterion. Adopting agile methodology changes teaching strategies and study habits, necessitating a cultural transformation in students and teachers [10].

Next, I provide details on implementing flipped learning and eduScrum on the SOV course.

METHODS

SOV is a 6 ECTS project-based course [19] that encompasses a broad range of topics on digital technologies, all of which are rapidly evolving. Given that and following Iscte’s pedagogical model [20], students are expected to be active participants, utilising all available resources (materials provided by teachers, bibliography, online research, and discussions with colleagues) to deepen their knowledge of each topic autonomously, while being supported by teachers and colleagues.

SOV 2024-2025 implementation consisted of face-to-face theoretical-practical-laboratory classes, each lasting 3 hours, for 12 weeks of the semester, following the Iscte-Sintra model. A minimum attendance rate of 80% of classes was required, and it was mandatory to complete at least 80% of the practical assignments (PA) [19]. Summative assessment (SA) weights [19]:

SA1: 2 practical assignments (PA1, PA2, 12.25% each): 25% – group practical assignments.

SA2: 2 mini-tests (MT1, MT2, 12.25% each): 25% – multiple-choice tests, carried out individually, on Moodle in the classroom, without consultation, and using Safe Exam Browser (SEB), protected with several passwords. Each mini-test covered half of the subjects, lasting 30 minutes plus a 10-minute grace period.

SA3: Laboratory Project, including group presentation, demonstration, and individual oral discussion, accounted for 50% of the grade. The Project work is eliminatory. Anyone who did not achieve a minimum mark of 9.5 out of 20 on the Project failed the course.

The implementation of SOV in 2024-2025 has evolved based on the foundations established in previous years. It maintains a constructivist and connectivist approach [21 – 23] while incorporating flipped learning [3 – 8] and eduScrum [10 – 18], all of which contribute to students’ increasingly active role in their education.

Before the classes began, I prepared the Teaching and Learning Work Plan (TLWP), which I shared with fellow teachers and some of the previous year's students to gather their opinions. I received valuable help from all of them, which enabled me to improve the plan.

I published the Curricular Unit Form (CUF) and the Teaching and Learning Work Plan on Moodle, which I presented in detail during the first lesson, informing that we will use an adaptation of the flipped learning methodology, associated with an adaptation of the eduScrum agile methodology, to maximise efficiency, promote teamwork, and developing autonomy in learning. I also explained and published information on Moodle about flipped learning and eduScrum, including bibliographical references and suggested "prompts" for the AIs to help students deepen their knowledge independently. I informed the students that they could use AI tools, as long as I guided them, to prevent misuse.

Given the content and the students' recent arrival at university and their lack of accustomedness to working independently, I traditionally taught the first three lessons. In those lessons, I taught the binary, octal, and hexadecimal numbering systems, which require a revision of the decimal system's math.

The flipped learning methodology was implemented over eight lessons, 4 to 7 and 9 to 12, and eduScrum was used to manage the development of practical assignments (PAs) and Project work. In the eighth lesson, the first mini-test was administered, the best SOV Project work from the previous school year was presented by its authors, and for the remainder of the lesson, students had the opportunity to dismantle and reassemble a PC, a tablet, and a smartphone. The second mini-test was administered in the last class.

PAs consisted of autonomous study and in-class presentations. Each of the eight classes had presentations made by two groups, and each group presented twice. I created detailed instructions for carrying out each of the PAs, including details on preparing the slides: subjects for each group, number of slides per student, number of words per slide, font size, cover slide, slide with credits indicating what each person did and how long it took, slide with member-evaluation of effort, slide with questions for the class and slide with bibliography. I also created detailed instructions for the classroom presentation, including posture guidelines and time allocation for each student's presentation. The files supporting the presentations (slides and videos) were submitted to the Moodle Workshop before the classroom presentations. I also created a formative evaluation questionnaire in the Moodle Workshop with three questions about each presentation. In this questionnaire, I defined the evaluation criteria and asked for a rating on a scale of 0 to 4, along with comments.

At least a week in advance of each lesson (an eduScrum Sprint for PAs), I made various materials and guidelines available on Moodle: slides created by me

covering the subject of the lesson, bibliography/book chapters, websites-links, videos, “prompts” for AI chats (designed and tested by me to produce the results in line with the way the content is studied in SOV – students would use AI chats anyway, so I hope that providing appropriate “prompts” will improve the results), list of questions for formative self-assessment, subjects distribution between the two groups, recommendations for preparing the presentations (Study and follow the instructions for carrying out the PAs; Remember what eduScrum is and how it works; Study and follow the Recommendations for the presentations; Arrange an appointment with the teacher 2 days before the presentation in class to rehearse the presentation; Submit the presentation file in PDF format on Moodle before the start of the class). I provided synchronous formative assessment online, via Microsoft Teams, lasting at least half an hour per group to support the preparation of each presentation. I created a mini-self-evaluation questionnaire (5-15 minutes) to be completed on Moodle at the end of each lesson.

I provided the Project statement after the eighth lesson. The Project aims to provide students with practical application contexts for the topics studied in SOV. Through this, students would observe the impact of the interaction between software applications, the OS, and hardware resources. It would equip students with the skills to investigate, design, and construct technological solutions that facilitate the digital transformation of workflows within organisations. Competencies acquired include examining the workflows associated with each job position, identifying the necessary software applications, OSs, and hardware specifications; creating virtual machines; installing the OSs and software applications; testing and demonstrating functionality; and presenting a rigorous, verifiable, and structured report. For the Project report, I provided a mandatory template and instructions for using the Zotero [24] referencing tool. I provided instructions for carrying out the Project, which included subdividing it into several parts (the eduScrum Sprints) and submitting a partial report corresponding to each part on Moodle. To support the Project development, I offered at least two online meetings to each of the 16 groups, lasting at least one hour each.

The adaptation of eduScrum to SOV was as follows:

1. Groups consisting of 4 to 6 students. For PAs, groups were randomly selected, as students did not know each other at the beginning of the semester. For the Project, the students formed the groups autonomously after the eighth lesson. Students roles within each group: Scrum Master (facilitates the organisation and progress of work by ensuring that everyone follows the eduScrum process); Product Owner (serves as a liaison between the group members and between them and the teacher, ensuring that expectations and learning objectives are understood); Group members (all students, including the coordinators, Scrum Master and Product Owner, participated in the realisation of the tasks).

2. Sprint planning: Each PA was a one-week Sprint. I divided the Project work into four Sprints, the duration of each proportional to the tasks to be performed, lasting at least one week. I defined the learning objectives for each Sprint; Backlog Creation: Students create a list of tasks that the group must complete to achieve the defined objectives, distributing them among group members. Backlog created on the online platform Trello [25], which, among other things, allows integration with the communication platform Slack [26], changing the task status (“to be done”, “in progress”, “completed”), sharing between group members and the teacher; Task estimation: Students estimate the time required for each task, using a simple scale (e.g., small, medium, large); Division of work: Tasks distributed autonomously among group members.
3. Sprint execution. Group work: Each member of the group work on their task individually, but in collaboration with the other group members; Daily Stand-ups: Brief meetings (no more than 15 minutes) where the group discuss progress, share challenges, and adjust planning; Meetings with the teacher: Before each presentation in class, each group present their work to the teacher. This occurred two days before the class, allowing for implementing any improvements I suggested.

In addition to the previously mentioned materials and guidance, I provided tutorials for using Trello and Slack, sample tests to practise, and various didactic materials, such as games and links to platforms with relevant content. Before the classes, I made all resources and support materials available on Moodle and Microsoft OneDrive.

I shared some supplementary materials for this paper on Annexes: Work Plan for Teaching/Learning, Instructions for completing the PAs, and an Example of a lesson plan for one of the eight lessons with students' presentations. In figshare [27], I shared a complete set of the materials I provided to students, in Portuguese (as SOV is taught in Portuguese). I included a video screen recording of Moodle illustrating how I structured the course.

RESULTS

When I presented the Teaching and Learning Work Plan and the teaching and learning methodology we would follow, along with an explanation of the flipped learning and eduScrum methodologies, in the first class, students who had just arrived at university reacted with a mixture of surprise and apprehension. Surprise that they would be the ones to decide how to study/learn the content. Fear that they wouldn't be able to manage their studies. Regarding the returning students, they showed greater security, but also expressed concern that they would have a significantly heavier workload.

The lessons on number systems were highly participative, with several students going to the board to solve exercises. To encourage everyone to participate, I invited students with and without doubts to the board to work together. Two groups of students were on the board simultaneously while I was guiding and helping.

Before the first presentations in class, one of the groups didn't book a rehearsal with me. Then, it was the only group that made mistakes in their presentation in class, and I corrected them in front of the whole class. As a result, the peer evaluations were low, and some classmates commented in the peer evaluation questionnaire that they should have benefited from the support offered by the teacher before the class. Since then, a whole group has never failed to rehearse with me before the class presentation. It has happened that someone from the group is missing, but not all of them, and those who missed have given weaker presentations with mistakes that I correct during the lesson.

For initial presentations, I timed each presentation to ensure sufficient time for everyone, ensuring they all utilised the time allotted to them, and no more. I also wanted to remind the whole class to adhere to the timings. The following week, I timed everyone's times during rehearsals, but I didn't do it in class, and everything went well. From then on, I stopped timing, and some groups requested permission to modify the presentation structure to make them more dynamic and interactive. I agreed, on the condition that they used up all the time allocated to the group and no more. Seeing the creativity and commitment some of them invested in their presentations was fascinating. They created videos to better convey the practical aspects of the content to their classmates, and they developed online quizzes (Kahoot) to promote their colleagues' participation. Their colleagues loved the Kahoots.

Throughout the semester, I observed a healthy competition among some groups to create the most interesting, comprehensive, and innovative presentations. Not all groups or members of each group did this; about half did.

Some students approached me, saying that by distributing the tasks within the group, they had been left with very little to present in the next lesson. They came to ask me what else they could do to improve their presentation. It was genuinely unusual—students asking for more work, and I always suggested some improvements they could make.

I realised that only a few groups used Trello to manage Sprints; if they did, they didn't add me. They did not use Slack to communicate with each other; instead, they preferred WhatsApp, which they had already established groups. As they were managing their time well and delivering good presentations, I didn't think forcing them to use those platforms was necessary. I suggested those platforms to help them, but if they manage in other ways, I thought letting them be autonomous in their choice of platforms would be good.

When group mates evaluated the effort put into preparing each presentation, the marks awarded were almost always the same and of the highest value. The same happens with the formative evaluation questionnaire completed on Moodle by colleagues about each presentation. Most students awarded the same maximum marks to all their colleagues without providing any comments.

In almost all the classes with presentations, there was absolute silence—zero background noise.

Some groups benefited from contact with companies to carry out the project work. They received information from the companies about the actual situation regarding jobs, computer programmes used, operating systems, and PC characteristics. Some even benefited from interviews with the companies' IT managers. After this, they were ready to implement and simulate it in virtual machines. These groups did the Project work more quickly and produced better work, requiring less support from me. The other groups had to imagine that they would computerise an imaginary company. They had to choose a business area, research how a business in that area operates, investigate the jobs and computer programmes they use, and then research the operating systems and hardware required. Only once they had studied and understood everything could they move on to implementation on virtual machines.

Students who scored positively on the Project passed the course. No students took a final exam.

Table 1 – Mean and standard deviation of students' scores on assessment elements

	PA1	PA2	MT1	MT2	Project	Global
Mean	15	15	13	17	16	16
Standard Deviation	2	3	2	2	2	2

DISCUSSION AND FUTURE WORK

The study, planning and preparation of the Teaching and Learning Work Plan for SOV took some time, but given the results, it was worth it, and next school year it won't need to take up so much time, as there won't be many changes to the plan. The detailed explanation of the TLWP for SOV in the first lesson was relevant because it created, at least in some students, a sense of responsibility for their learning journey. In the following lessons, I reminded the students

that they should be autonomous in their studies and that autonomy implies responsibility. Moodle reports show that the TLWP was viewed almost 350 times during the semester. Detailed instructions on adapting flipped learning for conducting PAs and an explanation of the eduScrum methodology received around 400 views collectively on Moodle.

The students' initial resistance, fearing they wouldn't be able to adapt to the new teaching-learning method, was quickly overcome after the first week of lessons with in-class presentations. The students felt supported by the fact that they could rehearse with the teacher before the classroom presentation, which gave them self-confidence. The weekly rehearsals with the students also took up extra time for the teacher, but gave me confidence that at least the students who presented every week were keeping up with the subject. Each rehearsal was an opportunity to make a formative assessment and get feedback on the students' progress. Rehearsing the presentations beforehand was necessary so that I could help them correct their mistakes, deepen their knowledge, and give them the self-confidence to deliver their presentations in class. I'm convinced that all of this contributed not only to the good grades that the majority achieved but also to the enthusiasm, desire to do more and better, innovation, and healthy competition between some groups of students.

Providing guidelines and "prompts" I built and tested for the AIs helped prevent the repetition of disastrous uses that students from the previous year experienced. A student asked my permission to use Google Notebook LM to upload the slides and "prompts" I had provided, along with recommended book chapters, and to generate Podcasts to make the most of the time spent travelling on public transport. I asked her to demonstrate in the classroom so that I could assess the quality of the result. It was good, and she shared the example with the rest of the students.

The group mates' evaluation of the effort put into preparing each presentation and the feedback questionnaire completed by colleagues on Moodle about each presentation didn't yield the results I expected. In future SOV implementations, I will design these questionnaires so that only the teacher knows who provided each answer, ensuring that students don't feel embarrassed when grading their colleagues. The embarrassment of saying what one thinks about each colleague's work is found in people of all ages, and most people. It would take a profound change in mentality for all students to say what they think of their colleagues' work openly.

According to the students themselves, the low uptake of Trello was due to a lack of time to learn yet another tool. They had a lot of material to study, not only SOV but also the other CUs. Learning and using Slack as a communication platform would only make sense when integrated with Trello. Slack became redundant since they already used WhatsApp for communication and didn't use Trello.

The list of questions for formative self-assessment to be filled in before each lesson and the mini-self-assessment questionnaire to be filled in on Moodle at the end of each lesson, along with the sample tests, were the most viewed content on Moodle, which recorded between almost 200 views and more than 7000 views each.

For those groups that benefited from the company's support, the Project work became significantly more straightforward. For students, research is the most complicated part of the Project work because there is limited information available in scientific articles or theses about the computerisation of companies. Students must rely on grey literature, which is often unreliable. Additionally, for most SOV students, it is their first time implementing a literature review, and they usually lack the knowledge to distinguish between reliable and unreliable sources, which requires considerable guidance from the lecturer. I demand rigour in Project work as it is worth 50% of the grade and is eliminatory.

In the future, finding more organisations willing to provide information and support for the Project work would be desirable. This would make the Project work more realistic and motivating and reduce the effort required.

Most of my time as an SOV teacher is spent guiding the Project work, and that's because SOV is a project-based CU. It's independent of the teaching-learning method. This academic year has been even more time-consuming, but only because there are more students. To guide the Project work, I provided at least two hours of support to each of the 16 groups, although more time was needed for some groups, as they wrote excessively and I couldn't read everything within the allotted time. In future, I'll have to impose a word limit on the Project report.

CONCLUSION

In the 2024-2025 SOV implementation, students achieved the best academic results ever, with a higher pass rate, improved average grades, and a higher level of motivation. This aligns with previous research on the implementation of flipped learning and eduScrum methodologies [3 – 18]; however, as found in previous studies [5], [6], [8], it required more effort on the part of both students and the teacher.

In the subsequent SOV implementations, I will aim to address the weak points identified in the previous section and create additional materials for self-study and guidance.

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ANNEX 1 WORK PLAN FOR TEACHING/LEARNING

Introduction

This text is a general work plan for the entire Curricular Unit (CU) of Operating Systems and Virtualisation (SOV) for the academic year 2024-2025. A detailed plan for each assignment will be provided in due course.

We will adapt the flipped learning and agile eduScrum methodologies in 8 of the 12 classes planned for the semester.

The goal is to maximise the efficiency of your study, promote teamwork, and develop autonomy in learning.

FLIPPED LEARNING-BASED TEACHING/LEARNING

1. What is the Flipped Learning methodology?

The flipped learning methodology is a pedagogical approach that alters the traditional sequence of teaching. Instead of the teacher presenting the content during the class and then the students doing the exercises at home, this logic is inverted:

- Preliminary Study: Before classes, students study the content at home using materials provided by the teacher, such as slides, book chapters, articles, internet research references, AI chat prompts, videos, etc.
- In-Person Class: Class time is dedicated to the practical application of knowledge acquired through independent study: presentations made by students on what they have studied, debate with questions/answers, problem-solving, and clarification of doubts.

This method places the student at the center of the teaching/learning process, promoting greater autonomy, engagement, and responsibility for their study.

2. How does the Flipped Learning process work?

The implementation of flipped learning involves several steps that must be followed to ensure the effectiveness of the process:

1. Preliminary Preparation:

- Study materials: Before each class, the teacher provides materials related to the syllabus content that students must study. These materials are chosen according to the objectives of the next class.

- Independent study: Students should set aside time to study the content independently, taking notes, preparing group presentations, and identifying any questions that may arise.
- Time and task management: To manage autonomous study time and task completion in teamwork, the eduScrum methodology will be adapted.
- Review of pre-class presentations: Before the in-class presentation, each group meets individually with the professor to present what they have done. This will occur during a timetable of questions to be scheduled, before the class, so students can implement any improvements the professor suggests.

2. Classroom Activities:

- Teamwork: Presentations are made by some groups in each class. After the presentations, these groups ask the rest of the class questions about the content they presented.
- Questions/answers and debate: The entire class participates in the question/answer session, clarifying doubts. The teacher facilitates the discussion on the studied topics, encouraging students to share their doubts and understandings, clarifying concepts, and helping to resolve students' difficulties.

3. Reflection and Continuity:

- Content review: After the class, students can review the discussed content and improve their knowledge with further study. The groups that presented have time to make minor improvements to their presentation materials and resubmit them if necessary.
- Formative assessment (feedback): Before the end of each class, all students fill out a self-assessment questionnaire on the content studied in the class.
- Summative assessment (grades): Flipped learning methodologies assessments can include individual tests, individual assignments, or group work. The teacher will conduct the summative assessment according to the weights defined in the FUC.

3. Advantages of the Flipped Learning Methodology

- Personalized learning: Students study independently, revisiting the materials as often as necessary.
- Greater interaction: Class time is optimised to promote interaction between students and the teacher, creating a more dynamic and participatory environment.
- Skill development: Besides learning the content, students develop skills such as critical thinking, collaboration, and problem-solving. They learn to learn autonomously, which will be helpful in the rest of their lives, especially in the constantly and rapidly changing world of technology.

4. How to prepare for UCs that follow the Flipped Learning methodology

- Time management: Plan your study time, ensuring that you complete the preparation before each class.
- Active participation: Actively participate in class discussions and activities, sharing your ideas and doubts.
- Autonomy and responsibility: Take responsibility for your learning process, using the resources available to deepen your knowledge.

5. Resources to learn more

Suggestions to deepen the understanding of the flipped learning methodology:

- Book: “Flip Your Classroom: Reach Every Student in Every Class Every Day” by Jonathan Bergmann and Aaron Sams (available in English).
- Article: “Flipped Learning: What It Is and What It Is Not” by the Flipped Learning Network (2014). Available online: <https://flippedlearning.org>.
- Video: TED Talk by Salman Khan, “Let’s Use Video to Reinvent Education,” available on YouTube.
- Prompt for Artificial Intelligence (AI) chats: *“I am a first-year university student. My professor will use a methodology based on flipped learning. Explain this methodology in detail and give me references to learn more. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.”*

AGILE METHODOLOGY EDUSCRUM

1. What is eduScrum?

eduScrum is an adaptation of the agile Scrum methodology initially used in software development. It is called eduScrum because it adapts to the educational context. This methodology promotes teamwork, collaborative learning, and student autonomy. eduScrum organises the learning process into short and iterative cycles, known as “sprints,” where students, in groups, plan, execute, and review their tasks continuously.

2. Fundamental Principles of eduScrum

eduScrum is based on some key principles that guide its implementation:

- Collaboration: The students work in groups, each taking on a specific role, to achieve the best possible results.

- Transparency: All group members have a clear view of the tasks to be performed, the progress made, and the obstacles encountered.
- Iteration and continuous improvement: The work is organised in short cycles (sprints), allowing for constant adjustments and learning through regular feedback
- Autonomy and responsibility: Each student is responsible for contributing to the group and fulfilling their tasks.

3. How are we going to implement eduScrum in SOV?

The Practical Assignments (PAs) consist of the independent preparation and presentation of SOV programmatic content in the classroom. The Project work consists of conducting a laboratory project, in which the aim is to apply the studied content creatively with a rigorous scientific foundation. The management of time and tasks to be performed by the group members will follow an adaptation of the eduScrum methodology.

The implementation of eduScrum involves several stages that structure group work and promote collaborative learning:

1. Formation of groups:

- The groups will consist of 5 or 6 students. For the PAs, the groups will be selected randomly. For the Project, the students will form the groups autonomously, ideally with different skills and learning styles to ensure diversity and complementarity.
- The students assume specific roles within each group:
 - The Coordinator of task execution (Scrum Master) facilitates the organisation and progress of the work, ensuring that everyone follows the eduScrum process.
 - The communication coordinator (Product Owner): Serves as a liaison between the group members and between them and the teacher, ensuring that the expectations and learning objectives are understood.
 - Group elements: All students, including the coordinators (Scrum Master and Product Owner), participate in completing the tasks.

2. Sprint Planning:

Each PA is a sprint. The teacher will divide the Project work into several sprints. The duration of each sprint is proportional to the tasks to be executed and lasts at least one week.

- Definition of objectives: The teacher defines the learning objectives for each sprint, according to the syllabus to be studied.
- Backlog Creation: A list of the tasks that the group must complete to achieve the defined objectives. The professor will indicate an online platform for creating this backlog. The platform allows, among other

things, changing task statuses (“to do,” “in progress,” “done”) and sharing among group members and with the professor.

- Task estimation: Estimating the time required for each task using a simple scale (for example, small, medium, large).
- Division of work: Tasks are autonomously distributed among the group members based on their skills and interests.

3. Sprint Execution:

- Group work: Each group member works on their task individually but constantly collaborates with others.
- Daily Stand-ups: Brief meetings where the group discusses progress, shares challenges, and adjusts planning if necessary. Ideally, these meetings should not take more than 15 minutes and should be held standing up to encourage speed. Each group member responds to:
 1. What did I do yesterday?
 2. What will I do today?
 3. Is there any obstacle?The backlog on the online platform is updated during these meetings.
- Meetings with the professor: Before each PA is presented in the classroom, each group meets with the professor to show what they have done. This will occur during a timetable of questions before the class so that students can implement any improvements the professor may suggest. Before the final presentation of the Project work, each group meets twice with the professor to show what they have done and to receive guidance.

4. Review and Reflection (sprint review and retrospective):

- Sprint review: At the end of each sprint and before the work presentation in class, the group evaluates whether the objectives were achieved and assesses the effort and commitment of each member.
- Retrospective: After each work’s presentation and final submission, the group reflects on the process, identifying what went well and what needs improvement in the next sprint.

5. Continuous feedback:

- Formative assessment (feedback) is an essential part of eduScrum. Students receive feedback from peers (peer evaluation) after classroom presentations and from the teacher (during pre-presentation doubt sessions and in the classroom), allowing for continuous adjustments and improvements.

4. Benefits of eduScrum

- Skills development: Promotes skills such as collaboration, communication, time management, and problem-solving.
- Active involvement: Students take a more active role in managing the teaching/learning process, increasing their engagement and motivation.

5. Tips for a successful implementation

- Clarity in roles: Ensure each group member understands their roles and responsibilities.
- Effective communication: Use communication tools that facilitate constant contact among group members. A communication tool that integrates with the online platform should be used for the backlog.
- Flexibility: Be open to constructive criticism and adjust the plan as necessary to ensure all elements progress appropriately.
- Mutual support: When someone is having difficulty completing their part of the tasks, adopt a constructive attitude, try to understand the reasons, and help. When any member feels in difficulty, ask colleagues for help.

6. Resources to learn more

Suggestions to deepen your knowledge about eduScrum:

- Book: «eduScrum Guide» by Willy Wijnands and Rolf Dräther, available on the official eduScrum website.
- Articles:
 - Agile_Methods_in_Higher_Education_Adapting_and_Using_eduScrum_with_Real_World_Projects.pdf
 - On_the_Use_of_Scrum_in_Project_Driven_Hi.pdf
 - Scrum Methodology in Higher Education-Innovation in Teaching.pdf
 - Three Concepts to Use .pdf
- Site: <https://www.eduscrum.org>
- Prompt for Artificial Intelligence (AI) chats: *"I am a first-year university student. My professor will adapt the agile eduScrum methodology to guide students in preparing for flipped classes and project work. Explain the eduScrum methodology to me in detail and give me references so I can learn more. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement."*

ANNEX 2 INSTRUCTIONS FOR COMPLETING THE PAs

About Autonomous Works

- Each group has to complete 2 Practical Assignments (PAs).
- Out of 12 classes, 8 will have PA presentations.
- In each of the 8 classes, 2 groups present.
- For each student, completing 80% of the PAs is mandatory. $0.8 \times 2 = 1.6$. Each student is required to participate in both PAs, even if only partially.
- For each student, completing 80% of the learning assessment questionnaires in classes with presentations is mandatory. $0.8 \times 16 = 12.8$. Each student is required to evaluate (formative assessment/feedback) 13 PA presentations.
- The teacher objectively defines what each group prepares to present, indicating a list of topics, corresponding bibliography, links, prompts to use in AI chats, and other materials.

Instructions for the completion of PAs

- The work of each group follows a methodology adapted from eduScrum.
 - The task execution coordinator (Scrum Master) was chosen randomly. If the group decides to change the student, it can be done in the following PA.
 - Each group chooses a Communication Coordinator (Product Owner) to contact the professor. Then it can change in the following PA, if the group deems it necessary.
 - Each group subdivides and manages the execution of tasks by the group members following the agile methodology, eduScrum. They must necessarily use Trello + Slack. Slack integrates with Trello to facilitate communication.
 - The teacher is added to the groups using these tools to supervise the progress of the work.
- Each student prepares 1 slide/minute. 5 slides in total per student, to present their part in 5 minutes.
- Each student prepares 1 question about what they presented, to be posed to the class at the end of the group's presentation;
- Each group prepares:
 - 1 slide for the cover, which identifies the PA, a title for the content, and the group identification.
 - 5 theoretical slides for each group member. Each slide cannot have more than 75 words, and the font size cannot be smaller than 24.

- 1 slide with the questions created by all the group members.
- 1 slide with the consulted references. AI chats are not accepted as references unless supported by references in books or articles.
- 1 slide (on the penultimate page) with the credits:
 - Work performed by each group member, which should include:
 - Numbering of the slides they prepared
 - Numbering of the references they prepared
 - Approximate time invested
- 1 slide (on the last page) with a grid for formative assessment containing:
 - Self-assessment of your effort (0 to 5)
 - Evaluation of each group member's effort (0 to 5)

Table 2 – Evaluation of effort expended at work

Evaluation of effort expended at work						
Receiver / evaluator	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6
Element 1						
Element 2						
Element 3						
Element 4						
Element 5						
Element 6						

Self-assessment

- The preliminary presentation to the teacher is mandatory at least 2 days in advance.
- The submission of the files with the presentations on Moodle closes at the start of the class.
- Each group can improve up to 10% of the work and resubmit it within a week.

Structure of classes with presentations: theoretical exposition followed by exercises

- In the presentations, each group member has exactly 5 minutes for their presentation.

- During the presentations, no one interrupts. Questions are asked at the end.
- In the end, each group presents the 5 or 6 questions/exercises (one for each group member) to the rest of the class to assess whether the classmates understood and could answer their questions. This takes place in the 30 minutes allocated to each group for discussion.
- The selection of 5 or 6 classmates who answer the questions for each group is done randomly at the moment (<https://pickerwheel.com/tools/random-team-generator/>).
- The teacher explains what the students cannot explain and can also introduce questions into the debate.

With 2 groups per class, the presentations will take up 2 hours in each class (out of a total of 8 classes); 20 minutes spent on breaks; 40 minutes for the teacher to explain what hasn't been well explained. TOTAL: 3 hours of class

- 1 group in the first half of the class (1 hour) + 20 minutes for the teacher
- 20-minute interval (maximum strict)
- 1 group in the second half of the class (1 hour) + 20 minutes for the teacher

Formative assessment of PAs by peers + instructor

- Feedback questionnaire: Formative assessment assigned by peers, with grading criteria based on what they have learned.
- Numeric rating (from 0 to 5) for each question in the feedback questionnaire, assigned in a tool on Moodle.
- Everyone can give a rating, including themselves, as a self-assessment.
- Each student receives 0.02 points for each feedback questionnaire they fill out.
- Peer grading on Moodle ends as soon as the class is over.

Summative assessment – teacher

- The teacher will assign a grade from 0 to 20 to each student in each PA, based on the opinion formed and peer students' feedback.

ANNEX 3

EXAMPLE OF A LESSON PLAN FOR ONE OF THE EIGHT LESSONS WITH STUDENTS' PRESENTATIONS

For pre-class work

- Study the teacher's slides – Lesson 5
- Instructions for the presentations on 17-10-2024
- Self-study materials for the 17-10-2024 lesson
- Prompts for AI chats for the 17-10-2024 lesson
- Questions relating to the 17-10-2024 lesson

Until the start of the lesson

- Submission on Moodle Workshop PA1 17-10-2024

Final minutes of the lesson

- End of lesson quiz 17-10-2024

After class

- Teacher evaluation of PA1 17-10-2024

INSTRUCTIONS FOR THE PRESENTATIONS ON 17-10-2024

Distribution of material among the groups

- The 1st group to present prepares the material from the slides of Lesson 5, up to page 13 (inclusive).
- The 2nd group to present prepares the material from the slides of Lesson 5, from page 14 to the end.

Preparation of the presentations

Students can use everything available on Moodle and anything else they want, as long as the teacher authorises it.

Don't forget to:

- Study and follow the Instructions for the completion of the PAs;
- Recall what eduScrum is and how it works.
- Study and follow the Recommendations for the presentations.
- Schedule a doubt session with the teacher, 2 days before the classroom presentation, to practice the presentation.
- Submit the presentation file in PDF format on Moodle (PA1 17-10-2024) before the start of the class.

Self-study materials for the 17-10-2024 lesson

Study the materials and complete the exercises before class.

- [Teacher slides for Class 5](#)

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KHAN ACADEMY

- [Computers](#)

VIDEOS

- [Videos about the physical structure of computers](#)

PROMPTS FOR AI CHATS FOR THE 17-10-2024 LESSON

- Study the answers you get in the chats before the lesson on 17-10-2024.

1 – History of Intel CPUs

I am a first-year university student studying the historical evolution of computers. Draw up a list of the main Intel CPUs, indicating their name, year, number of architecture bits, clock frequency, and any other characteristics you consider important. I want you to write in Portuguese from Portugal after the spelling agreement 1990.

2 – History of AMD CPUs

I am a first-year university student studying the historical evolution of computers. Draw up a list of the main AMD CPUs, indicating their name, year, number of architecture bits, clock frequency, and other characteristics you consider important. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.

3 – History of Apple CPUs

I am a first-year university student studying the historical evolution of computers. Draw up a list of the main CPUs used in Apple computers, indicating the name, year, number of bits in the architecture, clock frequency, and any other characteristics you consider important. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.

4 – History of tablet devices

I am a first-year university student studying the historical evolution of computational devices. Draw up a list of the main tablets, indicating their name, year, number of architecture bits, clock frequency, and other characteristics you consider important. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.

5 – History of smartphone devices

I am a first-year university student studying the historical evolution of computational devices. Draw up a list of the main smartphones, indicating their name, year, number of architecture bits, clock frequency, and other features you consider important. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.

6 – Hardware inside computers

I am a first-year university student. I am starting to study computer systems. Write a list of the main components of the physical structure of computers, indicating their names, purposes, and main characteristics. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement.

7 – What are the components of computers made of

I am a first-year university student starting to study computer systems. Draw up a list of the main components of the physical structure of computers, indicating the material they are made of and why. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

8 – What's inside the CPU

I am a first-year university student. I am starting to study computer systems. Draw up a list of the main constituents of the CPU, indicating their name, purposes, and main characteristics. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

9 – What is a computer bus

I am a first-year university student. I am starting to study computer systems. Draw up a list of buses, indicating their name, purpose, and main characteristics. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

10 – How are the instructions executed

I am a first-year university student. I am starting to study computer systems. Draw an ordered list of the steps to execute the programme's instructions, indicating what is done and the time taken for each step. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

11 – CPU clock frequency

I am a first-year university student. I am starting to study computer systems. Explain to me what the CPU clock frequency is and how it influences the execution of program instructions. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

12 – Clock frequencies in a computer

I am a first-year university student. I am starting to study computer systems. Draw up a list of the clocks that can exist in a computer, their purpose, and their typical frequency. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

13 – Characteristics of Intel processors

I am a first-year university student. I am starting to study computer systems. Give me a link to Intel where I can find the characteristics of processors. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'. (Recommended: Gemini)

14 – Characteristics of AMD processors

I am a first-year university student. I am starting to study computer systems. Give me a link to AMD, where I can find the characteristics of their processors. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'. (Recommended: Gemini)

15 – Characteristics of ARM processors

I am a first-year university student. I am starting to study computer systems. Give me a link to ARM where I can find the characteristics of their processors. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.

16 – Characteristics of Apple processors

I am a first-year university student. I am starting to study computer systems. Give me a link to Apple where I can find the characteristics of their processors. I want you to write in Portuguese from Portugal after the 1990 orthographic agreement. You cannot use the word 'crucial'.