EduPar 2025 Posters

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***Abstract*—This paper presents an overview of the two posters accepted for the EduPar'25 poster session. The poster session serves as a valuable opportunity for community interaction, encouraging discussions on innovative approaches and emerging ideas.**

High-Performance Computing (HPC) and Quantum Computing (QC) are both critical for advancing computational capabilities, each complementing the other in solving complex problems. HPC provides the classical infrastructure necessary for simulating and optimizing quantum algorithms, enabling researchers to test and refine quantum models before deploying them on quantum hardware. The integration of HPC and QC paves the way for breakthroughs in scientific discovery, artificial intelligence, and next-generation computing technologies.

In the first poster, the authors propose a workshop aimed at introducing secondary school students to the fundamentals of Quantum Computing (QC) and High-Performance Computing (HPC) combining a theoretical presentation with an escape room hands-on experience. The second poster explores how postgraduate students learn HPC skills through a qualitative approach, aligning key themes with learning theories and proposing interventions into undergraduate modules.

***Index Terms*—Computer Science Outreach, Quantum Computing (QC), High Performance Computing (HPC), Secondary School, Escape room, HPC learning experience, learning hands-on HPC, learning research computing.**

I. An Escape Room to Learn about Quantum and HPC

Authors - Sandra Catalán, Rocío Carratalá-Sáez, Vicente López-Oliva

A. Introduction

As technology advances at a rapid pace, it is important to understand the basic concepts behind the innovations. Quantum computing (QC) and high performance computing (HPC) stand out as two fields that are changing the way we tackle complex problems. To make them more accessible, the authors designed a workshop intended for teenagers that combined theory, practice, and a bit of entertainment. The workshop, designed for secondary school 15/16-year students (a total of 53 students attended), began with an introductory presentation where the basics of QC and HPC were explained. Afterward, the participants were immersed in an escape room where they faced different games designed to reinforce the knowledge they had acquired.

At the end of the activity, participants were asked to complete a survey. This feedback allowed us to understand their level of satisfaction and how the format facilitated their understanding of these concepts, as well as identifying areas for improvement. In this way, the combination of theoretical and practical learning, together with gamification, provided an innovative way to explore and deepen knowledge of QC and HPC.

B. State of the Art

The pedagogy of Computer Science (CS) has evolved significantly over the past few decades, incorporating new techniques that focus on the students motivation [10]. Studies indicate that interest in CS is best cultivated between the ages of 11 and 15 [6], yet comprehension difficulties remain a challenge [9].

Nowadays, introducing CS to teenagers needs to cover not only the basics, but also present trending areas, such as HPC and QC in order to motivate them, encouraging and awakening the curiosity of the next generation of computer engineers. While HPC education has been explored for university students [7], its introduction at the secondary school remains scarce. Regarding QC education, an increase in dedicated courses and materials [4] has been observed, with software-based approaches proving to effectively introduce university students to quantum concepts [8]. Furthermore, efforts to incorporate QC into secondary school curricula have demonstrated encouraging results [3], although there is still a lack of QC introductory activities at this teaching level.

The utilisation of educational games has garnered significant acclaim as an efficacious pedagogical strategy [5], enhancing engagement and nurturing computational thinking skills [2]. Although there is a multitude of educational games available, their complexity can occasionally hinder comprehension [1]. Consequently, there is ongoing work to refine game design to maximize educational benefits. As a consequence, our approach focuses on introducing HPC and QC to secondary school students through a game-based workshop.

C. Workshop structure

The workshop consisted in 1hr session structured into two main parts (each of 30 min), combining theory and practice to ensure a comprehensive and enriching experience for students. At the end, a survey was filled up by the students in order to know their opinion.

1) First part: Theoretical presentation: The first part began with a presentation covering both QC and HPC. Basic concepts of both fields were explained using examples accessible to the students' age group. During this introduction, the practical applications of each field were discussed, highlighting how HPC is used for analyzing large volumes of data and solving complex problems, and how QC is revolutionizing areas such as artificial intelligence. The examples were carefully selected to connect the topics with everyday situations or areas of common interest, facilitating the understanding of abstract concepts.

2) Second part: Escape room: The second part consisted of a dossier-based escape room designed to reinforce learning in a dynamic and enjoyable way. In this activity, students worked in groups to compete in solving three game-based challenges:

- Word search game: the students had to identify the names of key concepts presented in the session.
- Connect the dots game: the participants had to group related concepts, distinguishing between those belonging to QC and HPC. This challenge helped to differentiate the two fields, reinforcing their differences and similarities.
- Fact or Fiction: the students answered true/false questions related to both fields, testing their acquired knowledge.

After solving the last game, they knew how to open a safety box to turn on a "quantum computer".

3) Feedback survey: At the end of the session, the students answered a feedback survey, allowing the organizers to gather their opinions about the experience. The survey included a question to find out how much students liked the workshop. Additionally, participants had the opportunity to express their thoughts in two open-answer textboxes to find out what the students liked the most and the least about the workshop.

D. Method

1) Participants: A total of 53 high school students of 15 and 16 years old voluntarily enrolled the activity with no formal prerequisites in CS.

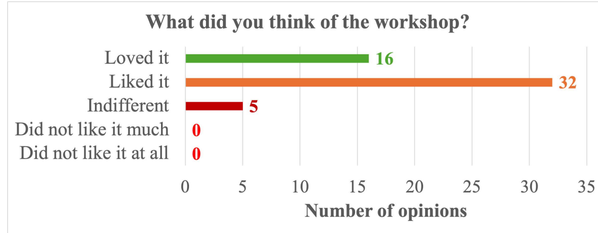

Fig. 1. Students' general opinion of the workshop.

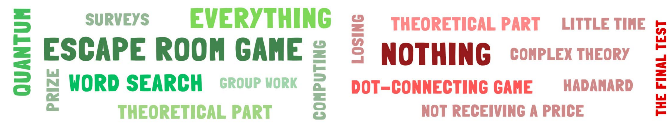

Fig. 2. What the students liked most (left) and least (right) of the workshop.

2) Students' opinion: All students answered the surveys. Figure 1 represents their general opinion. It is remarkable that none of them opted for "Did not like it at all" or "Did not like it much". In particular, 30% said they loved the workshop, 60% liked it, and only 10% felt indifferent.

Figure 2 represents the categorization of the textbox answers, showing the most (left) and least (right) enjoyed aspects. A variable font size is used to represent the terms appearance frequency, with the largest size representing the most used term. The game itself was the part they enjoyed most (almost 40%), and 50% of the students replied "Nothing" to what they liked least. Unalike opinions are seen with respect to the theoretical part.

E. Conclusion

The workshop successfully combined theoretical knowledge with interactive activities to create an engaging and enriching learning experience. By introducing students to key concepts of QC and HPC through simple explanations and real-life examples, participants gained a solid foundational understanding of these fields. The escape room activity served as a fun and effective way to reinforce learning, encouraging students to apply what they had learned in a team-based setting.

The feedback survey demonstrated high levels of satisfaction among students, with the majority of participants expressing positive reactions to the workshop. The game-based activities were well received, indicating that interactive learning methods are highly effective in engaging students.

The *connect the dots* game presented some difficulties. In the future, we plan to either improve its explanation, or opt for another game.

II. How do STEM postgraduates acquire skills needed to master HPC use - a qualitative view

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A. Why Study HPC Learning Experience

High performance computing (HPC) is pervasive at universities, as computational analysis and processing of large amounts of data underpin most research projects across disciplines [11]. It is also a highly sought-after skill in the current job market. Numerous skills feed into successfully using HPC - from programming, computing environments, software engineering, optimisation and debugging - which are not always part of undergraduate curricula even in computationally heavy engineering disciplines. Even though our postgraduates' programming preparedness has generally improved, I have observed while teaching practical HPC that they tend to embark on their projects ill-equipped and with little prior knowledge of the scope of what needs to be mastered. So, how do students amass the required knowledge? The study aims to map student experiences, appreciate their perspectives, improve their learning experience and make institutional recommendations. Better-prepared postgraduates will be able to engage with more ambitious computational aspects, inherently leading to better scientific output.

B. Qualitative Method

This study examines the experience of postgraduate students while mastering the prerequisite and HPC. Such a lived experience is best studied using a qualitative approach. This approach is common in social sciences and allows for in-depth analysis and examination of a subject that does not lend itself easily to purely quantitative analysis. The data was gathered during in-depth interviews and systematically examined using thematic analysis [12]. This qualitative approach is, to a degree, subjective and relies on defining and refining a set of meaningful topics (termed "codes" in social sciences literature) identified in the interview transcripts (usually hundreds of pages); for example, "skills self-evaluation" or "undergraduate experience". This step is data-driven and inductive. The next step is to examine the topics (codes) and group them into related themes (usually 3-4 per study) to allow interpretation of the wealth of data in a meaningful manner. Again, this step is subjective, and the author's role is to explain and defend this decision. I observed that the method provides an efficient feedback loop as poorly chosen themes lack internal consistency and an overarching story that goes beyond a collection of the original observations.

C. Student Experience in Three Themes

Student experiences are described in three themes which were chosen depending on the source of control. The first theme concerns what students can control themselves, the second is what they can negotiate, and the third is what is decided for them. It is also customary to identify an overarching theoretical foundation for each theme as a lens for further explanation and analysis.

1) What students control: Students have control over many decisions during their postgraduate studies. The theme includes narratives about preexisting skills, skills self-evaluation, motivation for learning, metacognition, and understanding the scope of learning for HPC. Some students were concerned about not knowing what they should learn as they did not have a comprehensive mental map of the field. This theme can be mapped to a theoretical framework of self-efficacy theory [13]. This theory discusses how students perceive their skills and what influences this perception.

2) What institutions decide: The second theme concerns factors controlled by higher learning institutions, such as relevant prior education, accommodating students' educational or professional backgrounds, and the level of guidance from supervisors and colleagues. Accounts of relevant undergraduate education in various research computing topics stood out – all students considered it insufficient. This theme can be contemplated using Wenger's community of practice [14]; the community of practice being the staff at a higher learning institution. There are also elements of null and hidden curriculum design [15] [16].

3) What is negotiated together: The third theme concerns negotiable elements and can be explained through the lens of constructivism [17], including the social constructivism branch [18]. It includes, for example, professional interactions that feed into the lab selection process. Similarly, how students perceive doctoral-style work is also determined by a combination of students' experiences in the lab and preexisting perceptions. Interestingly, I encountered a wide range of opinions from students expecting to get very little or no support (and considering it completely normal) to students choosing labs based primarily on training opportunities. The theme also includes students' research computing skills development, which depends on students' initiative and institutional offering. Finally, the general perception of HPC arises from an interaction between institutional services outreach, teaching, and students' experience. Unfortunately, it is not uncommon to encounter discouraging comments from teaching staff about HPC during undergraduate studies, such as that it is too exclusive, expensive or difficult to include in regular teaching. They present an unhelpful barrier to later adoption.

D. Interpretations and Recommendations

This thorough analysis and interpretation, validated by consistent theoretical foundations, helps us appreciate student perspectives and provides substantial evidence supporting module and curriculum design and professional skills development decisions. The study identified a few interventions that will be advocated at the home institution. These interventions concern coordinating research computing content in the modules throughout undergraduate degrees and developing learning plans for postgraduates. One could argue that aligning undergraduate and postgraduate education is impractical due to a diverse student body from various countries and institutions. That is undoubtedly true, but it does not mean we should not map this issue and develop a comprehensive guidance for our students.

A notable outcome is the sophisticated level of student self-management needed to navigate the research computing landscape - understanding the skills required, finding the right opportunities and learning paths, and synthesising the new knowledge. Higher learning institutions do not address this problem systematically and rely on doctoral students' inherent self-efficacy. Students are often expected to acquire this knowledge "somehow" as they progress through the degree. Lifting some of this burden and assisting our students with this task is an investment worth taking. Even in this study's small group of students, I observed marked differences in understanding the research computing landscape. Two students, who were following a structured learning plan, demonstrated high awareness of software engineering practices even though these were not explicitly taught to them. At this point, one can only speculate why. Still, I'd argue that 1) they were in a lab where everyone received structured training and benefited from better-than-average colleagues' support and 2) structured learning frees some mental capacity to reflect and synthesise more efficiently than unsupported students would do. This study presented a rare opportunity to engage with students from various STEM disciplines on non-technical grounds. In our discussions, they reflected on their learning journeys and unanimously emphasised the fundamental nature of research computing skills that culminate in successful use of HPC resources. They dedicated significant effort to mastering these skills and, having an opportunity to retrospect on their learning journey, highlighted the importance of early and structured learning opportunities.

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