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Aprovechando las patentes caducadas para la innovación social: un enfoque de aprendizaje basado en retos en la educación en ingeniería (*)

Harnessing expired patents for social innovation: a challenge-based learning approach in engineering education (*)

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RESUMEN

En una era de rápidos avances tecnológicos, la capacidad de innovar de manera eficaz es una competencia fundamental. El proyecto Patentes para Tod@s, respaldado por la Alianza Europea para la Innovación y la Ciencia en la Enseñanza de la Ingeniería (EELISA), redefine la innovación haciendo hincapié en el potencial de las patentes caducadas como base para el progreso social. Implementada en el marco del curso Conceptos y aspectos legales de la innovación de la Universidad Politécnica de Madrid, esta iniciativa involucra a estudiantes nacionales e internacionales en la reutilización de inventos existentes para abordar retos sociales.

Basado en el aprendizaje basado en retos (CBL), el proyecto tiende un puente entre los conocimientos teóricos y la aplicación práctica, dotando a los estudiantes de habilidades esenciales en gestión de la propiedad intelectual, colaboración interdisciplinar y resolución de problemas. A través del trabajo en equipo estructurado y la formación impartida por expertos, los estudiantes analizan y modifican patentes caducadas, fomentando un enfoque iterativo de la innovación. Un marco de evaluación integral —que incluye evaluaciones de los estudiantes, entrevistas con expertos y el modelo CIPP (Contexto, Aportación, Proceso, Producto)— demuestra el impacto del proyecto en la mejora de la creatividad, las competencias profesionales y la responsabilidad social de los alumnos.

Los resultados sugieren que trabajar con patentes caducadas fomenta una comprensión más profunda de la innovación tecnológica y la sostenibilidad, lo que refuerza el importante papel de la educación superior en el fomento de la innovación en el mundo real. Las futuras iteraciones perfeccionarán las metodologías y las estructuras de colaboración para maximizar los beneficios educativos y sociales.

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PALABRAS CLAVE

Innovación; patentes caducadas; aprendizaje basado en retos; propiedad intelectual; Educación Superior.

ABSTRACT

In an era of rapid technological advancement, the ability to innovate effectively is a critical competency. Patentes para Tod@s (Patents for All) project, supported by the European Engineering Learning Innovation and Science Alliance (EELISA), redefines innovation by emphasizing the potential of expired patents as a foundation for social progress. Implemented within the Concepts and Legal Aspects of Innovation course at Universidad Politécnica de Madrid, this initiative engages national and international students in repurposing existing inventions to address societal challenges.

Rooted in Challenge-Based Learning (CBL), the project bridges theoretical knowledge with hands-on application, equipping students with essential skills in intellectual property management, interdisciplinary collaboration, and problem-solving. Through structured teamwork and expert-led training, students analyze and modify expired patents, fostering an iterative approach to innovation. A comprehensive assessment framework —including student evaluations, expert interviews, and the Context, Input, Process, Product (CIPP model)— demonstrates the project's impact on enhancing creativity, professional competencies, and social responsibility.

Findings suggest that working with expired patents cultivates a deeper understanding of technological adaptation and sustainability, reinforcing the important role of higher education in fostering real-world innovation. Future iterations will refine training methodologies and collaborative structures to further maximize educational and societal benefits.

KEYWORDS

Innovation; expired patents; Challenge;Based Learning; intellectual property; Higher Education.

1. INTRODUCTION

In an era of rapid technological progress, the ability to innovate effectively is a critical competency. While innovation is frequently associated with the development of entirely new ideas and products, Patentes para Tod@s (Patents for All) project —supported by the European Engineering Learning Innovation and Science Alliance (EELISA)— challenges this conventional perspective by emphasizing the potential of expired patents as a foundation for social innovation. Implemented as a collaborative initiative within the course Concepts and Legal Aspects of Innovation at Escuela Técnica Superior de Ingenieros Industriales (Universidad Politécnica de Madrid), the project engages both national and international students in exploring how existing inventions can be refined and repurposed to generate meaningful advancements. Designed to encourage creative problem-solving and broaden traditional approaches to teaching innovation (Romero, 2022), the project was well received by students in its first edition during the 2023-2024 academic year.

The project is structured around key objectives. First, it seeks to redefine students' perceptions of innovation, demonstrating that meaningful advancements do not always require creating entirely new solutions but can emerge from building upon existing technologies. By analyzing and repurposing expired patents, students engage with the process of continuous improvement, reinforcing the concept that innovation is often an iterative rather than an entirely original process (Drucker, 1985). This approach not only enhances students' learning experiences but also cultivates an appreciation for the strategic use of existing knowledge and resources (Kolb, 1984).

A second fundamental objective is to bridge the gap between theoretical knowledge and practical application. The project provides students with hands-on opportunities to apply classroom concepts to real-world challenges, fostering a deeper comprehension of innovation's complexities (Bammer, 2013; Prince, 2004). Through direct engagement with practical problem-solving, students transition from abstract learning to tangible outcomes, reinforcing their ability to navigate the intricacies of intellectual property and technological adaptation.

Furthermore, the project emphasizes university-community engagement by encouraging students to develop solutions that address local societal needs. By applying their work to concrete social challenges, students gain a clearer understanding of the broader impact of innovation beyond academic settings. This engagement fosters a sense of social responsibility and encourages students to view technological development as a tool for addressing pressing societal issues (Bringle & Hatcher, 1996).

Lastly, the project is designed to equip students with essential professional skills, including project management, teamwork, research, and problem-solving. The structured methodology of the initiative ensures that participants develop competencies that are directly transferable to their future careers. Engaging in the full cycle of innovation —from conceptualization to implementation— enhances students' ability to manage complex projects effectively, contributing to their overall professional and academic development (Binkley et al., 2012).

1.1. Challenge based learning methodology

Challenge-Based Learning (CBL) is an increasingly relevant pedagogical approach, particularly in technology-focused higher education and Science, Technology, Engineering, Arts and Maths —STEAM— programs. It fosters competency-based learning through a multidisciplinary and collaborative methodology, encouraging students to address real-world challenges (Servicio de Innovación Educativa de la UPM, 2020). CBL requires integrating disciplinary knowledge with sustainability, industry, and business considerations. The complexity of these challenges necessitates structured planning to ensure feasibility within academic constraints. Key factors include aligning challenges with curricular objectives, defining learning outcomes, and specifying faculty involvement. The degree of student autonomy in defining and solving the challenge should be carefully determined. Additionally, the process must be well-organized, ensuring appropriate timelines, resource availability, and continuous student engagement.

To maximize its impact, CBL requires structured planning, balanced workload distribution and well-defined evaluation strategies: Challenge duration and workload should be balanced to maintain engagement while allowing for thorough exploration, teams should be limited to a maximum of five members to facilitate effective collaboration, and evaluation should include clear objectives, defined milestones and structured feedback, with regular involvement of external experts. Design thinking and maker culture methodologies can enhance the prototyping process, while sustainability and knowledge transfer considerations reinforce educational impact, with communication of progress and results and appropriate feedback essential.

Assessment should be transparent and in line with competence development. Clearly defined criteria justified in weighting of milestones and continuous assessment mechanisms help to manage expectations. Learning contracts can formalize responsibilities, and alternative assessment methods such as self- and peer-assessment promote team autonomy. Given the real-world context, assessments should reflect professional competence through presentations, portfolios, prototypes and videos. Involving students in defining rubrics and deadlines can further increase engagement.

Technological tools play a key role allowing for quick progress checks and structured feedback. Collaborative platforms such as wikis, learning journals and self-assessment rubrics support project management and reflective learning. Regular meetings should be scheduled to guide learners through the process, using guiding questions such as: What stage are you at? What new skills have you acquired? What has been your biggest challenge? How does the team work? These reflections promote self-inquiry and continuous improvement.

This methodology offers significant benefits, as it enhances technical skills, application of real-world knowledge, interdisciplinary teamwork, problem-solving skills and innovative thinking (Helker et al., 2025; Doulougeri et al., 2024; Gallagher & Savage, 2023; Kohn Rådberg et al., 2018; Lin & Chen, 2018). It also fosters stronger research-industry collaborations, improves teaching methodologies and contributes to the development of commercial products (Membrillo-Hernández et al., 2019).

1.2. Patentes para Tod@s' Project.

Patentes para Tod@s project employs a structured methodology to facilitate comprehensive learning and the practical application of intellectual property concepts. The initial phase consists of specialized training sessions, during which students participate in workshops led by experts from the Spanish Patent and Trademark Office (OEPM). These sessions provide fundamental knowledge on patent systems, their economic relevance, and the utilization of databases such as Espacenet. This foundational instruction is essential for students, enabling them to navigate the complexities of intellectual property and appreciate the role of patents in promoting innovation (OEPM, 2020). By establishing a solid conceptual base, these workshops prepare students to explore how expired patents can be repurposed for novel applications (Lerner et al., 2021).

A core element of the methodology is collaborative group work, which integrates students from diverse academic and cultural backgrounds. This diversity enhances teamwork and critical thinking by incorporating multiple perspectives, aligning with research findings that suggest heterogeneous teams often produce more innovative and effective solutions (Page, 2007). Within their groups, students select an expired patent and develop strategies to modify or improve it to address a specific societal need. This process not only reinforces the value of interdisciplinary collaboration but also deepens students' understanding of patents as instruments for solving real-world challenges (Bessen & Meurer, 2008). The final assessment evaluates projects based on criteria such as creativity, social impact, and technical feasibility, ensuring that proposed solutions meet high academic and practical standards. This rigorous evaluation framework ensures that student projects are not only innovative but also possess the potential for tangible societal impact (Tushman & O'Reilly, 1996).

Patents serve as legal mechanisms that grant inventors exclusive rights to their innovations for a defined period, typically 20 years. Upon expiration, these inventions enter the public domain, making them freely accessible for further development and adaptation. This transition presents a valuable opportunity for innovation, particularly for resource-constrained organizations such as nonprofit entities and social enterprises. *Patentes para Tod@s* project capitalizes on this opportunity by engaging students in identifying and repurposing expired patents to address societal challenges. Through this initiative, the project fosters the utilization of existing knowledge while promoting the democratization of technological advancements.

The project's methodology is anchored in workshops and training sessions conducted by experts from the Spanish Patent and Trademark Office (OEPM). These sessions introduce students to the fundamentals of patents, including their purpose, granting process, and economic significance (OEPM, 2021). A key component of the training involves the use of patent databases such as Espacenet, enabling students to search for expired patents and evaluate their potential applications. By learning to identify and analyze patents, students develop the skills necessary to navigate intellectual property landscapes and make informed decisions regarding patent repurposing.

A team-based approach is central to the educational framework, fostering interdisciplinary and multicultural collaboration. Students form diverse teams, integrating both local and international participants. This heterogeneity enhances the exchange of ideas, leading to greater creativity and more effective problem-solving strategies (Page, 2007). Each team selects an expired patent to modify and apply to a specific social issue. The selection process involves rigorous research and assessment to ensure the patent's feasibility and potential for societal impact (Bresnahan et al., 1995). Teams subsequently develop comprehensive repurposing strategies, which include technical enhancements, potential applications, and implementation plans. This experiential learning process deepens students' understanding of innovation and the steps required to transition an idea from concept to implementation (Fleming, 2001).

The project is designed to bridge the gap between theoretical knowledge and practical application (Davenport & Prusak, 1998). The academic course Concepts and Legal Aspects of Innovation provides students with a foundational understanding of patents and intellectual property (Arora & Gambardella, 2010). This theoretical component is reinforced by practical workshops and collaborative projects, ensuring students can apply their knowledge to real-world challenges.

Continuous assessment is integral to the project's success. Throughout the process, teams engage in periodic reviews, presenting their progress and receiving constructive feedback (Toulmin, 2003). This iterative approach enables students to refine their ideas, address weaknesses, and strengthen their projects (Hattie & Timperley, 2007). The final project evaluation assesses creativity, technical quality, and social impact, ensuring high standards and practical applicability. By integrating these elements, *Patentes para Tod@s* project effectively combines theoretical learning with hands-on experience, equipping students with essential skills for future professional challenges (Beckman & Haunschild, 2002).

2. MATERIAL AND METHODS

Patentes para Tod@s challenge involved the participation of 57 students, with one student opting for course evaluation through a final exam in Universidad Politécnica de Madrid (Spain). The students were divided into groups of four to five members, comprising 43 local students and 14 international exchange students. This diversity enriched the collaboration process by incorporating varied experiences and perspectives. Each group selected an expired patent with potential for improvement and its application to a specific social problem. Throughout the project, students conducted an in-depth analysis of their selected patents and proposed enhancements, developing detailed execution plans.

This research employed a case study methodology (Yin, 2003), which is particularly suitable for process analysis. This approach utilized analytic induction, integrating multiple sources of information to ensure a comprehensive assessment (Eisenhardt, 1989; Woodside & Wilson, 2003).

Initially in January 2024, semi-structured interviews were conducted with five teachers and Intellectual Property (IP) experts with teaching experience to obtain initial impressions of the project and assess its potential effectiveness (Ponce et al., 2022). These face-to-face or telephone interviews lasted an average of 43 minutes and explored the experts' views on the relevance and benefits of the project for students. These experts were interviewed again at the end of the process (July 2024) to help draw conclusions and improvements to the project, with feedback from the students' evaluation.

As part of a final degree project, a student, under the professor's supervision, conducted a student evaluation following the Context, Input, Process, Product —CIPP— model (Lobato, 2024), which is widely used in educational assessments (Stufflebeam, 2000). CIPP model evaluates programs across four dimensions: (1) Context, which assesses the needs and objectives of the program; (2) Input, which examines resources and strategies used; (3) Process, which evaluates implementation; and (4) Product, which measures outcomes. This comprehensive approach facilitates both formative evaluations—used for continuous improvement during program implementation—and summative evaluations, which focus on final outcomes and overall effectiveness. CIPP framework is influenced by systems theory, viewing educational programs as interactive systems with interdependent inputs, processes, and outputs. In February 2024 interviews with students were conducted exploring students' expectations and motivation, their initial interest in the project, prior knowledge, teamwork expectations, and perceptions of the course. In March 2024, a midterm questionnaire was administered after students had accessed patent databases and presented their ideas. It examined aspects such as students' understanding of project objectives, team collaboration, the applicability of their work, and perceived usefulness and achieved a 60 % participation rate.

Final interviews were conducted with seven students in May 2024, shortly after project submissions and presentations. Additionally, a brief qualitative questionnaire was distributed in June 2024 to gather feedback on team dynamics. This final survey received 25 responses (approximately 44% participation). Given its lower response rate, the findings were less conclusive than those from previous evaluations.

To ensure construct validity, data from these various sources —including personal notes, documents, and student submissions— were triangulated (Yin, 2003), enhancing the reliability and depth of the results and final analysis presented in the next section.

3. RESULTS

In the first qualitative study (January 2024) innovation experts indicated that, a priori, the proposed methodology was of interest and could serve to increase students' innovation competences in an industry-facing way and highlighting the originality of the project.

Preliminary interviews with students (February 2024) explored key aspects such as students' expectations, their interest in the project and their prior knowledge of the subject. Responses indicated that students had high expectations of the challenge and anticipated that the project would provide them with practical knowledge not covered in other courses. For example, one participant stated: 'I hope to learn how patents work and how they can be reused to drive innovation.' Initial interest in the project was generally positive, and students were motivated by the novelty of the topic and the opportunity to work with expired patents. Responses reflected curiosity and enthusiasm, exemplified by comments such as: 'I find it fascinating to explore how expired patents can be reused to create something new.'

In terms of prior knowledge, responses varied considerably, with students demonstrating a basic understanding of patents, others had little or no prior exposure to the topic. One student commented: 'I have heard of patents, but I have never collaborated with them directly.' This variability underscores the need for thorough initial training to ensure a common basic understanding among participants. In addition, students expressed concerns about potential challenges, mainly related to the complexity of patent documents and time management. One student noted: 'I am worried about having difficulties interpreting patent documents and not being able to contribute effectively to the project.' Expectations regarding teamwork were also highlighted, with most expecting the project to foster collaboration and collective learning: I hope we can work well together and learn from each other.' Before participating in the project, students mainly associated innovation with the creation of completely new concepts although some already recognized the potential of leveraging existing technologies: 'I had never considered reusing expired patents before, but it seems like an effective way to innovate without starting from scratch,' suggesting an openness to redefining their understanding of innovation. Overall, the initial interviews revealed a high level of interest and positive expectations in relation to the Patents for All challenge. Students were motivated by the opportunity to gain practical knowledge and explore an unknown field. However, the diversity of prior knowledge and the concerns expressed about specific challenges highlight the importance of adequate preparation and ongoing support to maximize the impact of the project.

The intermediate questionnaire, with a quantitative and qualitative component, (March 2024) was conducted after the working teams had their first exposure to patent databases and presented their ideas in class. In terms of the perceived usefulness of the project, the majority of students found the experience valuable for their academic development and future professional careers: 70% of the students claimed to have acquired valuable skills and 68% of the students indicated that the project has broad applicability for the future.

This result indicates that the majority of participants recognize the long-term potential of their projects as viable solutions to solve problems. However, 26% of the students remained neutral or disagreed, suggesting that they did not clearly perceive the future relevance of their work. Feedback

from teachers and lecturers explaining aspects such as databases was also rated positively, with 71% of students agreeing or strongly agreeing that they had received useful feedback throughout the project, 63% of students agreed or strongly agreed that the patent search and selection process was clear and well-structured. In addition, 67% of students felt that the project framework allowed sufficient flexibility to explore creative ideas. This indicates that the majority perceived the project as a space for innovation within defined parameters. This flexibility fosters creativity and allows for individual adaptation, which is crucial for encouraging novel approaches. As a result, it is expected that the increased creativity of the students will lead to the development of more original projects, integrating conventional and unconventional ideas, thus promoting 'thinking outside the box.'

Final student interviews (May 2024) revealed that most students perceived the challenge as a significant contribution to their academic development: 'I found it very interesting, and it certainly added value to my education. I learned things that I had not encountered in other courses.' Students echoed this perspective, suggesting that the project offered a distinctive hands-on learning opportunity. The innovative and practical approach to the challenge was welcomed by participants: 'I liked the hands-on approach, much better than just theory.' This preference for experiential learning underlines the importance of incorporating interactive methodologies in future initiatives. However, doubts were raised about the organization and structure of the project. One student noted: 'No, I found it disorganized." I would have liked a continuous follow-up throughout the project.' These comments indicate that, although the practical nature of the challenge was appreciated, the structuring and monitoring of the project needs to be improved. Teamwork experience varied among the students who reported effective collaboration, as reflected in the comment: 'Yes, we all got involved and worked well together.' In contrast, students highlighted disparities in the distribution of the workload. One participant stated: 'It was a disaster; I had to do most of it by myself.' This comment suggests the need to improve team management strategies to promote balanced participation among all members. In terms of skills development, learners claimed to have acquired or improved specific competences through the project. One participant noted: 'I improved my research skills and my ability to analyze legal documents.' Another highlighted the advancement of soft skills, such as 'teamwork and effective communication.' These responses indicate that the project facilitated the development of both technical and interpersonal skills, reinforcing its value as a learning experience.

Finally, students were asked to complete a short qualitative questionnaire (June, 2024) in which they gave their opinion on the internal organization of their groups. The students suggested improvements for future iterations of the challenge, highlighting aspects that could be improved: 'Improve the structure, with more deliverables instead of just one final,' 'Allow students to form their own groups independently,' 'Better organization, teacher-assigned groups do not work' and 'Better distribution of workload throughout the semester.' A recurring theme in the responses was the perception of unequal workload. Participants stated: 'Some worked more than others' and 'Some group members contributed too little.' This issue is critical and suggests the need for strategies to ensure a more balanced distribution of tasks within teams. In contrast, students reported a positive experience, noting that 'The workload was divided equally' and 'All group members contributed equally.' These responses indicate that while some groups faced difficulties, others achieved an effective distribution of tasks, reinforcing the importance of well-functioning team dynamics in improving collaborative work.

4. DISCUSSION, RECOMMENDATIONS AND FUTURE RESEARCH

4.1. Discussion

Patentes para Tod@s project has faced challenges, offering valuable insights for future editions. These challenges primarily revolve around team dynamics, communication, and the feedback and evaluation process.

Teams faced difficulties with distribution of workload and effective collaboration, often due to unclear guidelines and expectations for team roles and responsibilities (Hackman, 2002). To address these challenges, establishing clear and detailed guidelines at the outset is crucial. Defining specific roles and responsibilities for each team member can help ensure equitable workload distribution and foster effective collaboration (Larson & LaFasto, 1989). Furthermore, teams struggled with varying levels of commitment and participation. Implementing regular check-ins and progress updates can help keep team members accountable and engaged, thus improving overall collaboration. Providing additional support and resources for teams facing challenges can further enhance their ability to work effectively together (West, 2012).

The inclusion of international students underscored the need for effective communication strategies. Language barriers and cultural differences can complicate interactions, highlighting the importance of providing communication tools and training (Gudykunst, 2004). Encouraging teams to use collaborative platforms and establishing regular communication protocols can bridge these gaps (Kaneko, 2023). Effective communication is vital for ensuring that all team members are aligned and able to contribute their ideas and perspectives. Offering training on cross-cultural communication and conflict resolution can also help teams navigate challenges and collaborate more effectively (Ting-Toomey, 2018). By fostering an environment of open and respectful communication, teams can leverage their diverse backgrounds and experiences to generate innovative solutions (Page, 2007).

Finally, students expressed the need for more frequent feedback to continuously improve their projects. Incorporating regular intermediate reviews with detailed feedback can help students stay on track and adjust as needed (Hattie & Timperley, 2007). These reviews provide essential opportunities for guidance and support, enabling students to refine their ideas and enhance the quality of their work. To facilitate effective feedback, it is important to establish clear criteria and expectations for the evaluation process (Black & Wiliam, 1998). Providing detailed and constructive feedback helps students identify their strengths and areas for improvement (Sadler, 1989). By incorporating regular review sessions and ensuring that feedback is specific and actionable, the project can better support student learning and development (Shute, 2008).

From both scientific and pedagogical standpoints, one of the most significant contributions of the project is its ability to connect technical knowledge with social awareness. The selection of patents based on their applicability to real-world problems—particularly those of a social or environmental nature—fosters ethical responsibility within the innovation process. This approach aligns directly with trends in academic literature, such as frugal innovation, social entrepreneurship, and appropriate technology, all of which emphasize the efficient use of resources and inclusive design of technological solutions (Radjou et al., 2012; Gupta et al., 2003). Moreover, the interdisciplinary and multicultural team structure introduces a level of complexity that accurately reflects contemporary innovation environments, which are characterized by global collaboration and the hybridization of knowledge. Rather than serving as a barrier, group heterogeneity becomes a catalyst for creativity and critical thinking. This aspect opens new avenues for exploring how cultural, cognitive, and communicative variables influence processes of technological co-creation.

The findings of *Patentes para Tod@s* project reveal a valuable synergy between theoretical instruction and the practical application of intellectual property concepts. The methodology employed demonstrates how higher education can transcend the boundaries of the classroom to become a tool for social transformation. The focus on analyzing and repurposing expired patents not only introduces students to the innovation ecosystem but also promotes a critical perspective on the technological life cycle and its potential to generate value beyond the period of legal protection.

4.2. RECOMMENDATIONS

Based on the challenges and insights gained from the project, students' evaluations and recommendations from IP experts have been proposed to improve future iterations. These recommendations focus on optimizing training schedules, refining team formation strategies, clarifying evaluation criteria, strengthening community engagement, and incorporating structured feedback mechanisms.

One key recommendation is to extend the time between initial training sessions. Spacing out these sessions allows students to better absorb the complexities of the patenting process, promoting deeper comprehension and retention. Research has demonstrated that spaced learning enhances understanding and long-term memory, particularly in complex subjects such as intellectual property (Cepeda et al., 2006). Providing students with additional time to reflect on the material before engaging in practical applications can facilitate more meaningful learning experiences.

Another critical area for improvement is team training. Allowing students to self-select their teams while ensuring a quota for international members can enhance group cohesion and commitment. Studies indicate that individuals who have autonomy in selecting their collaborators tend to form more effective working relationships, leading to improved group dynamics and productivity (Hackman & Oldham, 1976). Additionally, the inclusion of international members promotes diversity, which has been linked to enhanced problem-solving and creativity. Exposure to diverse perspectives encourages critical thinking and fosters a richer exchange of ideas, ultimately contributing to the development of more innovative solutions.

Clarifying evaluation criteria is also essential to ensure fairness and transparency in the assessment process. Clearly defined evaluation standards help students understand how their work will be assessed, allowing them to align their efforts with project objectives. This transparency can reduce anxiety, enhance motivation, and improve overall performance (Gibbs & Simpson, 2004). Providing students with detailed rubrics or guidelines can further support their ability to meet project expectations effectively.

Strengthening the project's connection with local needs is another valuable recommendation. Establishing a suggestion box or an email system for NGOs to propose project ideas can ensure that student initiatives address real-world community challenges. Research on service-learning indicates that projects with direct community engagement enhance students' sense of purpose and civic responsibility, leading to both personal growth and societal impact (Eyler & Giles, 1999). By integrating community needs into project topics, students gain practical experience in applying their knowledge to address pressing social issues.

Regular intermediate reviews with detailed feedback are critical for ensuring continuous improvement. Incorporating structured review sessions allows students to receive timely guidance, make necessary adjustments, and refine their projects iteratively. Studies have shown that formative feedback is an effective tool for enhancing learning outcomes and project quality (Nicol & Macfarlane-Dick, 2006). Providing specific and actionable feedback during these reviews enables students to identify their strengths and areas for improvement, ultimately contributing to the development of higher-quality final projects with significant social impact.

By implementing these enhancements —such as spaced-out training sessions, optimized team formation strategies, transparent evaluation methods, and stronger community linkages— *Patentes para Tod@s* project can further its educational and societal contributions. Addressing key challenges, including communication barriers, workload distribution issues, and the need for structured feedback mechanisms, will strengthen the overall learning experience. This iterative approach to project refinement underscores a commitment to academic excellence and social innovation, ensuring sustained success in future editions.

Despite the promising outcomes of this project, there remains a lack of research on CBL initiatives, particularly regarding their impact on students' skill development and their benefits to industry.

In terms of applicability, the project's outcomes have potential impact beyond the educational setting. The methodology could be adapted to other institutional contexts—such as university incubators, NGOs, or public innovation labs—to promote the strategic reuse of expired patents. Furthermore, its challenge-based approach could be aligned with the United Nations Sustainable Development Goals (SDGs), thereby contributing to the international discourse on responsible innovation and sustainability.

4.2. Future research

Future research should replicate this methodology across various educational fields to explore its broader applications. Selecting topics that are engaging, socially relevant, and aligned with real-world cases can enhance student motivation and learning outcomes. One interesting direction is the longitudinal analysis of the impact of this type of methodology on students' professional trajectories. To what extent does participation in patent repurposing projects influence students' orientation toward careers in social innovation or technological entrepreneurship?

It would be relevant to explore the replicability of the model in disciplines beyond the STEM fields, including the social sciences, humanities, or the arts. This interdisciplinary expansion would allow for a broader conception of innovation, encompassing non-conventional forms of applied creativity. Another fertile area lies in studying the role patent databases can play as open-access tools for disseminating technical knowledge. Future research could investigate ways to improve the accessibility and usability of these platforms for non-specialist users, thereby supporting a more genuine process of technological democratization.

Finally, further inquiry into the ethical and legal dimensions of expired patent reuse is suggested—especially when dealing with sensitive technologies or those with deep social implications. This line of investigation could contribute to the development of clearer, more adaptive regulatory frameworks suited to open innovation models.

5. CONCLUSIONS

Patentes para Tod@s project, rooted in CBL methodology, effectively bridges theoretical knowledge with practical application, enabling students to address social issues by applying classroom concepts. By working with expired patents, students develop skills in innovation and iterative improvement, fostering a mindset of continuous learning and problem-solving. This pedagogical approach enhances educational experience by demonstrating the relevance and applicability of academic studies to real-world challenges. The project's structured methodology—comprising comprehensive training sessions, collaborative teamwork, and continuous assessment—has proven effective in equipping students with new skills while advancing both educational and social objectives. The applicability of CBL methodologies can extend to disciplines in the social sciences and other fields where knowledge acquisition and innovation play a crucial role in student development. By expanding research on CBL approaches, educators and researchers can refine pedagogical strategies to maximize their effectiveness in fostering critical thinking, problem-solving, and interdisciplinary collaboration.

Additionally, the project cultivates a sense of responsibility and empowerment among students, as they recognize the societal impact of their work. Engaging with expired patents challenges them to think critically and creatively, strengthening their analytical skills and fostering an innovative-oriented mindset. Regular feedback mechanisms, including periodic reviews and final evaluations, ensure that students remain engaged and motivated, facilitating ongoing improvement throughout the project. Implementing further enhancements, such as optimized training schedules, improved team formation strategies, and structured intermediate reviews, will help address challenges identified in earlier iterations—such as communication barriers and workload distribution—while maximizing the project's educational and societal impact.

Taken together, *Patentes para Tod@s* project not only contributes to the development of key competencies in intellectual property and entrepreneurship but also serves as a catalyst for new research questions that can significantly enrich academic debate around sustainable, inclusive, and ethical innovation.

6. LIMITATIONS

Despite the valuable insights gained, limitations must be acknowledged. The study involved a relatively small sample of 57 students, including 14 international participants. While diverse perspectives were captured, the findings may not be broadly generalized across different student populations. The study was conducted within a single Spanish university, limiting external validity. Institutional and cultural factors may have influenced student engagement and expert evaluations. Expanding the study to multiple institutions across various regions would enhance generalizability. The case study methodology, though effective for in-depth exploration, poses limitations in terms of replicability and statistical generalizability. The use of expert interviews, student evaluations, and faculty assessments strengthens internal validity but introduces subjectivity. While triangulation mitigates bias, personal interpretations cannot be entirely eliminated. Finally, the interactive nature of CBL introduces variability in student experiences and outcomes, influenced by prior knowledge, motivation, and teamwork dynamics. Future research should adopt longitudinal designs and control groups to assess long-term impacts more comprehensively.

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