forensic sciences

Technical Note

Involving Forensic Students in Integrative Learning—A Project Proposal

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Abstract: In our experience, university students enrolling in health science and forensic science degrees show difficulty in retaining and integrating basic scientific knowledge learned in their first academic year. Furthermore, in the forensic sciences case, many students have oversimplified and unrealistic expectations as a result of the exposure to crime TV shows, internet blogs, and other social media platforms. Our pedagogical proposal is focused on second-year university students, aiming at promoting effective learning and the integration of scientific knowledge from previous courses, in this particular example, molecular and cell biology and biochemistry, with more advanced forensic courses, such as forensic anthropology and odontology. Teams composed of students and tutors from the teaching staff, with the help of dichotomous keys, are challenged to analyze a crime scene and choose the relevant evidence to further investigate, determine the scientific approach, execute the experimental work, interpret the results and, finally, resolve the case. To assess the pedagogical advantages and the receptivity of this project, a survey is to be carried out among students, and respective statistical analysis is also proposed. Finally, we hope this project outline may be adapted to other subjects, and, therefore, be used to address different pedagogical questions in forensic studies.

Keywords: integrative learning; b-learning; molecular biology; cell biology; biochemistry; forensic anthropology; forensic odontology; higher education

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1. Introduction

Forensic sciences became a popular area of study in part due to TV series such as Crime Scene Investigation (CBS), Dexter (Showtime) and Bones (Fox Broadcasting Company). However, the science behind these tv plots is often oversimplified and the scientific labs and procedures are unrealistic [1], which, although expected and understandable, may create false notions and expectations in the students. Furthermore, the advent of new technologies has changed the way in which the whole society, including students, communicates and obtains information, which poses an additional challenge for educators [2]. Namely, information is readily available on social media platforms, which may be overwhelming and confusing. In addition, it is often inaccurate, which may compromise the student's ability to critically analyze the information to draw conclusions [2]. To complicate things further, scientific themes are increasingly too broad and complex to be covered by a single discipline. These are some of the challenges of 21st Century Higher Education teaching that should also consider moving away from didactic forms of teaching to active learning, including integrating digital learning into practice and feedback assessments to evaluate and ensure student learning [3,4].

Another important aspect to be considered is students' academic performance throughout their academic path. Frequently, it is subject to fluctuations as it tends to increase near the evaluation/exam period and decrease afterward, and in some cases, "unlearning" and the loss of academic skills seem to occur from one year to the next, sometimes referred to as "knowledge decay" [5].

These concerns have led us to develop and implement integrative educational practices for first year Health Science students, inspired by problem-based learning strategies [6]. As there is very little information regarding the application of this pedagogical tool to future forensic scientists, we propose to adapt our integrative model to a forensic setting to engage the student in their learning process, as well as to provide them with lifelong knowledge and skills, while keeping in mind the purposes and contributions associated with forensic science, as well as the need for a solid and rigorous scientific background when addressing forensic problems [6,7].

The aim of this project is to propose the implementation of a problem-based learning project in forensics, to promote research, discussion, and collaboration between forensic science students and teachers, providing the means for the effective and interdisciplinary learning of key concepts learned previously and fighting "knowledge decay".

1.1. Interdisciplinary and Integrative Learning in Health Science Students

The Bologna Process, and its implementation, aims for a more inclusive and competitive higher education, not only by implementing the uniformization of a three-cycle system and mutual recognition of qualifications in European universities, but also by promoting student-centered learning to help students develop the competencies they need in an ever-changing labor market [8,9]. As such, it has had a significant impact on teaching and learning strategies, as well as assessment methods, in higher education, where teachers were challenged to become knowledge facilitators (tutors) and students to take a center stage in their learning process [10]. Among the different pedagogic strategies developed, problem-based learning (sometimes referred to as inquiry-based learning) has been well-established and widely used in universities around the world, particularly in medical schools [6,11]. Problem-based learning can be defined as a pedagogical approach in which students engage in collaborative activities to solve a problem [12]. In general, different approaches can be considered on the degree of student's freedom and the tutor's involvement, as well as the student's group it is designed for [10]. In the case of health/dental/medical schools, problem-based learning cases have been used over the years and are, in general, similarly popular with students and teachers as they tend to be collaborative, but centered on the students, promoting teamwork, research, and group discussions. This arguably leads to critical thinking, enabling knowledge acquisition and application in the process [10,12]. This inspired us to develop a collaborative project featuring Biochemistry, Molecular and Cell Biology, and Epidemiology and Statistics, to promote effective learning and the integration of scientific knowledge through the development of bibliography research skills among first-year students from the Faculty of Dental Medicine of the University of Porto. In this project, the students addressed suitable scientific themes, using the Pubmed database and the e-learning platform of the University of Porto (http://moodle.up.pt/ accessed on 2 June 2014), and prepared a PowerPoint/Webpage presentation, where the perspectives and contributions of the three scientific domains were explored and integrated. The students filled in a questionnaire to evaluate their responses to this teaching exercise. The students then completed the evaluation questionnaire; the great majority of the students considered that this new methodology promoted the development of a broader view of the research subjects and the acquisition of new knowledge [13].

1.2. Interdisciplinary and Integrative Learning in Forensic Science: Project Implementation

Based on the project previously presented, we propose to develop a hands-on curricular unit, starting in the second academic year, to promote the integration and application of knowledge from cell and molecular biology, biochemistry, and laboratory techniques learned in the first academic year, and forensic anthropology and odontology, which are second-year disciplines in most forensic science curricula. This problem-based, information-driven, team-based learning project is designed for forensic science students; however, we believe this project outline may be adapted, using other subjects to respond to their specific pedagogical needs.

To implement this project the following steps are suggested:

Step 1: Organization of materials and project teams

- Formation of the Research teams

Each team is composed of four students and two tutors from the teaching staff (in this case one from sciences and another from forensic anthropology/odontology).

- Distribution of forensic cases

A different case scenario is handed to each group containing:

- a brief report/description of the case (an example is presented in Box 1)
- a list of evidence collected at the crime scene
- the material collected or photographed at the crime scene
- three dichotomous keys to help the teams analyze and solve the case (Schemes 1–3)

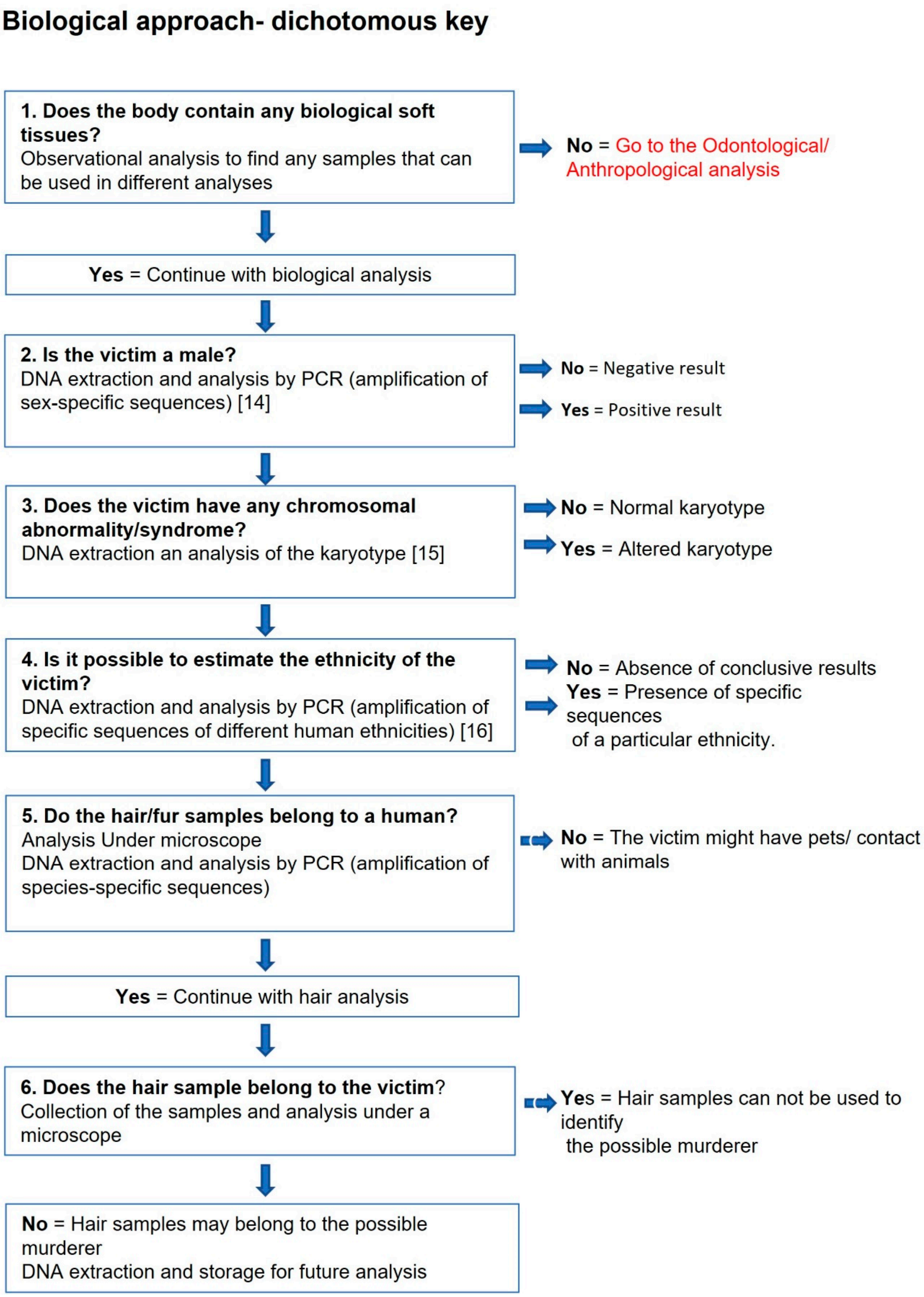
Box 1. The Forensic case: an example of a crime scene for student analysis and resolution.

The Forensic Case

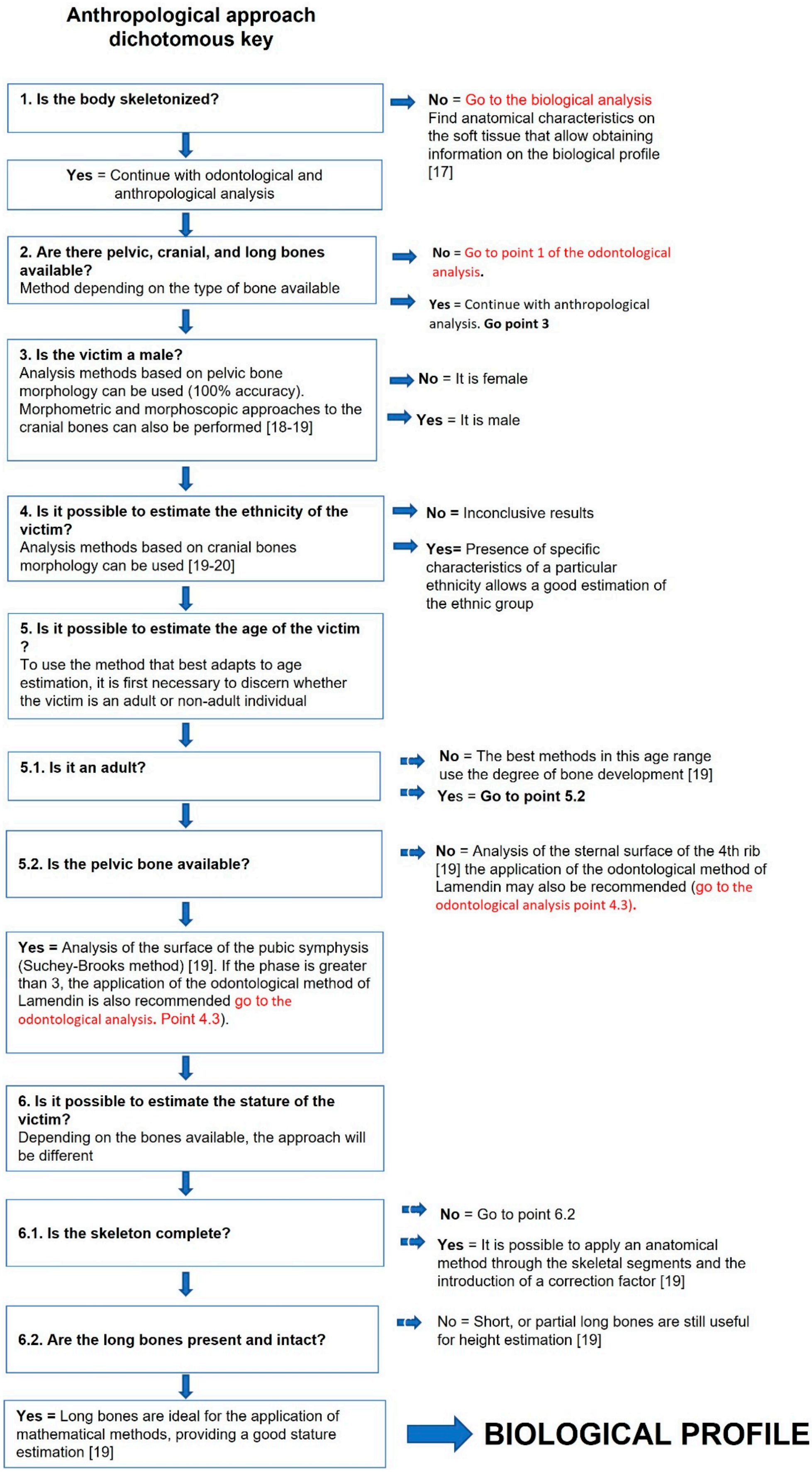
In an empty house, a dead body partially skeletonized was found on the floor. The right hand had a glove, whereas the left was fully skeletonized. On close inspection and opening of the cadaver's mouth, both the upper canines and the lower incisors and canines could be observed. The first lower left premolar was found, laying on the floor, next to the cadaver. Some dry blood spatters were identified on the cadaver's clothes and on the floor, nearby. Hairs and fibers could also be seen scattered on the floor.

Step 2: Evidence analysis and student planning

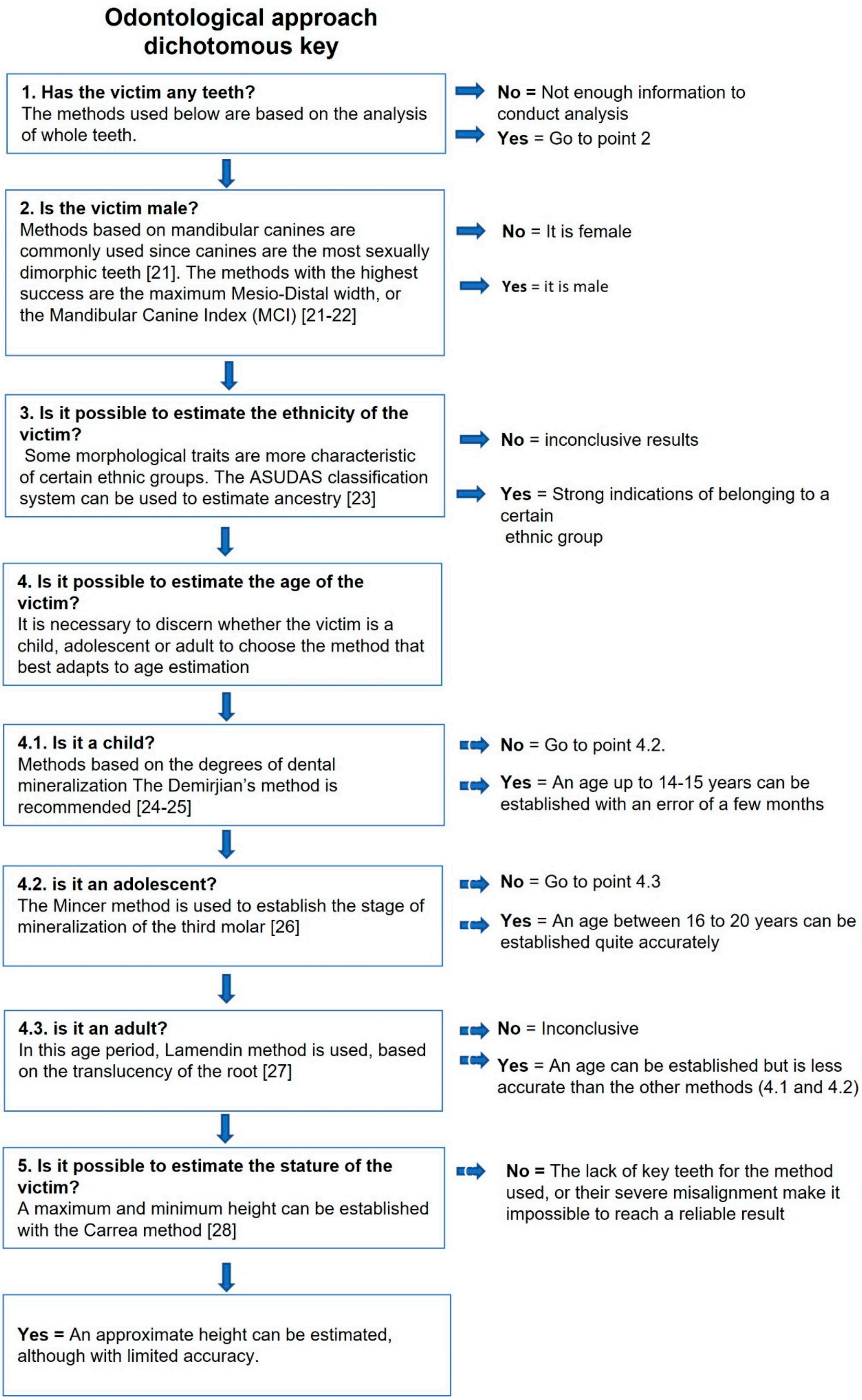
During this phase, the students should analyze the evidence collected in their work case and, with the help of the dichotomous key, choose which samples/material will be processed in the laboratory (Scheme 1) [14–16], analyzed using forensic anthropology (Scheme 2) [17–20], or forensic odontology methods (Scheme 3) [21–28]. Together with the tutoring staff, the students plan the research strategy, develop the laboratory protocols and execute the lab work.



Scheme 1. Dichotomous key for students using a biological approach to evidence testing.



Scheme 2. Dichotomous key for students using bone forensic analysis.



Scheme 3. Dichotomous key for students using a forensic odontology approach.

Step 3: Data analysis and Resolution of the case

Once the analysis is performed and the laboratory results have been obtained, the students prepare a case for presentation to the class, in which they explain in detail their approach and the results obtained, and propose a resolution of the case. All cases will be presented and discussed by all team members.

Topics of discussion might include:

The scientific approach, tests used, advantages, limitations, and possible redundancy of the tests performed, difficulties during the planning execution and interpretation of the results.

The students' efforts will be evaluated by the teaching staff based on their results and case presentation.

Evaluation of the pedagogical impact on student learning: A statistical study in order to assess the possible pedagogical advantages and the receptivity of this project, a survey will be carried out among students. This survey will take place in the last class, and it is divided into two parts.

The first part of the questionnaire consists of five statements, the agreement is measured on a 5-point Likert scale (Table 1). The first two statements aim to assess the pedagogical advantage recognized by students. The next two statements are intended to assess the satisfaction and enthusiasm in participation. The last question is intended for students to assess the fairness of the assessment method of this pedagogical project.

Table 1. Student feedback survey on the integrative project learning experience.

Question							
This project allowed me to develop a broader view of the subjects studied	Not at all	1	2	3	4	5	Yes, I agree completely
This new method was essential to acquire new concepts and scientific knowledge	Not at all	1	2	3	4	5	Yes, I agree completely
This pedagogic approach promotes pleasant and effective learning	Not at all	1	2	3	4	5	Yes, I agree completely
Although it's a time-consuming approach, it was worth it	Not at all	1	2	3	4	5	Yes, I agree completely
The evaluation/grading was adequate a fair	Not at all	1	2	3	4	5	Yes, I agree completely

In Table 2, there are three questions. The students are asked to mention the positive and negative aspects of the pedagogical project in which they participated, as well as highlighting aspects that could improve it.

Table 2. Student's reflection on the positive and negative aspects of the integrative project learning experience.

Open Questions
Refer to the standout positive aspects of this pedagogic approach
Refer to the negative aspects of this pedagogic approach
Suggestions to improve the integrative pedagogic project

2. Discussion

In a traditional education model, learning is frequently focused on discipline-based, expositive information that is validated by faculty members from the respective courses and very rarely integrates the knowledge needed for effective decision-making in a problem-solving context [29]. In contrast, in a problem-based learning environment, students are presented with a question and engage in collaborative activities to solve it [12]. In this case, different approaches can be considered on the degree of student's freedom and the tutor's involvement, as well as the student's group it is designed for [10,12]. Some proposals grant the students a great level of freedom to identify and solve the problem, but most frequently the problem is presented, and the student is coached by the tutors to develop the best strategy to solve it [10]. Frequently, in this case, students are encouraged to use their previous knowledge, investigate, and acquire new information, with the tutor's guidance, to solve the problem in an information-focused approach [10]. In some cases, however, the students are challenged to create something that is original and new to solve a question, and in this case, the tutors' role is to guide the students in a discovery-focused approach. Finally, the project may be individual or team-based [10]. In this work, we present an integrative problem-based learning proposal for forensic sciences students aiming at promoting knowledge retention and critical thinking in different domains, in this example biology/genetics and forensic odontology/anthropology, to achieve a practical goal: the resolution of a forensic case (Box 1). This hands-on approach will be supervised, at all times, by the teaching staff, allowing students the freedom to develop their strategy while ensuring the correct application of the scientific concepts and techniques. In our view, this is particularly important as students who learn in more traditional environments tend to apply the different techniques separately in their respective classes, therefore compartmentalizing the knowledge. Due to the lack of published reports regarding problem-based learning and its application in forensics, we believe this proposal might also contribute to the development of these approaches in future forensic teaching. Nevertheless, there might be limitations to this project that should be addressed, as they might limit or create difficulties in its implementation. Some of the possible obstacles to the successful application of this proposal include the necessity to ensure the correct design and preparation of the forensic cases; to ensure that all staff involved, from lab technicians to the teaching staff are well prepared and fully committed to the project; teachers should be facilitators and create an environment where all students are involved in the learning process as well as monitor their progression; finally, students should be proactive in their learning process [11]. Another critical aspect following the implementation of problem-based learning projects is the evaluation of its efficacy, where the evaluation strategy must be well-adjusted to the pedagogical outcomes [10,12]. We believe the proposed student survey on their learning experience, including open questions to promote a more detailed reflection on the positive and negative aspects of this project, will certainly contribute to an evaluation of this proposal from the student's point of view, allowing us to further develop and adapt this pedagogical approach to meet the student's expectations and promote its improvement before applying it in subsequent years. As the students will work in proximity with the tutors and present their cases to the teaching staff for grading, the knowledge acquired, concept integration, laboratory skills, problem-solving skills, and critical discussion of the problems can also be evaluated. However, the impact of this type of project on short-term and long-term learning outcomes is much more complex and difficult to measure. One possible approach, although empirical, is to evaluate the students' performance in conceptual tests at different times after the project and follow the student's academic performance to determine its evolution. However, to clearly test the efficacy of this approach, a direct comparison between traditional and problem-based methods would be necessary [12]. There are several examples in health sciences university degrees where the implementation of problem-based programs were well accepted by the students and teaching staff [30–32]. Specifically, in dental and medicine courses, problem-based learning implementation has been reported to help students understand the interrelationship between clinical knowledge and basic science concepts, as well as improving integrated thinking and problem-solving skills [6,32,33]. A meta-analysis of 22 studies evaluating the pedagogical impact on Nursing teaching also suggests the effectiveness of this approach, with particular impact on the students' satisfaction with the skills development and clinical training [31]. Interestingly, Strobel and van Barneveld evaluated eight meta-analyses and systematic reviews addressing the effectiveness of problem-based learning when compared to traditional teaching, and their analysis showed that even though the impact on short-term learning seems to be identical in both education models, problem-based learning is perceived to be more effective when considering the long-term retention of knowledge and skills development, which strongly suggests there are benefits to this pedagogical approach [30].

Most of the problem-based learning in health sciences is developed in clinical environments aimed at teaching medical, dental, and nursing students, and in forensic science teaching, there are very few reports in the literature regarding this pedagogic approach and its implementation. However, a recent publication discussed and proposed the use of problem-based learning to teach future forensic speech scientists [34], while an active learning approach to forensics through the development of simulated crime scenes has also been proposed as a way to promote effective learning and critical thinking [35]. Therefore, although this work is only a proposal, which has not been implemented and is therefore not yet tested or validated, we believe it is an interesting and valuable contribution to forensic sciences teaching, to stimulate students to learn and develop technical skills inspired by the many examples of PBL activities in higher education [6,12,30–33]. Furthermore, as the learning outcomes seem to be more effective than the existing long-term knowledge retention, it would benefit forensic students by helping fight "knowledge decay" [12,30].

3. Final Remarks

Overall, we believe this project will create interest in the student community, which might help consolidate previously addressed scientific themes, fight knowledge decay, and increase the scientific preparation of forensic science students. We also believe this is a valuable contribution to the field of problem-based learning in forensics and hope this project outline may be adapted to other subjects, and, therefore, be used to address different pedagogical questions. Once the project is implemented, survey results may help optimize and further develop this project. However, to evaluate the efficacy of this pedagogic proposal, namely in mitigating "knowledge decay", an academic follow-up should be conducted to assess the students' academic performance in the following years.

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