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Review

Methods of Cyclist Training in Europe

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Abstract: The following study aims to address the issue of cyclist training methodologies. Recent European bicycle accident statistics reveal a troubling upward trend. A potential solution to mitigate such incidents involves providing cyclists with comprehensive training encompassing traffic regulations and interactions with fellow road users. We conducted a comparative analysis of the cycling education approaches and cyclist training systems in several countries, including the Netherlands, Germany, Austria, England, Slovenia, Poland, and Italy. This analysis underscored the importance of standardizing training protocols and criteria across Europe. The training model should draw inspiration from countries with well-established cycling cultures and serve as a foundation for harmonizing training practices.

Keywords: cycling safety; cycling education; cycling proficiency test

Citation: Wachnicka, J.; Jarczewska, A.; Pappalardo, G. Methods of Cyclist Training in Europe. *Sustainability* **2023**, *15*, 14345. https://doi.org/10.3390/su151914345

Academic Editor: Socrates Basbas

Received: 8 August 2023
Revised: 9 September 2023
Accepted: 26 September 2023
Published: 28 September 2023

1. Introduction

Owing to the active promotion of environmentally friendly lifestyles in several European nations, the bicycle is progressively emerging as a predominant mode of transportation on the roadways. This phenomenon can be attributed to a plethora of factors. Numerous cities are gradually prioritizing the development of sustainable transportation systems, which includes restricting car access to central areas. Moreover, there is a growing ecological awareness among individuals who are averse to contributing to urban pollution with vehicle emissions. Additionally, the bicycle offers a means of travel that enables users to maintain and enhance their physical health and overall well-being.

Various initiatives, including promotional campaigns in workplaces, schools, and local governments, play a pivotal role in encouraging people to transition to cycling. The introduction of electric bicycles and rapid technological advancements have also broadened the demographic interested in cycling. Consequently, it provides a swifter mode of travel with extended accessibility, particularly benefiting those residing in suburban regions. Given the daily issue of traffic congestion, especially during peak hours, bicycles offer a rapid alternative for movement. Furthermore, the cost savings on fuel serve as an appealing incentive, especially in scenarios where the risk of being ensnared in traffic jams is high.

In this paper, we embark into a pivotal inquiry, namely, the adequacy of the preparation of every individual who utilizes a bicycle for safe riding. Are prospective cyclists sufficiently educated about essential road etiquette? Do all bicycle users possess the requisite qualifications for road travel? Could this deficiency in preparedness lead to an upsurge in accidents, especially if there is a lack of emphasis on educating future cyclists? We will explore diverse practices across different countries and analyze the potential ramifications of these varying approaches to this matter. The emphasis on research pertaining to education methods and bicycle regulations as the central focus of this paper was driven by the recognition of their pivotal role in the process of harmonizing European regions. Education methods influence not only the development of individuals but also shape broader

societal attitudes and behaviors, contributing significantly to the overall well-being and safety of European communities. Additionally, bicycle regulations, encompassing aspects such as infrastructure and safety standards, play a crucial role in promoting sustainable transportation and ensuring the safety of cyclists throughout the continent.

By highlighting these key areas of research, our aim was to shed light on the interconnectedness of education and transportation policies across European regions. We believe that a comprehensive understanding of these subjects is essential for fostering a cohesive and sustainable Europe, where the harmonization of practices and regulations can lead to improved mobility, safety, and overall quality of life for its residents.

2. The State of Cycle Safety in European Union

Through its mobility policy, the European Union is actively implementing measures to enhance road safety. As an integral component of the Commission's strategic action plan spanning 2021 to 2030, a specific objective was established to reduce the number of fatalities and severe injuries among road users by 50%. Moreover, the plan delineated a series of initiatives with the ambitious aim of completely eliminating fatal road accidents by the year 2050, a concept referred to as "Vision Zero" [1].

Data derived from European statistics unveil a significant deviation in the trend of fatal accidents among cyclists on urban roads from 2010 to 2019, which contrasts with the declining trend observed in all other modes of transportation (see Figure 1) [1].

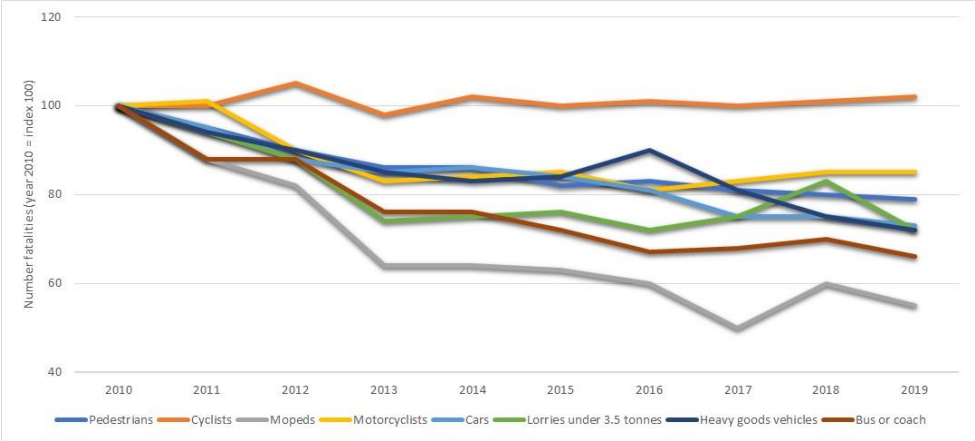

Figure 1. Trend of fatalities in crashes involving different transport modes in the EU27 (2010–2019) [1].

The highest cyclist mortality rate per 1 million residents within the European Union (EU) countries during the period spanning from 2017 to 2019 was concentrated in Central Europe (refer to Figure 2) [1]. Analyzing accidents at the level of individual European Union nations proves to be exceptionally challenging due to the varying levels of popularity attributed to bicycle transportation. In accordance with the findings presented in the report titled "Safety of Cyclists in the Context of National Legislation and Local Initiatives," it is noteworthy that the average Dutch citizen covers approximately 1000 km annually on a bicycle, whereas their French and British counterparts travel around 70 km [2]. Paradoxically, in nations characterized by a strong cycling culture and heightened awareness, such as the Netherlands and Denmark, a higher proportion of cyclists are recorded as fatalities in road accidents within the European Union. This complex scenario arises from two key factors: the substantial volume of bicycle trips undertaken and the notable representation of cyclists within the overall road traffic framework. It would be erroneous to pinpoint hazardous cycling areas based solely on the rate of road fatalities. This is due to the fact that, in regions where cycling enjoys immense popularity and population density is elevated, the prevalence of active transportation significantly increases, consequently leading to a rise in the number of fatalities [3].

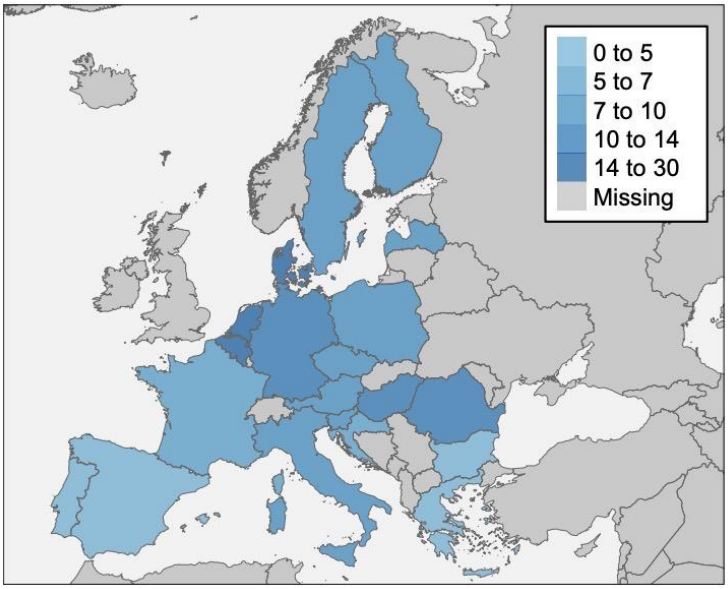

Figure 2. Cyclist fatalities per million inhabitants per country in the EU27 (2017–2019) [1].

Evaluating the risk encountered by cyclists involves considering a non-linear correlation known as the "safety in numbers" relationship. This concept considers mortality statistics that have been adjusted to account for exposure, which is quantified as the annual distance traveled per person in active modes of transportation, typically measured in kilometers [3]. The visual representation below accentuates a discernible pattern: countries such as the Netherlands, Denmark, and Germany markedly contrast with nations like Italy or Belgium, as they display substantially lower risk rates for cyclists.

The majority of incidents involving cyclists occur away from intersections when they share the road with other users. However, during the period spanning 2017–2019, there was a notably greater proportion of cyclist fatalities occurring within intersections compared to the proportion of all fatalities occurring within intersections (refer to Figure 3) [1].

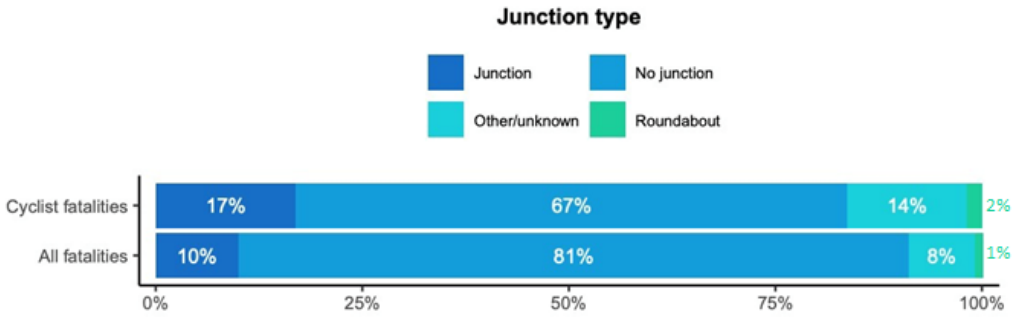

Figure 3. Distribution of fatalities from accidents in and outside intersections by type of facility [1].

With respect to age demographics, the year 2019 marked a time of pronounced vulnerability among individuals aged 65 and older concerning cyclist fatalities resulting from road accidents within the European Union. Conversely, young individuals aged 15 to 17 experienced a considerably diminished level of risk in this regard. It is worth noting that Germany accounted for the highest number of cyclist fatalities. A close examination of these statistics reveals a notable frequency of accidents within the 25 to 65+ age group, thereby emphasizing the imperative for making comprehensive cycling education accessible to individuals spanning all age cohorts [4].

3. Cycling Education in Europe

Within the framework of international law, European nations are obliged to adhere to a series of treaties that govern road regulations. The 1968 Vienna Convention, in particular, encompasses all type of vehicles, including cyclists and pedestrians, within its traffic rules [5]. Some countries further elaborate upon these provisions with additional clauses that complement the Convention's guidelines. These supplementary regulations primarily address aspects such as mandatory equipment to enhance cyclist visibility (e.g., pedal reflectors, spoke reflectors), standards for child bicycle seats (e.g., seat design, mounting mechanisms, footrests), the minimum age for cycling on public roads, and rules pertaining to helmet usage [6].

In countries boasting well-developed educational systems and robust bicycle infrastructure, young children are educated about anticipating hazardous scenarios on the road from an early age. They become acquainted with road signs and traffic regulations, which enables them to react appropriately. The responsibility for imparting road safety knowledge to children at an early stage lies with their family members. Recognizing that childhood perceptions, beliefs, and repetitive behaviors often solidify and prove resistant to change in the future, parents or guardians must prioritize cycling education and act as commendable role models [7].

It is imperative to note that a significant portion of a child's physical development occurs before the age of 7 and continues to refine throughout adolescence. Cycling, being a fine motor skill, demands ample practice for the movements to become instinctive and well-coordinated. Riding within traffic involves two categories of motor skills:

1. Fundamental bike handling skills:
    - Maintaining balance.
    - Pedaling.
    - Steering.
    - Braking.
2. Safety skills:
    - Scanning the environment (e.g., moving one's head).
    - Merging into traffic.
    - Braking to halt at traffic signals and stop signs.
    - Signaling maneuvers when turning [8].

With this foundational context in consideration, let us delve into exemplary training systems found in various European countries. This examination of training systems and examination of school-age cyclists was conducted in a limited set of seven countries. This restriction was imposed due to the challenges associated with accessing the required information, which is often available in the native language of each respective country. Nevertheless, our efforts were meticulous to ensure the inclusion of representative materials from countries with extensive histories of promoting cycling such as the Netherlands or Germany, as well as countries from the Eastern Bloc, where transformative shifts in transportation behavior are still in their nascent stages.

3.1. The Netherlands

The Netherlands stands out on a global scale as one of the most bicycle-friendly nations, renowned for its well-established cycling infrastructure and innovative approach to training young cyclists. In the Netherlands, the paramount importance of education in ensuring road safety has long been acknowledged for an extended period. This recognition has materialized through the introduction of road safety education courses within the school system. Notably, cycling education is a mandatory component of this curriculum and culminates in a cycling examination. While the theoretical examination is compulsory, the practical examination is at the discretion of individual schools, with approximately 80% typically opting to include it [9].

From an early age, parents instill safe cycling practices in their children, seamlessly integrating road rules into everyday play and activities. Dutch data reveals that children under the age of 11 cycle almost as frequently as they walk. Within the school curriculum, a dedicated subject on road safety exists, which must be successfully completed to advance to the subsequent grade level. Formal cycling education begins in elementary school and extends beyond mere classroom learning. A crucial aspect of this education involves biannual visits to a "traffic garden," a purpose-built facility designed to simulate various traffic scenarios. Equipped with traffic lights, road signs, bike paths, roundabouts, and more, the facility serves as a practical training ground. These educational visits are led by trained instructors who initiate the lessons by explaining road regulations within small, specialized groups. Following this, students are divided into three groups: one group operates small vehicles, another cycles, and the third navigates the space as pedestrians. After approximately 20–30 min of practice, the groups rotate. Typically, these visits occur when pupils are around 10–11 years old, coinciding with their transition to junior high school [9].

Between March and June, seventh- and eighth-grade primary school students participate in the Nationaal VVN Verkeersexamen practical test on road bikes. This practical examination assesses students' ability to apply theoretical knowledge to real-world situations and demonstrate their acquired road traffic skills. The examination takes place on a predetermined city route, with stationed police officers or volunteers who evaluate students based on a predefined checklist (refer to Figure 4). An illustrative route for the Verkeersexamen exam, complete with checkpoints, is depicted in Figure 5. The exam aims to closely replicate everyday cycling conditions; thus, no additional signage is placed on the route, nor are streets closed off to traffic. Well in advance, students and parents receive details about the exam's structure and route to allow ample preparation for the tasks ahead. To participate in the Verkeersexamen, students must use an approved bicycle, adhering to specific requirements outlined in a provided folder distributed at school. A passing score on the Verkeersexamen necessitates achieving at least 80% of the available points. Exceptions arise in cases of critical errors, such as running a red light or disregarding right of way, which result in an automatic exam failure regardless of point accumulation. Results are typically delivered on the same day as the exam. Subsequently, teachers can discuss results individually or with the entire class, focusing on commendable aspects and areas for improvement. In cases of a negative outcome or illness, students are allowed another attempt within a 4-week timeframe, with the date being set by the school [10].

Figure 4. VVN road practical test [11].

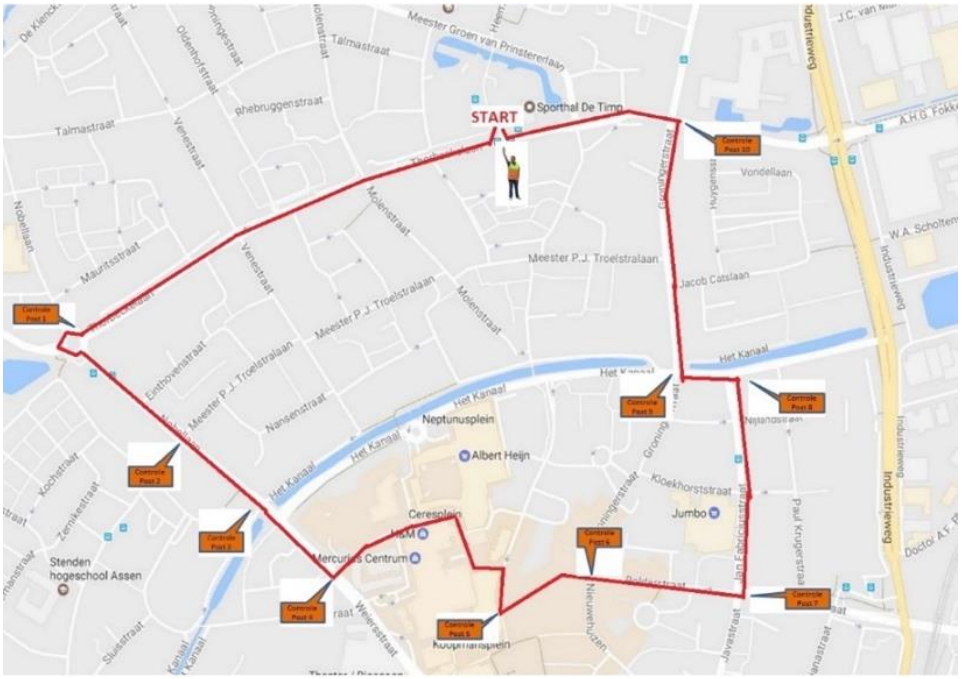

Figure 5. The route of the practical Verkeersexamen 2020 in Assen [10].

Moreover, to augment preparedness for the practical examination, the introduction of the VVN application has played a pivotal role. This application enables facilitating independent practice for children within the comfort of their own homes. Over a four-week period, the app provides guidance by offering instructional videos, assignments, and valuable tips that align with the examination format [10].

3.2. Germany

Germany boasts a well-developed traffic education system. Due to its federal structure, the responsibility for road education in schools lies within the jurisdiction of individual Länder (states). While these states have the autonomy to develop distinct curricula, the "KMK Recommendation on Road Education," issued in 1972 within the Federal Republic of Germany, serves to standardize the content, scope, and teaching methods of road education [12]. The initiation of road education in Germany begins at the preschool stage, where foundational knowledge regarding road traffic participation is introduced through various exercises and interactive activities. Typically, by the first year of primary school, most Länder incorporate a dedicated subject into the curriculum, aimed at familiarizing young students with essential traffic-related behavior patterns [13]. A significant milestone in assessing the reaction of first graders to real-life road traffic situations is the pedestrian examination [13]. Upon achieving the Walking Diploma, German students commence preparations for the bicycle license examination, a process that begins in the second grade.

In schools, transportation education in schools is facilitated by specialized educators who impart theoretical knowledge concerning road education. The practical aspect of training (refer to Figure 6) is supervised by specialized police officers referred to as "traffic guards" at the Jugendverkehrsschule (youth traffic school) [14]. These institutions operate under the oversight of local traffic authorities, occasionally in collaboration with the police, and participation in their programs comes at no cost to the students. Practical cycling training is also often conducted within the confines of the school playground.

Figure 6. Practical part of the training [15].

Within Germany, the non-governmental organization Deutsche Verkehrswacht plays a pivotal role in advancing road safety education. This organization not only provides bicycle education within schools but also assists parents in nurturing their children's sense of balance and motor skills, especially for those who are just beginning to learn how to cycle [16].

In Germany, the bicycle license examination, which encompasses both theoretical and practical components, primarily occurs during the fourth grade of primary school. Although participation in this examination is voluntary, it is taken quite seriously. The examination is conducted within the school courtyard, in simulated traffic settings, or most commonly, at the Youth Traffic School. Prior to the examination, participants have the opportunity for a practice run with police officers.

The formal part of the examination typically lasts for 15 to 20 min and involves the student navigating a designated route. In certain instances, children even have the option to choose their route. Should a test taker accumulate more than 10 penalty points, they are required to retake the examination.

The bicycle license awarded upon successful completion of the examination is symbolic in nature, as it does not grant immediate riding privileges. Germans understand that passing the examination does not automatically ensure flawless road cycling skills, necessitating ongoing practice.

To further enhance the scope of cycling education, Germany has introduced mobile traffic schools, a concept that has also been adopted by other countries. These mobile schools consist of specialized trucks equipped with bicycles and the necessary materials to create a simulated traffic environment.

The mission of the mobile youth schools is to travel across counties, visiting schools and providing training to all enrolled students in safe cycling practices.

3.3. England

Until 2007, England implemented the Cycling Proficiency Test to elevate cyclists' competence and enhance road safety. The early 21st century witnessed a resurgence of bicycle transportation in the country, leading to a comprehensive transformation that established new benchmarks. Presently, the basis for assessing cycling proficiency in England is the National Cycling Training Standard, commonly referred to as the National Standard. This standard serves as a comprehensive manual outlining proper bicycle riding techniques, elucidating essential knowledge and skills necessary for proficient cycling, eliminating disparities in the interpretation of applicable rules, guiding the development

of educational resources, and supporting various cycling education programs, including Bikeability [17].

The National Standard is organized into five distinct roles, each comprising separate chapters (as shown in Table 1). Within each chapter, specific points outline the competencies a cyclist should possess and actions they should be capable of performing. Importantly, the National Standard aligns with benchmarks set for other road users, thereby enhancing road safety during shared usage. While accessible to all, it is particularly geared towards cyclists, driving and cycling instructors, organizations engaged in setting standards, and those engaged in planning cycling training or delivering educational services [17].

Table 1. Information contained in National Standard (own elaboration based on [17]).

	Name	Description of Contents	Division into Chapters
Role 1	Prepare for a journey	How to prepare myself and the cycle, and plan a journey	1.1. Prepare myself for a journey 1.2. Preparing the cycle for a journey 1.3. Plan a journey
Role 2	Ride with control	How to set off, ride, and stop the cycle	2.1. Set off and stop the cycle 2.2. Ride safety and responsibly
Role 3	Use the road in accordance with the highway code	How to negotiate roads and junctions and comply with signals, signs, and road markings	3.1. Negotiate roads safely and responsibly 3.2. Comply with signals, signs, and road markings
Role 4	Ride safely and responsibly in the traffic system	How to share the road with others	4.1. Interaction with other road users 4.2. Minimize risk when cycling
Role 5	Improve cycling	Learn from experience and keep up to date with changes	5.1. Review and improve your cycling practice
Role 6	Deliver cycle training	Enable others to cycle safety and responsibly	6.1. Prepare to train learners 6.2. Design cycle training sessions 6.3. Enable safe and responsible cycling 6.4. Manage risk to maximize learning 6.5. Improve professional practice 6.6. Train instructors to deliver cycle training

Drawing upon the English National Standard, a government-initiated cyclist training initiative named Bikeability has been established. This program provides invaluable guidance on best practices and the necessary training criteria, along with comprehensive evaluation procedures. Since its inception in 2007, this program has successfully trained over 3.5 million children. Bikeability is structured into three tiers (as outlined in Table 2) and places significant emphasis on an 80–20 training ratio: 80% of the training focuses on hands-on cycling experiences, while the remaining 20% is dedicated to instructor-led activities encompassing demonstrations, open discussions, addressing queries, and providing feedback to trainees [17].

Table 2. Bikeability training program structure (own elaboration based on [18]).

	Description	Maximum Number of Participants per Instructor	Minimum Time Requirements	Recommended Age Limits
Level 1	It teaches basic bicycle handling skills in a controlled, traffic-free environment	12	2 h	From 7 to 9 years
Level 2	It teaches students how to cycle along planned routes on roads with less traffic	6	6 h	From 9 to 11 years old
Level 3	Provides participants with the ability to cope with a variety of traffic conditions; training is conducted on normal traffic roads with advanced features and systems	3	2 h	Over 14 years old

In addition to serving children and school groups (refer to Figure 7), Bikeability extends its scope to include adults and whole families through customized training programs. These training sessions are adapted to align with the skill levels of the participants. It is worth noting that, at present, the Department of Transport exclusively provides funding for courses aimed at children. It is important to emphasize that participation in school cycling activities is not mandatory and typically takes place outside of regular school hours [19].

Figure 7. Practical exercises in the field conducted as part of Bikeability [19].

3.4. Austria

In Austria, road safety education is a mandatory component for children aged 6–18. Within the school environment, educators utilize educational materials from the Austrian Youth Red Cross to prepare children for the voluntary bicycle test. Furthermore, children engage in cycling classes within small groups, with a focus on acquiring safe traffic navigation skills. In Austria, children aged 10 and above have the opportunity to obtain a bicycle card, which grants them permission to cycle independently. Attaining this card involves successfully passing the voluntary Radfahrprüfung bicycle test, which consists of both a theoretical written component and a practical section conducted by Austrian police officers within an actual traffic environment. During the practical test, children navigate a designated route under the supervision of teaching staff, volunteers, the police, and parents, allowing them to demonstrate their skills in a secure setting. Typically, Austrian children undertake this examination at the age of 9, typically during the fourth grade of primary school. Alternatively, they have the option to schedule private testing appointments within a simulated traffic town [20,21].

To enhance preparedness for the voluntary bicycle test, Austria has introduced the online educational platform radfahrprüfung.at. This platform empowers children to practice the concepts learned in school and simulate an examination scenario. Additionally, an application named JRK Mobile Campus has been developed, offering structured training modules to facilitate effective learning. Each module includes visual aids such as photos and instructional videos. The application features flashcards designed to assess the student's comprehension, and their progress in learning can be monitored at any point [20,21].

3.5. Slovenia

An illustrative instance of Slovenia's initiatives aimed at enhancing road safety involves preparing children and adolescents for a bicycle examination. Typically, children aged 4–5 commence learning their initial cycling skills under the guidance of parents and

caregivers. In Slovenia, the Ministry of National Education, Science, and Sport has issued a document titled "Concept of Bicycle Training and Bicycle Examination in Primary School." This publication delineates objectives, content, methodologies, and modes of instruction related to educating students about cycling safely in road traffic [22,23]. Primary schools, parents, local councils organized for road traffic accident prevention and education, and the police collaborate to prepare students for independent cycling while also evaluating their driving skills. Teachers who have completed a seminar to serve as training program providers offered by the Institute of Education of the Republic of Slovenia design the training curriculum. The program encompasses three distinct segments:

- Attaining theoretical knowledge and assessing comprehension.
- Practicing cycling skills in controlled environments.
- Experiencing hands-on riding within actual traffic scenarios [23].

The training framework follows a structured approach, commencing in grades 1–3 with the establishment of theoretical groundwork on road safety. The comprehensive document specifies the specific topics to be covered during these theoretical sessions. In the fourth and/or fifth grade, theoretical knowledge is revisited and reinforced, culminating in a theoretical exam that assesses familiarity with cyclists' rights and traffic regulations. This assessment of theoretical knowledge utilizes a dedicated platform tailored for cyclists, generating questions of varying difficulty levels at random. Each participant responds to 20 questions, and the results are promptly disclosed upon completion of the test.

Practical training is scheduled for the fifth grade of primary school. This includes sessions in a designated maneuvering area, where children practice essential maneuvers, adherence to road rules, and the skill to inspect their bicycle's technical condition. Subsequently, students transition to practicing in real traffic settings around the school, where they encounter diverse traffic scenarios within a safe environment. Each group, comprising five students and a teacher, participates in 3 to 5 h of training. Before practical sessions, thorough bicycle technical assessments are conducted, which include affixing a bicycle safety sticker, issuing a bicycle inspection report, and ensuring the bicycle is ready for use. Mandatory bicycle helmets are worn during these classes and reflective vests are also worn during practical training and the bicycle exam. Initially, students traverse the traffic practice route on foot, enabling them to internalize feedback and observations for later riding sessions. The practical examination begins with maneuvering area tasks, where students must successfully navigate at least five obstacles without touching a wheel or toppling structures. Subsequently, the examination progresses to real traffic scenarios in the school's vicinity, mirroring the practice locations. The "Concept of Bicycle Training and Bicycle Examination in Primary School" document meticulously outlines the criteria for passing the individual components of the bicycle exam (refer to Table 3). Upon completion of the entire training regimen, children receive a bicycle card issued in the form of a document bearing signatures from both the school and parents. With this card, children gain the autonomy to independently participate in road traffic [23,24].

Slovenia demonstrates another commendable cycling practice through nationwide educational campaigns. One of these campaigns, the "Safe Bike" initiative, previously mentioned in the training protocol description, stands out. This program is integrated into the school system and specifically targets children aged 10–11 as well as their parents. As part of the bicycle training curriculum, students are obligated to undergo inspections of their bicycle's technical condition before cycling. The campaign encompasses training in bicycle repair and maintenance while emphasizing safe riding practices through the use of appropriate equipment. Each spring, technical inspectors collaborate with the Slovenian Road Safety Council to conduct classes within schools, preparing bicycles for the upcoming season. Successful completion of the inspection earns participants a "Safe Bike" sticker. The sticker's color changes annually, rendering the previous one invalid. To obtain a new sticker the following year, bicycles must undergo another inspection. If a bicycle fails to meet specific criteria, parents are notified about the necessary repairs. Frequently, parents take the initiative to address defects and arrange for the bike's inspection, with

their children closely involved. Implementing a "Safe Bike" campaign is straightforward and cost-effective, yet its outcomes are of paramount importance in bolstering cyclists' safety [25].

Table 3. The criteria for passing the bicycle exam in Slovenia (own elaboration based on [24]).

	Success Criteria	Penalty Points
Theoretical	At least 75% of possible points, including all tasks for 2 points.	None.
Practical—driving around the maneuvering area	Overcoming 50% of the obstacles without error, which must include stopping, not moving an object, and slalom.	For each contact of the ground with a foot, for each time touching the boundary line of the maneuvering area, for each loss or movement of a peg cone or mark, for each omission of an obstacle, for knocking down the first stick in the final obstacle or knocking down the last stick in the final obstacle, for knocking down all obstacles, for destroying an obstacle that should not be touched by the examinee at all.
Practical—driving in traffic	Credit is granted if the student has not collected more than 25% negative points and did not make cardinal errors such as forcing the right of way, incorrect signaling for a turning maneuver, etc.	1. Driving technique: failure to check the suitability of the bicycle for riding, incorrectly getting on the bike, getting off the bike, incorrect one-handed driving, incorrect driving straight ahead, abnormal stop. 2. Driving on the road: too large a bend when turning into a road with priority, too much distance from the edge of the road, incorrect use of the bicycle path, incorrect passing of a railway crossing. 3. Turning right: lack of hand signaling of the intention to change direction. 4. Turning left: failure to turn and look backwards before turning left, no hand signaling of the intention to turn left, incorrect arc when turning. 5. Passing: failure to look back before making a turning maneuver, hindering traffic coming from the opposite direction, wrong turn right. 6. Behavior towards pedestrians: obstructing the passage of pedestrians through the pedestrian crossing. 7. Intersection: disregarding the STOP sign, failure to comply with the applicable rules, wrong roundabout driving.

Another widely promoted nationwide initiative is the "A Wise Head Wears a Helmet" project, which advocates for helmet usage among children and youth aged 6–17. Annually, the campaign distributes various informative leaflets and produces posters and brochures to disseminate the message. Furthermore, schools endorsing helmet use have the option to procure helmets with a safety certification issued by the Slovenian Road Safety Council at a special discounted rate. The overarching objective of the campaign is to popularize helmet wearing and enhance public consciousness about its pivotal role in enhancing cyclist safety on the road. This project is even equipped with its own website, developed in collaboration with the Ministry of Health [25].

3.6. Poland

In Poland, cycling education is integrated within the technology subject module in primary schools. Within these classes, children acquire skills for safe participation in road traffic as cyclists. They learn to interpret road signs, grasp bicycle maintenance techniques, and prepare their bicycles for safe riding. The core curriculum of this subject offers students an opportunity to obtain a bicycle card, which grants minors over the age of 10 permission to cycle independently. The curriculum suggests dedicating no more than 12 h to the

content associated with preparing for this card. The examination for primary school students consists of both a theoretical and a practical component, conducted at a location designated by the school principal. A positive result in the theoretical segment requires achieving a minimum of 80% of the points. In the practical segment, a successful outcome necessitates correctly executing at least 90% of the maneuvers without posing a threat to road traffic. Moreover, individuals not enrolled in primary school have the option to undertake these activities at voivodship traffic centers and certified driver training centers that meet additional requirements [26].

Within the Polish examination system, educational institutions are responsible for developing regulations and procedures for acquiring a bicycle card (refer to Figure 8). A thorough analysis of these documents reveals noteworthy disparities in the training and examination of young cyclists. These differences manifest in several aspects:

- The role of the coordinator and teaching staff assisting students in obtaining a bicycle card.
- The curriculum content covered in preparation for acquiring a bicycle card.
- The duration of each examination segment.
- The format of the theoretical examination, encompassing question count and knowledge scope.
- The location of the practical examination.

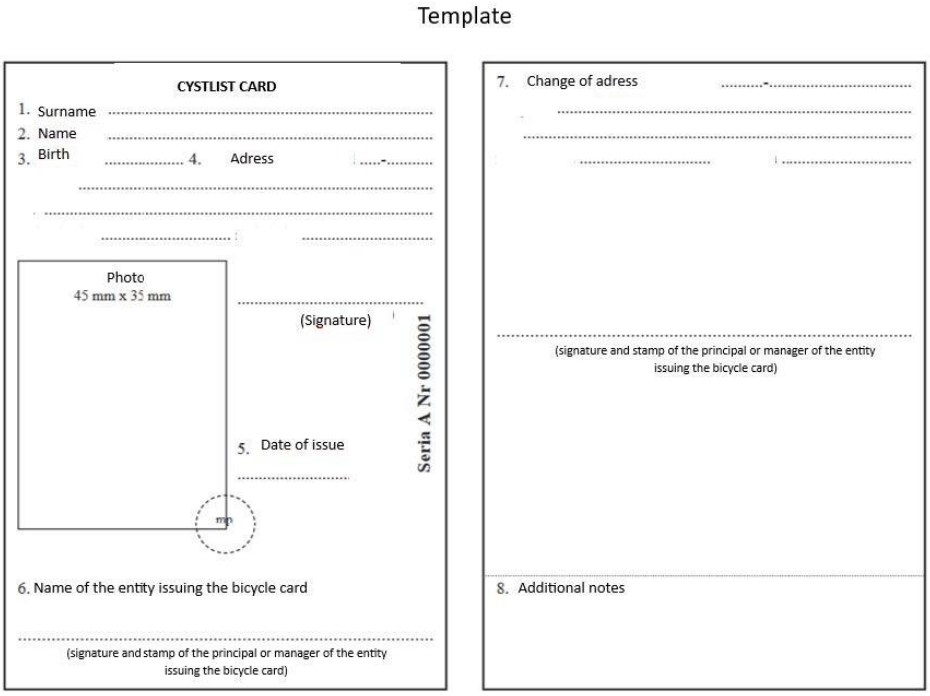

Figure 8. Template of Polish bicycle card [27].

The specific skills students must demonstrate during the practical exam [27].

3.7. Italy

In Italy, Article 230 of the Highway Code [28] has introduced mandatory bicycle education in educational institutions of all levels, including artistic education institutes and nursery schools. The programs cover a range of topics, including knowledge about road safety principles, road structures, related signs, general vehicle conduct regulations with a specific focus on bicycle usage, and user conduct rules. Additionally, there is a particular focus on providing information on the risks associated with the consumption of psychotropic substances, narcotics, and alcoholic beverages. These courses can be organized by both public and private institutions, and they may involve collaborating teachers in program implementation.

Within this educational context, the Italian Federation for the Environment and Bicycles (FIAB), which has been recognized as an ONLUS association since 1998, plays an active role. Its primary objective is to promote the bicycle as an environmentally friendly mode of transportation, contributing to both urban and rural environmental revitalization [29].

The courses offered by FIAB are tailored to different age groups of young cyclists. For children aged 5 to 6, the course focuses on guiding them in observing their surrounding street environment and instilling appropriate behavior. For those aged 6 to 10, a five-year course comprising modules of four hours per year integrates the understanding of concepts such as signage, road safety, vehicle intermodality, and local geography, alongside the promotion of environmentally friendly practices. The course concludes with a final game and the issuance of a "good cyclist" license.

Children aged 11 to 13 engage in a road safety and sustainable mobility education course. For the first class, the course spans ten sessions over three years, and for the second class, it is condensed into six sessions over two years. Each module, involving six hours per year, covers various subjects ranging from the role of bicycles as a mode of transportation to an introduction to local cycle paths.

4. Comparative Analysis of Training Methods, Rules, and Regulations for the Training and Examination of Cyclists

The methodology for training and assessing cyclists differs across countries, despite their adherence to the same Vienna Convention on Road Traffic. The following tables (Tables 4–12) provide a comparative overview of training approaches, legal frameworks, and regulations concerning both novice and experienced cyclists in the Netherlands, Germany, Austria, England, Slovenia, and Poland. The primary objective of the following tables was to provide a comprehensive synthesis of the information detailed in the preceding sections. By doing so, we aimed to discern and highlight potential areas of convergence and shared practices among the diverse states under examination. This comparative analysis enabled us to identify common threads, similarities, and consistent approaches adopted by these countries in the realm of cyclist training and regulations.

Table 4. Bicycle exam (own elaboration).

Country	Description
The Netherlands	In grades 7 and 8 of primary school, children take a bicycle test which consists of a mandatory theoretical part and a practical part which takes place in traffic, but the decision to conduct it is up to the school.
Germany	Children take the bicycle test in the 4th grade, which is usually when they are 10 years old, and the teacher conducting the classes decides whether a child has mastered the safe riding and first aid elements, and whether the results of the theory test and practical test are satisfactory. The exam consists of a theoretical and a practical part.
Austria	Children as young as 9 who are in 4th grade, or those who have just turned 10, can take the voluntary bicycle test. The test is divided into a theoretical and a practical part. A positive result from the voluntary bicycle test entitles children to independently ride a bicycle on public roads without a guardian.
England	The idea of organizing bicycle exams, which had been practiced in the past, was abandoned. The current training system does not provide for them and focuses on the implementation of the assumptions of training levels.
Slovenia	The exam usually takes place in the 5th grade of primary school. Children who pass the bicycle exam receive a bicycle card. The exam usually takes place in the 5th grade of primary school.

Table 4. *Cont.*

Country	Description
Poland	Most often, it is carried out in the 4th grade (some institutions organize it in the 5th grade) of primary school. A positive result on the theoretical and practical parts entitles the student to receive a bicycle card.
Italy	The current training system does not provide for bicycle exams and focuses on the implementation of the assumptions of training levels.

Table 5. Location of practical examination of cyclists (own elaboration).

Country	Description
The Netherlands	It takes place in real traffic, on a route designated by the organizers.
Germany	The practical part of the exam usually takes place in youth movement schools.
Austria	The practical exam is conducted in real traffic.
England	There is no bicycle exam. The training is carried out successively in the following environments: free from traffic (level 1), on roads with less traffic (level 2), on roads with normal traffic (level 3).
Slovenia	The first part of the exam takes place in the maneuvering area and the second in real traffic.
Poland	The place is determined by the school principal. Depending on the infrastructure at the facility's disposal, it is a maneuvering area, a school playground, a gymnasium, a schoolyard, or a traffic town.
Italy	There is no bicycle exam.

Table 6. Scope of skills tested during the bicycle exam (own elaboration).

Country	Description
The Netherlands	Before the start of the practical exam, the ability to check the technical condition of the bicycle is assessed. One by one, children cover the bicycle route in traffic, which is determined individually by the organizers. The course of the route and specific tasks are made public in good time. The skills that would need to be tested are not specified. During the exam, it is generally checked whether children apply knowledge and rules of the road in practice.
Germany	The exam consists of driving a designated route in a traffic town; in most cases children can decide on their own which route they want to take. The scope of the tasks to be examined has not been specified; the policeman observes the driving style of students and assesses any traffic violations.
Austria	There are no specific skills that a bike test must include. It is up to the organizers of the exam how it will be run, its route, and what it will check.
England	There is no bicycle test in England, but the "National Standard" defines what a cyclist should know and be able to do at each level of training. Bikeabilty instructors prepare a schedule of classes individually for participants, taking into account and meeting the standards set for each level.
Slovenia	The document "Concept of Bicycle Training and Bicycle Examination in Primary School", issued by the Ministry of National Education, Science, and Sport, defines the objectives and thematic areas that teachers should raise during the course. In addition, it provides the criteria for passing individual parts of the bicycle exam (Table 3). The questions on the theory test are drawn from a pool of questions which the person taking the exam can prepare for in advance.

Table 6. *Cont.*

Country	Description
Poland	The new core curriculum for the subject of technology presents the required skills that a primary school student should have after completing the training. The role of the teacher conducting the subject is to draw up regulations that specify the conditions for applying for a bicycle card and the procedure for obtaining it. The scope and rules for obtaining a bicycle card by persons who are not primary school students are specified in the Regulation of the Minister of Transport, Construction, and Maritime Economy of 12 April 2013 on obtaining a bicycle card. The organizer is responsible for the questions in the theoretical exam and the course of the practical exam. The form of the exam must comply with the provisions in the regulations.
Italy	There is no bicycle exam.

Table 7. Bike card document (own elaboration).

Country	Description
The Netherlands	Does not exist. Children who pass the bike license exam receive a diploma.
Germany	After passing the exam, students receive a bicycle license, which is symbolic and not enforced by German traffic law.
Austria	Its possession entitles children over 10 years of age to ride in traffic without a guardian.
England	Does not exist. With the completion of each Bikeability level, the student receives a diploma with congratulations on completing the course.
Slovenia	Upon successfully passing the bicycle examination, the student is granted a bicycle card, enabling children below the age of 14 to independently ride a bicycle [24].
Poland	It is an official document that authorizes persons under 18 to ride a bicycle. It is issued for free and indefinitely [27].
Italy	Does not exist. With the completion of each course, the student receives a diploma with congratulations on completing the course.

Table 8. Person(s) training and examining cyclists (own elaboration).

Country	Description
The Netherlands	School teachers and Traffic Garden employees are responsible for education.
Germany	Lessons on road safety are taught by school teachers, while traffic guards and the police are responsible for classes in Youth Traffic Schools.
Austria	The voluntary bicycle test is carried out in cooperation with the police.
England	The Bikeability program is run by specially trained instructors [19].
Slovenia	A trained teacher in cooperation with parents, the police, and the municipal council for prevention and education in road traffic [23].
Poland	"The classes are conducted by a teacher with specialist training in road traffic organized free of charge in the provincial road traffic center, a police officer or a retired police officer with specialist training in road traffic, an examiner or an instructor" [27].
Italy	The classes are conducted by a teacher coming for free from a private institution.

Table 9. Wearing helmets by cyclists (own elaboration).

Country	Description
The Netherlands	Dutch do not wear helmets, nor are they obliged to do so. Cyclists there are convinced that the rules of the road and infrastructure design will protect them against injuries.
Germany	There is no obligation to wear a helmet. The German traffic police focuses on education by running campaigns promoting helmet wearing [30].
Austria	Children under the age of 12 must wear a helmet when riding a bicycle, as well as those traveling in a seat behind the cyclist [31].
England	British law does not require cyclists to wear a helmet, but the Highway Code suggests wearing a helmet with particular attention to its correct size and secure fastening.
Slovenia	A cyclist under the age of 18 must wear an approved protective helmet on his head while riding, and the same applies to a child riding on a bicycle as a passenger [32].
Poland	There is no law in Poland that would require cyclists to wear a helmet.
Italy	The Highway Code [28] includes an obligation to wear a helmet, for electric bicycles and traditional bicycles, only for children and teenagers up to the age of 14.

Table 10. Bicycle equipment (own elaboration).

Country	Description
The Netherlands	• The Dutch have established very meticulous regulations regarding the technical condition of the bicycle and its additional equipment [33]. • Headlight: White or yellow for front, red for rear. No other colors allowed. • Loose lighting allowed, e.g., attaching lights to bike or clothing. • Two-wheeled bicycle: 1 red rear reflector between rear carrier and mudguard OR white/yellow reflectors on wheels + 4 yellow/amber reflectors on pedals. Optional extra rear red and front white reflectors. • More than two wheels: 1 red rear reflector, white reflector forward if wider than 0.75 m with 1 front wheel. White/yellow wheel reflectors + 4 amber/yellow pedal reflectors. Adjust red reflector for two rear wheels. • Intact, non-corroded frame. • Width limits: 0.75 m for two wheels, 1.50 m for more than two wheels. • Securely fastened battery and light cables. • Good condition handlebars and forks (no cracks, deformations, or rust). • Operational brakes, with hand brakes for front and rear wheels if present. • Functional, non-slip surface pedals. • Nothing protruding to prevent injury in collisions. • Functional bell [33].
Germany	• Ringing bell. • Two independent brakes. • Two non-slip and firmly screwed pedals. • Yellow reflectors facing forwards and backwards. • White headlight and front headlight (often a combination). • Red tail light and red headlight (often a combination). • Optional reflective strips on the wheel, spoke clips, or on the wheel two yellow spoke reflectors [34].

Table 10. *Cont.*

Country	Description
Austria	• Austrian bicycle regulations, as outlined in the Ordinance of the Federal Minister of Transport, Innovation, and Technology, include the following requirements: • Two independent braking devices. • Audible warning device (bell or horn audible from 20 m). • Yellow pedal reflectors. • A bright, firmly attached headlight emitting white or bright yellow continuous light with at least 100 cd luminous intensity. The headlight can be removable or battery-powered. • A red tail light with a luminous intensity of at least 1 cd, which can also be removable or battery-powered. • Headlight must not flash, but rear light can. • White wide-angle reflector and red reflector or reflective materials with a light entry area of at least 20 cm^2. • Two independent braking devices achieving an average deceleration of 4 m/s^2 on a dry road at 20 km/h. • Reflective elements or materials with a light entry area of at least 20 cm^2 on each side of each tire. • For bicycles designed to carry multiple people, each person should have their seat, handle, and pedals or support devices. • Riding without front and rear lights is allowed during daylight with good visibility [35].
England	The rear hand brakes are placed on the left side, and the front ones on the right side. Bell. White or yellow reflectors on both sides of each wheel or tire. White wide-angle headlight or front lamp. Red wide-angle rear reflector. Yellow reflectors front and rear on each pedal [36].
Slovenia	Working front and rear front brakes. White light at the front for road lighting and red light at the rear. Pedal reflectors. Bell. Properly inflated tires. Properly adjusted steering wheel and seat height. It is also recommended that a bike have mudguards, a chain guard, and a rack [37].
Poland	In front—at least one position light of white or selective yellow color (a flashing light may be used). At the rear—at least one red reflector with a shape other than a triangle and at least one red position light. At least one effective brake. A bell or other non-shrill sound warning signal. From October 8, 2013, cyclists do not need to have lights on their bikes if they are not going to ride after dark. This does not apply to the red rear reflector, which must be permanently installed [38].
Italy	According to the Highway Code [28], in order to be able to circulate, bicycles must necessarily be equipped with a bell, front lights, rear lights and reflectors, and reflectors on the pedals and side.

Table 11. Wearing a reflective vest (own elaboration).

Country	Description
All analyzed countries	None of the analyzed countries require cyclists to wear a reflective vest.

Table 12. Age limit authorizing a cyclist to move independently on the road (own elaboration).

Country	Description
The Netherlands	There is no age limit that would entitle children to move independently on the road. Children under the age of 10 can use the footpaths for cycling [39].
Germany	Children up to the age of 8 must ride on the pavement. At this age, they may start to use separate bike lanes if they are available for use. However, at the age of 10, they can start driving independently in road traffic. The German legislature explains this by saying that children under the age of 10 are particularly at risk in road traffic because they have not yet acquired the necessary knowledge and skills [40]
Austria	A child under the age of 12 may not ride a bicycle in traffic without being accompanied by a responsible person who is at least 16 years old. Children between the ages of 10 and 12 may ride alone on the streets only if they have passed the voluntary bicycle test and have their bicycle license as proof [31].
England	In England, there are no legal age limits for when children can start cycling on the street. The decision is up to the parents and is based on observation of cycling skills and awareness of the dangers on the road. Although there are no penalties for unaccompanied driving under the age of 10, this does not mean that such children should drive in traffic unaccompanied by their parents or guardians [41].
Slovenia	If a child does not have a bicycle card, he/she cannot ride a bicycle in road traffic until the age of 14 [23].
Poland	Children under the age of 10 cannot ride a bicycle without the supervision of an adult; they are treated by law as pedestrians. Therefore, they must ride on the pavement. A positively passed exam for a bicycle license entitles children and youth aged 10–18 to ride a bicycle on their own on the street. Adults can ride a bike without any limits or additional permissions [42].
Italy	In Italy, there are no legal age limits for when children can start cycling on the street but a child under the age of 14 is under parental responsibility.

5. Conclusions

It is imperative to emphasize that despite this analysis being limited to seven countries, substantial disparities exist in the standards for the training and examination of cyclists across Europe. Considering that cyclists frequently traverse the roads of multiple nations, ensuring consistent standards pertaining to knowledge and bicycle equipment is of paramount importance. This becomes even more critical with the proliferation of electrically assisted mobility, where cyclists can attain higher speeds and, consequently, pose increased risks. Hence, the divergences elucidated in this paper underscore the need for the European Cyclists' Federation to spearhead the development of uniform standards for educating future cyclists in each European Union member state.

As elucidated in this paper, there is still a substantial amount of work to be undertaken in Europe to enhance cyclist safety comprehensively. Establishing a comprehensive training

program aimed at cultivating a culture of conscientious cyclists is imperative for mitigating the frequency of accidents involving them. It is strongly recommended that regulations and training norms be standardized across Europe, drawing inspiration from countries with well-established cycling practices. To attain optimal outcomes in cyclist training endeavors, the following strategies are strongly advised:

- Prioritizing the education of children and adolescents, recognizing their role as bearers of knowledge to future generations.
- Undertaking a long-term process of standardizing cycling education that aligns with current needs and prevailing standards.
- Elevating awareness about the significance of cycling education among parents, as their behaviors and practices serve as models for their children.
- Infusing safe cycling content into all levels of education, ranging from kindergarten to high school, within defined and consistent time frames.
- Establishing a governing body responsible for cyclist education that acts as a training coordinator, and defines and enforces standards and prerequisites.
- Amending legal provisions regarding age limits for independent cycling.
- Intertwining theory and practice during cycling education sessions.
- Facilitating opportunities for cycling practice, initially within secure and controlled environments and subsequently in real traffic settings during training.
- Advocating the core importance of cycling proficiency testing and elevating its prominence, as a pivotal stage in advancing road safety.
- Ensuring that instructors of bicycle courses are well-prepared and adhere to specific standards.
- Implementing mandatory annual refresher training for teachers and instructors.
- Evaluating the knowledge and skills of trainers through mandatory competency examinations.
- Conducting recurring campaigns aimed at promoting safe cycling practices for both children and adults.

These concerted efforts must be sustained in the long term and be subject to continuous evaluation to best meet the societal needs. Only through proactive measures in reevaluating cyclist training methodologies can we hope to make a substantial impact on reducing accidents involving cyclists [43].

Author Contributions: Conceptualization, methodology: J.W. and A.J.; writing: J.W., A.J. and G.P.; review and editing: J.W. and G.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This work was related to the PNRR project National Centre for HPC, Big Data and Quantum Computing, Missione 4 Componente 2, Investimento 1.4, CUP E63C22001000006.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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