InfRO@D

EUROPEAN DIGITAL EDUCATION IN RIM

A guidebook for Road Infrastructure Management teachers and trainers

InfRO@D
EUROPEAN DIGITAL EDUCATION IN RIM

Co-funded by
the European Union

WP4 – Development of teaching and training resources with the use of remote teaching methodology

IO.11 Development of resources for roadside safety management

This project has been funded with the support of the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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About the project

International project entitled "European Digital Education in Road Infrastructure Management INFRO@D", is co-founded by the European Union under the Strategic Partnerships of ERASMUS+ program.

The leader of the consortium in charge of the project is the Department of Road and Transport Engineering of the Faculty of Civil and Environmental Engineering of the Gdańsk University of Technology aho cooperate with: Universita Degli Studi di Catania (Italy), Universitaet Klagenfurt (Austria), Zilinska Univerzita in Ziline (Slovakia), Szechenyi Istvan University (Hungary), Cracow University of Technology (Poland).

The COVID-19 pandemic has forced a departure from the existing ways of functioning of societies in many aspects related to the economy, travel, work and education. This also applies to higher education. The need for remote learning is one way to maintain social distance and protect our lives and health. The preliminary assessment of the situation at universities in Poland and other European countries shows that the academic staff is not sufficiently prepared to run attractive and effective classes conducted in a remote format.

The need to conduct online classes requires the development of a dedicated project of the didactic and training process, taking into account specific requirements for interdisciplinary engineering knowledge. The transfer of this knowledge in remote learning, due to the large scope, requires the use of many teaching tools (lectures, field, project, exercise, laboratory, independent work of students and assessment of the progress of work and knowledge of students and course participants).

As part of the INFRO@D Project, a model product dedicated to distance learning at technical universities in the field of civil engineering and transport will be developed. This product will contain comprehensive and innovative solutions enabling the implementation of distance learning at the highest possible level. Developed methodology and materials didactic courses will be based on the course on road infrastructure management (ZID), and in particular on road infrastructure safety management (ZBID). Way preparation of methodology and teaching and training materials will enable their implementation for any thematic scope in the field of civil engineering and transport (ILiT). ZID, like the entire ILiT area, requires continuous improvement of the teaching staff's competences and increasing the level of knowledge of students and employees. The project provides building a digital education methodology for didactic classes at universities and training for engineering staff. Preparation of the ZID distance learning course during studies at technical universities will enable the use and verification of the best teaching methodology solutions in this mode from Austria, Italy, Slovakia, Hungary and Poland. Design

INFRO@D makes it possible to raise the level of teaching and training, using innovative digital teaching materials for remote learning, which will be used by other universities dealing with this subject. The importance of RISM justifies the choice of this issue as a subject area for the development of model solutions for remote education. RISM is one of the most important challenges of the modern world. More than a million road fatalities annually worldwide, constituting the main cause of death of young people, is a sufficient argument to take radical remedial actions.

The main objective of the INFRO@D Project is to improve the competence and skills in remote education in a model solution in the field of RIM, with a particular focus on RISM. In order to achieve this goal, efforts should be made to promote the best solutions in the field of digital education (remote teaching – implemented ad hoc during the pandemic and elearning courses, which may become a permanent part of the teaching process in the near future).

The Project provides for the implementation of innovative traditional and online education in road infrastructure safety management.

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Introduction

The COVID-19 pandemic has forced a departure from the current functioning of society in many aspects of the economy, travel, work and education, not excluding higher education. The necessity of remote education is one of the ways to maintain social distancing and protect our health and life.

A preliminary assessment of the situation at universities in European countries indicates that academic staff were not sufficiently prepared to conduct attractive and practical classes in a remote format.

The necessity to conduct classes remotely involves developing a dedicated didactic and training process project, considering the specific requirements of interdisciplinary engineering knowledge. Transferring this knowledge in remote education, due to its large scope, requires various didactic tools (lectures, fieldwork, design, practicals, laboratories, student assignments and assessment of the progress and knowledge of students and trainees).

The measurable expected final results are:

- Development of a remote learning methodology for Road Infrastructure Management (RIM) as a model solution to provide a basis for extending the methodology to include further aspects of civil engineering and transport.
- Developing an e-handbook for academic staff supporting the remote learning process.
- Development of model digital teaching and training materials dedicated to technical colleges and training for road management staff on RIM:
  - Road safety audit,
  - Roadside safety management,
  - Safety management of vulnerable road users,
  - Road pavement management.
- Developing an e-learning platform with access to project products.
- Appointment of a panel of experts in road infrastructure management.

The InfRO@D project targets the following groups:

1) Students, researchers, and academic teachers at universities.

2) Road authority staff at national, regional and local levels.

3) Experts, specialists, and practitioners involved in RIM activities, including staff who conduct training in various RIM courses.

4) All users of road infrastructure, as an indirect target group, for whom the risk of road accidents will ultimately be reduced by increasing the effectiveness and efficiency of RIM activities.

The project is also supported by a group of associates who will cooperate with project partners to consult and evaluate the results. They will implement final products and promote the dissemination and accessibility of the project results.

ABOUT OUTPUT IO.11

Objective: Development of resources for roadside environment safety management.

Work package: The task falls under WP4 – Development of teaching and training resources with the use of remote teaching methodology.

Target Groups:

- Research and teaching staff from institutions involved in the project and other European institutions.
- Students of civil and transportation engineering.
- Road authority staff at a national, local and regional level.

Chapter I

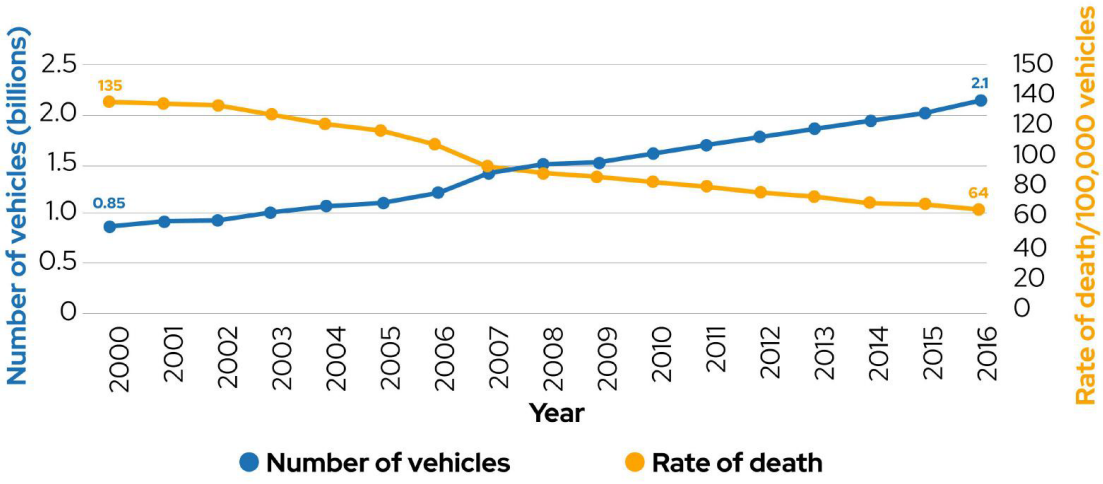
Importance of RIM Education

Importance of RIM Education

The way we travel is constantly changing, now more than ever, we're thinking about how safe our modes of transportation are. One of the best ways to encourage safer traveling is by being well informed on the risk levels that do exist and how they differ between each of the most common forms of transportation.

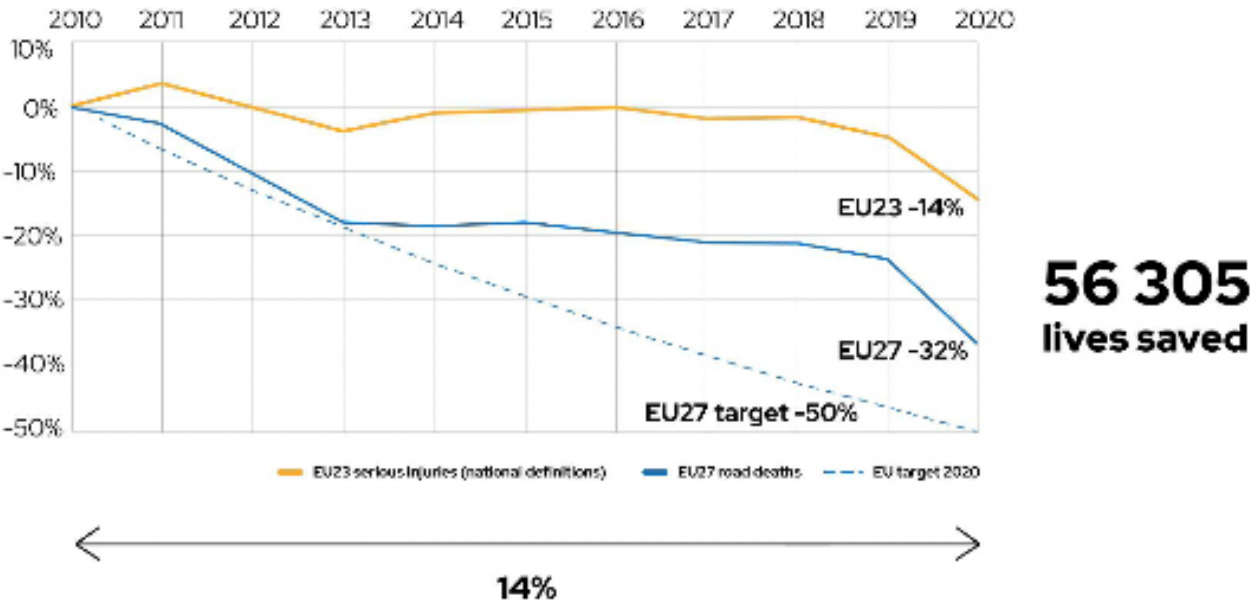
In the air the speed is much higher than on the roads. In spite of that there are much fewer traffic incidents in the air. Even the aviation industry is not delivering zero casualties every year, but it is much safer than road traffic. Not that easy to find a comparison between the safety of different traffic modes, but based on data from EU-27 member nations between 2008–2010 the ratio between air and road safety could be somewhere 1:45, and 1:29 between water and road safety. The highest death rate by far in road transport is the two-wheeled motor vehicles. Trips by public transport on roads are 10 times safer than car trips.

In fact, fatality rates across all modes of transport have fallen dramatically since the 1970s, and highway fatalities for private cars alone have nearly halved. That said, travel risks are by no means eliminated. During the period 2000-2016 the number of vehicles worldwide has steadily increased, while death rates declined from 135 deaths for every 100,000 vehicles in 2000 to approximately 64 deaths for every 100,000 vehicles in 2016.



This represents a reduction of more than 50% in 15 years period suggesting some progress in mitigating the adverse effects of increasing motorised transport. Although progress has been made, these data show that it has not occurred at a pace fast enough to compensate for rapid population growth and increasing motorisation worldwide.

The EU27 collectively reduced the number of road deaths by 37% over the 2010-2020. There were 56,305 fewer deaths on EU roads over the target period than there would have been if deaths had continued at the same level as in 2010.



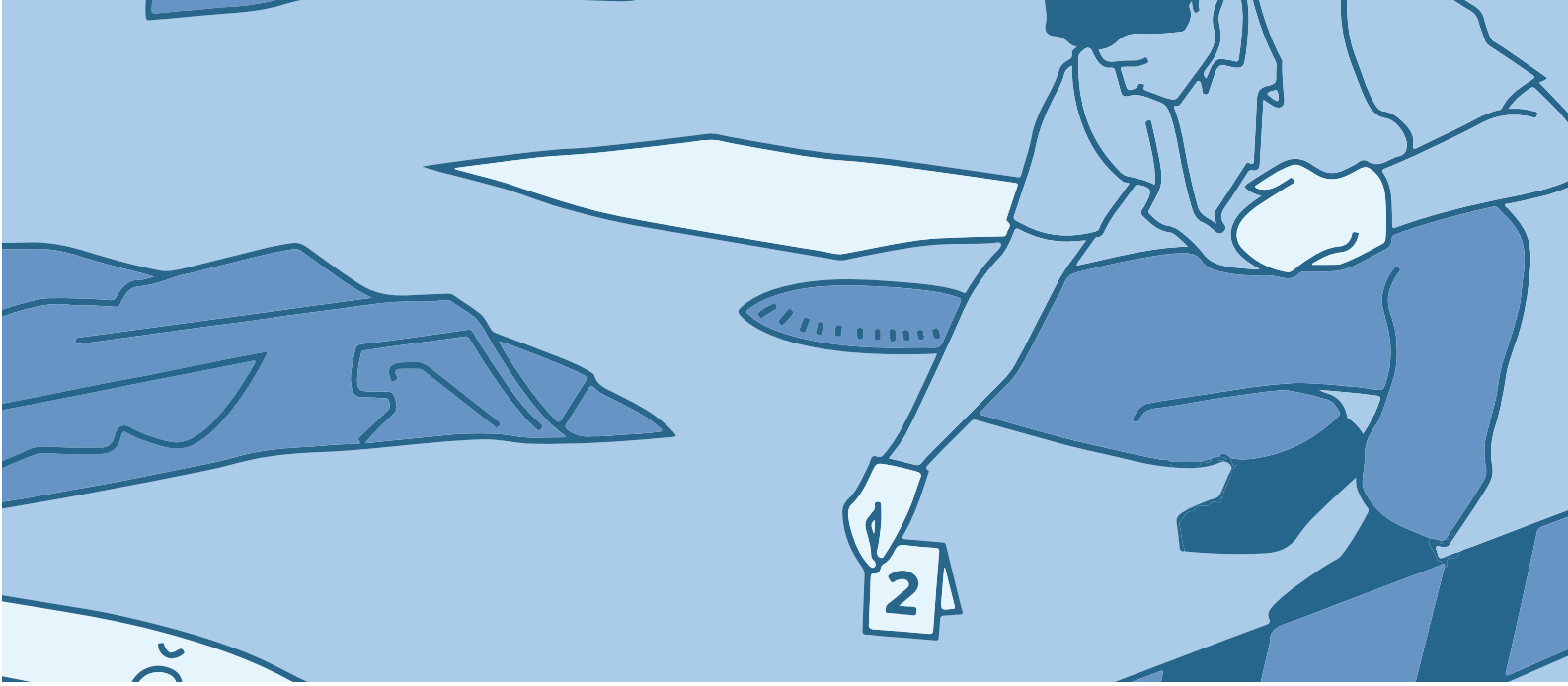
The overall progress in reducing road deaths on EU roads was almost on track with the EU target from 2010 until 2013, with an 18% decrease. But the good start was followed by six consecutive years of stagnation with only a 6% reduction over the 2013-2019 period. In 2020, there was an exceptional drop of 17% compared to 2019. The 2020 result is strongly related to travel restrictions across Europe due to the Covid-19 pandemic.

The progress in reducing serious road traffic injuries in the last decade in the EU23 collectively was poor, especially in comparison with the reduction in deaths. There was only a 14% reduction over the period 2010-2020. There was a 4% increase in the number of serious injuries in 2011; it went back to the 2010 baseline level in 2012 and remained almost unchanged for seven years until 2019. While the collective EU road death reduction target for 2020 was not met, all countries made improvements, and saved lives by trying to reach it. Only Greece reached the target with a 54% reduction in road deaths. Portugal, Spain, Croatia, Belgium, Slovenia, Italy, Lithuania, Bulgaria, Denmark, Austria and Hungary achieved a decrease above the EU average of 37%, while the other countries progressed to a lesser extent. The progress was slowest in the Netherlands with a 5% decrease and the UK with 14%.

The number of road traffic deaths on the world's roads remains unacceptably high, every year 1.35 million people die worldwide. Between 20 and 50 million suffer non-fatal injuries. However, the rate of death relative to the size of the world's population has stabilised and declined relative to the number of motor vehicles in recent years. Road traffic injuries are the 8th leading cause of death for people of all ages. More people died as a result of road traffic injuries than from HIV/AIDS, tuberculosis and diarrhoeal diseases. According to the statistical data in the year 2016 road traffic injuries were the leading killer of children and young adults aged 5-29 years. Young road user deaths represented 23% of all road deaths in the EU 27 in 2019.

To take differences in changes in demographics into account, figure presents the annual reduction in young road user mortality plotted against other road user mortality since 2010. The reduction in the number of young people killed can be explained by the 9% decrease in the population aged 18 to 30 in the EU between 2010 and 2019, while the population of the other age groups increased by 4%.

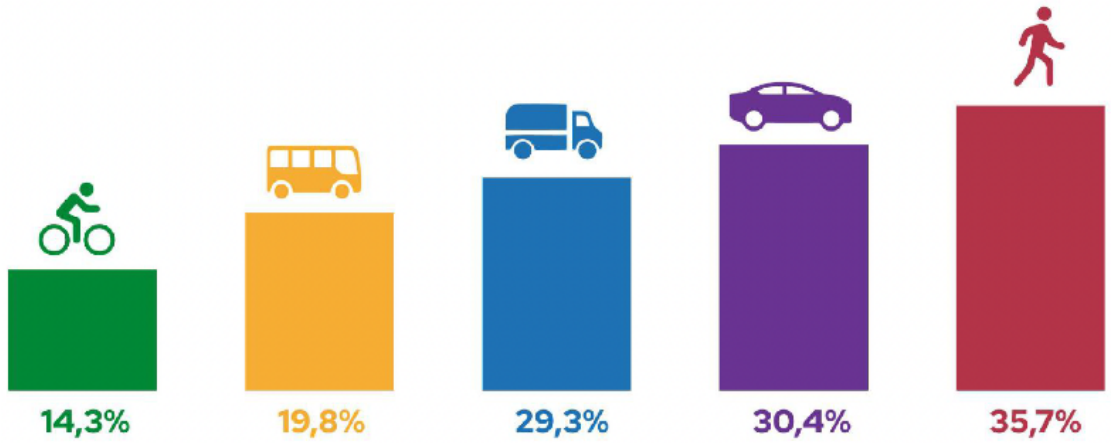
Road deaths per million young inhabitants went down by 34% over the period 2010-2019 compared to just 19% for other age groups over the same period. Most of the reduction was made between 2010-2014, during the economic recession that followed the financial crisis 2008.



The European Commission published a new analysis of EU road death data that shows which transport modes are responsible for inflicting the most harm. The breakdown on infographic shows road user type and the other 'main vehicle' involved in the crash. The analysis shows that deaths overwhelmingly occur in collisions involving cars and trucks, and the need to increase the protection of vulnerable road users (VRU) such as pedestrians and cyclists. Of course, this is not new information, but presenting the data in this way highlights the need to do much more to encourage a move away from those modes that cause the most harm, and more and better ways of protecting the most vulnerable road users. Matthew Baldwin, the European Commission's road safety coordinator uses the term 'valuable road users' for these groups – because walking and cycling also contribute to reducing air pollution, congestion and climate change as well as reducing overall harm in terms of injury and death.

Nearly half (49%) of the people who die on the world's roads are pedestrians, cyclists and motorcyclists. Deaths among pedestrians and cyclists, the most vulnerable road users, account for 29% of all road deaths across the EU. These groups are also the least likely to harm other road users. The proportion of pedestrians and cyclists killed has also increased slightly since 2010. In 2018, pedestrians killed represent 21% and cyclists 8% of all road deaths compared to 20% and 7% respectively in 2010. Big disparities exist between countries in terms of the relative safety of walking and cycling.

Underreporting of road deaths and injuries in official statistics is also a bigger problem for pedestrians and cyclists than for other road users. Underreporting is highest for cyclists, especially in single bicycle collisions involving no motorised vehicle..



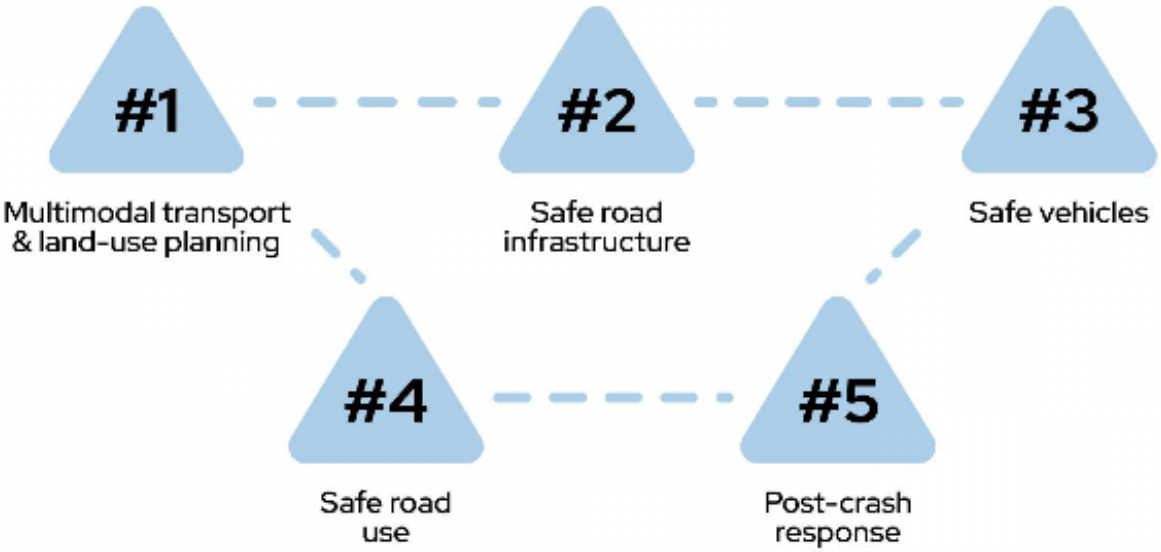
Progress in reducing road traffic deaths ower the last few years varies significantly between the different regions and countries of the world. There continues to be a strong association between the risk of a road traffic death and the income level of countries. With an average rate of 27,5 deaths per 100.000 population, the risk is more than 3 times higher in low-income countries than in high-income countries where the average rate is 8,3 deaths 100.000 population. The burden of road traffic deaths is disproportionately high among low- and middle-income countries in relation to the size of their populations and the number of motor vehicles in circulation. Although only 1% of the world's motor vehicles are in low-income countries, 13% of deaths occur in these countries.

The variation in rates of deaths observed across regions and countries also corresponds with differences in the types of road users most affected. Globally, pedestrians and cyclists represent 26% of all deaths, with those using motorized two- and three-wheelers comprising another 28%. Car occupants make up 29% of all deaths and the ramaining 17% are unidentified road users. Africa has the highest proportion of pedestrian and cyclist mortalities with 44% of deaths. In South-East Asia and the Western Pacific, the majority of deaths are among riders of motorized two- and three-wheelers who represent 43% and 36% of all deaths respectively. Important marker for road safety in 2020 was the Coronavirus pandemic. Covid-19, for all its negative impact around the world, also brought with it an unexpected, significant decrease in the number of road deaths in those regions forced to go into lockdown.

The number of road deaths decreased sharply on all types of roads in 2020, compared to the average for 2017-19. The 15 countries that provided data by road type recorded -20% fewer fatalities on motorways, -15% less on rural roads, and a drop of -10% on urban roads.Monthly data also show a significant reduction of motorway fatalities during the second wave of the pandemic. As things stand road traffic crashes are set to cause a further estimated 13 million deaths and 500 million injuries during the next decade. These unacceptable numbers, both in absolute and relative terms, have remained largely unchanged for the past 20 years, despite the painstaking work of the United Nations and other road safety bodies. Recognizing the importance of the problem

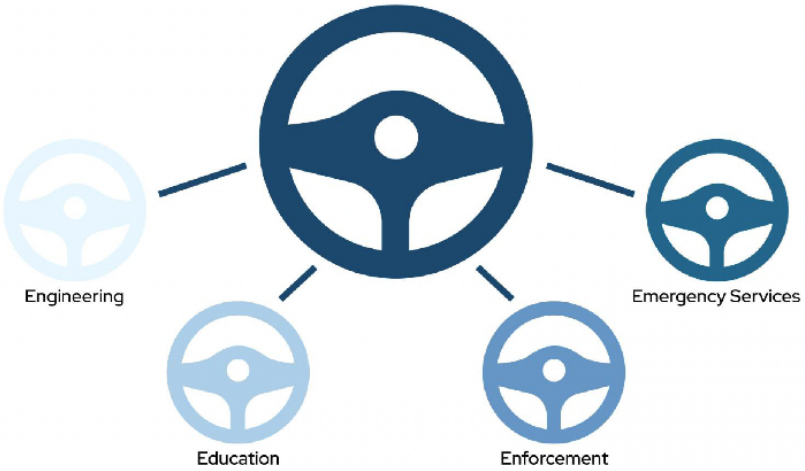
and the need to act, governments from around the world declared unanimously — through UN General Assembly Resolution 74/299 — a Second Decade of Action for Road Safety 2021–2030 with the explicit target to reduce road deaths and injuries by at least 50% during that period. Studies revealed that driver related factors are to blame for around 50% of accidents on roads. But there are also accidents, which have 2 or 3 causation factors - when combinations of driver factors and environment or vehicle are added, the driver was involved in more than 90% of accidents. It is a hard task to change human behaviour, but indirectly across these two factors we can influence it - we can achieve positive effects on human behaviour across the safe road design. Four guiding principles are central to a safe system:

- people make mistakes that can lead to road traffic crashes;
- the human body has a known, limited physical ability to tolerate crash forces before harm occurs;
- individuals have a responsibility to act with care and within traffic laws, but a shared responsibility exists with those who design, build, manage and use roads and vehicles to prevent crashes resulting in serious injury or death and to provide post-crash care;
  and in order to multiply their effects, all parts of the system must be strengthened in combination, and road users are still protected if one part fails.



A safe system requires the complex and dynamic interaction between operating speeds, vehicles, road infrastructure and road user behaviour to be understood and managed in a holistic and integrated manner. In this way, the sum of the individual parts of the system combine ffor a greater, more significant overall effect, and if one part fails, the other parts will still prevent serious harm from occurring. There is no single pathway for the adoption, establishment and implementation of a safe system: moving to a safe system is a learning-by-doing process best described as a journey that presents opportunities, hazards and challenges along the way. The experiences of

pioneering countries such as the Netherlands and Sweden show that each country follows its own journey, shaped by the cultural, temporal and local context, but guided by the four underlying principles. With this approach, instead of seeing how to make incremental progress in road safety, one starts by setting the goal of no road traffic deaths and then works backwards, implementing measures to achieve that goal in a systematic and steady fashion.



Understanding Road Safety Infrastructure

Road infrastructure significantly affects our daily life. It defines how we move, determines the appearance of the environment in which we live, supports community connections, influences when goods and services reach us. It brings significant economic development to cities, regions and countries. Roads interconnect the points of production and consumption and influence the national and international trade flows of a country.

However, it is also accompanied by many ecological and social impacts. It is therefore necessary to apply an inclusive approach to its planning and management. This consists in anticipating future demand and balancing the needs of people, the environment and the economy. Road infrastructure must also face future challenges such as increasing urbanization, overloading of the road network, increasing air pollution and deforestation. It is therefore necessary for it to be well planned, sustainable and durable.

It is also important to focus on increasing the safety of road infrastructure. High-quality, well-planned and appropriately maintained road infrastructure can significantly contribute to increasing the safety of road transport and thereby prevent significant economic and social losses resulting from traffic accidents. It is necessary to carry out an assessment and analysis of the state of the existing road infrastructure as well as of new projects. Based on the findings, concrete actions must be taken to eliminate the shortcomings and deficiencies. It is necessary to invest

in the maintenance of the existing road infrastructure, introduce new elements that increase its safety, and also improve the analysis of traffic accident data.

All these aspects should be covered in the education of road infrastructure management experts, which is the main topic of the InfoRoad project.

Road Infrastructure definition

Definition of road infrastructure has evolved over time. Initially, it encompassed physical elements such as roads, bridges, tunnels, etc. However, as transportation systems became more complex, the definition expanded to include not only the physical structures but also the related systems, technologies and services that enable safe and efficient movement of people and goods. It means that the road infrastructure can be understood as the entire set of elements that allows the movement of vehicles comfortably and safely from one point to another. Due to mobility changes, the actual definition of road infrastructure not only includes design and construction that facilitates the transit of motorized vehicles, but also includes the mobility of pedestrians, cyclists and users of other non-motorized means of transport such as e-scooters or electric skateboards.

The new paradigm of road infrastructure is also closely linked to green mobility. It is about highways, roads, streets, avenues, bicycle lanes and pedestrian crossings designed to improve the quality of life of inhabitants, regardless of whether they have a private vehicle or not.

Objectives of Road Infrastructure Management

The management of road infrastructure has two fundamental objectives: to ensure that the infrastructure is kept in good condition and in continuous operation; and optimize the use of public resources invested in its development and maintenance.
The main principles to be followed are:

Integrity principle

The road infrastructure is made up of a set of elements. Each of them fulfils a specific function, with the purpose to ensure a comfortable and safe transit of road infrastructure users (pedestrians and vehicles). Pavements are considered the basic and most important element of road infrastructure. Around them other elements have developed other elements as bridges, signs, safety devices and sidewalks. Road infrastructure management must take into account all these elements, ensuring that they are in good condition and providing an adequate service to the users.

Strategic principle

The road infrastructure is built to long term service for its users. It represents a significant investment of public resources and its maintenance requires a sustained effort over the years. These characteristics make its management an activity of a strategic nature, which must respond to a long-term vision, be oriented towards the achievement of objectives and goals, and the provision of an efficient and quality service.

Systematic principle

Well-working system for road infrastructure management should properly combine technical, political and administrative criteria and practices to manage efficiently available resources (human, technical, financial), guide decision-making towards the achievement of institutional objectives and satisfy the needs and demands of its users. The main components of such system are: diagnosis, collection of data about condition and operation of the road infrastructure; definition of the objectives, goals and institutional policies; definition of maintenance strategies and programs; mechanisms for realization of works; and indicators for evaluating the results.

History of RIM education

The history and development of road infrastructure management have evolved alongside the advancement of road systems and transportation technologies. The road infrastructure has evolved from basic paths for foot and animal traffic to sophisticated, interconnected networks supporting modern transportation needs. The education in this filed was strictly connected to this process.

Here is an overview of the key milestones in the history of education for road infrastructure management:

Evolution of RIM education

- Ancient civilizations
- 19th Century - Emergence of Civil Engineering Programmes
- Early 20th Century - Integration of Road Management in Engineering Curricula
- Mid-20th Century - Rise of Transportation Engineering
- Late 20th Century - Focus on Safety and Environmental Concerns
- 21st Century - Integration of Technology and Data
- Current Times - Continuing Professional Development & Global Future
  - Sustainable Infrastructure

Early Development

Education in road infrastructure management can trace its roots back to the early engineering and surveying practices of ancient civilizations. However, formal education specific to road infrastructure management was limited during this period. Knowledge and skills were often passed down through apprenticeships and practical experience rather than formal academic institutions.

Emergence of Civil Engineering Programs

As the importance of road infrastructure grew during the 19th century, civil engineering as a profession began to take shape. Universities and technical schools established civil engineering programs, providing foundational knowledge in construction and design of roads and transportation systems.

Incorporation of Road Management in Engineering Curricula

In the early 20th century, the management and planning aspects of road infrastructure began to be integrated into the civil engineering curricula. Academic programs started to offer specialized courses in highway engineering and road design, incorporating topics related to traffic flow, safety and road maintenance.

Rise of Transportation Engineering Programs

With the expansion of road networks and the growth of motor vehicle utilization, transportation engineering emerged as a distinct field. Academic institutions started to establish transportation engineering programs that covered broader aspects of road infrastructure management (including traffic engineering, urban planning and logistics).

Focus on Safety and Environmental Concerns

In the late 20th century, road infrastructure management education started to place greater emphasis on safety and environmental sustainability aspects. Curricula included courses on road safety audits, environmental impact assessments and sustainable transportation planning.

Integration of Technology and Data Analytics

As technology advanced, education in road infrastructure management incorporated tools like Geographic Information Systems (GIS), Building Information Modelling (BIM) and data analytics. Students learned to use these tools and technologies to optimize road designs, assess traffic patterns and improve road maintenance.

Continuous Education and Certification

In addition to formal academic programs, continuous education and professional development opportunities became more prevalent for practicing engineers and road managers. Professional workshops with certifications provided opportunities to stay updated with the latest advancements and best practices in the area of road infrastructure management.

Global Collaboration and Knowledge Sharing

With the rise of international collaborations and knowledge-sharing platforms, expertise in road infrastructure management became more accessible worldwide. Academic institutions and organizations from different countries collaborate to develop standardized practices and promote innovation in the field.

Sustainable and Smart Infrastructure Focus

Recent years have seen a growing focus on sustainable and smart road infrastructure. Education in road infrastructure management now includes training in green road design, integration of renewable energy solutions, and the implementation of smart transportation systems.

As it can be seen, the education in road infrastructure management has evolved significantly over the years, adapting to the changing needs of transportation systems and societal demands. The field continues to develop as it embraces emerging technologies and addresses the challenges of creating efficient, safe, and sustainable road networks for the future. The continuous development of road infrastructure management remains essential to address challenges such as urbanization, population growth, climate change, and the demands of a rapidly changing world. Nowadays, road infrastructure management has moved from traditional project management to a collaborative planning approach. It included elements such as process and program management.

Process management consists in identifying key processes and the relationships between them. It includes phases such as planning, design, construction, maintenance and monitoring of road infrastructure. It emphasizes the involvement of various participants, data collection and analysis, regular review of processes and adaptation to changing needs and technologies. It ensures that the road infrastructure is efficient, safe and adaptable.

The program approach consists in coordinated and strategic management of projects and activities oriented to fulfil long-term goals and reach established results. This approach is based on planning and managing resources, monitoring progress and evaluating success at the level of the whole programme. Its purpose is the efficient and synergistic use of resources. Program management of road infrastructure takes into account the connections between individual projects and results of risk analysis. Based on updated data and analysis of needs the strategy is adapted in real time. This leads to the effective use of resources, the minimization of duplicate actions and the achievement of overall efficiency in the development and management of the road network.

Education of experts in RIM

For the creation of safe, efficient and sustainable transport systems are needed highly qualified experts, including those from the area of road infrastructure management.

These experts play a pivotal role in designing, implementing, and managing road infrastructure projects that benefit society, environment and economy. Their knowledge and skills can contribute to the improvement of overall transportation networks and the quality of life for all citizens and communities.

The main reasons for the need of education of road infrastructure management experts in can be summarized as follows:

- Firstly, road infrastructure serves as the backbone of economies and societies, facilitating trade, connectivity and accessibility. Educated experts should possess the knowledge and skills to plan, design, and manage road infrastructure that optimize traffic flow, minimize congestion and support economic growth.
- Secondly, road safety is becoming a critical concern. Educated professionals should understand and implement safety measures that are reducing traffic accidents, related

injuries and fatalities. They design roads with the elements that are ensuring safety of all road users (proper signage, pedestrian crossings and cycling lanes, etc.)

- Thirdly, the importance of environmental consideration is increasing. Experts in road infrastructure management should be capable of introducing sustainable practices, incorporating public transportation alternatives and mitigating the societal environmental effects of road transportation.
- Furthermore, the rapid pace of technological advancement necessitates experts who are well-versed in smart transportation systems, data analytics, and digital infrastructure management. These experts should be able to incorporate innovations to enhance efficiency, reduce emissions and create a more connected and responsive road network.
- Additionally, urbanization and population growth demand effective urban planning. Professionals in road infrastructure management should be able to design roads that harmonize with urban environments, encourage accessibility, promote walkability and align with urban development goals.
- In conclusion, educating experts in road infrastructure management encompasses fostering knowledge and skills in efficient road design, safety measures, environmental sustainability, technological integration and urban planning. This expertise should ensure that road networks are well-designed, adequately maintained and responsive to the evolving needs of the entire society.

RIM impact

The main areas in which the education of road infrastructure management can impact the security of the word are:

1. Efficient infrastructure development

Road infrastructure management experts are trained in strategic analysis and planning of transport networks. They can identify areas that require improvement, optimize existing roads and plan new infrastructure to increase the overall efficiency of transport systems.

2. Safety improvement and accident reduction

Road infrastructure management experts understand the principles of road safety and traffic management. They can implement measures to reduce the number of road accidents, design safer roads (also with regard to vulnerable road users such as pedestrians, cyclists, motorcyclists, children and older people).

3. Environmental sustainability

Road infrastructure management education includes awareness of sustainable practices. Experts can develop green road designs, integrate public transport options and consider environmental impacts, contributing to greener and more sustainable transport networks.

4. Cost-benefit effectiveness

Road infrastructure management experts can make informed decisions that balance costs and benefits. By optimizing road designs and maintenance strategies, they can save resources while ensuring the longevity and functionality of the infrastructure.

5. Traffic flow and congestion management

Experts can employ traffic management techniques to reduce congestion and improve the overall flow of vehicles. This leads to reduced travel times, increased productivity, and a more pleasant commuting experience for the public. Implementation of road traffic flow solutions also minimize the safety risks and environmental burden of road transport.

6. Urban planning and development

Road infrastructure experts play a vital role in urban planning. Their education allows them to integrate road infrastructure effectively with other urban elements, such as public spaces, residential areas and commercial zones to create cohesive and sustainable communities.

7. Regulatory compliance

Experts in road infrastructure have knowledge on transport regulations, design norms and standards. Their education ensures that road projects comply with legal requirements, reducing the risk of legal disputes and project delays.

8. Public health and well-being

Safe and efficient road infrastructure positively impacts public health. By minimizing accidents and congestion, experts contribute to improved air quality, reduced noise and stress and improve the overall well-being of the citizens.

9. Economic Development

Properly managed road infrastructure is essential for economic growth. Well-educated experts can plan and implement transportation projects that connect regions, facilitate trade, and attract investment, boosting economic development.

In conclusion, education of experts in road infrastructure management is vital for creating sustainable, safe, and efficient transportation systems. These experts play a pivotal role in designing, implementing, and managing road projects that benefit society, the environment, and the economy. Their knowledge and skills contribute to the improvement of overall transportation networks and the quality of life for communities around the world.

Good practices of RIM teaching

This chapter presents key teaching strategies for four different road infrastructure management education topics:

- Road Safety Audit (RSA),
- Roadside Environment Safety Management (RESM),
- Safety Management of Unprotected Road Users (SMURU)
- Road Surface Management (RSM).

After discussing the challenges of teaching each of the above topics, this chapter also describes the best didactic practices for teaching each topic, which include methods such as case studies, interactive workshops, guest experts, multimedia resources, site visits, stakeholder involvement, and discussions of ethical dilemmas. The chapter emphasizes the importance of hands-on learning experiences, interdisciplinary collaboration, and ethical considerations for effective teaching of these topics. It also explores the potential of current AI tools to enhance customized teaching by adapting content, providing simulations, providing real-time feedback, and optimizing the learning experience for students. Finally, the chapter summarizes the innovative approaches and challenges associated with road infrastructure management education.

Safety Audit

This sub-chapter provides a comprehensive overview of best practices, teaching challenges, and the potential role of AI tools for a Road Safety Audit course. It first discusses the major challenges in teaching Road Safety Audit, including technical complexity, interdisciplinary nature, data availability, resource constraints, regulatory variability, and balancing theory with practice. Subsequently, the section details effective teaching strategies for Road Safety Audit, including case

studies, interactive workshops, guest experts, multimedia resources, group discussions, field visits, and assessment variety. The significance of these practices in creating an engaging and comprehensive learning journey is emphasized. Lastly, the section explores the potential of recent AI tools to enhance Road Safety Audit education, highlighting the benefits of adaptive learning platforms, personalized assessments, NLP-enabled chatbots, AI-driven simulations, and data analytics. The quintessence of the information provided in this sub-section is inspired from the references (those for Chapter 2) [1-3].

What is a Road Safety Audit (RSA)?

A Road Safety Audit is a systematic evaluation of road infrastructure and design elements to identify potential hazards, risks, and safety concerns for all road users. It aims to enhance road safety by assessing the road's layout, signage, markings, lighting, intersections, and other features to recommend improvements that reduce accidents and promote safer transportation.

What are the major challenges for teaching RSA?

Major challenges for teaching a course on Road Safety Audit may include: Technical Complexity, Interdisciplinary Nature of RSA, Data Availability, Resource Constraints, Regulatory Variability, and Balancing Theory and Practice.

Challenges for teaching a course on Road Safety Audit	
Technical Complexity RSA involves various engineering and design principles, making it challenging for students with limited technical background to grasp the concepts.	Simplifying very technical and complex concepts for students while covering various disciplines is a challenging task.
Interdisciplinary Nature of RSA RSA requires knowledge in multiple disciplines such as civil engineering, transportation planning, and traffic management, making it difficult to cater to diverse student backgrounds	Integrating the diverse aspects of the various fields coherently when teaching can be a complex task.
Data Availability Access to relevant accident data and road safety statistics may be restricted, hindering hands-on analysis and case studies.	Teaching the RSA course is challenging due to limited data availability, which can hinder practical examples and case studies for students

Resource Constraints Availability of specialized software, tools, and equipment for conducting virtual or on-site audits may be limited, affecting practical training opportunities.	Teaching the RSA course is challenging due including limited access to real-world road safety data, which are essential for a comprehensive learning.
Regulatory Variability Availability of specialized software, tools, and equipment for conducting virtual or on-site audits may be limited, affecting practical training opportunities.	Teaching the RSA course is challenging due including limited access to real-world road safety data, which are essential for a comprehensive learning.
Balancing Theory and Practice Striking the right balance between theoretical concepts and practical applications can be challenging to ensure students gain a comprehensive understanding of Road Safety Audit.	Ensuring that students grasp both the foundational knowledge and the skills needed for real-world RSA is not easy task.

Best didactic practices for teaching RSA

Effective teaching of RSA involves a combination of best didactic practices. Seven of the best didactic practices for teaching RSA include: Case Studies, Interactive Workshops, Guest Experts, Multimedia Resources, Group Discussions, Field Visits, and Assessment Variety. Table 2.2 provides a brief discussion of these didactic practices.

Case Studies

Explanation of the didactic practice. Utilizing real-world case studies to demonstrate practical applications of RSA concepts. Case Studies can enhance students' understanding and problem-solving skills.

AI tools can help in the creation of diverse Road Safety Audit cases, each presenting different challenges and scenarios. AI tools like ChatGPT can be used for this.

Interactive Workshops

Conducting hands-on workshops where students engage in simulated audits. Interactive Workshops can foster active learning and allow students to apply theoretical knowledge.
AI tools can help create virtual workshops where students collaboratively conduct mock Road Safety Audits, mapping out potential hazards, and proposing countermeasures. Virtual collabo-

ration tools like Miro can facilitate interactive workshops with virtual. whiteboards and collaboration features.

Guest Experts

Inviting professionals with practical experience in RSA to share insights with students. Guest Experts can provide students with valuable industry perspectives and networking opportunities.
AI tools can help Road Safety Audit experts, traffic engineers, or professionals from regulatory bodies to conduct virtual guest sessions, sharing their experiences and answering student questions. Video conferencing tools like Zoom or Microsoft Teams can facilitate remote guest expert sessions.

Multimedia Resources

Incorporating videos, animations, and interactive simulations to visually explain complex concepts. Multimedia Resources can enhance engagement and comprehension.
AI tools can support the creation of interactive videos explaining Road Safety Audit procedures, displaying before-and-after scenarios, and allowing students to interact with audit elements within the video. Interactive video platforms like H5P can be used to create engaging multimedia content.

Group Discussions

Encouraging peer-to-peer discussions and group activities to promote collaborative learning. Group Discussions can allow students to share ideas and learn from each other.
AI tools can support group discussions by helping people communicate better, suggesting relevant topics, summarizing important points, and making sure everyone gets a chance to participate. Discussion facilitation tools like Padlet can help structure and manage online group discussions.

Field Visits

Organizing visits to actual road sites for practical exposure. Field Visits can enable students to observe real-world challenges and solutions firsthand.
AI tools can enable Virtual Field Visits that can provide students with insights into real-world Road Safety Audit scenarios and challenges. Virtual reality (VR) platforms like Engage or ClassVR can simulate virtual field visits.

Assessment Variety

Employing a mix of assessments, including quizzes, assignments, presentations, and projects, Assessment Variety helps to cater to different learning styles and effectively evaluate students' grasp of the material.

AI tools can enable the creation of an assessment variety that includes different types of assessments evaluating Road Safety Audit understanding. AI-powered assessment platforms like ProProfs can help create and grade diverse assessments.

Roadside Environment Safety Management (RESM)

Roadside Environment Safety Management is the systematic planning, monitoring, and implementation of measures to ensure the safety of the surrounding environment along roadways. Teaching a course on this topic can be challenging due to the multidisciplinary content, limited availability of case studies, need for technology integration, stakeholder engagement, and sensitive safety and ethical considerations. However, incorporating the best didactic practices, such as interactive case studies, experiential learning, collaborative projects, guest lectures, technology integration, stakeholder engagement, and ethical dilemma discussions, can greatly enhance the learning experience. Recent AI tools offer a wealth of possibilities to significantly enhance a customized teaching course on Roadside Environment Safety Management. By harnessing these advanced AI tools, a customized teaching course can curate a dynamic, adaptive, and technologically enriched learning experience, ultimately optimizing students' comprehension, engagement, and practical skills. This section elaborates on the following concepts: the multidisciplinary nature of Roadside Environment Safety Management, the challenges of teaching a course on this topic, the best didactic practices for teaching this topic, and the potential of AI tools to enhance the teaching of this topic. The quintessence of the information provided in this subsection is inspired from the references (for Chapter 2) [4-6].

What is Roadside Environment Safety Management (RESM)?

Roadside Environment Safety Management refers to the systematic planning, monitoring, and implementation of measures to ensure the safety of the surrounding environment along road-

ways. This includes addressing potential hazards, minimizing risks to pedestrians, cyclists, and adjacent properties, and maintaining a secure and harmonious coexistence between the road infrastructure and the surrounding natural and built environment.

What are the major challenges for teaching Roadside Environment Safety Management?

Teaching a course on Roadside Environment Safety Management presents several challenges. These may include: Multidisciplinary Nature, Constantly Evolving Regulations, Practical Application, Technological Advancements, Community Engagement, Data Collection and Analysis, Emergency Response Planning, Sustainability Considerations.

Challenges for teaching a course on Roadside Environment Safety Management.

Multidisciplinary Nature RESM involves a blend of disciplines such as civil engineering, environmental science, urban planning, transportation management, and safety regulations.	Teaching students from diverse backgrounds can be challenging, as they may have varying levels of familiarity with these disciplines.
Constantly Evolving Regulations Regulations and guidelines related to roadside safety and environmental management are constantly evolving due to changing technological advancements and societal concerns.	Keeping the course content up-to-date with the latest regulations can be demanding.
Practical Application Bridging the gap between theoretical knowledge and practical application can be challenging.	Roadside safety management often requires hands-on experience in assessing, designing, and implementing safety measures.
Technological Advancements Rapid advancements in technology are affecting roadside safety management, with innovations like autonomous vehicles, smart infrastructure, and real-time traffic data.	Integrating these technological changes into the curriculum can be challenging due to their rapid pace.

Community Engagement Roadside environments often intersect with communities, and local residents may have diverse opinions on safety measures and environmental impacts	Teaching students how to effectively engage with communities, address concerns, and consider public perspectives is important but can be challenging.
Data Collection and Analysis Effective safety management relies on accurate data collection and analysis.	Teaching students how to gather and interpret data related to traffic patterns, accident statistics, environmental impacts, and more can be complex.
Emergency Response Planning In the event of accidents or emergencies, effective response plans are crucial.	Teaching students how to develop comprehensive emergency response plans that consider various scenarios and stakeholders can be demanding.
Sustainability Considerations With a growing emphasis on sustainability, integrating eco-friendly practices into roadside safety management is vital.	Teaching students how to balance safety measures with environmental sustainability can be challenging due to the need for interdisciplinary knowledge.

Best didactic practices for teaching Roadside Environment Safety Management

Incorporating the best didactic practices for teaching Roadside Environment Safety Management can greatly enhance the learning experience. We can consider the following seven didactic practices: Interactive Case Studies, Experiential Learning, Collaborative Projects, Guest Lectures, Technology Integration, Stakeholder Engagement, and Ethical Dilemma Discussions.

Clear Learning Objectives

Clearly defining the learning objectives for each module or topic. Communicate how learning objectives connect to real-world applications and why they are important for Roadside Environment Safety Management.

AI tools can support setting clear learning objectives by analyzing the curriculum and learning materials to identify key concepts and outcomes. This automation streamlines the process of objective formulation, enhancing the clarity and effectiveness of learning goals for students in online courses. Tools such as ChatGPT can be useful for this task.

Multimedia-rich Content

Incorporating a variety of multimedia elements such as videos, images, infographics, and interactive simulations. Embedding relevant videos demonstrating safety procedures, use images to illustrate hazardous conditions, and utilize interactive simulations to allow students to explore virtual scenarios related to roadside safety.

AI tools can support multimedia-rich content by recommending and generating relevant multimedia elements such as videos, images, and interactive simulations based on the course topics. Content creation platforms like Canva can help design visually appealing graphics and images.

Interactive Assessments

Designing assessments that require active engagement and critical thinking. Incorporating quizzes, case studies, and discussions to assess understanding and practical application of concepts.

AI can support interactive assessments by generating and administering quizzes, assignments, and simulations that adapt to individual student progress. Quiz platforms like Quizlet[11] can assist in creating interactive quizzes and flashcards.

Structured Modules and Resources

Organizing course content into well-structured modules with clear headings, subtopics, and resource materials. This helps students navigate the course easily. Divide the course into manageable modules, each focusing on a specific aspect of roadside environment safety. Provide downloadable lecture notes, readings, and supplementary resources under each module.

AI can support structuring modules and resources by automatically organizing course materials into logical sections, creating headings, subtopics, and arranging resources in a coherent manner. AI-driven algorithms can analyze the content hierarchy and suggest effective ways to present information. Learning management systems (LMS) like Moodle can help structure and organize course modules.

Timely Feedback and Communication

Providing prompt feedback on assignments and assessments. Set clear assignment submission deadlines and provide detailed feedback within a reasonable timeframe. Set clear assignment submission deadlines and provide detailed feedback within a reasonable timeframe.

AI can support timely feedback and communication by automating the process of providing feedback on assignments and assessments. AI-driven systems can analyze student submissions and offer instant feedback, highlighting strengths and areas for improvement. AI-powered chatbots like IBM Watson Assistant can provide instant responses to common queries.

Real-world Application

Connecting theoretical concepts to real-world situations and practical applications in Roadside Environment Safety Management. Use case studies, examples from recent accidents or incidents, and news articles to demonstrate how the concepts covered in the course relate to actual safety issues on the road.

AI can support real-world application by involving simulations to connect theoretical concepts to practical scenarios and industry practices. Simulation platforms like AnyLogic can model roadside safety scenarios and outcomes.

Collaborative Learning Opportunities

Fostering a sense of community among students by incorporating collaborative learning activities, such as group projects and peer reviews. Assign group projects where students work together to analyze a safety challenge, develop solutions, and present their findings.

AI can support collaborative learning opportunities by facilitating virtual group formation, suggesting discussion topics, and automating peer review processes. AI-powered systems can analyze student profiles and preferences to create diverse and effective teams for group projects. Collaboration platforms like Google Workspace can facilitate group projects.

Safety Management of Unprotected Road Users (SMURU)

Safety Management of Unprotected Road Users is a complex and interdisciplinary field that involves designing and maintaining road infrastructure, signage, and traffic control measures to minimize risks and accidents for pedestrians, cyclists, and other vulnerable road users. Teaching a course on this topic presents a number of challenges, including the need to keep up with evolving practices, address sensitive ethical considerations, and assess students' practical skills. However, immersive learning experiences such as case studies, interactive simulations, and field visits can help students gain a deep understanding of the issues involved. Recent advances in artificial intelligence (AI) can also be used to enhance the teaching of this course, such as by providing personalized learning experiences, analyzing large datasets, and simulating real-world scenarios. This section outlines the challenges and innovative didactic approaches that can be considered when teaching a course on the Safety Management of Unprotected Road Users in the context of Road Infrastructure Management. The quintessence of the information provided in this sub-section is inspired from the references (for Chapter 2) [7-9].

What is Safety Management of Unprotected Road Users?

Safety Management of Unprotected Road Users (SMURU) in the context of Road Infrastructure Management involves implementing measures and strategies to enhance the safety of vulnerable individuals, such as pedestrians and cyclists, who share or interact with roadways and transportation systems. This includes designing and maintaining road infrastructure, signage, and traffic control measures to minimize risks and accidents for these unprotected road users.

What are the major challenges for teaching Safety Management of Unprotected Road Users?

Teaching a course on Safety Management of Unprotected Road Users presents a multifaceted set of challenges. These may include: Complexity, Evolving Practices, Ethical Considerations, Interdisciplinary Nature, and Assessment of Practical Skills. Table 2.7 provides a brief discussion of these challenges.

Challenges for teaching a course on Roadside Environment Safety Management	
Complexity The SMURU involves a diverse set of factors, including human behavior, vehicle dynamics, road infrastructure, and traffic regulations	Online courses must find effective ways to convey this complexity without overwhelming learners. Balancing depth and simplicity is crucial to ensure that learners grasp the fundamental concepts and their interrelationships without getting lost in intricate details.
Evolving Practices The field of SMURU is constantly evolving due to advancements in technology, changes in urban planning, and new insights from research. Keeping the course content up-to-date can be a challenge.	The course designer needs to establish mechanisms to regularly update the course materials. Incorporating case studies and real-world examples that reflect recent changes can help learners connect theoretical concepts with current practices.
Ethical Considerations Teaching SMURU involves addressing sensitive and ethical issues, navigating discussions around topics like blame attribution, privacy concerns in data collection, and social justice disparities in road safety.	Creating a safe and inclusive learning environment is essential, where students feel comfortable discussing these topics without fear of judgment.
Interdisciplinary Nature SMURU is inherently interdisciplinary, requiring insights from psychology, engineering, urban planning, public policy, and more.	Collaborating with experts from various fields to contribute to the course content or guest lectures can enhance the interdisciplinary perspective.

Assessment of Practical Skills SMURU involves not only theoretical knowledge but also practical skills, such as risk assessment, data analysis, and designing interventions.	Besides traditional written exams, incorporating practical assignments, case studies, and simulations can better evaluate a student's ability to apply theoretical concepts to real-world scenarios.

Best didactic practices for teaching Safety Management of Unprotected Road Users?

Immersive learning experiences form the core of the teaching approach in the Safety Management of Unprotected Road Users course. didactic practices to do this may include: Case Studies, Interactive Simulations, Guest Experts, Field Visits, Group Projects, Debate and Discussion, and Debate and Discussion.

Case Studies

Case studies involve presenting real-life scenarios that require students to analyze and solve problems related to the SMURU. These scenarios could involve pedestrian safety, cyclist safety, etc. In the course, you can provide written or video-based case studies and then facilitate discussions through forums, video conferences, or dedicated discussion boards.

AI can help in the generation of diverse scenarios involving unprotected road users' safety issues, fostering discussions and analysis among students. AI tools like chatGPT can be used for this.

Interactive Simulations

Interactive simulations provide a virtual environment where students can explore different aspects of SMURU. An example would be a simulation allowing students to experience traffic situations from the perspective of a pedestrian or cyclist.

AI tools can enable simulation where students can manipulate traffic parameters, pedestrian behavior, and road design to observe the impact on safety outcomes. Simulation platforms like Simul8 can help build interactive simulations of road traffic scenarios involving unprotected road users.

Guest Experts

Inviting guest experts who are knowledgeable in the field of SMURU can provide valuable insights and practical experiences. Guest experts can deliver lectures, participate in Q&A sessions, or even lead discussions on specific topics through live webinars, recorded video interviews, or asynchronous Q&A forums.

AI tools can facilitate the hosting of virtual guest sessions to share their knowledge and engage in discussions. Video conferencing tools like Zoom or Microsoft Teams can facilitate remote guest expert sessions.

Field Visits

While traditional field visits might be challenging in an online course, you can creatively adapt this practice. Record virtual tours of road safety installations, high-risk areas, or intersections. Students can watch these tours to observe real-world examples and discuss their observations.

AI can enable the creation of virtual field visits to intersections, pedestrian crossings, and other locations where unprotected road users face safety challenges. Virtual reality (VR) platforms like Engage or ClassVR can simulate virtual field visits.

Group Projects

Assigning group projects encourages collaboration among students. For instance, you could task groups with designing a road safety campaign for a specific target audience. Online collaboration tools, video conferencing, and shared documents facilitate group work even in remote settings.

AI can enable the creation of Collaboration platforms that can allow students to collaborate on safety improvement projects, share resources, and discuss their strategies when working on group projects. Collaboration platforms like Slack can facilitate communication and coordination among group members.

Debate and Discussion

Debates and discussions encourage critical thinking and the exploration of various viewpoints. Assign specific road safety topics for students to research and debate. They can present arguments for and against different safety measures or policies.

AI can support group discussions and debates by helping people communicate better, suggesting relevant topics, summarizing important points, and making sure everyone gets a chance to participate. Discussion facilitation tools like Padlet can help structure and manage online group discussions.

Problem-Based Learning (PBL)

Problem-Based Learning involves presenting students with real-world problems related to SMURU. Students work individually or in groups to identify solutions, research relevant information, and develop strategies to address the problems. This approach promotes self-directed learning and problem-solving skills.

Road Surface Management (RSM)

This section discusses the concept of Road Surface Management within the context of Road Infrastructure Management, taking into account planning, monitoring, and maintenance of roadways to ensure safety and functionality. The subject's multifaceted challenges, spanning technical complexity, environmental sustainability, data management, interdisciplinary collaboration, and practical experience, are explored. Navigating these challenges requires a grasp of intricate concepts, meticulous selection of maintenance strategies, harmonizing road upkeep with environmental concerns, adept data handling, and interdisciplinary teamwork. The importance of real-world grounding through field experiences is highlighted, despite logistical hurdles. The narrative further outlines seven effective didactic practices for teaching Road Surface Management, including hands-on demonstrations, case studies, simulations, guest lectures, collaborative projects, field trips, and continuous assessment. The integration of recent AI tools is proposed to enhance personalized learning, providing tailored support and guidance to students in understanding this complex subject.

What is Road Surface Management (RSM)?

Road Surface Management (RSM) in the context of Road Infrastructure Management involves the planning, monitoring, and maintenance of the physical surface and condition of roadways to ensure their safety, durability, and usability for vehicles and pedestrians. It includes activities such as assessing pavement quality, identifying and repairing defects, applying preventive measures, and optimizing resources for efficient road surface upkeep.

What are the major challenges for teaching Road Surface Management?

Road Surface Management is a critical aspect of maintaining safe and efficient transportation networks. As the lifelines of modern societies, roads facilitate the movement of goods and people, underscoring the need for their consistent upkeep. However, the process of teaching Road Surface Management presents a set of formidable challenges that educators and practitioners

must navigate. These may include: Complexity, Maintenance Strategies, Environmental Sustainability, Data Management, Interdisciplinary Collaboration, and Field Experience.

Challenges for teaching a course on Road Surface Management	
Complexity RSM is a multifaceted topic that involves a wide range of engineering, materials science, and management principles	Teaching this subject online requires breaking down complex concepts into digestible modules, supplemented with visual aids, interactive simulations, and real-world examples.
Maintenance Strategies RSM is a critical aspect of infrastructure management. In an online course, conveying various maintenance strategies such as preventative, reactive, and predictive approaches requires not only theoretical explanations but also practical case studies.	Engaging students with real-world scenarios and discussing the decision-making process behind selecting appropriate maintenance strategies enhances their understanding of the subject.
Environmental Sustainability Modern RSM involves considerations of environmental impact and sustainability.	Online teaching must highlight the importance of using eco-friendly materials, techniques, and technologies to minimize carbon footprint and resource depletion.
Data Management Data-driven decision-making is increasingly crucial in RSM. Teaching students to collect, analyze, and interpret data related to traffic, weather, pavement conditions, and more is challenging in an online setting.	Integrating data visualization tools and providing hands-on experience with data analysis software can empower students to make informed decisions based on available data.
Interdisciplinary Collaboration RSM inherently involves collaboration between various disciplines such as civil engineering, materials science, urban planning, and environmental science. Fostering interdisciplinary understanding is harder in an online course compared to a traditional classroom.	Incorporating group projects, discussion forums, and virtual collaborative activities can simulate interdisciplinary teamwork and help students appreciate the holistic nature of road management.

Field Experience Practical experience is crucial for understanding RSM. Online courses lack physical access to field sites, equipment, and hands-on training, making it challenging to provide authentic experiences.	To address this, instructors can leverage virtual reality simulations, 3D models, and augmented reality tools to create virtual field trips, where students can explore real-world road scenarios and apply theoretical knowledge.

Best didactic practices for teaching a course on Road Surface Management

Road Surface Management is an important aspect of the way modern infrastructure is to be maintained, thus ensuring the longevity, safety, and efficiency of road networks. Teaching a course on Road Surface Management necessitates that several effective best practices be observed. In this section we are going to discuss the following seven didactic best practices: Hands-on Demonstrations, Case Studies, Interactive Simulation, Guest Lecturers, Collaborative Projects, Field Trips and Site Visits, and Continuous Assessment.

Hands-on Demonstrations

Hands-on Demonstrations allow students to see practical aspects of Road Surface Management, such as pavement construction techniques, maintenance procedures, and equipment operation. In an online setting, hands-on demonstrations can be conducted through videos, interactive simulations, or live streaming sessions.

AI tools can enhance understanding of practical concepts, reinforce theoretical knowledge with real-world applications by creating engaging video demonstrations with animations, text overlays, and visuals. Video creation platforms like Lumen5 or InVideo.

Case Studies

Case studies provide practical scenarios where students can apply their knowledge to analyze and solve real Road Surface Management issues. Presenting students with actual challenges, such as selecting appropriate materials for different climates or devising strategies for cost-effective maintenance, encourages critical thinking and problem-solving skills.

AI-powered data analysis tools can help process and visualize road maintenance data for case studies.Tableau can be used to analyze data from various RSM projects.

Interactive Simulation

Interactive simulations let students virtually engage with Road Surface Management tasks. Through simulation software, students can experiment with various factors like road design, material choices, and traffic loads.

AI tools can enhance Interactive simulations to replicate real-world scenarios and allow students to experiment and learn from their actions. Simulators like AnyLogic can be used to create interactive road maintenance simulations.

Guest Lecturers

Inviting guest lecturers who are experts in Road Surface Management, such as civil engineers, pavement specialists, or transportation officials, brings diverse perspectives and real-world insights to the course.

Guest lectures can offer practical experiences, case studies, and industry trends that enrich students' understanding beyond traditional course content.

AI tools can enable Guest lecturers to offer diverse perspectives, exposes students to industry professionals, and enhances networking opportunities. Virtual conferencing tools like Zoom or Microsoft Teams can facilitate remote guest lectures.

Collaborative Projects

Assigning collaborative projects encourages students to work together in virtual teams. As an example, students could develop a comprehensive road maintenance plan for a specific region, considering factors like climate, budget constraints, and traffic patterns.

AI tools can enable students to develops teamwork skills, promote peer learning, and simulate real workplace collaboration. Collaboration platforms like Slack can facilitate communication and project management among students.

Field Trips and Site Visits

While physical field trips might be challenging in an online course, you can utilize virtual tours, 360-degree images, or pre-recorded videos to virtually take students to real road construction and maintenance sites.
This provides students with a visual context and a sense of the practical challenges involved. AI tools can offer practical insights by bridging theory and practice, and enhancing understanding of site-specific challenges. Virtual reality (VR) platforms like Engagevr or ClassVR can simulate Virtual field trips.

Continuous Assessment

Implementing continuous assessment methods, such as quizzes, discussions, and peer reviews, ensures ongoing engagement and feedback throughout the course. Regular assessments help students stay on track, identify areas needing improvement, and reinforce their learning.
AI tools can enable consistent engagement by helping students track their progress, and identifying areas needing improvement. Learning management systems (LMS) with AI-based analytics, like Moodle, can help track and analyze student performance data.

Chapter II

Online teaching and learning overview

Online teaching and learning overview

The following lists are the result of workshops with teachers, modern education experts, doctoral students and students.

Advantages of online teaching and learning

Teachers perspective

- Ability to learn soft skills and knowledge in less time
- Automatic tests
- Availability of resources
- Capability to learn alone
- Clothing/dress code considerations
- Combining studying and working
- Easy administration of attendance
- Easy splitting students into workgroups with less disturbance
- Economical (less travel expenses)
- Easier involvement of more colleagues
- Evaluation processes automation
- Flexible time management
- Focused lectures
- Group chat in lectures for better communication
- Involvement of experts and professionals through webinars
- Integration of work and teaching
- Lectures can be recorded
- Less conflicts between people
- Media competence and online search skills
- More engaging tools for testing
- More interactive tools for visualization
- More time with family
- No space limitations, allowing students to switch between practical classes
- Possibility of face-to-face meetings through video calls with time flexibility
- Possibility to combine all lectures in two working days
- Prepared and reusable materials, including whole video lectures
- Repeatability of content
- Sharing files/materials
- Students become more mature and self-motivated to learn
- Time-saving measures
- Uniformity in education delivery
- Virtual visits, e.g., to factories

Students perspective

- Accessibility
- Availability of new teaching tools
- Durability / no dress code
- Easy enrollment
- Electronic interactive
- Environmental friendly
- Flexible location
- Increase the capability of learning
- Information retention
- Kids on sick-leave can be looked after
- Less stressful (exams)
- Money saving
- More focus and concentration
- More motivation from attendance
- New testing methods possible like Kahoot (existing)
- Online exams, tests can be used many times
- Part-time students can easily join classes

- Quality of learning
- Recordings can be used later as a make-up class
- Saving time
- Shared lab experiment
- Technology-oriented (cloud saving)
- Tests automatic evaluation
- Time management
- Time-saving measures
- Unified system of learning

Disadvantages of online teaching and learning

Teachers perspective

- Ecological aspects
- Energy consuming
- Exams are more stressful
- Failure to consider accessibility
- Good net connection costs
- Hard to follow the progress of students' work
- Hard copies are still very important (in Civil engineering)
- Harder to gain attention/engagement
- Health problem
- Increased written-email-communication
- Inadequate assessment
- Initial challenges
- Kids at home
- Lack of clear learning objectives
- Lack of comfort at home
- Lack of feedback
- Lack of interaction and engagement
- Lack of opportunity to meet the professors
- Lack of social interaction
- Labs online are very challenging
- Low attention
- Low missing support from management (not established onboarding process)
- Losing meeting skills
- More self-discipline needed (work and leisure time imbalance)
- No interaction with human beings
- No social life
- Not good for introvert students
- Not send for health
- Possibility to cheat (attendance/exams)
- Possibility of technical problems
- Practical classes difficulties (consultations)
- Quiet room in household needed
- Stress from recording/publishing
- Teacher has no feedback
- Teachers face technical challenges

Students perspective

- Boring time and fewer activities
- Changes in teaching styles, forgetting to engage students
- Cheating is easier
- Class becomes theoretical
- Copyright issues
- Difficult to organize experiments in online offering
- Distraction by other devices
- Economic impact on government
- E-learning fraud (tests, exams)
- Effective students' interaction or group work performance
- Health-related problems and bad life routine
- Hybrid class, declined focus
- Ineffective students' interaction or group work performance
- Lack of feedback and reflection
- Lack of presentation skills
- Lack of privacy
- Lack of social interaction
- Less access to the library
- Less communication and interaction
- Less connection with professors
- Less effective in project meetings
- Less extracurricular activities
- Less method to engage students
- Less productivity
- Less access to students' life facilities and activities
- Less interaction for technical courses
- Less privacy
- Less spend attention
- Limitation in student evaluation
- Limited connection
- More screens interaction
- No chance to control students in class
- No network between students and professors
- No social interaction
- Obesity and health risk
- Privacy issues
- Professor may become useless
- Recording is not guaranteed
- Sita a lot at home (not healthy)
- Technical issues
- Technical problem (Internet instability)
- Too fast to follow up
- Unstable internet connection
- You get lazy at home
- Lack of Univ. gastronomy
- Expensive equipment
- Higher capacity of internet connection is needed
- From 8 to 17 Netflix traffic was higher
- Bit difficult for part-time job (attendance)
- Problem with practical classes

Possible solutions to the identified challenges

- Hybrid learning
- Chatting sessions / discussions
- Spreading out students activities in a digital way
- Connection evaluation
- Keeping connection with networks
- Having private online meetings
- Informal communication
- Official rules put by the university to some the rights of students
- Provide online access for the university library
- More projects based education
- More projects
- More interaction (quiz, crosswords, games)
- Promoting activities
- Equipment investition
- Social events
- Hybrid exams
- Hybrid classes e.g. lectures online, tutorials in person
- Meeting in person sometimes
- Possibility to borrow equipment
- Project based teaching
- Open web cam. more interactive activities
- VR classes

Strategies for creating engaging content

- Define learning objectives.
- Choose appropriate multimedia formats.
- Gather and analyze content
- Prepare script or storyboard.
- Create and edit multimedia elements.
- Add interactive elements.
- Incorporate accessibility features.
- Test and refine.
- Deliver the multimedia resources.
- Continuously evaluate and update.

Resources types for online teaching

- PPT presentations (with and without voice)
- Video and video tutorial
- Simulations
- Podcast
- Quiz.
- Ebooks
- Interactive mind map.
- Forum
- Photo gallery

Chapter III

Techniques of the online teaching and training process

Techniques of the online teaching and training process

Methods of conducting lectures in online and hybrid mode

Lecture is perhaps the most prevalent instructional strategy used in higher education—on campus and online. Just as they would in a classroom, many online professors use lectures to transmit information, promote comprehension, and spark students' interests. Learning management systems (LMSes) typically allow instructors to record lectures, deliver them live, or both. However, it is helpful to keep in mind that lectures place students in a passive role, which could negatively impact student engagement in the online learning environment. Online lectures are most beneficial when used in conjunction with more active instructional strategies.

Best practices for online lectures

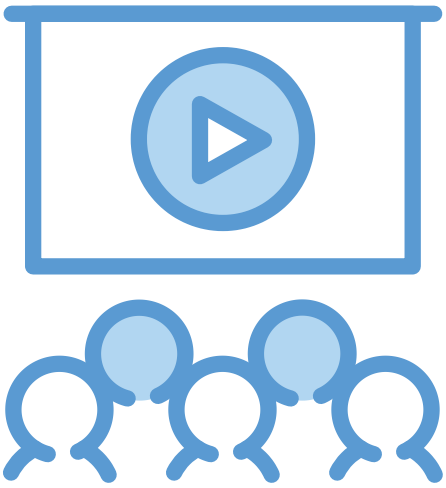
- Provide an introduction to each week's topics.
- Contribute advanced knowledge and insight to online class discussions.
- Incorporate references to current research and resources from the field of the online course.
- Serve multiple roles in the course (e.g., teacher, facilitator, collaborator, co-participant, observer).
- Use announcements to maintain a presence in the course.
- Participate in discussions to maintain a presence in the course.
- Connect students' prior knowledge of the course content.
- Connect learning to real-world situations and contexts.
- Maintain proper pacing of the course to allow adequate time for reading, practice, and assignments.
- Model higher-order critical thinking. Encourage and develop student critical thinking skills.

Best practices for learning activities

- Intervene when monitoring data or assessments indicate that students are at risk for failure.
- Use the gradebook effectively to provide timely feedback to students.
- Ensure the accessibility of all online content in the course.
- Maintain course pace to allow adequate time for reading, practice, and assignments.
- Encourage and develop students' critical thinking skills.
- Create cooperative learning opportunities to allow students to learn from one another.
- Use group work to provide opportunities for collaborative learning.
- Acknowledge learner efforts publicly and/or privately.

Live online classes

- Technology has made it straightforward to deliver lectures online even if you are not in the same room as the students, replicating many of the elements of face-to-face interaction.
- Using video conferencing tools you can connect and communicate with students across the globe to deliver lessons. Incorporating an online whiteboard, you can make the classes even more engaging.
- Lectures tend to put students in a passive role. Therefore to keep students engaged throughout the class online;
- Be prepared by outlining the content of the lesson
- Ask questions during and after the lesson and leave time for students to answer
- Carry out discussions around the topic and encourage students to participate actively
- Make use of graphic organizers, images, posters, videos, visuals, etc.
- Break down the main topic into sub-parts which will allow you to deliver the lecture in smaller chunks making it more effective in terms of keeping the students focused and engaged
- Set clear guidelines for online class etiquette for students to maintain



Online whiteboard

Online whiteboards have risen as a popular choice to virtually emulate the in-person classroom experience shared between teachers and students. They offer an infinite canvas, shape libraries to create different diagrams and charts, pre-made templates, sketching, typing, image import options, etc. Unlike the traditional whiteboards, they also let you digitize the content created, hence allowing you to re-share them and refer to them at a later time. You can also collaborate with students on the same canvas in real-time which paves the way to:

- Carry out assignments
- Brainstorm around lessons
- Mind mapping
- Do interactive exercises such as quizzes
- Review homework and leave feedback

Pre-recorded video lectures

The benefit of pre-recorded lectures, as opposed to the live ones, is that the former allows the students to learn at their own pace at any time without the presence of the teacher. It also gives them material to go over during revision. The teacher or instructor, on the other hand, can use the videos to avoid repetitive teaching between different classes.

To create effective pre-recorded lectures;

- Start with a script. Outline the talking points and what should go on each slide.
- Practice as necessary. Unless you are confident enough to do it in one go, rehearse what you will be saying prior to recording.
- Keep it short. If the video is longer than 20 minutes, consider breaking it up into smaller videos. This will not only come in handy when uploading them online but in case you need to replace the content with new information, it'll be easier to re-do a few minutes video than an hour-long one.
- Have everything ready before recording. Make sure that you are in a place devoid of distracting noises and backgrounds, and that your script and props are in place.
- If you are recording your screen, make sure to have closed unnecessary tabs and apps that may send you notifications.
- Maintain good eye contact with the camera and a tone you would use in a normal one-on-one conversation.

Methods of conducting practical classes in online mode

Create a positive online learning environment

Just as in a physical classroom, create an environment where students feel comfortable and safe voicing their opinion and exploring their curiosity.

- Allow students to take notes and ask questions in real-time, just like you would have in a physical classroom. Interact with the students more attentively, even though you are not in the same room. Create an environment where they have the freedom to conduct more discussions with you and among themselves during the class.
- Use a communications platform to allow students to share their thoughts, questions, and resources they discover that can be discussed during the next class. This can be a WhatsApp group, a Facebook group, or even a Google Document that all students have access to.
- Also encourage your students to work together with others in class such as sharing notes or resources when they miss a class, helping out with assignments, and discussing lessons among themselves.

Asynchronous instructions

Online courses that allow students to view lectures, access materials, and collaborate with teachers and peers on their own schedule are called asynchronous courses. Lectures might be pre-recorded or presented on a program like Microsoft PowerPoint, perhaps with instructor voice-over. These delivery methods allow students to review and re-review lessons as necessary. These options could be quite helpful to students who cannot attend scheduled sessions, hope to minimize live group projects or discussions, or want to work through lessons at their own pace. Programs that use asynchronous content delivery methods require a different approach to teaching—one that depends heavily upon the technologies used. As with synchronous instruction, characteristics like class size and instructor preferences can influence which tools are used in asynchronous online classes. Many employ more than one technology, which could include the following:

- Downloadable pre-recorded lectures
- Microsoft PowerPoint presentations with or without voice-over
- Forums and discussion boards
- Email communication
- Google Drive and similar collaborative tools
- Tools for off-hour support, like virtual tutoring centers and virtual resource centers

Each of these delivery formats allows instructors to overcome teaching challenges, but few programs adopt just one approach to teaching. Professors pull from a much larger instructional toolbox. Teachers and students both benefit from knowing how various teaching methods work online, and in what circumstances.

Active learning

Active learning methods are instructional strategies that encourage students to actively engage with the course material, participate in discussions, and apply their knowledge in meaningful ways. These methods promote critical thinking, problem-solving, and deeper understanding of the subject matter.

- Online quizzes – help students self-regulate what they have learnt and further improve their comprehension of the subject
- Polls – help students reflect and analyze what they have learned by polling their own choices
- Infographics – increase student engagement and enhances memory
- Mind maps or word clouds – allow students to brainstorm around topic areas and develop their thinking skills

Videos and other resources

You can ask students to create a short (3-5) minute video to explain a course concept to their peers and post it to a discussion board in Canvas. Consider trying Flipgrid, which can be used to share short student videos. Other alternatives are to ask students to post a concept map, infographic, or content review questions to share with peers.

Google docs for collaboration

Consider using Google docs or Google sheets for student collaborations. For example, worksheets or handouts that you might have used for in-person activities can be made into a Google doc. Students can contribute to them simultaneously, as well as provide a way for you to give feedback. Google Apps can be integrated into Canvas pages, and students should access Google Suite using their authenticated Cornell accounts.

Hypothesis (link is external)

Students can annotate readings online and respond to each others' comments using this social annotation tool in Canvas. It encourages students to read closely and thoughtfully and can identify areas of common interest or confusion.

Gamification

Gamification in e-learning for students is an effective strategy that leverages game elements and principles to enhance the learning experience. It can make the learning process more engaging, motivating, and enjoyable for students, ultimately leading to better retention and understanding of the material. Some key ways to implement gamification in e-learning for students are: points, badges, and leaderboards, storytelling and narrative, quests and missions:game-based simulations, interactive challenges, avatars or characters, rewards and prizes, feedback and progress tracking.

Blog

A blog can be a great place for students to share what they have learned in the form of in-depth articles. Students can work on blog posts individually or in groups. It's a great strategy to improve students' research skills and encourage them to explore self-learning.

The teacher can also use the blog as a platform to share learning material for the lessons.

Live chatting

Live chatting is another great way to replicate the real-time discussions that take place in the classroom. Platforms such as Slack, WhatsApp, Facebook Messenger, Skype, etc. allow students and teachers to communicate and brainstorm around lessons. The chat itself will provide the students with information for revising before exams or assignments. Make sure to set clear guidelines to ensure that all students get an equal chance to communicate their ideas and pose their questions. Use the chat option to take down concerns and questions of students and clarify and you can answer them live. Allow students time to reflect on their answers and discuss them with other group members by breaking down the game into subsequent periods. Allow students to carry out discussions using chat platforms such as WhatsApp, Skype, Slack, Facebook, Zoom breakout rooms, etc.

Discussion boards and forums

These tools provide students the space to share what they have learned or what they want to know more about with others in the classroom including the teacher. You can maintain different discussion boards for individual lesson topics, so it'll be more organized. You can create one easily with an online visual workspace like Creately and share it with all students with one public edit link giving everyone quick access. You can also create separate Slack channels, Facebook groups, or Whatsapp groups for forum discussions.

Whether used in conjunction with lectures or as a separate learning exercise, class discussion supports learning and actively engages online students in the learning process. Learners have an opportunity to ask questions and communicate their ideas while practicing analytical and cognitive skills. The ability to participate in a 'safe' environment is also one of the hallmarks of online learning. Not all students have the confidence (or language skills) to freely express themselves in a traditional course setting. In synchronous courses, professors pose questions and discuss course material using real-time chats and web-conferencing tools. Students enrolled in asynchronous classes tend to communicate with peers and instructors using discussion boards, Web forums, and social media tools

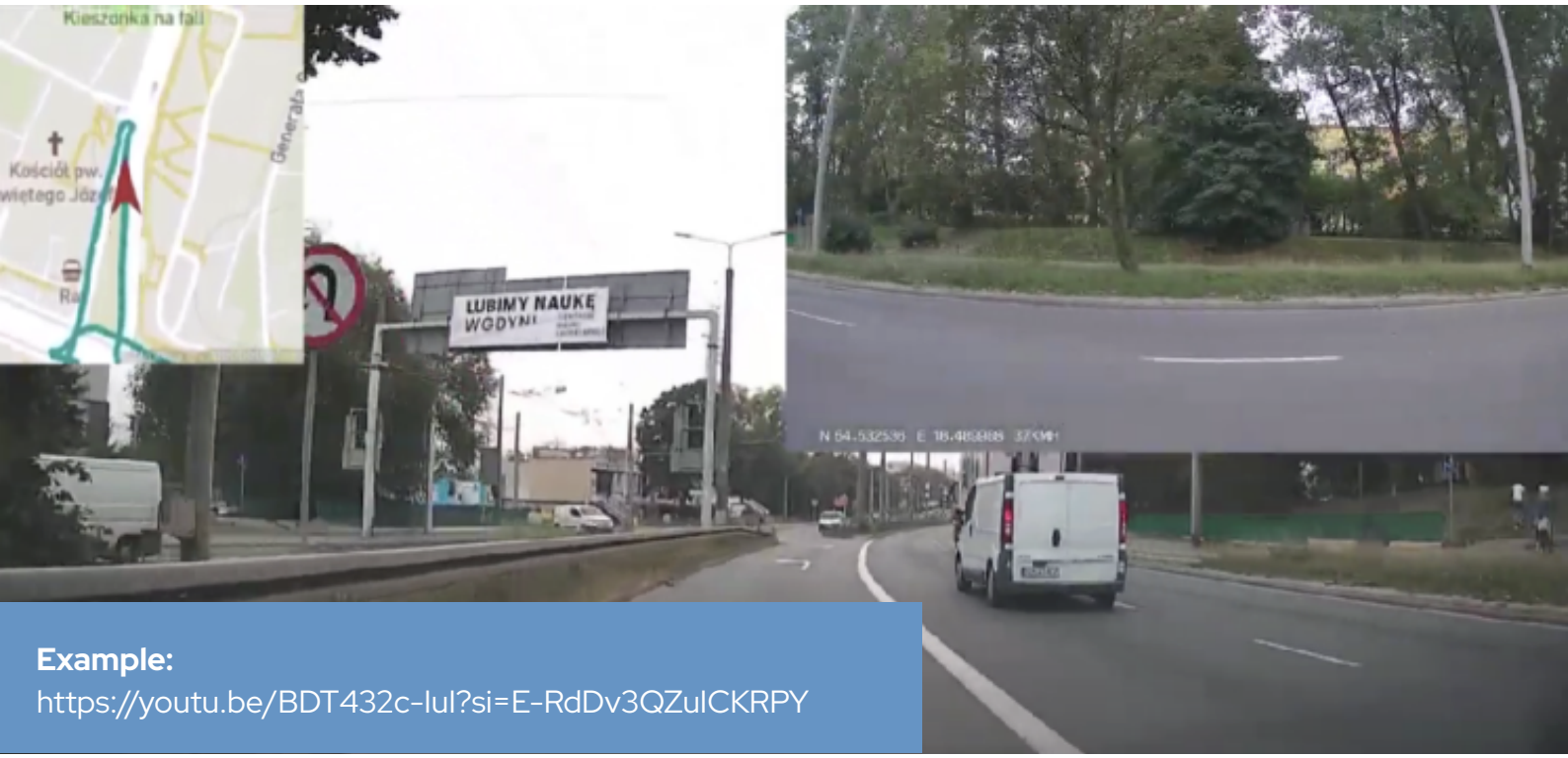
Methods of conducting online and hybrid fieldwork classes

Video tutorials

Video tutorials, whether recorded or live, are important to students because they add another dimension to learning that makes a student's educational experience more effective, helping with retention.. The videos allow a classroom setting to come to life, offering different perspectives and tools that students might not normally be able to take advantage of in their learning.

Video tutorials can be viewed on computers through websites, using online streams, as well as with other mobile devices, such as smartphones. They provide accessibility to those with disabilities who are not able to physically be present in a live classroom. The importance of video lessons includes the ability of adult students and parents of students to save on transportation costs and commuting time. It also allows students who were unable to attend class at their school or college due to illness or vacation to catch up on missed lessons from any location.

Video tutorials also allow students to access lessons from instructors who are well-known as specialists in their fields, but otherwise inaccessible to students due to distance, such as professors in foreign countries. These professors on video might add another dimension to the students' learning in those fields that their local schools cannot provide.



Example:
https://youtu.be/BDT432c-lul?si=E-RdDv3QZulCKRPY

Virtual field trips

Use technology to take students on virtual field trips. There are many online resources, including 360-degree videos, interactive maps, and virtual tours, that can provide a sense of being in the field even when students are remote.

- GoPro Fusion Studio
- Adobe Premiere Pro
- Final Cut Pro X
- CyberLink PowerDirector

Live streaming

If you have access to a field location, consider live streaming the experience to remote students. Platforms like Zoom, Microsoft Teams, or dedicated live streaming tools can be used to broadcast fieldwork activities in real-time.

Pre-recorded videos

Create pre-recorded videos of fieldwork activities, experiments, or demonstrations. This allows students to watch at their convenience and review material as needed.

Interactive simulations

Use online simulations or virtual labs to replicate fieldwork scenarios. These can provide hands-on experiences without the need for physical presence.

Collaborative online tools

Utilize collaborative online tools such as Google Workspace, Microsoft 365, or specialized research and data analysis platforms to facilitate teamwork, data collection, and analysis.

Online portfolio

Instructors can use portfolio options, in conjunction with data backpacks, to teach students how to build a narrative of their growth and achievement – a skill they can use in both their personal and professional development. The best portfolios are those which are compiled by students themselves.

Methods of conducting online design classes

Conducting online design workshops for road safety education presents a unique challenge and opportunity to engage learners effectively. Below are examples of methods to be used in online or hybrid classes.

Online software use tutorials

Creating an online software tutorial for classes involves breaking down the process into clear, step-by-step instructions to help students understand how to use a specific software application.

Project based learning

To successfully use PBL in an online or hybrid classroom, consider these four tips:

1. Be mindful of the devices students are using

Teachers may design projects fit for a laptop or computer with a larger screen. However, some students without those devices may not experience them in the same way, which could impede student engagement, explains Rich Dixon, PBLWorks' director of online learning, in a webinar. "The technology that's in the hands of students can vary greatly," Dixon says. "For many of our students, that may include mobile phones with a much smaller screen."

2. Use Video Conferencing Platforms for Meaningful Collaboration

Teamwork and collaboration are essential to PBL. In a traditional PBL classroom, students congregate in small groups and work together to solve specific problems, which involves asking each other questions, brainstorming strategies and finding resources.

Videoconferencing platforms with built-in collaboration features such as Microsoft Teams and Google Meet can help teachers replicate those experiences online. For instance, Microsoft Teams has a digital whiteboard that students can use to create concept maps or sketch out ideas from a laptop, computer or mobile device. Google also is bringing the Jamboard interactive whiteboard directly into Meet. Additionally, both Teams and Meet have screen sharing capabilities that make it easier for students to work on files together, in real time, in Office 365 or G Suite for Education.

3. Make Group Work Effective with Project Management Tools

Using project management tools such as Project Pals, Headrush and Student Corner can also help teachers drive student engagement, Dixon explains. They allow teachers to manage student groups and monitor what they're working on, as well as improve communication with them. Additionally, with a project management tool, students can have all of their project resources in one place. "It can be so easy for students to get lost if you're referring

to four or five different tabs," Dixon says. "It can be overwhelming, and students' ability to concentrate may wane, so being able to have it all anchored in one spot within a tool is really important."

4. Provide Ongoing Feedback and Promote Reflection

Learning management systems such as Google Classroom, Canvas and Schoology allow teachers to conduct formative and summative assessments during PBL. Using Google Slides and Adobe Spark to share work or showcase final projects also encourages students to give each other constructive feedback. Many educators also use Microsoft's Flipgrid, a video-based social learning platform, to engage students in weekly reflections. With a simple video recording, students can share their wins and challenges, ask classmates questions or discuss next steps as they progress through their projects.

Using PBL in remote learning lets teachers build a meaningful curriculum while giving students the opportunity to collaborate and connect with each other – even if they're not face to face.

Problem-Based Learning Projects

Problem-based learning (PBL) encourages students to practice many of the same skills as case studies while actively solving problems. Projects are usually collaborative in nature: teams of online students can use collaborative document programs like Google Drive to manage their work and share information. Small group chats and forums can also become a sounding board for theories and discussion.

According to the ION, this work places instructors in an advisory rather than an authoritative position. An online resource called WebQuest lets instructors find, create, and share the type of inquiry-based assignments used in PBL projects.

Techniques for cultivating long-term projects

Lab classes that engage students in semester-long projects will likely prove the most difficult of all to migrate into a remote teaching modality. In many such courses, your students will already have been working on their projects for several weeks before being separated from the facilities, equipment, and materials they need to bring those projects to completion. In some cases, students may be able to produce a subset of the project originally envisioned, by focusing on the data they have already collected and giving detailed descriptions of what their next experimental or investigative steps would have been, given appropriate physical resources. You might even be able to re-envision the culminating deliverable. For example, if you intended for students to report their results in a publishable journal article, but they cannot now complete that task due to lack of laboratory access, perhaps you could revise the assignment into a grant proposal sup-

porting the additional research that would be needed to complete the project.

Guided Design

Guided design is an inquiry-based instructional method that encourages online students to familiarize themselves with resources available in their local communities. In guided design, learners are tasked with solving open-ended problems. Unlike most PBL projects, this technique requires students to complete some work outside of class. Guided design emphasizes independent research making it ideal for teaching students in self-directed online degree programs.

Case Studies

Case studies are another instructional method that places students in an active learning role while promoting research, problem-solving, and high-level cognitive skills. When used in a collaborative way, these exercises present another opportunity for online students to connect and learn from one another. It can be helpful for instructors to suggest reputable online resources students can consult for information.

According to CSN, case studies work well in online courses and do not require much preparation. Instructors can search OER sites and databases to find case studies prepared by other online professors.

Methods of conducting online and hybrid laboratory classes

For lab experiences that primarily address learning outcomes related to developing students' skill implementing experimental protocols, digital simulations may allow you to meet or at least approach those objectives. Websites that provide virtual laboratories in which students may simulate experiments and demonstrations include: If the primary learning outcome the lab experiences address has to do with data analysis rather than data collection, consider providing the students with realistic data sets upon which to perform the required analysis. Video-recorded experiments from the aforementioned sources could also provide raw data in a less processed form.

Demonstrations

Teaching by showing is just as prevalent in online courses as traditional ones. Demonstrations are a mainstay when it comes to conveying certain concepts and processes. They are also among the instructional methods enhanced by the virtual learning environment. Online instructors frequently upload recorded video demonstrations to the LMS regardless of whether they delivered them synchronously or asynchronously. Students can review these clips as often as necessary to master the lesson.

Simulations

Simulations delivered in a realistic digital environment allow online students to test practical skills and knowledge remotely. Major colleges and universities sometimes use simulations to prepare online students for fieldwork traditionally carried out in a face-to-face setting. These virtual experiences are applicable in several fields and disciplines. Online biology students can use simulations for dissection while the University of Southern California uses managerial simulations that let students make decisions and experience their outcomes. According to Harvard Business Publishing, simulations reinforce key concepts and let students explore them in a real-world context. Preparing simulations was once a lengthy, tedious process, but leading LMS platforms can

streamline the process by allowing instructors to choose from a variety of scenarios that complement course content. Professors can also search open source educational resources (OERs) like Merlot for compatible simulations made freely available by their creators.

Games

Like simulations, games let online students gain practical experience in an accessible digital environment. They can also increase student participation as learners may find them more engaging and less stressful than simulations. Educational technology developers like Distance2Learn integrate game-building applications directly in the LMS to simplify the design process.

"It is important to design alternative and flexible ways for students to demonstrate their knowledge," Mr. Chapman told OnlineEducation.com. "We launched our Game Based Activity Builder for instructors to easily create visual games ... from the content [they] already have in their course." Online instructors can use leaderboards and other motivating tools to introduce friendly competition and, in turn, motivate students to master whatever skills and concepts the game is meant to convey.

Evaluation methods in online and hybrid teaching

Importance of evaluation methods in online and hybrid teaching

For various reasons, evaluation methods are crucial in online and hybrid teaching. Firstly, they help ensure the effectiveness of the learning process. By assessing students' understanding and progress through quizzes, assignments, and assessments, instructors can identify areas where students may be struggling and adapt their teaching methods accordingly. This allows for timely intervention and personalized support, ultimately leading to better learning outcomes.

Secondly, evaluation methods in online teaching provide accountability and a means of measuring the quality of instruction. They enable instructors and institutions to gauge the success of their courses and make data-driven decisions for improvement. Additionally, evaluation methods can help maintain academic integrity by detecting and preventing cheating or plagiarism, ensuring that the grades and credentials awarded are legitimate and reflect the students' true abilities. So, evaluation methods play a pivotal role in enhancing the overall quality, efficiency, and integrity of online education.

Major evaluation requirements in online and remote learning

In the context of remote teaching and learning, this section explores the critical aspects of evaluation requirements. The major evaluation requirements include having clear guidelines, authenticity of the assessments, assessment variety and adapted assessments, equity and accessibility, technology compatibility, feedback mechanisms, rubrics and criteria, time flexibility because of the time zones, secure assessments, assessment integrity, proctoring solutions, student support, consistent communication, data privacy when storing the assessment, catering for both individual and group assessments, formative and summative assessment, peer review, and alignment with learning objectives. These requirements are essential for effective remote learning assessment. By addressing them, educators can create meaningful assessment strategies that align with learning objectives and support student progress.

Major evaluation challenges in online and hybrid remote learning

Online and hybrid remote teaching presents significant evaluation challenges. First, ensuring the authenticity of student work in online assessments can be complex, with the risk of plagiarism and cheating. Technology disparities, such as unequal access to the internet and devices, create a digital divide that affects participation and fairness.

Proctoring in remote settings is another concern, with privacy issues and potential security vulnerabilities. Monitoring student engagement poses challenges, impacting their understanding and overall performance. Providing timely and effective feedback in online environments can be difficult, lacking the nuances of face-to-face interactions.

The overreliance on traditional tests for assessment may not effectively evaluate diverse student skills and competencies. Both students and instructors struggle with time management in remote settings, affecting deadlines and assignment completion. Ensuring equity and inclusivity, especially for students with disabilities or diverse backgrounds, is vital but complex.

Safeguarding sensitive student data is crucial, with concerns about privacy and compliance. Faculty members often require training to navigate online teaching effectively, as a lack of adequate training can impact the quality of instruction and evaluation. Continuous improvement is an ongoing challenge, as assessing and adjusting online teaching methods can be more complicated than in traditional settings.

Lastly, the impact on student well-being should not be underestimated, as the online learning experience can affect mental health, particularly in relation to assessment load. Addressing these issues requires a comprehensive approach, combining technological solutions, pedagogical adaptations, and institutional support to ensure fair and effective evaluation in remote teaching.

Types of evaluations in online and hybrid teaching (which are relevant for RIM)

Online and hybrid teaching in road infrastructure management employs various evaluation methods to assess students effectively. These include formative evaluation techniques like online discussions and real-time quizzes, which offer continuous feedback. Summative evaluation methods encompass traditional online exams and practical final projects, ensuring a comprehensive assessment of students' knowledge and skills.

- **Peer assessment** promotes collaborative learning through group projects and peer reviews, while self-assessment encourages students to reflect on their progress using online journals. Authentic assessment techniques make use of online simulations, case studies, and real-world scenarios to test practical application.

- **Feedback and surveys** play a role in collecting valuable insights from students, with course evaluations and continuous feedback mechanisms helping instructors refine their teaching methods. Additionally, assessing soft skills such as communication and time management is crucial, as these skills are essential in road infrastructure management.

- **Mastery-based assessment** ensures that students have mastered essential competencies before advancing in their studies. These diverse evaluation methods collectively provide a well-rounded assessment of students' readiness for the challenges and responsibilities in road infrastructure management, all while adapting to the demands of online and hybrid teaching environments.

- **Specific assessment** perspectives related to different course components/types for RIM (theoretical part, lab or simulation experiments, tool-based design assignment, field-works).

This section discusses specific assessment perspectives related to different course components of Road infrastructure Management.

Theoretical part

Teaching road infrastructure management theory benefits from diverse assessment perspectives. These include knowledge-based assessments like exams and written assignments to test understanding. Case studies provide practical applications, research projects deepen exploration, and group discussions foster collaboration. Simulations offer hands-on experiences, presentations develop communication skills, and peer assessments encourage mutual learning. A combination of assessments, industry engagement, and self-reflection ensures a comprehensive approach to theory instruction, preparing students with both knowledge and practical skills for their future careers in the field.

Lab or simulation experiments

Teaching lab or simulation experiments in Road Infrastructure Management involves assessing specific perspectives. This includes evaluating students' performance in operating tools and conducting experiments, analyzing data, testing problem-solving skills, assessing communication abilities through reports or presentations, and promoting critical thinking. Collaborative teamwork is also important in group experiments, and students should reflect on their experiences to apply their insights to real-world scenarios. These assessments ensure that students gain practical experience and develop essential skills for road infrastructure management.

Tool-based design assignments

When assessing tool-based design assignments in Road Infrastructure Management, specific assessment perspectives include evaluating students' proficiency in using design tools effectively, their ability to apply design principles and standards, and their capacity to create practical and efficient road infrastructure solutions. Additionally, assessing their attention to safety and environmental considerations, as well as their communication skills in presenting their designs, is crucial. These assessments ensure students can apply theoretical knowledge to real-world design tasks effectively.

Field-works

When assessing fieldwork in Road Infrastructure Management, specific assessment perspectives include evaluating students' ability to apply theoretical knowledge to practical situations, their attention to safety and environmental considerations, their data collection and analysis skills, and their ability to communicate findings and recommendations effectively. Fieldwork assessments ensure that students can translate classroom learning into real-world applications while adhering to industry standards and best practices.

Tools and Technologies for Evaluation in online and hybrid teaching

Evaluation in online and hybrid teaching relies on a range of tools and technologies to facilitate efficient and effective assessment processes. Central to this is the use of Learning Management Systems (LMS), which serve as comprehensive platforms for content delivery, assignment submission, communication, and tracking student progress.

Online assessment tools play a crucial role in evaluation. They enable the creation of quizzes, polls, and interactive assignments, both for formative assessment to gauge student understanding during the learning process and summative assessment to measure overall achievement.

To ensure the authenticity of student work, plagiarism detection software is employed to identify any instances of academic dishonesty, helping maintain the integrity of the evaluation process.

Peer review platforms facilitate peer assessment and feedback on assignments, encour-

aging collaborative learning and providing students with valuable insights from their peers. Data analytics tools are utilized to analyze student performance and engagement data, aiding instructors in making data-driven decisions to enhance their teaching methods and adapt to students' needs.

For subjects requiring practical assessment, simulations and virtual labs offer authentic assessment experiences. They allow students to apply theoretical knowledge to real-world scenarios, providing a more accurate evaluation of their practical skills.

Together, these tools and technologies streamline and enhance the evaluation process in online and hybrid teaching, ensuring a comprehensive and efficient assessment of student performance.

Best Practices for Implementing Evaluation Methods in online and hybrid teaching for RIM

Online and hybrid teaching has reshaped education, calling for innovative evaluation methods in specialized fields like Road Infrastructure Management. This overview explores best practices in student evaluation, considering didactic approaches and assessment diversity.

Creating a collaborative learning environment is crucial. Facilitate interactions through asynchronous/synchronous discussions and group projects, mirroring teamwork in Road Infrastructure Management.

Leverage technology for content delivery and interactive learning tools. Use multimedia elements, simulations, and virtual site visits to make complex concepts accessible and practical.

Diversify assessment methods beyond exams. Include formative assessments, rubrics, and clear criteria. Use case studies and real-world scenarios to apply theory to practice.

Provide continuous feedback through check-ins, virtual office hours, and peer evaluations, fostering support and accountability.

Integrate hands-on assignments and fieldwork where possible, assessing practical skills through video submissions or digital portfolios.

Align assessments with course objectives and update them to reflect evolving industry demands.

In conclusion, effective student evaluation in online and hybrid teaching for Road Infrastructure Management blends pedagogical principles, technology, and authentic assessment. Collaboration, diverse assessments, constructive feedback, and practical skills preparation are key.

Chapter IV

RIM teaching program

The complete programme of RIM education and sample teaching resources can be found in the e-learning courses developed under the Infro@d project:

Erasmus+ European Digital Education in Road Infrastructure Management INFRO@D. Road Safety Audit (RSA)
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=19518

Erasmus+ European Digital Education in Road Infrastructure Management INFRO@D. Road Pavement Management
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=31194

Erasmus+ European Digital Education in Road Infrastructure Management INFRO@D. Roadside Safety Management
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=31192

Erasmus+ European Digital Education in Road Infrastructure Management INFRO@D. Safety Management of Vulnerable Road Users
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=31193

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[5] https://h5p.org/tutorial-interactive-video

[6] https://padlet.com/

[7] https://engagevr.io/

[8] https://www.classvr.com/

[9] https://www.proprofs.com/

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