



STAFFER
EUROPEAN RAIL SKILLS ALLIANCE



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**Benchmarking of the existing
programmes and catalogue of the
best practices**

DELIVERABLE D.4.3



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1 INTRODUCTION

Railway transport will be essential for achieving Europe's strategic objective of smart, green, and sustainable growth. Railways are extremely energy efficient and as such should form the backbone of Europe's future transport system. Rail transport already plays a key role in Europe's economy and society but could contribute much more.

A critical problem holding back railway transport is a severe shortage of skilled workers due to both the large number of workers expected to retire in next 10 years and the changing skills needed by railway sector workers (e.g., due to increasing digitalisation). The STAFFER project is a first step in defining these problems and developing effective solutions. Solving these deep problems will require transformation of railway sector employment practices to, among other objectives, make railway jobs more attractive, emphasise re-skilling and lifelong learning programs, and address fragmentation among railway stakeholders (operators, infrastructure managers, suppliers, etc.).

STAFFER Work Package 4 consists of developing new railway sector mobility and training programmes based on the findings of STAFFER Work Packages 1, 2 and 3. This deliverable (D4.3) presents a summary of existing and emerging railway sector training and education programmes in Europe. This summary will be used as input for the development of new mobility and training programs in Tasks 4.4 and 4.5.

Chapter 2 of this report summarises the existing railway sector training and education paths, curricula and courses identified in Task 4.1. Task 4.1 assessed the distribution of the training courses suitable for the rail sector and the possible unbalances in terms of geographical localization in European countries, EQF levels and qualification standards (QS).

Chapter 3 of this report summarises new and emerging innovative teaching and training approaches that could be used to develop new railway sector education and training programs.

Chapter 4 presents the conclusions related to the previous chapter, outlining some key considerations for the development of training programmes and how the new methods and tools outlined in Chapter 3 could be used in training programmes in Chapter 3 above could be used in these programs

In the last chapter, the 5th one, the references of the information consulted during the development of this deliverable are shown.





2 EXISTING RAILWAY TRAINING PROGRAMMES

This chapter summarises existing railway sector training and education programs in 13 European countries. These programs are analysed in the chapter's final section. The 13 countries were: Italy, Belgium, Greece, Germany, France, Spain, Czech Republic, Austria, Serbia, Netherlands, Luxembourg, Poland and Slovakia. The data was collected by a survey in Task 4.1. . The output of this task was a database with the list of VET and Higher-Education entities providing mobility and training related to the rail sector, differentiating for EQF levels of certification and diploma.

2.1 ITALY

Options available	
Vocational Training	<p><u>Strategic level</u></p> <p>Different options were found, including infrastructure managing director, vehicle managing director, operations managing director, signalling managing director, commercial managing director, administration managing director and dean/director.</p> <p><u>Tactical level</u></p> <p>Several training options were found, infrastructure planner, vehicle design engineer, timetable planner, signalling planner, commercial director, administration director and group director.</p> <p><u>Operational level</u></p> <p>The following trainings have been found, track inspector, railway vehicle maintenance, train crew, signalling inspector, sales assistant, administration assistant and research/teaching assistant.</p> <p>In addition, Ferrovie dello Stato Italiane offers training courses in Station Manager, Train Driver, Train Manager, Technical Manager, Specialised Maintenance Operator (for railway infrastructure), Specialised Traffic Operator or Specialised Maintenance Operator (for rolling stock), Also FS provides in-house training for its personnel and has its own instructors coming from the O&M area.</p>





Forfer Formazione Ferroviaria offers professional training courses for, Manoeuvring Machinist, Train Preparer, Machinist (Plant Operator), Multifunctional Machinist and Driver.

ITS, Istituto Tecnico Superiore has training available in the fields of Railway Transport and Railway Maintenance.

And finally, the Centro di Formazione Ferroviaria, which is recognised by the Agenzia Nazionale per la Sicurezza delle Ferrovie, offers 9 courses. But there are also several other academies offering a wide range of training possibilities.

Academic

Bachelor's Degree

Although no degree courses directly related to the sector were found at bachelor's level, there are a number of universities that offer rail-related subjects in some of their degree programmes.

At the Università di Genova in the Electrical Engineering Degree the Transportation Systems and Sustainable Mobility subject is available.

At the Politecnico di Milano, also in the Degree of Electrical Engineering, subjects related to mobility, transport and the railway sector are offered.

At the Politecnico di Torino, in the Degrees of Electrical Engineering, Mechanical Engineering and Automotive Engineering, students have the possibility to choose the subject of Electric Propulsion Systems for Transport.

At the Università degli Studi di Napoli Parthenope in the Degree of Civil and Environmental Engineering for Risk Mitigation subject of Construction of Roads, Railways and Airports it's available.

At Sapienza Università di Roma in the Degree of Civil Engineering the subject of Railway Infrastructures is taught.

The University of Florence offers degrees in Management Engineering, Civil Engineering and Mechanical Engineering. As for Second Cycle Degrees within Mechanical Engineering there is the option of Railway Vehicles.





Master's Degree

With regard to training at Master's Degree level, some have been found:

The 2nd level Master's Degree in Infrastructure and Railway Systems Engineering, the Master's Degree in Geopolitics and Global Security and the Master Degree in Transport System Engineering at the Sapienza Univerit  of Rome.

At the Universit  degli Studi di Roma tor Vergata we can find the Master II level in Management and Technology of Transport and Logistics.

At the Universit  di Genova they offer the Masters' Degree in Safety Engineering for Transport, Logistic and Production.

The University of Catania offers a Master's Degree course in Civil Engineering of Water and Transport.

And finally the ones that are not directly related to the sector, such as the Master's Degree in Civil Engineering offered by the Politecnico di Torino which is also available at the Universit  di Bologna.

TABLE 1 - TRAINING AVAILABLE IN ITALY

In summary Italy offers a good selection of railway academic and vocational training programs. However, Italy does not have any Bachelor's Degree directly related to the railway sector. Further, as any emerging opportunities there are gaps in college education related to how apply key emerging technologies in the rail sector.

2.2 BELGIUM

Options available	
Vocational Training	The list of approved training organisations and centres in Belgium includes, the followings: Trainsport NV, Eurostar International Ltd., Crossrail Benelux NV, SNCB, Asespramiento R&C BVBA etc. which offer courses of; train driver and train crew training, train driver training at levels A3, A4, B2, and the passenger train attendant course.





	<p>With regards to professional training, the jobs with training available are: track inspector, timetable planner, train crew, signalling planner and signalling inspector. Some job positions (vehicle design engineer, maintenance of rail vehicles; job categories of economics and administration) have VET/CVET available.</p>
Academic	<p><u>Bachelor's Degree</u></p> <p>No options found</p> <p><u>Master's Degree</u></p> <p>At SELOR the Official Master of Information is available and the University of Liège offers the Specialised Master in Transport and Logistic, but is only available in French.</p> <p>In addition to these Master's Degrees, at the Catholic University of Louvain in the Master's Degrees of Electromechanical Engineering and Mechanical Engineering, the subject of Vehicle System Dynamics is taught.</p>

TABLE 2 - TRAINING AVAILABLE IN BELGIUM

In summary Belgium even though it is a country with a fairly active railway sector, there are not many possibilities for students or professionals to specialise in railway issues.

2.3 GREECE

Options available	
Vocational Training	<p><u>Strategic level</u></p> <p>Professional trainings are available for Infrastructure Managing Director, Vehicles Managing Director, Operations Managing Director, Signalling Managing Director, Commercial Managing director and Managing Director.</p> <p><u>Tactical level</u></p> <p>Courses for the infrastructure planner, vehicle design engineer and timetable planner has been found.</p> <p><u>Operational level</u></p>





	The only degree courses available are training track inspectors and research/teaching assistants.
Academic	<p><u>Bachelor's Degree</u></p> <p>At Bachelor's level the only option found has been the subject of Railway Infrastructure in the Civil Engineering Degree at the Aristotle University of Thessaloniki.</p> <p><u>Master's Degree</u></p> <p>No options found</p>

TABLE 3 - TRAINING AVAILABLE IN GREECE

In summary Greece has a deficiency at tactical and operational level, so more training is needed, as there are not enough courses for specializing in the rail sector. Furthermore, there are no options available for training at university level as the only option is a subject, so there is a major deficiency in this sense.

2.4 GERMANY

Options available	
Vocational Training	<p>Deutsche Bahn operates the DB Rail Academy, which offers various practice-oriented training courses in the railway sector, such as Components of Rail Infrastructure & Maintenance (also available online), Fundamentals of Railway Brake Technology, Online Training Fundamentals of Rail Electrical & Power Engineering. In addition, since 2019, it has a training centre in Cologne.</p> <p>Training to be track inspectors, timetable planners, train crew members, signalling inspectors, sales assistants and administration managers have the possibility of taking VET & CVET training.</p> <p>BSZ Schkeuditz offers training for Railway worker in operational service with track specialisation.</p> <p>Gotha State Technical College for Construction, Economics and Transport offers training for Traffic Technicians.</p>



IZBTM offers training in the fields of Modern railway drivetrains with hydrogen and fuel cells and Railway brake systems and brake calculation.

The company Rhomberg Sersa Vossloh has available an extensive training program for the qualification of employees in the railway industry in order to be able to meet the growing requirements in the future with well-founded specialist knowledge and experience. In addition to face-to-face and in-house seminars, location-independent online training courses complete the offer.

The VDV Akademie It offers training in Operating Standards and also offers the Railway Operations Management Congress and the 11th BME/VDV International Railway Congress.

Academic

Courses

Technische Universität Dresden offers courses such as, Railway Operation and Signalling and Safety Technology.

At the Technische Universität Berlin the course of Transport Systems is available.

München University of Applied Sciences offers a university certificate in "Railway Technology -Drive, Brake, Driving Dynamics" which is aimed at professionals who want to further their education in railway technology.

Finally, the University of Applied Sciences Zwickau offers the German Diploma Degree in Traffic and Transport Engineering.

Bachelor's Degree

At the Rheinisch-Westfälische Technische Hochschule Aachen the Bachelor Degree in Railway Systems Engineering (RSE) is available.

Bbw Hochschule - University of Applied Sciences in Berlin, together with Deutsche Bahn and other regional companies, offers dual training for Electrical Engineers specialising in "control and safety technology" and "traction power supply and overhead lines". In connection with the dual training, STRABAG Rail GmbH also offers this type of training for civil engineers. In addition, The Technical



University of Applied Sciences Wildau offers the possibility of obtaining the Bachelor Degree in Transport System Engineering also with an option of dual training.

The University of Stuttgart offers the option of obtaining the degrees of Civil Engineer and Science Transport. The Civil Engineering Degree is also available at the Technical University of Darmstadt with an addition in geodesy, at the University of Kassel and at the Nuremberg Institute of Technology Georg Simon Ohm which also offers the option of taking a degree in Civil Engineering with the dual option. There are more universities that offer this degree along with other options and they will be mentioned throughout the section.

The FH Aachen University of Applied Sciences offers a Degree in Rail Vehicle Engineering, which also offers the dual option of this degree by means of a course that allows the student to combine training and studies in Rail Vehicle Technologies. At the same university, the Civil Engineering Degree offers the possibility of specialising in transport.

The FH Bielefeld University of Applied Sciences offers a Bachelor's Degree in Infrastructure Engineering.

Furthermore, the FH Münster offers its Civil Engineering Degree students the possibility to specialise in transport where they prepare the students for the field of road traffic, rail transport and airport planning.

At the University of Applied Sciences Potsdam there is the option of studying for a degree in Infrastructure Systems Engineering.

Ostfalia, the Hochschule für angewandte Wissenschaften offers the Bachelor's Degree in Mobility and Passenger Transport Management (MPM), the Bachelor's Degree in Industrial Engineering, Mobility and Transport (WMV).

A degree in Transport Systems, is available at the Technical University of Berlin.

At RWTH Aachen University there are several options to train for the railway sector level, among which are the Bachelor in Transport Engineering and Mobility and the Bachelor in Civil Engineering, in





which students acquire knowledge about transport and land use planning. The Transport Engineering Degree is also available at the University of Wuppertal.

Moreover, at the Fachhochschule Erfurt in the Bachelor's Degree in Industrial Engineering, in the subject of Railway Engineering, holistic knowledge and ready-to-use skills are imparted in the fields of technology, operational organisation and control of the various subsystems of railway operations and infrastructure as well as their interaction.

The University of Applied Sciences Mittelhesen offers a complete degree in Railway Engineering.

The Ruhr Master School offers the Mobility and Logistic Degree.

At the Technical University of Braunschweig, the Transport/Traffic Engineering Degree is available.

Finally, the Hamburg University of Technology offers the Bachelor's in Logistics and Mobility and Civil and Environmental Engineering.

Master's Degree

Technische Universität Dresden offers the Master's Degrees in Railway System Engineering, Transport Engineering, Transport Economics, Mechatronics and Railway System Engineering.

The Technische Universität Darmstadt offers an extra-occupational master's degree in "Rail Transport, Mobility and Logistics". Related to this the Ruhr Master School offers the Master's Degree in Mobility and Logistics.

At Zeppelin University the Executive Master in Mobility Innovations is available.

The University of Applied Sciences Erfurt offers the Master in European Railway Systems and the Master in Transport and Logistics.

The University of Kassel offers two masters: Public Transport and Mobility and Civil Engineering.





At the University of Stuttgart, there is the possibility to obtain the Master of Science in Infrastructure Planning, Transport Engineering and Civil Engineering. In the same city, the Hochschule für Technik Stuttgart offers the Master in Transportation Infrastructure Management. Also, at Ostfalia, the Hochschule für angewandte Wissenschaften the Master's Degree in Transport and Logistics (MVL) is available.

The Nuremberg Institute of Technology Georg Simon Ohm offers the Master in Urban Mobility/Transport Engineering.

At the Karlsruhe Institute of Technology, the Master's programme in Mobility and Infrastructure is offered.

At RWTH Aachen University there are several options to train for the railway sector at master level, among which are the Master in Transport Engineering and Mobility, the Master in Automotive Engineering and Transport, and the Master in Transport.

At the Technische Universität München you can obtain a Master's degree in Rail, Transport and Logistics, the Master of Science in Transportation Systems or you can take the Urban Environments and Transport module within the Master in Environmental Engineering.

The Technical University of Berlin offers three master's degrees, Transport Planning and Operation, Sustainable Mobility Management and Vehicle Technology.

The Technical University of Applied Sciences Wildau offers the Master of Technical Management.

Finally, the Technical University of Darmstadt has several master's degrees available: Traffic and Transport, Rail Transport, Mobility and Logistics and Civil Engineering. And the Hamburg University of Technology, which offers the possibility of studying for a master's degree in Logistics, Infrastructure and Mobility.



Others

The Technische Universität Braunschweig has the Institute of Railway Systems Engineering and Traffic Safety. The institute's primary fields of research area are railway operation and railway safety technology.

At the Technische Universität München a Research Group focused on Railway Technology is available, and at the München University of Applied Sciences there is the Innovation Centre for Rail Technology and Mobility which is focused on promoting sustainable mobility and looking at the core competences in digitalisation and the search for innovative technical solutions.

The Technical University of Braunschweig has the Institute for Railway Systems Engineering and Traffic Safety. It sets its research priorities mainly in the fields of railway operation and railway safety technology. And the Institute for Rail Transport, Construction and Operation. This represents the disciplines of track technology, public transport development and transport management science in the context of intermodal mobility concepts in research and teaching.

In addition, the Institute of Transport Sciences (VIA), the Institute for Rail Vehicles and Transport Systems (IFS) and the Institute for Power Electronics and Electric Drives (ISEA) of the RWTH Aachen University founded the Rail Research Centre (RCR) in 2017. The RCR covers the three main fields of rail transport engineering: rail vehicle engineering, rail infrastructure and operation as well as electric drives.

TABLE 4 - TRAINING AVAILABLE IN GERMANY

In summary Germany is a country with a wide range of training opportunities related to the railway industry, especially in the university sector, where the combination of dual education is particularly noteworthy.



2.5 FRANCE

Options available

Vocational Training

SNCF offers several in-house training programmes through a dozen of training centres overall France and provided e.g., 3 660 972 hours of training in 2020.

For the “core railway” professions, the company offers programmes and delivers certifications recognized by the French government. These programmes prepare diplomas for occupations such as Rail traffic operator, Railway Operator, Catenary Operator and Railway electrical signalling production operator (all EQF level 4) and for Operational manager of rail traffic site (EQF level 5).

Furthermore, SNCF has its own Railway Apprenticeship Training Centre which works with 9 high schools in France and 4 SNCF training centres. The Railway Apprenticeship Training Centre prepares apprentices through the following programmes:

- Professional certification-Mediation Information Services (EQF level 3)
- Professional baccalaureate-Maintenance of Connected Production Systems
- Professional certification: Maintenance technician
- Professional Baccalaureate – Contact person in station
- Certification for reception in transports
- Professional certificate Technical-Transport safety technician (all EQF level 4)
- Advanced Technician Certificate for System maintenance-Option Production System (EQF level 5).

About 330 apprentices are trained per year.

UDI (Université de l’Ingénierie), subsidiary of SNCF Réseau, also offers many training options and prepares, for example, for occupations such as:

- Signalling engineering (EQF level 5)
- Railway project management



- BIM
- Rail operation processes
- Power supply design
- Telecommunications
- Civil engineering – Bridges & tunnels, Track design, Safety & security
- Railway systems (all EQF level 6).

Centre International de Formation Ferroviaire de la Côte D'Opaleciffco (CIFFCO) offers different types of training through courses including, train driver, HIJKL essential safety tasks, technical visitor, level 1 maintenance technician, working train movement orientation, essential safety tasks A,B,I, L,M and F, railway risks and use of beacon speed control.

GTIF (Gestion des Techniques d'Ingénierie et de Formation) offers training both in its centres available in Rueil-Malmaison, Montceau-les-Mines and Combrode and directly in companies. They also have rooms equipped with simulators to assist students during practical training on trains.

In addition to the mentioned courses RailTech launched a series of webinars to help rail professionals to further develop their knowledge and skills during the COVID-19 crisis.

Furthermore, the academy offers training at the strategic level, for General Manager of Vehicle Divisions, Infrastructure Director, Operations Director, Signalling Director or Administration Director.

At the tactical level they offer training on Train Vehicle Design Engineers who are involved in the design, manufacture and operation of rail vehicles and their respective subsystems, as well as training for Infrastructure Planners, Timetable Planners, Signalling Planners and Administration Managers.

At the operational level, they offer training for the position of Maintenance Engineer, for supervisor, manager or worker. They also offer training for the position of Track Inspector, Signalling Inspector,



	Administration Assistant and Train Crew, who are in charge of providing safe, on-time and on-plan movement of trains.
Academic	<p><u>Bachelor's Degree</u></p> <p>ESTACA University has an engineering programme focused on the railway sector in which the Railway and Guided-Transport Engineer Degree is available.</p> <p>At the University of Burgundy the Bachelor's Degree in Logistics and Transport Management is offered.</p> <p>The University of Orléans offers complementary training in Logistics and Transport Management.</p> <p>Also, at university level ENTPE offers a three-year study to qualify as an urban planning engineer.</p> <p><u>Master's Degree</u></p> <p>The French Association of Tunnels and Underground Spaces (AFTES) together with ENTPE and INSA Lyon offers the Specialised Master in Underground Structures and Tunnels. ENTPE also offers the Professional Master in Urban and Regional People Transport. And INSA offers the Master in Civil Engineering and Urban Planning.</p> <p>The University of Technology of Compiègne offers a 15-month training course in Rail and Urban Transport Systems for engineers, project managers or executives.</p> <p>CESI École D'Ingénieurs offers the Specialised Master in Construction Project Management -Urban Transport.</p>

TABLE 5 - TRAINING AVAILABLE IN FRANCE

In summary France, has a wide range of training courses on offer, however, even if it has several options available, training at university level in the railway sector is more limited as not many options are available compared to other European countries.



2.6 SPAIN

Options available

Vocational Training

Both operators and training centres offer courses to train in the railway sector.

On the website of the State Railway Safety Agency (AESF), you can find the training centres approved by the AESF for railway staff. ADIF, Acciona Rail, ALSA, CAPTRAIN, Centro de Formación Ferroviaria Low Cost Rail, Centro Europeo de Formación Ferroviaria, Cetren, Colegio de Huérfanos de Ferroviarios, Continental Rail, Create Human Resources, Foravant Formación y Desarrollo S.L., NEDWAY, Plasser Ibérica, Raxel Rail, S.A., Escuela Técnica Profesional de Conducción y Operaciones de Renfe-Operadora and the Escuela Ferroviaria de TRANSFESA, offer training courses for:

- Traffic Managers
- Traffic Assistants
- Works Supervisors
- Traffic Safety Pilots
- Infrastructure Machinery Operators
- Train Operations Assistants
- Loading Operations Managers
- Shunting Vehicle Operators
- Driving Staff
- Staff Responsible for Railway Rolling Stock Maintenance Control
- Cabin Assistants

At the vocational training level, the qualification of Technician in Railway Rolling Stock Maintenance is available at the Secondary Education Institute in Malaga, at the Private Centre of Vocational Training in Madrid, at the Integrated Public Centre of Vocational Training in Madrid and at the Private Centre of Specific Vocational Training in Valencia.



Academic

Bachelor's Degree

No specific Bachelor's Degrees have been found but many universities offer rail-oriented subjects within their degrees.

At the School of Civil Engineering of the University of Cantabria, in the Civil Engineering degree, several subjects related to the railway sector are taught: Transport Systems, Railways and Road Infrastructures (Transport), Railways and Road Infrastructures (Construction) and Expansion of Transport Infrastructures.

At the University of Granada, in the Degree in Civil Engineering, students have the option of taking two subjects in the last year of their degree course belonging to the Specific Technology of Transport and Urban Services module, which are Railways and Railways and Guided Transport; the subject of Railway is also available at Polytechnic University of Cartagena the in the Civil Engineering Degree.

At the University of Seville, also in the Civil Engineering Degree, two subjects are taught about the railway sector: again, Railways, which is also available in the Master's Degree in Road, Canal and Port Engineering, and the subject of Railway Infrastructure.

Master's Degree

At Master's Degree level many options have been found. The Comillas Pontifical University offers several master's degrees related to the sector the Master's Degree in Railway Systems, the Double Master's Degree in Industrial Engineering and Engineering for Mobility and Safety and the Double Master's Degree in Industrial Engineering and Railway Systems.

At the National University of Distance Learning (UNED) the Master in Railway Engineering and Maintenance is available.

The Carlos III University of Madrid (UC3M) offers, together with BOMBARDIER, its own Master's Degree in Railway Systems Engineering.



The Universitat Politècnica de Catalunya offers the following university master's degrees, the Master's Degree in Supply Chain, Transport and Mobility, the Master's Degree in Road, Canal and Port Engineering and the Master in Railway Systems and Electric Traction. As part of the Master's Degree in Railway Systems and Electric Traction, they offer two postgraduate courses with a duration of four months each, the postgraduate course in Railway Installations and the postgraduate course in Vehicles and Operation of Railway Services. In addition, within the postgraduate courses, they offer two two-month continuous training courses, one in Railway Vehicles and Operation of Railway Services and the other in Operation and Exploitation of Railway Services, and in the postgraduate course in Railway Installations, they offer courses in Signalling, Communication and Management of Railway Traffic and in Electrification and Railway Energy.

The Official Master's Degree in Intelligent Systems in Energy and Transport (MSIET) is an initiative framed within the Campus of International Excellence Andalucía Tech and is offered at both the Higher Polytechnic School of the University of Seville and the Higher Polytechnic School of the University of Malaga.

The School of Engineering and Architecture of Madrid offers the Master in Railway Infrastructures. In the same city, the Polytechnic University of Madrid also offers the Master's Degree in Railways and Railway Transport and the Master's Degree in Infrastructure Planning and Management.

The Universitat Politècnica de Valencia, for its part, offers two Master's degrees related to the sector, the Master's Degree in Intelligent Transport Systems and the Master's Degree in Railways and Rail Transport.

At the University of Cantabria two options have been found, the first of these is the Master's Degree in Civil Engineering, in which the following subjects are taught: Railway Systems, Transport Planning and Management, Territorial and Urban Planning, R+D+I for Civil Engineers and Territorial and Urban Planning. And secondly, the



	<p>Master in Railway Engineering offered by the University of Cantabria in collaboration with MAFEX.</p> <p>To end with, some universities offer subjects related to the sector at the University of Malaga, several subjects are taught in the Master's Degree in Industrial Engineering. On the one hand compulsory subjects:</p> <ul style="list-style-type: none"> • Modelling of Mechanical Systems for Transport • Smart Grid • Intelligent Transport Systems and Advanced Vehicle Technologies • Railway Systems and Electric Traction <p>On the other hand, the optional subjects such as:</p> <ul style="list-style-type: none"> • Materials Analysis in Transport and Energy. <p>At the Polytechnic University of Madrid, in the first year of the Master's Degree in Road, Canal and Port Engineering, they have the subjects of Transport Systems and Railway Systems.</p> <p>Finally, at the University of the Basque Country, in the Master's Degree in Mechanical Engineering, they offer the aforementioned subject of Railways.</p>
Others	<p>The University of Oviedo in collaboration with the University of Nottingham, the University of Coimbra and the University of Rome offers a different kind of training through the Erasmus Mundus Master in Sustainable Transport and Electric Power Systems in which students take at least 3 subjects in at a minimum of 3 different countries.</p>

TABLE 6 - TRAINING AVAILABLE IN SPAIN

Spain is a country with many training opportunities. Both operators and training centres offer courses to train in the railway sector. But in terms of university training there is a deficiency in Bachelor's Degrees, although there are many subjects available there are no specific degrees for the sector, most of the specialisation is at master's level.

2.7 CZECH REPUBLIC

Options available	
Vocational Training	Siemens Mobility, sro is part of the global Siemens brand and offers a mobility scholarship program in the country for third and fourth year Mechanical or Electrical Engineering students who want to train in the railway sector.
Academic	<p><u>Bachelor's Degree</u></p> <p>The Institute of Technology and Business in České Budějovice offers a Bachelor's degree in Technology and Transport Management designed with a professional approach preparing students for jobs in transport, logistics, industrial companies and public administration.</p> <p>In addition, the Czech Technical University in Prague (CTU), within its degrees, has subjects that support training in the railway sector.</p> <p>The different departments of the University are in charge of subjects with relevance to the sector, as shown below.</p> <p>The Department of Transport Telematics is in charge of the subjects:</p> <ul style="list-style-type: none"> • Applied Telematics • Modern Techniques of Safety Control of Moving Rail Vehicles • Railway Interlocking Systems • Railway Traffic Control. <p>The Department of Applied Transport Information is in charge of the subject:</p> <ul style="list-style-type: none"> • Digital Support for Railway Lines and Transport Information Systems <p>The department of Transport Systems manages the subjects:</p> <ul style="list-style-type: none"> • High Speed Railways • Railway Lines and Stations • Rail Transport Infrastructure • Rail Transport in Settlements and Regions



- Railway Operation
- Railway Stations and Centres
- Urban Rail Transport.

The department of Railway Structures teaches the subjects:

- High Speed Tracks
- Construction of Railway Structures
- Railway Track Diagnosis in relation to Noise Measurement
- Design of Modern Railway Structures
- Hazard Control in Railway Transport
- Maintenance Technology of Railway Structures
- Noise Measurement in Railway Transport
- Rail Traffic and Environment
- Railway Construction and Environment
- Railway Structures
- Realisation of Railway Structures
- Recent Constructions of Railway Structures
- Software for Railway Applications
- Noise Sources in Railway Transport
- Theory of Continuous Rail Jointing

The department of Automotive Engineering and Combustion Engines is in charge of the subjects:

- Rail Vehicle Accessories
- Conceptual Design of Rail Vehicles
- Design of Rail Vehicles
- Drive of Rail Vehicles, Evolution of Railways and Rail Transport
- Manufacturing Technology of Rail Vehicles
- Principles of Design: Railway Vehicles
- Railway Rolling Stock Running Gear
- Dynamics of Railway Vehicles



And finally, the department of Logistics and Transport Management is in charge of the subjects:

- Microsimulation of Railway Operation
- Rail Transport Technology and Control of Transport Processes
- Transport Technology and Logistics.

Furthermore, the Technical University of Ostrava offers two-year specialisations in Transport Technology and Transport Systems in addition to the Bachelor of Civil Engineering - Traffic Structures.

At BRNO University of Technology, the Faculty of Civil Engineering offers training courses in Railway Structures and Railway Stations and Crossings.

Finally at the University of Pardubice in its Faculty of Transport Engineering, the Degree in Transport Means and Infrastructure is available.

Also at the same university, both, the three-year and two-year training is available in Means of Transport in the field of Rail Vehicles, which focuses on the problems of railway vehicles, trams, metro vehicles, as well as special railway vehicles, especially with regard to their construction, maintenance, innovation and reconstruction. The staff of the Subsidiary Česká Třebová is involved in the teaching of technical courses in the field of means of transport, especially in the specialisation of Railway Vehicles in the Bachelor, Master and Doctoral study programmes, both in Czech and English.

Master's Degree

No options have been found

PhD

At BRNO University of Technology, they offer the possibility of pursuing a PhD in Structural and Transport Engineering.

TABLE 7 - TRAINING AVAILABLE IN THE CZECH REPUBLIC

In summary Czech Republic has a lack of training courses. As shown in the table above, there are no Master's Degree options and most of the Bachelor's Degree options are subjects, instead of



specific Degrees for the railway sector, and finally looking at the training at vocational level very few options have been found.

2.8 AUSTRIA

Options available	
Vocational Training	<p>At course level, Independent Railway Services offers under the umbrella of Tex Rail Training, a wide range of modularly structured training and further education programmes for Train Drivers, Wagon Masters, Driving Supervisors and other railway-specific professions.</p> <p>The Langenlois State Vocational School (LBS) has available training in Track Construction Technology.</p> <p>In addition to this the Vocational School for Industry, Finance and Transport (IFT) offers training for different parts of the sector.</p> <p>ÖBB also offers through its school the possibility to train in special modules of the railway sector, such as the special module for Railway Electrical Engineering, Railway Safety Technology, Track Construction Technology, Railway Vehicle Maintenance Technology, a special module in Railway Operation Technology (dispatcher) and a special module in Railway Transport Technology (train driver).</p> <p>Finally, Vienna University of Technology, within its Institute for Transport Science - Railway Transport, offers different courses and didactic events, e.g., High Performance Railway Systems, CAD for traffic route planning, Transport Industry, Railway Maintenance, etc.</p>
Academic	<p><u>Bachelor's Degree</u></p> <p>At university level, various universities in the country offer bachelor's degrees with compulsory subjects related to the sector. The University of Applied Sciences of the Vienna Institute of Vocational Education offers the possibility to study the Bachelor's Degree in Logistics and Transport Management. This degree is also available at the Upper Austrian University of Applied Sciences, Steyr Faculty.</p> <p>Other universities offering bachelor's degrees in the railway sector include: the Fach-Hochschule des BFI Wien who offers the Bachelor's</p>



Degree in Logistics and Transport Management; Vienna University of Technology who offers the Bachelor's Degree In Civil Engineering and the Graz University of Technology which has available a Bachelor's Degree in Civil Engineering and Construction Management.

The Institute of Railway Engineering and Transport Economy which belongs to Graz University of Technology offers different courses throughout the year, in the winter semester; Railway Engineering Basis, Track Construction and Maintenance, Cable Car Engineering, Local and Urban Transport, etc. and during the summer semester: Railway Operations, Traffic Economies, Track guiding, Infrastructure Pricing, etc.

The University of Applied Sciences St. Pölten offers a Bachelor's degree in Railway Technology and Mobility, both at full-time and part-time. In addition to the module of Railway Infrastructure and Operation and the Master's degree in Railway Technology and Railway Systems Management.

In cooperation with the University College of Teacher Education in Lower Austria, they offer the training programme called "Academic Trainer in Railway Services", a three-semester programme designed together with ÖBB and its academic partners. Furthermore, together with the leading German, Austrian and Swiss railway corporations (DB, ÖBB and SBB), it offers a course in Railway Technology and Mobility, oriented towards the key requirements of railway companies and authorities.

Master's Degree

Apart from the previous mentioned Bachelor's Degrees the University of Applied Sciences of the Vienna Institute of Vocational Education offers the possibility to study a Master in Logistics and Transport Management.

At the Upper Austrian University of Applied Sciences, Steyr Faculty the Master's Degree in Supply Chain Management is available.

The Master's Degree in Civil Engineering - Infrastructure is offered at Graz University of Technology.





	<p>The Master of Integrative Urban Development -Smart City Is available at the University of Applied Sciences Technikum Wien.</p> <p>And finally, the Vienna University of Technology offers the Master's Degree in Civil Engineering.</p>
Other	<p>Austria promotes mobility education from an early age. Apart from introducing subjects on the topic from an early age, there are various offers for students to choose the type of training they would like to pursue in the railway sector at a later age.</p> <p>The most common apprenticeship in the transport sector is that of a transporter. In 2016, almost 800 young people apprenticed in this profession. The second most popular apprenticeship in the transport and traffic sector is that of Electrical Engineer.</p> <p>In schools in Austria, pupils are confronted with the subject of traffic at an early age. Classical traffic education begins in the first grade of primary school and is a compulsory exercise. Due to technical and social changes in recent years, the concept of "mobility education" is increasingly emphasised. Young people are now becoming aware of new forms of mobility and the different aspects of transport and their effects at an earlier age.</p> <p>In addition to all the mentioned above, the FH Joanneum University of Applied Sciences has an Institute of Energy, Transport and Environmental Management which is part of the Department of Building, Energy and Society. Its activity focuses on addressing the challenges of sustainable urban design in terms of transport and energy.</p>

TABLE 8 - TRAINING AVAILABLE IN AUSTRIA

In summary, Austria has a different education system compared to other European countries, but even though training in the sector is encouraged from an early age, there are not as many options as one would expect.



2.9 SERBIA

Options available

Vocational Training

On the one hand, in November 2020, Russian Railways opened a regional information and training centre at the headquarters of Serbian Railways in Belgrade.

At the centre, the staff can get acquainted with the technologies used by Russian Railways for the construction of railway infrastructure, and the mechanisms of train-traffic control can be tested. The centre is equipped with various simulators, including an operational and technological communication terminal, equipment for the centralisation of dispatching, control of railway sections and an electric traction substation. Among other things, the centre is equipped with a prototype of a collective use panel for the entire dispatching centre, which is designed to display the current status of the railways in real time.

On the other hand, the Higher Railway School of Professional Studies conducts first-degree basic vocational studies and second-degree master's vocational studies of higher education. The basic professional studies include:

- Railway Traffic
- Railway Mechanical Engineering
- Electrical Traffic Engineering
- Railway Construction
- Railway Commercial Business
- Public and Industrial Traffic
- Traffic Environmental Protection Engineering

Professional master studies include:

- Traffic and Generation
- Traffic Electrical Engineering
- Traffic Commercial Business.

Finally, the specialised professional studies offered include:



- Rail Traffic
- Railway Mechanical Engineering
- Electrical Engineering in Traffic
- Railway Construction
- Railway Commercial Business
- Public City and Industrial Traffic
- Environmental Protection and Energy Efficiency.

Academic

Bachelor's Degree

The University of Belgrade in its Faculty of Transport and Traffic Engineering has the following modules available at Bachelor's level; Railway Transport and Traffic, Road and Urban Traffic Engineering and Traffic Safety.

Master's Degree

As mentioned in the previous section, the University of Belgrade in its Faculty of Transport and Traffic Engineering has the available the Bachelor's Degrees in Railway Transport and Traffic, Road and Urban Traffic Engineering and Traffic Safety, all these are also available at Master's Degree.

PhD

The University of Belgrade in its Faculty of Transport and Engineering offer the possibility of obtaining a PhD in Decision Support Systems in Transport and Traffic Engineering, Information Systems in the operation and maintenance of means of transport, Traffic and Communications Management and other subjects related to the sector.

TABLE 9 - TRAINING AVAILABLE IN SERBIA

In summary Serbia has different options available but in all the categories above these options are very limited. In university level only the University of Belgrade has training available related to the railway sector.





2.10 NETHERLANDS

Options available	
Vocational Training	No options found
Academic	<p><u>Bachelor's Degree</u></p> <p>No options found</p>
	<p><u>Master's Degree</u></p> <p>Very few options have been found, at the Technische Universiteit Delft the MSc in Transport, Infrastructure and Logistics is available. Also at the same university, it is available the Railway Engineering online course which covers Track and Train Interactions, Real Time Operations, Performance Over Time and Capstone Project and lastly the one at the University of Twente in which within its Master in Civil Engineering and Management they offer the possibility of doing the specialisation in Transport Engineering and Management.</p>

TABLE 10 - TRAINING AVAILABLE IN THE NETHERLANDS

In summary the Netherlands has a big deficit in terms of training in the railway sector. Few options are available at university level, and at VET/CVET level it has not been possible to find anything. Moreover, it was not easy to find the different options described above on the internet, as it was necessary to search further to find them.

2.11 LUXEMBOURG

Options available	
Vocational Training	No options have been found
Academic	<p><u>Bachelor's Degree</u></p> <p>No options have been found</p>
	<p><u>Master's Degree</u></p> <p>No options have been found</p>

TABLE 11 - TRAINING AVAILABLE IN LUXEMBOURG



In summary Luxembourg has a huge deficit as no training related to the railway sector has been found.

2.12 POLAND

Options available

Vocational Training

In Poland, the main employer of the railway industry is Polskie Koleje Państwowe Spółka Akcyjna – the Polish National Railway Company. Without much competition, the PKP S.A. dictate the terms and conditions of employment and provide their employees with both ongoing and entry-level training. Details of the training methods are a company secret. All training and courses on the strategic level are provided by the PKP S.A.

At the tactical management, the situation from the strategic level is that anyone with a relevant degree can become an infrastructure planner, but further more precise training is provided by the company when hiring a prospective planner.

In Poland, there are a few companies that do their own vehicle design, one of which are Pesa Bydgoszcz S.A. They offer both, professional training and apprenticeships. In order to enrol on these courses, candidates must hold a relevant education certificate and/or have experience. Admittance is awarded on the discretion of the company.

For operational level, the situation is again dominated by the government-owned company PKP S.A. Most of the education available at the operational level is provided when accepted into the company.

In recent years, Public Railway Technical Secondary Schools have regained their popularity. They began to decline in popularity from 1989 onwards. These schools expand the educational offerings relevant to rail every year. Currently, they provide courses to become a general railway technician and traffic controller. As well as vehicle maintenance courses. However, all of the courses are fairly



flexible, allowing graduates to look for work in other industries as well.

Akademia Bezpieczeństwa Kolejowego offers training in seven cities in the country; Warsaw, Lublin, Krakow, Katowice, Gdansk, Wroclaw and Ponznan as well as training through an e-learning platform which aims to shape a safe, competitive and efficient railway sector. The courses offered include transport of dangerous goods by rail, modernisation of railway vehicles, railway commissions, etc.

In addition, TÜV Rheinland offers seminars, courses and training workshops on topics such as railway maintenance based on technical condition assessment, IT safety for railway systems, etc.

PKP Szybka Kolej Miejska, offers training for train drivers as well as examinations for passenger train manager, traffic dispatcher, signalman, rolling stock auditor, crossing line tracer, switchman...

In addition, there are various institutions offering the possibility of obtaining a train driver's licence and courses for other rail transport workers.

Academic

Bachelor's Degree

In terms of the university level, not many options have been found. At the Cracow University of Technology, within the Bachelor's Degree in Civil Engineering, students have the possibility of attending the specialisation in Rail Transport, with subjects such as Rail Transport Infrastructures, Strategies for the Development of Transport and Logistics Systems or Travel and Traffic Forecasting, for example.

Master's Degree

The SGH Warsaw School of Economics offers the possibility to take a postgraduate course in Rail Transport Management. The Silesian University of Technology in Gliwice offers the possibility to study Transport at both Bachelor's and Master's level.

The University of Science and Technology (UTP) offers second cycle studies in Transport.



Other	The Silesian University of Technology in Gliwice has a Faculty of Transport where research is carried out in the areas of transport network optimisation, transport logistics, mathematical modelling of engine combustion processes, application of numerical methods in the design and optimisation of wheel units and vehicle suspension dynamics, among others.
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TABLE 12 - TRAINING AVAILABLE IN POLAND

In summary Poland most vocational training is controlled by the government-owned company PKP S.A.. Regarding university level training, there are some sector-specific options at master level but at bachelor level only subjects are taught, not specific degrees.

2.13 SLOVAKIA

Options available	
Vocational Training	Slovak passenger transport company ZSSK signed in 2019 for the creation of an educational centre focused on the vocational training of transporters who want to increase the interest of young people in professions such as machinist, mechanic or electro-mechanic.
Academic	<p><u>Master's Degree</u></p> <p>The University of Žilina within the Master's degree of the Faculty of Civil Engineering trains its students in mobility and the railway sector through the subjects of Engineering and Traffic Structures, Transport Infrastructure Planning and Railway Engineering.</p> <p>Furthermore, in the Master's degree of the Faculty of Mechanical Engineering, the subject of Rail Vehicles is taught, in which students acquire the knowledge and skills necessary for research and development of railway vehicles, rationalisation and improvement of quality and management of maintenance projects, as well as knowledge of how to increase their operational efficiency while respecting environmental requirements.</p>



Other

The Slovak University of Technology in Bratislava (STU) counts with the Department of Transportation Engineering. This department is responsible for training bachelor's, master's and doctoral students in the specialisations of: road and railway engineering, urban road planning and design and traffic engineering.

The University of Žilina also has a Department of Rail Transport within the Faculty of Operation and Economics of Transport and Communications. The department in turn is divided into three sub-departments: transport processes, transport processes and management.

TABLE 13 - TRAINING AVAILABLE IN SLOVAKIA

In summary Slovakia has limited options for training in the railway sector. There is the possibility to attend subjects at different universities, but there is no sector-specific and ad hoc training available.

2.14 COUNTRY ANALYSIS

This section it is summarises the gaps found during the country analysis. It can be seen an average supply of rail-oriented university degree programmes in Spain, Germany and Italy. A comprehensive training system for rail are in place in such countries and there are a reasonable number of certified companies offering courses to meet the needs for daily operation. However, it is difficult to access to detailed information of these training programs since in many cases only the title of the courses/training programs were available.





3 NEW AND EMERGING TRAINING TOOLS AND METHODS

This chapter describes new and emerging training tools and methods currently being used for academic and vocational education programs. These tools and methods will be considered and applied in the proposed railway sector education and training programs developed in STAFFER Task 4.5.

3.1 E-LEARNING

E-learning is a term that is becoming more widespread and increasingly used by institutions, companies and educational agents. Nowadays it is more and more common to find a training offering different options, being able to choose between traditional teaching methods in physical classrooms, but also through what is known as virtual classrooms. E-learning is spreading rapidly throughout the education system, allowing both formal and non-formal education, and face-to-face or distance learning.

The concept of e-learning is a teaching-learning modality that consists of the design, implementation and evaluation of a course or training plan developed through computer networks and can be defined as education or training offered to geographically dispersed individuals who are able to interact from a different location and at a different time from when the teaching has taken place by the use of computer and telecommunications resources. The characteristic feature of e-learning is that the training process takes place wholly or partly through a kind of virtual classroom or environment in which teacher-student interaction takes place as well as students' activities with the learning materials. (Manuell Area Moreira 2009)

The worldwide growth of e-learning education is developing in parallel with the progress of the information and telecommunications society itself, caused, among other reasons, by the reduction in the economic cost of computers and telecommunications; by the familiarity of the younger generations with the Internet, mobile telephony and digital culture; by the ease and improvement of access to network technology; by the use of more user-friendly interfaces such as multimedia, as well as by the generalisation of information and communication technologies in homes, schools, universities, companies, cultural centres and other social institutions. (Manuell Area Moreira 2009)

Traditional methods can reach a limited number of people per year but e-learning is able to reach thousands of people (FAO, 2021).

E-learning can cover a wide target audience, including learners who are:





- geographically dispersed, with limited time and/or resources to travel
- busy with work or family commitments, which do not allow them to attend courses at the dates and times stipulated in the timetable
- contingent workers, such as consultants, part-time professionals, independent contractors
- located in conflict and post-conflict areas and/or with restricted mobility due to security concerns
- limited to participate in classroom sessions due to their cultural religious beliefs
- real time communication difficulties (e.g. foreign language learners)

Moreover, e-learning activities can be monitored, tracked and managed through the use of learning management systems.

Distance Learning

Also known as online or remote education, it is an innovative way of learning and teaching which takes the dynamics of a traditional, face-to-face classroom into the digital world. In this way, from anywhere in the world, students and teachers can connect in a virtual environment on their computers via the internet, making intensive use of the facilities provided by new digital technologies.

There are different systems that can be used when employing the distance learning method. It can be done by live videoconference, which is the most common form, as there is direct interaction between the learner and the teacher. Another method is synchronous distance learning, in which the students share location, but the teacher is in a different one, this type of lessons are also usually given by videoconference.

Asynchronous learning is when the teacher and learner are both in different locations and at different time. In this case, learners receive tasks that guide them through the learning process. Another method is open-ended online courses, although it is similar to asynchronous learning, in this case there are no deadlines to meet, so learners can organise their time. This is often the method of choice for people who combine studies with work. On the other hand, fixed-time online courses do have more control as they require the user to log on at a certain time, but it is not as rigid as synchronous education. And finally, blended learning, which combines synchronous and asynchronous elements. Some lessons may be more scheduled, while others will be self-directed.



Mobile-learning or m-Learning

O'Malley defines m-Learning as: "Any type of learning that occurs when the learner is not permanently fixed in a certain location, or learning that occurs when the trainee takes advantage of the learning opportunities offered by mobile technologies". (O'Malley s.f.)

It is a teaching and learning methodology that makes use of mobile devices, such as phones, laptops, tablets, iPad..., and any handheld device that has some form of wireless connectivity. It is a ubiquitous term that links mobility to the learning context. Its advantages include spatial-temporal flexibility, versatility, ease of communication and above all, its intrinsic motivation in students, who are used to this type of technology for their relationships and daily communication. (Francisco Brazuelo Grund 2011)

Mobile learning allows trainers to promote more dynamic training environments by using interactive and dynamic models during teaching that lead to better communication and instructional feedback loops. (Cristina Almeida 2013)

By using mobile devices or laptops, whether in the classroom or in any other location, trainers will be able to initiate discussions among learners or introduce assessments to be carried out in groups, and get the results instantly, thanks to the communication facilities offered by mobile learning. (Cristina Almeida 2013)

From the point of view of the students, as wireless devices provide immediate feedbacks, they have the possibility to directly interact with their instructor and classmates and also access to course materials. The system is also customized to meet student's requirements and provide individualized advice to them.

3.2 VIRTUAL/AUGMENTED REALITY

Through the use of simulation, a highly interactive form of learning can be offered as it is based on creating a learning environment that simulates the real world. This similarity to reality allows the learner to learn by doing rather than only observing. Simulation is also a web-based training that immerses the learner in a real situation and makes him/her have to respond to the proposed situations in a more dynamic way.

Simulation includes virtual reality and augmented reality, which offer a new and more effective approach to simulation.

Virtual reality (VR) is a digital environment, created through technology, to simulate reality. The scenes, objects or figures that make up these virtual reality scenarios appear real and the user enjoys an immersive experience. To create this virtual environment, a technological device is

needed, usually virtual reality glasses, but other devices such as gloves or suits are also integrated to enhance the experience and interaction with the scenario. This type of technology has a variety of recreational uses, from art to education and training in multiple fields.

Augmented reality (AR) combines the real environment with an additional layer of visual elements created virtually by computers with images of the environment, both direct and indirect and in real time (Azuma 1997) (Zhou 2008) thanks to the camera of an electronic device such as a smartphone or tablet. Unlike VR, it does not try to replace the physical scenario with a digital one designed by a computer, it allows virtual elements to be superimposed on our vision of reality, intermingling the virtual world with the real world, in a contextualised way, and always with the aim of better understanding everything that surrounds us. This new layer of information can be made up of text and images, videos, animations, 3D elements, audio, etc. And it can be accessed by pointing the device's camera at a specific point on the real or superimposed plane as if it were an interface.

The coexistence of virtual objects and real environments allows learners to visualize complex spatial relationships and abstract concepts (Arvanitis 2007), experience impossible phenomena's in the real world (Klopfer 2008), interact with two-dimensional synthetic objects in mixed reality (Kerawalla 2007), and develop important practice and literacy, which cannot be developed and implemented in a learning environment enhance by other technologies (Squire 2007). These education advantage make AR one of the key emerging technologies in education.

Both augmented reality and virtual reality can be created of created and implemented through different technologies, such as laptops, augmented reality glasses, etc. (Johnson 2010) It is not limited to any one type of technology, so it adapts to the present day without any problem. They provide additional information to the learner, creating a new context in which the learner can gain a greater experience than would not be possible without the use of this technology (K. & Squire 2007).

According to a case study conducted by Beijing iBokan Wisdom Mobile Internet Technology Training Institutions and Beijing Bluefocus E-Commerce Co., Ltd. This type of training improves trainees' performance compared to traditional training and improves talent retention, with fewer students being left behind (Beijing Bluefocus E-Commerce Co., 2016).

3.3 GAMIFICATION IN LEARNING

Today's students are part of a generation that has grown up in a much more digitalised society and therefore their demands on educational methods have changed compared to previous generations. Teachers have to adapt educational methods to the new demands, adapting them to the needs, preferences and requirements of the students.

The main problem in today's education is the lack of motivation and engagement of the students. Teachers have to use new methods and approaches that enable active participation of students with strong motivation and engagement to their own learning.

One of the solutions to this problem may lie in the integration of gaming elements into the educational system. Students would be rewarded and this would lead to an increase on the motivation, participation and increased activity.

According to Kapp gamification is "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems." (Kapp 2012)

Gamification is the use of game thinking, approaches and elements in a context different from the games. The use of game mechanics improves motivation and learning in formal and informal conditions. (Gabriela Kiryakova s.f.)

The use of game mechanics improves the abilities to learn new skills by 40% (Giant 2013). Game-based methods increase students' engagement and motivation, as many of them are consumers of games and this approach is familiar to them. The application of games in education is very similar to that in reality. In games, users have to carry out actions or missions in order to achieve goals, overcome obstacles or win. This can be taken to the world of education; the objective would be learning and students would achieve it by carrying out different activities. Tracking the progress of players in games is an important element, because the next steps and moves are based on their results. In education, tracking students' progress is essential to achieve learning objectives. The learning trajectory of students is determined by the levels of knowledge and skills achieved. (Glover 2013)

Gamification leads to an improvement of students' knowledge and skills, although it is not directly associated with knowledge and skills, it is connected with students' behaviour, engagement and motivation. (W. Hsin-Yuan Huang 2013)

The key element of gamification is the inclusion of tasks to be completed by the students. This will allow them to accumulate points, move to higher levels and win prizes. All these actions are geared towards the achievement of pre-determined learning objectives. The elements to be included in the training depend on the defined objectives (the knowledges and skills to be

acquired as a result of the task). Activities that require independent work by learners result in individual rewards (such as badges). Activities that require interaction with other students are the social element of training, they make learners part of a large learning community and their results are public and visible (such as leader boards).

It is important to adapt gamification to the tasks to be performed by learners, allowing them to accumulate points, move to higher levels or win prizes. As it has been seen, all the actions are oriented towards the same objective; that the students obtain the necessary knowledge. When the work has to be done individually, the prizes will also be individual, but when this work requires participating in group tasks, the interaction between them will be an important aspect. (W. Hsin-Yuan Huang 2013)

3.4 INSTRUCTOR-LED INDIVIDUALISED TRAINING

Instructor-led training is a teaching method in which an instructor or teacher interacts with one or several trainers, depending on whether the training is individual or group-based. The instructors are in charge of providing the trainers with learning material through their knowledge and experience.

The training can take place in a classroom, in a workshop in which trainers interact with each other, in a demonstration in which they will have to participate or even in a virtual format. When this type of training is conducted virtually, learners, facilitators and trainers can use a variety of communication tools to work together. These can be either synchronous, if they take the form of live videoconferencing sessions, or asynchronous, such as emails, discussion forums and wikis.

Executive coaching is one kind of instructor-led individualised training. In this method, and qualified professional works with individuals, often employees, with the aim of helping them gaining self-awareness, clarifying goals, achieving their development objectives, unlocking their potential and acting as a sounding board.

Executive coaches are neither consultants nor therapists, they do not try to fix the problems of the participants in the process, they just ask them questions so that the trainers are able to solve them by themselves.

There are different ways of leading an executive coaching process, but the usually most of the follow the same phases; intake, assessment, goal setting and development planning. During the development of the plan, the executive director should conduct periodic reviews to ensure that everything is proceeding as originally planned and that goals are being met.

The process ends when the coach and the learner decide to stop, usually after approximately 12 months from the start.

3.5 BLENDED LEARNING

Blended learning, or b-learning, is a mixture of different mixing of multiple learning. Unlike fully online learning, the online part of training does not replace face-to-face classes with a teacher. Teachers incorporate technology to enhance the learning experience and broaden understanding of certain topics, generating and developing different actions for students to learn.

Blended learning can be used in different ways as shown below (FAO, 2021):

- **Before a face-to-face event**

Virtual training methods can be used before a face-to-face class in order to level up the knowledge and skills of the trainees before the class starts.

Thanks to this, the trainer can analyse the results obtained in the online part and adjust the face-to-face training to the identified needs. By combining face-to-face training with online training, F2F events are much more effective as a pre-event activity allows participants to come to class with ideas and opinions on the topics to be covered.

- **As follow-up to a face-to-face event**

Another combination would be to start the training with a classroom event and then include online activities, interaction with online resources or e-tutoring services for ongoing reinforcement. This approach could be used to develop communities of learners or to engage in further discussions on advanced topics of individual interest.

- **Before and after a face-to-face event**

Virtual methods can be used for the start and end of training.

Blended learning requires the teacher to plan and develop educational processes in which time and tasks that take place either in the physical classroom or in the virtual classroom overlap, without there necessarily being any inconsistencies between the two. Likewise, the teacher must develop materials and activities for the student to develop them autonomously outside the traditional classroom context. (Manuell Area Moreira 2009).

Based on the literature, it has been seen that more skilled workers are obtained through the mixing of multiple resources, media and techniques, and when the learner is placed as a central and active agent in the learning process.

3.6 PEER LED LEARNING/MENTORING

Peer learning encompasses a wide range of activities, from the traditional tutor model, in which older students tutor younger ones, to the more innovative learning cells, in which students in the same year form partnerships to help each other with both course content and personal concerns. Other models include discussion seminars, private study groups, parrainage (buddy system) or mentoring, peer assessment systems, collaborative laboratory or project work, etc. It should involve the exchange of knowledge, ideas and experiences between participants and should therefore be mutually beneficial. Peer learning is not a single, undifferentiated educational strategy (Boud, 2002).

When peer learning is between an experienced person and an inexperienced person, it is called mentoring. In the last few years the concept of mentoring more and more popular, as it is one of the simplest techniques for developing skills and talent. There are different definitions for mentoring but traditionally it has been defined as the process of interaction between an experienced person (the mentor) and a less experienced person in the field (the mentee), who aims to acquire knowledge from the mentor. (Judy O'Neil 2009). The relationship between mentor and mentee, provide both psychosocial and career related support.

The process of interaction between mentor and mentee usually takes place through conversation. During the conversation, there is an interactive communicative exchange between the two participants. This exchange is considered the means of learning and development.

In order to achieve results, the process needs to be examined by the mentor, i.e. reflected upon, in a way that ensures the mentor's role as a helping agent, and therefore the choice of a "good" mentor is very important (Harm Tillema 2015).

3.7 NETWORKED LEARNING

Network learning can be defined as a learning in which information and communications technology are used to promote the connections between one learner and other learners; learners and tutors; a learning community and its learning resources (Goodyear 2001). It can offer educational institutions greater functional efficiency by allowing curricula to be managed in a tighter and more centralised way.

Networking is about cultivating relationships to improve both professionally and personally. When you share your talent, intelligence, experience and vision with other people in your sector or environment, you learn. And you learn because by sharing the work of one person with others, you will be able to extract the best from each other and thus obtain mutual progress, leaving aside individualism, selfishness and competitiveness.

When you share information with another person, you always learn something, whether it is about yourself, your colleagues, the sector you work in, the business...

Moreover, people who value relationships and contacts are especially valuable for the companies they work for, as everyone can benefit from this. But it is also an advantage for the person, since the network of contacts that one creates can be of great help in times of need, whether to create a business, to learn about a sector...

3.8 SMART LEARNING TECHNOLOGIES: PERSONALISED LEARNING

There is not a clear and unified definition of smart learning, although there are common elements among all the definitions provided by different researchers in the field. They all emphasise that intelligent learning is based on two types of technologies, smart devices and smart technologies (Gros 2016).

Smart devices refer to artefacts that exhibit some properties of ubiquitous computing, e.g. the Internet of Things. The use of smart technologies, such as cloud computing, learning analytics or big data, focuses on how to capture, analyse and target learning data to improve learning and teaching, as well as to support the development of personalised and adaptive learning (V. Mayer 2013). Despite this distinction between smart devices and smart technologies, the two are related, as neither type of technology stands alone.

In smart learning, real-time location can be important to adapt the content and situation to the learner. However, location is not always a necessary condition for this. The most important feature is that the system is able to advise and predict the learner's needs. Intelligent learning is a learning system that can advise learners to learn in the real world.

The concept of smart learning underlines the importance of technological design to enhance learning. The use of mobile devices has given rise to the idea that the place and context in which learning takes place is not very important. However, places (physical and virtual) are not irrelevant, indeed they are increasingly important and the design of learning environments must orchestrate the different places in which a person can learn, combining formal and informal situations (Gros 2016).

Smart learning environments are used for this purpose and go beyond the application of smart technology. A smart learning environment not only allows learners to access digital resources and interact with learning systems anywhere, anytime, but also provides the active guidance necessary for learning by providing support tools, advice or learning suggestions at the right place, at the right time and in the right way.

Intelligent learning environments must integrate formal and informal learning in order to create autonomous and adaptive environments. These environments should use big data and learning analytics techniques to integrate real-time information about learners' location and historical data to identify meaningful learning patterns.

3.9 SCENARIO/STORY BASED LEARNING

Within the community of intelligent tutoring systems, narrative is emerging as an effective mean of contextualising learning.

Story-based learning is a model of learning that is based on the fact that all people define their experiences in a narrative context, which serves as cognitive structures and as a mean of communication, which helps people to frame and understand their perception of the world. Narrative contextualises abstract concepts and provides an aid to knowledge transfer in specific contexts and settings.

It introduces learners to new ideas and pushes them to rethink and re-evaluate concepts, but also encourages and motivates them to go beyond their own limits. It is engaging, easy to remember and appeals to learners of all backgrounds. It can therefore be used as a learning strategy, especially when you want to bring about change.

In corporate trainings, story or narrative is used as a common thread to organise information as it can provide a structured learning pathway leading to specific learning outcomes. Sometimes a narrative may not be able to connect all aspects of the training. In such cases, it may branch out into the other pathways of the training.

3.10 EXPERIMENTAL LEARNING

The pedagogical method known as experiential learning attempts to develop people's ability to learn from their own experience, always within a concrete and well-developed conceptual and operational framework. A suitable conceptual framework for learning from experience implies a significant effort to systematically structure the various experiences according to the educational objectives to be achieved and the profile of the learner group.

On the other hand, it is also necessary to choose a series of action techniques supported by specific tools and devices. The different activities framed in this methodology must be very well structured and divided into sequences.

Experiential learning is structured in cycles that respond to different models that allow us to understand how the learning process works. These cycles also consider the subjective experience

of each student and are based on the proposal of an interactive series of different phases (from 4 to 6) that encourage the learning process.

Learning based on experience provides different advantages, such as a greater space for personal growth, encouragement of the personal knowledge and a constant reflection. Moreover, when it is done in a group environment, learning is enriched and therefore accelerates and facilitates the integration process so that there can be better teamwork.

Experiential learning, however, is far from random; on the contrary, everything has to be very well planned, which involves a lot of work and preparation beforehand. It also requires research into possible transitions in learning in relation to the subject matter or training issue and involves learning about theories and explanatory models with a critical perspective that can be evaluated, supplemented and improved.

This is all part of the experiential methodology aimed at promoting critical reflection by learners on their own learning, and by instructors or teachers on what they are teaching.

3.11 INFORMAL LEARNING

Informal education is a concept used to define the learning obtained from an unstructured way, outside the formal educational establishments of a society. This includes notions and concepts that are acquired in the activities of everyday life, such as work, hobbies and contact with other people. The concept of informal education is based on the premise that it is transmitted outside of formal educational institutions, recognised by governmental authorities.

It is not organised or planned, and does not progressively lead to a degree or certification. Instead, it is an individual learning that arises from the contact with the environment in which one lives and from the information received through the media and other sources of knowledge.

Moreover, informal education does not require the presence of a teacher or professor and is not deliberate, as it does not seek to educate in an intentional way. It does not have deadlines and goals to be met, neither a specific timetable to follow.

It can occur in schools when it arises informally in the interaction between pupils, outside the pedagogical objectives of the school itself. This learning is generally unconscious and involuntary and is not tied to rules of any kind. However, this does not imply in all cases that its quality is inferior to that of formal education.

Informal education is spontaneous, haphazard and occurs as a person grows up within a society. Its development therefore lasts a lifetime.

3.12 WORK – BASED LEARNING

Work-based learning is a growing priority in the European Union, improving users' skills, as well as promoting their employability, economic competitiveness and social inclusion.

In work-based learning, not only learners and workers benefit, but all the main stakeholders, such as the company or society, gain something from it.

Work- Based learning is defined as the various procedures necessary to achieve the learning objectives of skills and competences linked to the labour market (Commission 2013).

Work-based learning is one of the new training models capable of resolving the traditional dichotomy between formal university learning and informal learning specific to work contexts, through the integration between theory and practice carried out on a reflective basis. It would then be defined as a system suitable for supporting the integration of young people into the labour market and the continuous professional updating of workers. Work can be paid or unpaid, but it must be real work leading to the production of tangible goods and services.

Moreover, it is not an education system that focuses on one group, as people of all ages, levels of experience and backgrounds can benefit from it: from students and young adults just starting their careers to adult jobseekers and people with many years of experience who need to learn new skills. Work-based learning can help people not only to advance in their current businesses, but also to change direction and move into new areas.

Employers also reap huge benefits when their employees participate in training programmes, as retention rates improve and employees make fewer mistakes. In addition, the ability to hire better trained employees who understand the expectations of the workplace, and to reduce training costs for new employees.

Students or workers also benefit from this, as it has been found that the work combined with lectures improves academic results as students are more motivated and attendance increases. Furthermore, this method links what they learn in the classroom with what they actually need in the real world, as well as being an experience that can help them explore their future career options.



4 DEVELOPING NEW TRAINING PROGRAMS FOR THE RAILWAY SECTOR

The railway sector needs new training programs both because of the large number of new employees required to replace retiring workers, and due to the rapid introduction of new technologies such as digitalisation. This chapter outlines the key considerations for developing these programs and summarises how the new methods and tools outlined in Chapter 3 above could be used in these programs. These will be used in the development of specific training programs for the railway sector in STAFFER Task 4.5 and later work packages.

4.1 CONSIDERATIONS FOR DEVELOPING A TRAINING PROGRAM

According to the analysis carried out in the Deliverable 3.1. 70% of learning in the sector is related to problem solving in a challenging task, in which employees learn from their own successes and failures. 20% of learning is based on learning from others. Through exchange with other more experienced experts. And the remaining 10% would be formal training, where employees participate in courses or training sessions in order to learn more skills.

In order to prepare professionals in the sector, it is important to adapt educational methods and apply the emerging ones. To achieve the results that the sector needs, it is necessary to design and plan training programme activities correctly. Therefore, before choosing the programme to be used, it is necessary to ask oneself what the objective is, what the organisational problem to be addressed is, or whether the training serves to fill a gap. In addition, the design and delivery of learning must be adapted to the characteristics of the learner (their previous knowledge and skills, their geographical origin, the time available, their skills with technology, etc.). When choosing the type of methodology to be used, there are different factors to be taken into account (FAO, 2021):

- 1. The region or geographical area in which the learner resides.**

Depending on the location, language and cultural issues will change. Also, the time zone may vary depending on the location, therefore synchronous and asynchronous tools will have to be chosen.

- 2. In the case of training for employees, the type of organisation or institution in which they work and the roles they play.**

This will help to identify the needs according to the objectives of the job.



3. The learner's prior knowledge and experience of the subject.

Learners with prior knowledge will not need the same amount of time and support as beginners. As such, the content should be adapted to the technical level of the learners.

4. The skills of the learners when using the technology

This will help to define the level of complexity of the digital systems used.

5. The time available for study/training

This information will enable to adapt the amount of content provided to the learner, matching it to the learner's possibilities. Knowing how much time the learner has can be a crucial element in choosing the training method to be used, as those that allow for more independent training could be very beneficial.

6. The location from which the training will be conducted (at home, in the office, in front of a computer, in the workshop, etc.).

This influences the selection of the format in which training is provided. In some cases learners will have an internet connection while in others they will need to bring downloaded or printed material with them.

These considerations must be kept in mind as trainers and educators develop specific training programs for the railway sector. The next section outlines how the new training methods and tools could be applied in developing specific trainings after using the above considerations to better understand the specific needs of the workers being trained.

4.2 APPLICATION OF NEW TRAINING METHODS AND TOOLS IN PROGRAM DEVELOPMENT

Training based on e-learning methods offers learners the possibility to train at their own pace. E-learning can be used as a tool to support learning, teaching and assessment, and because it can be delivered synchronously and asynchronously, learners can tailor the training to their needs. Asynchronous learning offers greater flexibility in time management by allowing learners to attend class and participate in discussions at a time that suits them, and to review the material as often as they feel necessary (Stein, 2014). In addition, the content can be reused, so the same training can be offered to different individuals, which is something to take into account when a company wants to train a large part of its staff, transmitting the same knowledge to all of them. In addition, this type of training is very suitable for people who combine work and studies, people in different locations and time slots, or people who study in a language which is not their native language and need more time to understand the content.

Mobile technologies for example have proven to be useful for learners who move to remote locations with poor internet connections or when they need fast and timely support (Kukulska-Hulme, 2010).

One way of combining e-learning technologies with the more traditional way of teaching is through blended learning, whereby a combination of face-to-face events and online material allows learners to take advantage of the benefits of both methods. Through this type of training, key concepts can be developed in face-to-face classes and support materials, extra tasks or communications can be carried out via online platforms. This allows employees or students to adapt the time to their needs.

If motivation is an issue during training, adding game elements can increase learners' motivation. Games are designed to develop strategic skills by allowing learners to make decisions and witness the consequences of these decisions. However, it is important to use gamification exclusively to support learning objectives, otherwise there is a risk of it becoming a distraction. Another option could be the use of virtual reality and augmented reality, as these methods can be used to enhance learning and student engagement (Allcoat, 2018). However, these methods are more suitable when aiming to train learners in subjects that require hands-on training that cannot be easily obtained in reality or when training is to be conducted in the workplace as it offers a more realistic training experience. This type of method can be implemented as many times as necessary. Finally, within technology-based methodologies is smart learning, which is based on smart devices and smart technologies. By harnessing these resources, an effective digital learning environment can be created in which students are comfortable and can adjust to the changing demands of the digital age.

When the aim is to provide specific knowledge, describe complex processes, add human aspects to lessons or emphasise the usefulness of knowledge, storytelling-based training is the most useful methodology, as the realistic context created in it enables learners to acquire the aforementioned knowledge. Alternatively, training based on case scenarios presents more realistic challenges, unlike storytelling, this approach implies that the learner is the main actor and must respond to the challenges by making a series of choices and decisions. The scenario-based approach can be useful when there is a need to develop interpersonal or problem-solving skills, to teach strategic principles rather than conceptual and factual knowledge, or to develop an interactive exercise at the end of a conceptual unit, i.e. as a practice lesson after a set of lessons that provide underlying concepts and principles.

Instructor led training is an interesting option when the training is more complex or completely new to the learner, in which case the trainer will help the learner with any doubts that may arise

as well as helping him/her to better understand the new concepts. In addition, in instructor-led courses, tutors and facilitators should be able to follow the progress and performance of individual learners.

A similar case would be the use of the mentor-based training method. When the organisation has an expert in the area in which they want to train others, this method is very appropriate as the mentor will be able to help the other colleagues through his or her experience in the field.

When the training is focused on gaining knowledge in a more practical way, work-based training would be the most appropriate option. This type of training aims to bridge the gap between the academic world and the workplace, serving as a link between the two. It is a very appropriate idea for final-year students entering the sector, as it would provide them with the skills to better develop and adapt more quickly to the professional world. But it could also be useful for those workers who want to improve their skills.

Network learning training is more intended for those who want to develop a learning community for the professional development of workers or students, in which there is an interaction between professionals from different states, countries, companies or institutions for example, thanks to networking the social skills of the students increase, the relationships between organisations become stronger and new ideas emerge.

Experimental learning is a method to use when you want to trigger emotional reactions in learners. It is important that they are able to analyse their own reactions and develop strategies to manage or minimise them. It is an appropriate method when the aim is to increase the creativity and reflection of the learner, but less suitable when the objective of the training is the acquisition of knowledge, as in this case many of the previously mentioned methods will be more effective.

Finally, informal learning, which as the name suggests, is not based on any formal method. As this type of training is obtained in an informal way, it cannot be implemented; the trainees will obtain it through communication with other members of the company, university, etc. and their day-to-day actions.

The method to be chosen must be adapted to the needs of the training, since, as has been shown throughout the deliverable, each of the methodologies and tools is focused on obtaining specific objectives. Therefore, a previous analysis of the situation, a subsequent design of the methodology, a good development of this and an evaluation, in the cases where it is necessary, represent a series of necessary activities for a good development of the training.



5 BIBLIOGRAPHY

- Allcoat, D. v. (2018). Learning in virtual reality: Effects on performance, emotion and engagement. *Research in Learning Technology*, 26. doi:<http://dx.doi.org/10.25304/rtl.v26.2140>
- Arvanitis, T. N. (2007). . Human factors and qualitative pedagogical evaluation of a mobile augmented reality system for science education used by learners with physical disabilities. *Personal and Ubiquitous Computing*, 13, 243-250.
- Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments* 6, 355-385.
- Beijing Bluefocus E-Commerce Co., L. &. (2016). *A Case Study - The Impact of VR on Academic Performance*.
- Boud, D. C. (2002). Introduction: Making the move to peer learning, in *Peer Learning in Higher Education: Learning From & With Each Other*. Kogan Page Limited and Stylus Publishing Inc.
- Bronack, S. C. (2011). The role of immersive media in online education. *Journal of Continuing Higher Education*, 59, 113-117.
- Commission, E. (2013). *Building an overview in Apprenticeship and Traininship in Schemes in EU27: Key Success Factors*. Brussels: Directorate General for Employment, social Affairs and Inclusion.
- Cristina Almeida, L. M. (2013). Mobile learning methodology for European trainers and VET systems quality improvement.
- Dana Sitányiová, J. M. (2018). New Training Schemes for the Future Education in Railway Sector.
- FAO. (2021). *E-learning methodologies and good-practices: A guide for designing and delivering e-learning solutions from the FAO elearning Academy, second edition*. Rome. doi:<https://doi.org/10.4060/i2516e>
- Francisco Brazuelo Grund, D. J. (2011). *Mobile Learning. Los dispositivos móviles como recurso educativo*. Sevilla: MAD,SL.
- Gabriela Kiryakova, N. A. (n.d.). Gamification in Education .
- Giant, V. (2013). "Gamification" Techniques Increase Your Employees' Ability to Learn By 40%.
- Glover, I. (2013). Play as you lear: gamification as a technique for motivation learns. *World Conference on Educational Multimedia, Hypermedia and Telecommunications*. AACE.
- Goodyear, P. (2001). *Effective networked learnign in higher education: notes and guidelines*.
- Gros, B. (2016). The design of smart educational.
- Harm Tillema, G. J. (2015). *Mentoring for Learning "Climbing the Mountain"*. Sense Publishers.
- Johnson, L. F. (2010). Key emerging technologies for postsecondary education. *Education Digest*, 76, 34-38.
- Judy O'Neil, V. J. (2009). Peer Mentoring and Action Learning.
- Kapp, K. (2012). The gamification of learning intruction: game-based methods and strategies for trainint and education . *John Wiley & Sons*.
- Kerawalla, L. L. (2007). "Making it real": exploring the potential of augmented reality for teaching primary school science. *Virtual Reality*, 10, 163–174.



- Klopfer, E. &. (2008). Environmental detectives: the development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development*, 56, 203-228.
- Kukulska-Hulme, A. (2010). Mobile learnign as a catalyst for change. In *Open Learning: The Journal of Open and Distance Learning* (pp. pp. 181-185). UK: The Open University.
- Manuell Area Moreira, J. A. (2009). e-Learning: Enseñar y Aprender en Espacios Virtuales. In *Tecnología Educativa. La formación profesional en la era de Internet* (pp. 391-424).
- O'Malley, C. V. (n.d.). Guidelines for learning/teaching/tutoring in a mobile.
- Squire, K. &. (2007). Augmented reality simulations on handheld computers. *Journal of the Learning Sciences*, 16, 371-413.
- Squire, K. &. (2007). Mad city mystery: developing scientific argumentation skills with a place-based augmented reality game on handheld computers. *Journal of Science Education and Technology*, 16, 5-29.
- Stein, J. G. (2014). Essentials for Blended Learning: A Standard-Based.
- V. Mayer, K. S. (2013). Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt, Boston,.
- W. Hsin-Yuan Huang, D. S. (2013). Gamification of Education. Toronto: University of Toronto .
- Zhou, F. D. (2008). Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. *IEEE International Symposium on Mixed and Augmented Reality*, 15-18.