ASTONRAIL - Intellectual Output 4 - Approaches and teaching practices for rail skills development by subject area

November 2022

Marin Marinov

Reem Hadeed

Constant Iannacci

Aston University

Approaches and teaching practices for rail skills development by subject area

1) Rail safety and security

Current Delivery

Rail safety and security are two different subject areas although in many cases they are taught together, assuming there are overlaps. The current form of delivery includes in-class teaching. Learning activities are dominated by lectures. In addition to lectures, some courses also include short seminars and tutorials. To assess both the skills acquired and the knowledge gained, trainees must pass a closed book exam on campus.

The current delivery practice suggests that the student-teacher contact hours are adequate and that in-class teaching using well-structured lectures to introduce theoretical aspects, key standards, and operational rules to ensure safe and secure rail system performance are effective and beneficial.

In addition to in-class teaching, students benefit from lectures delivered remotely through online platforms.

In some cases when the form of delivery is linear meaning students attend a learning activity timetabled every week at the same time slot for the whole term, students can be given a specific task to complete on their own and be asked to present the outcome in class. Summative feedback is provided by tutor. Such tasks normally are not marked; however, they are helpful as they prepare students for their close book exams.

Changes in the current delivery

The number of lectures is to be reduced in favour of seminars and student-led teaching and learning activities.

Future Delivery

This subject area could benefit more from including Task based learning and Problem solving in the module T&L activities. Specifically, common problems related to violation of traffic rules and level crossing misuses can be set up and offered to student to analyse and solve. During a module students could be tasked to develop projects, both individual and group projects, to design rail vehicles when considering safety interior and crashworthiness requirements.

Alternative Form of Assessment

Any 2-hour closed book exam on campus in the end of a module could be replaced by a 24-hour open book online exam, during which students will be asked to answer 4 detailed questions out 6. Submission of exam of this kind should be online via a suitable platform.

A coursework based on a case study (group work) covering more professional learning outcomes. (Up to 2000 words) is also suggested. Ideally, each year the case study could be sponsored by a rail company. A prize for the best coursework could also be given to students. The "size" of the coursework task can depend on the module number of credits (15 credits: 2000 words).

2) Rail vehicles

Current Delivery

Rail Vehicles Dynamics, Technology, Maintenance, and the like are mainly taught at an MSc level (Level 7 in the UK). The current form of deliver includes a rather small group teaching, regular lectures, a course-long project task in parallel to lectures and study (technical) visit/field trips. These modules are complemented by invited/guest lecturers. Learning activities are centred on examining vehicle performance. Students benefit from 1) working in small groups which creates positive atmosphere for interactive learning, 2) field trips to relevant railway companies and the maintenance headquarters and 3) professional talks by specialists in the field in seminars focused on key points on vehicle dynamics, pantograph-catenary interaction, and superstructure maintenance.

Active learning is employed when 1) each student is tasked to review a paper about a recent research topic on railway technology and vehicle dynamics and discuss the key aspects learnt in class, and 2) students are invited to participate in a rail vehicles related event attended by professionals.

Learning outcome is assessed through a combination of methods including a closed books exam (normally 90 minutes), oral presentations (paper discussion) and project related/problem solving tasks. Participating in rail events with professionals, although highly beneficial, is not included in the assessment.

Changes in the current delivery

Participation in rail events with professionals is to be considered for assessing student knowledge. It would be considered as a bonus towards final assessment/mark.

Future Delivery

For future deliver a better synchronisation between lectures and project tasks is envisaged. This can be achieved by spreading the work more evenly throughout the term and/or by having Q&A sessions earlier on or more often. A requirement will be for lectures, exercises, and tasks to be more aligned.

The time dedicated to lectures can be reduced. More time can be made for practical exercises, Q&A sessions, advanced topics. This can be achieved by flipped classroom, but with a limited setup / amount of knowledge that is pre-recorded.

Short, pre-recorded videos on Key Concepts, about 10-15 minutes long can be offered to students prior to any learning sessions and actual lectures. The idea is for students to come prepared. This allows to start the activity directly with more advanced topics and use the time for more exercises and/or discussions, depending on the subject in question. This will promote Informal learning as YouTube channels with videos about relevant, specific, and additional information on vehicle dynamics can be used.

More and better hands-on mock-up models for studying different concepts are suggested to enhance the student experience. The design and creation of small physical setups that demonstrate key concepts such as equivalent conicity, guidance mechanisms, geometrical profile matching, stiff/flexible bogies, etc. are also recommended.

Students, as part of their studies, can be included in the delivery of a railway-based university project, complemented by more student-led/focused workshops/brainstorming sessions/flash hackathons with senior lecturers and professionals.

All individual student tasks could be organised in groups for students to improve their communication, collaboration, cooperation, and discussion skills. This will promote further active learning as “guide on the side” approach.

Activities in subject-specific research laboratories are of interest in the future for students to learn how to apply theoretical concepts and to acquire vehicle dynamics measurements. Research labs are expensive to set up, as a result some sort of simulation modelling computer-based programmes might be of interest as a substitute.

For teaching stuff and module tutors should prepare clear assessment guidance when new specific practical tasks are introduced. Such guidance should be communicated clearly to help students to prepare on time.

Alternative Form of Assessment

Project-related tasks can be emphasised further and given greater weight when assessing module learning outcome. For some specific areas an oral exam might be introduced to replace a written exam and vice versa. Promoting self-learning by favouring student’s natural curiosity with innovative/attractive maintenance challenges is of interest for subjects of this kind.

3) Rail Infrastructure

Current Delivery

Lectures are delivered to introduce key theoretical aspects (e.g., geometrical alignment, superstructure performances by typologies, constraints on operation, maintenance management, passengers' stations functions and layout, marshalling yards and other freight terminals operation, etc) to students. To enhance the student experience, a 50% coverage by extra-academic teachers from infrastructure managers and industries is offered to bring practical knowledge from the field.

In classroom practices targeting the application of concepts in wheel-rail contact, design, and rail operations, like rehabilitation of an existing line and constraints for operation joined with parallel approach to vehicles with final targets on capacity assessment and timetabling, are also included. The delivery is complemented by both seminars on ongoing research topics (by PhD students and/or teachers from other universities) and technical visits in groups to rail passenger stations with a focus on superstructure, layout, signalling, operation, and accessibility with students-to-students final presentation.

The assessment method includes an oral exam (part of the global exam on the module) including presentation of practices.

Changes in the current delivery

None.

Future Delivery

The delivery could be updated and enriched by introducing a *meddler in the middle* teacher role, namely a dedicated technical visit with task assignment to groups and a final 'students to students' presentation can be organised and included to enhance the student experience. Lectures can be delivered, not on campus, but during technical visits using a 1:1 physical example. More extra-academic teachers can be involved in the module delivery to bring practical experience from the field. It is also suggested for teachers from other universities to be systematically involved in a more osmotic multi-voice teaching.

Alternative Forms of Assessment

None.

4) Rail and the Environment

Current Delivery

Environmental impact assessment and related subjects are taught at post-MSc as part of Rail Infrastructures and Systems Engineering programmes.

Lectures in classroom learning are delivered to present students with key theoretical aspects (interaction between infrastructure and environmental systems, externalities and carbon footprint concepts, assessment of impacts during construction and operation, energy management by eco-driving and timetabling optimization) with 50% coverage by both professionals from infrastructure managers bringing practical experiences from the field and teachers from other universities. A specific learning practice includes an interactive assessment of carbon footprint by simulators. To assess learning outcome, an oral exam including presentation of practices is organised for every student.

Changes in the current delivery

Reduce the involvement of home lecturers in delivering talks and include more talks by guest lecturers from other universities.

Basic case study regarding environmental impact to be taught not only at post MSc level but at UG degree level as well.

Future Delivery

Systematic involvement of teachers from other universities in a more osmotic multi-voice teaching is recommended for future delivery.

Alternative Form of Assessment

None.

5) Rail Operations

Current Delivery

Rail operations-related subjects, like rail timetabling, planning, operations, slot allocation, signalling etc, are included in modules of both BSc degree programmes and MSc studies of railway engineering. In some East European HE institutions, e.g., UNIZA, such subjects can form a complete module.

Current form of delivery includes a set of in-class lectures, auditory exercises and seminars as well as lab-practice lessons. The lectures include real world examples to demonstrate the role, functionality and impact of different systems and methods of rail operations, signalling and control and to introduce key principles and processes for a safe rail operation encompassing all responsibilities and duties of signalmen, train crews and dispatchers.

Individual lessons offered by extra-academic teachers from the railway industry to bring practical experiences from the field are available. Students gain skills from practical exercises in rail operations laboratory equipped with original interlocking systems from different eras. Students also learn how to use IT applications to locate public transport vehicles as part of an Intermodal/Integrated Transport Control System (ITCS).

In addition to on campus learning activities, technical visits to different transportation companies with focus on transport operation control facilities are organised.

Existing static online platform (e.g., Moodle) is used for sharing learning material. There are possibilities for students to attend lectures remotely through dynamic online platforms.

Systematic student feedback is collected throughout the module delivery and used for continuous evaluation.

Learning outcome is assessed either by 1) two "open book" homework pieces (mini thesis) followed by a 1.5 hour written (closed book) exam on campus or by 2) a 30 min oral exam plus a case study for a public tender, short presentation of a “timely topic”, and successful practical performance in a rail operations laboratory.

Changes in the current delivery

None.

Future Delivery

The future delivery of such subjects can be improved by 1) including problem solving challenges in the module learning activities, 2) adding video materials that explains the theoretical and practical

side of rail operations, planning, slot allocation, etc 3) introducing railway simulation models in rail physical and online connecting laboratories for illustrating practices in different countries.

More student group work and interdisciplinary group work with students from other programmes (e.g., economics) can be envisaged to promote the development of team working skills. The outcome from group work should be presented in student seminars, where the lectures will act as a guide on the side.

More guest lecturers from other universities and the industry can be invited to contribute to some subject specific lectures/modules (e.g., on an international level to illustrate different philosophies for managing rail operations safely and securely and professionals with slot allocation background from railway companies and infrastructure managers for discussion session with students).

Module content could be more selective and elective giving students the opportunity to design their own curriculum.

Alternative Form of Assessment

In addition to the traditional forms of assessment, to enhance the overall student experience and confidence, self-assessment mock-up exams or similar can be organised through online learning platforms. Self- assessments of student knowledge and skills can be voluntary, as there is no need to be marked.

6) Rail Economics

Current Delivery

The subject of rail transport economics is currently delivered at BSc (Economics of railway transport 1, Economics of railway transport 2) and at MSc (Economics of railway transport 3).

A typical module structure includes a set of lectures (26 + 39 hours), practices (26 + 26 hours). Lectures provide an explanation of the issues using multimedia, with figures and graphs, demonstrations on example - economics and financial indicator on rail transport operators and rail transport infrastructure manager and example of rail investment projects.

Selective lectures with experts from industry (e.g., railway passenger and freight operators, rail infrastructure managers) are also included together with professional talks by specialists in the field focusing on key aspects of rail transport investment projects.

Students learn how to conduct comparative analyses of national and EU documents, directives, regulation, feasibility study and critical analyses of rail transport investment projects through desk top studies and PC work - search and information processing, calculation of economic indicators. Learning activities like in class discussions, brainstorming and brain-writing are organised in addition to student paper presentation on a predetermined theme.

Assessment of learning outcomes is done through work on individual assignments, written and oral exams, problem solving challenges, and oral presentation of the predefined theme.

Changes in the current delivery

None.

Future Delivery

Informal learning via online channels using YouTube and podcasts is recommended to improve future delivery. Student attendance in a scientific conference and guided activities to stimulate the students' interest in scientific information / results from available scientific databases are encouraged leading to publishable outcome individually and collectively as a result of proactive team working.

Alternative Form of Assessment

Instead of written exams, e.g., knowledge acquired can be assessed through oral Q&A sessions during which students ask and are asked to answer subject specific questions by a tutor. Tutor then evaluates the ability of each student to question and answer.

7) Rail Pricing, Ticketing and Access Charges

Current Delivery

Part of the Railway Transport Management theme, these subjects are more commonly taught in modules of MSc programmes, with some exceptions. Current form of delivery includes a set of lectures, auditory exercises, and seminars. For Ticketing e.g.: 10 hours lectures, 8 hours auditory exercises and 4 hours seminars. Learning activities are delivered on campus using traditional means like in class learning to present and discuss key theoretical aspects supported by real world examples. Students could use existing static online platforms (like Moodle) to share information and teaching material. Under specific circumstances, COVID 19 e.g., it was possible for students to attend the lectures remotely through common online platforms, like Teams, Zoom and Google rooms.

Changes in the current delivery

More use of Online platforms for informal learning.

Future Delivery

Lectures can be enriched by inviting and involving guest speakers from the industry and other universities. To enrich teaching material and to provide a better illustration of different practices adopted by different countries and rail administrations, the inclusion of short videos can be used by lecturers.

The seminars should encourage students to work in small groups and engage in provocative discussions leading to new approaches for pricing, ticketing and setting up access charges. Preferably these seminars should be student-led, meaning tutor's role should either be guide on the side or meddler in the middle.

In addition to on-campus learning activities, technical visits to the relevant departments of rail companies should be organised for students to familiarise themselves with the actual practice in the real world, feel the vibe of the professional environment and create a real sense of how it is done.

Alternative Form of Assessment

None.

8) Rail (passenger) service quality

Current Delivery

The topic of rail passenger transport service quality is included in BSc and MSc rail transport quality management programmes.

Current learning activities comprise a combination of methods. Specifically, 1) lectures introduce key concepts and theoretical frameworks, 2) Conceptual maps, Discussions, brainstorming sessions and Global 8D Method, 3) Practical exercises on personal computers - case studies, staging methods (role playing), problem solving, design of research questions, processing of research data, analysis of research data, and creation of written research report, 4) Individual work done in a laboratory, 5) student group projects.

The course delivery is complemented by professional talks during which specialists in the field elaborate on the practical aspects of service quality in railway transport, legislative background of quality approaches, methods of quality management used in practice.

Informal learning is also employed using online channels with short videos to introduce practical examples and technical aspects of the quality of passenger services.

The learning outcome is assessed through a closed book written exam centred on the methods of quality management in passenger transport service (duration is either 90 minutes or 120 minutes), oral presentations (paper discussion, where each student selects and presents in class a paper about a recent research topic on passenger service quality); and additional problem-solving tasks**.**

Changes in the current delivery

None.

Future Delivery

Form of delivery could be enriched and improved by: 1) Promoting self-learning by favouring student's natural curiosity with innovative/attractive challenges, 2) Encouraging students to engage in mystery-shopping when using a railway passenger service, 3) Involving more practitioners to bring valuable experience from the field, 4) Encouraging students' self-learning from foreign literature, and 5) organising systematic involvement of researchers from other universities/research centres to share knowledge and experience.

Alternative Form of Assessment

None.

9) Intermodal, with a focus on rail freight

Current Delivery

An example includes a twelve-hour MSc course being delivered in the 'pilot interdisciplinary university thematic courses' of a pan-European programme on Intermodal Transport.

The course comprises a set of lectures, in-class teaching with no compulsory assessment of learning outcome. The course content is limited to the production side linked to logistics, not connected to economic/legal aspects (e.g., market characteristics, demand, supply, regulation, etc.).

Changes in the current delivery

Compulsory assessment of learning outcome to be included. It could take a seminar-focused approach.

Future Delivery

The course should be delivered as a 6-credit full university module, and differentiated from railway transport-related programmes. Instead, it should be compulsory for Freight Transport-related programmes.

It is essential that students understand how to improve the output of intermodal transport and be aware of the different elements which compose it beyond the engineering terms. Such case study could consist, for instance, in requiring that the student finds out and describes the process of transporting a container unit from Valencia to Berlin.

Course content should be ameliorated to further cover: a) the different stakeholders within the Intermodal Transport production chain (e.g., shippers, forwarders, logistic providers, etc.), b) homologation and certification processes needed to overcome interoperability problems (e.g., standards definition), and c) different types of legal documents required.

Any module on Intermodal Transport should include field visits to different intermodal nodes.

Alternative Form of Assessment

The assessment of learning outcome should consist in preparing and presenting a practical case study as opposed to a conventional written exam.