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IO5 - TRANSFERABILITY GUIDE

ELIC

Engineering Literacy Online - Teachers as Medium for Change

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CRAMARS

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1. Introduction

This guide is the result of the work carried out by the ELIC Strategic Partnership (8 partners from Austria, Czech Republic, Germany and Italy) in the project entitled ELIC: Engineering Literacy Online - Teachers as Medium for Change within the framework of the European Union's Erasmus+ Programme Strategic Partnerships.

The guide focusses on the project framework, the learning resources developed, the evaluation results, lessons learned and possibilities to use the MOOC in the classroom. Furthermore, it contains information about the learning platform itself and options for transferability to other contexts.

This document is designed to be used by institutions interested in offering their teachers or recent graduates online learning resources to improve their engineering competences, which in turn should help them to develop an engineering mind set amongst pupils aged 15-18 with a view to increasing their interest in engineering professions. In particular, secondary school teachers of science, technology, engineering and mathematics (STEM) subjects, higher education institutions, but also other education providers (adult education, vocational training) are targeted.

2. Project Framework

The ELIC (Engineering Literacy Online - Teachers as Medium for Change) project has been funded with the support of the Erasmus+ Programme Strategic Partnerships and has been developed by eight international partners from four countries (Austria, Czech Republic, Germany, Italy).

The project consortium is composed of: FH JOANNEUM Gesellschaft mbH (AT), the coordinator, TU Ostrava (CZ), HS Düsseldorf (DE), Cramars (IT), ISCN – Austria, ISIS Fermo Solari (IT), BRG Kepler (AT), and PASCAL Gymnasium Grevenbroich (DE).

a. Background

"Serious shortages in qualified professionals and in technical job-specific skills are hampering Europe's sustainable growth objectives. "

This is particularly true for areas critical for innovation, in particular in Science, Technology, Engineering and Mathematics (STEM). Europe currently faces mainly qualitative labor shortages, which are caused by skills mismatch, functional mobility, preference or information mismatch.

Skills shortages are caused by technological change, recruitment rigidities, "wrong" choices in the fields of study chosen by students and the type of qualifications demanded by employers. Such shortages can be observed for low, medium and high-skilled jobs. However, in DE, AT, IT and the CZ such skills mismatches have been observed for high-skilled jobs.

Concerning differences across EU countries, the European Company Survey reveals that recruitment difficulties due to skills mismatch are particularly pronounced in AT (>60%) and less severe in HR, CY, GR or ES (<25%). A common characteristic of the selected countries is the specific shortage for high skilled technical occupations, namely engineering professionals.

Several Member States have developed good practices to alleviate their labour shortages. IT and DE try to attract young students from other Member States. Good practices in AT show that measures can greatly increase the number of students choosing an education needed by the labour market (guiding young people towards educational choices). Companies in the CZ are setting up projects between education and industry to align schools' programmes to the skills required by industry.

b. Why ELIC?

Europe is mainly confronted with qualitative shortages on the labour markets, linked to specific regions, skills or occupations. This project aims to ensure the availability of the right skills – and supports thereby a major concern of the European Commission and the Parliament (Strategy 2020 – Agenda for new skills and jobs) (European Parliament, Employment and Social Affairs, Labour Market Shortages in the European Union, 2015). In addition to the current deficits Europe is facing on the labour market, also learning and teaching methods are changing remarkably.

When considering the real learning needs, research revealed that technical skills and a stronger focus on engineering during secondary education are needed in all participating countries of ELIC. ELIC will

train secondary school teachers to improve their technical literacy. This in turn will increase the capability of teachers to convey technical aspects of engineering during natural sciences classes. ELIC tries to address the identified challenges concerning future oriented learning by focusing also on innovative learning and teaching methods (ICT) in natural sciences. The main aim is to increase interests in technical study programmes (and decrease barriers connected to natural sciences) and thereby motivate pupils to attend technical study programmes.

New information and communication technologies (ICT) transform how we learn and teach. The number of MOOCs as a supplement to traditional modes of education has exploded in recent years, thus this format was chosen as a means to deliver the technical content of the ELIC project.

c. Objectives

The main objectives of the ELIC project are to:

- Improve teachers´ technical literacy in the field of natural sciences by means of ICT

- Increase motivation to engage with engineering topics thereby attracting more pupils to engineering

- Impact the trainees´ competences heavily - it is assumed that 50% of teachers who completed the training will implement the knowledge gained straight after the training

- Impact the pupils´ interest in MOOCs, which are experiencing a recent upswing as an e-learning tool

- Adapt secondary school education to labour market needs and lead to a change in thinking

Due to high employability in the engineering sector in all participating countries, the improvement of technical skills is relevant transnationally. Resources can be pooled to achieve more impact on a national but also international level. Synergies can be used and learning across borders is highly recommended.

3. ELIC learning resources

The Engineering Literacy (ELIC) MOOC is an open educational resource (OER) aimed at secondary school teachers of science, technology, engineering and mathematics (STEM) subjects that provides multiple learning resources:

1. The online course ELIC MOOC addressing topics to help teachers to develop an engineering mind set amongst pupils aged 15-18 and increase their interest in engineering professions.
2. A content 'Toolbox'
3. Examples and experiments taken from automotive engineering
4. Assessment exercises to provide the final certification.

a. ELIC MOOC description

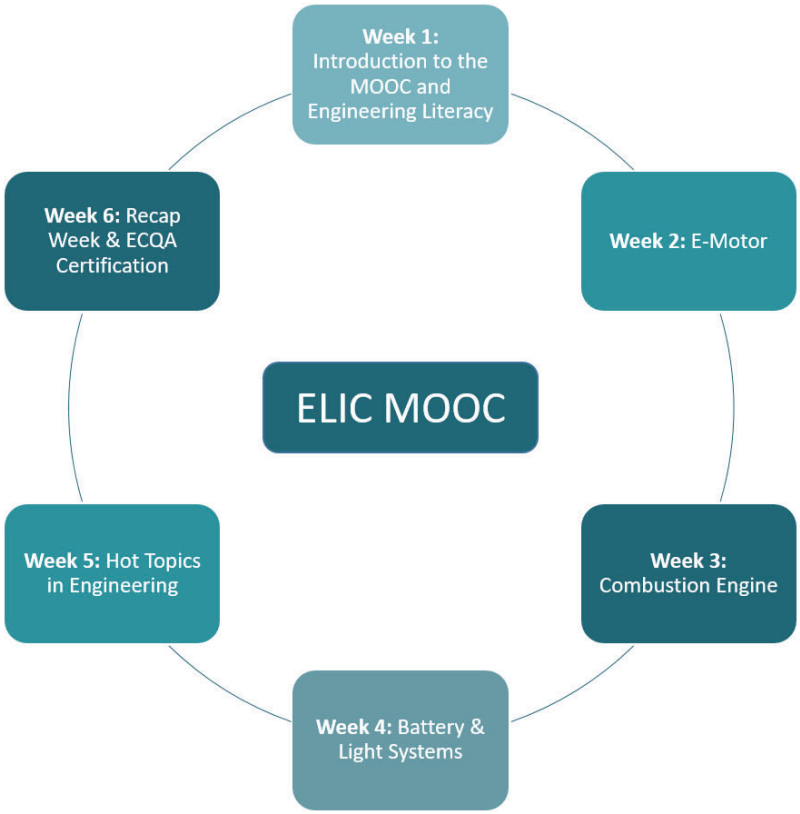
As part of the ELIC Project, the partners designed an open educational resource (OER) with the prime objective of improving students' interest in and access to STEM subjects as well as secondary school teachers' competences in terms of interdisciplinary methods and tools. These competences should help them to develop an engineering mindset amongst pupils aged 15-18, thereby increasing their interest in engineering professions.

The course is designed based on the competences and needs identified in the first stages of the project. The first step involved preliminary desk research divided into three categories, A, B and C. Categories A and B focused on secondary school teachers and examined further education and training as well as planned initiatives related to teaching interdisciplinary experiments for teachers, in particular in areas such as Electronics, Software, Mechanics, Mechatronics, Biochemistry, Renewable Energy among others. Category C was dedicated to the main competences specified in teaching plans at secondary schools with a focus on Chemistry, Physics, Biology, Mathematics, Computer Science and Electronics.

The focus group, run at national level, helped to identify whether teachers attend further training in the area of engineering literacy, if engineering literacy teaching content is interesting for secondary school teachers and is somehow already in place, and if the schools plan future initiatives for the implementation of engineering literacy.

The comparison of these elements represented the basis to define, nationally, the Needs and Gaps Report. This information was then shared among the partners, and based on these results the final Skills Card was developed.

With the core competences derived from the skill card in mind, the ELIC MOOC includes lessons structured around 6 modules delivered over 6 weeks which include examples and experiments from automotive engineering that are linked to content from different STEM subjects to show how knowledge of natural and technical sciences can be applied to real-world engineering issues:



In each week, facilitators provided learning materials and activities/assignments (e-tivities), including self-reflection and self-assessment exercises. At the same time moderators or conveners monitored the online learning process and actively supported teachers.

Teachers were able to participate in whichever modules were of interest to them.

Based on the experience of the 116 piloting learners, the full course required approximately 20 to 30 study hours.

Should the course be offered as part of a higher education institution's study curriculum, this would be equivalent to 1 ECTS. One ECTS credit point can equal on average between 25 and 30 study hours, depending on the country. For example, while in Italy 1 ECTS = 25 study hours, in Germany it is equal to 27 study hours.

b. Target groups

The ELIC MOOC is designed for two main target groups:

(1) Teachers of STEM-subjects for secondary school pupils (General Secondary School)

(2) Teachers of STEM-subjects for secondary school pupils (Secondary School with Natural Science Specialisation)

With the selected target groups and the didactical approach applied, the ELIC project aims to equip secondary school teachers with the adequate tools to present engineering topics in classes in an appealing way to students, while acting as multipliers and increasing the interest in engineering topics amongst pupils.

c. Expected outcomes

The main four outcomes of the project were:

1. The skill card
2. Training curriculum
3. MOOC to promote engineering literacy
4. Transferability and evaluation handbook

First, it was essential to develop a skill card in the frame of a competence matrix which defines the competences to be acquired during the planned training course in detail. The skill card is based on the European Qualification Framework (EQF) in order to comply with EU and the European Certification and Qualification Association (ECQA) quality standards.

The training curriculum developed includes descriptions of the different modules. The scientific /training partners FHJ, TUO, HSD and ISCN closely monitored all module descriptions in terms of content as it is essential that the curriculum meets European standards of education. The skill card as well as the training curriculum form the basis for the MOOC material development.

In a further step, the concept and the training materials for the MOOC were compiled. Here the experience of the different partners was the key factor in the development of the MOOC contents for the 30 training hours in each of the four partner countries. MOOC materials consisting of PPT slides, videos, etc. were designed to be used in the future to generate a multiplier effect.

Given the fact that the products generated in the course of the project may also be needed in other countries outside the consortium, it was essential that these products could also be transferred to other countries in an easy and effective way. Therefore, the consortium designed this transferability guide for the ELIC project to ensure that the training materials/products can be used outside the consortium to further promote STEM subjects as well as increase interest in engineering study programmes and engineering jobs at diverse levels.

d. Learning resources provided

The learning resources used in the ELIC MOOC include:

- Text-based material (OER; power point presentations, publications, articles, blogs, etc.)
- Lists of useful material and links for finding additional material to encourage the teachers to go beyond the required materials and investigate on their own
- Images: photos, screenshots, charts, graphs, illustrations, etc.
- Videos or links to audio recordings
- Free tools available on the web
- Teaching examples in the ELIC MOOC Toolbox

4. Results of the evaluation

To evaluate the piloting of the ELIC MOOC we followed the document *ELIC Evaluation Process* in which a questionnaire was provided and divided into seven main sections: participants' background information; course evaluation in general; overall layout; contents; activities; general aspects; open feedback and added value.

Answers came mainly from Austria and Italy. 75% of the respondents were men aged 36-55, teaching a variety of STEM subjects (just one participant teaches Art History), all targeting students aged 14-18+.

35.5% of the users stated that the platform is moderately or somewhat user-friendly, 83.3% attended all weeks. The time required to complete the course lay between 11 and 30 hours.

For the 33.3% of respondents the training contents conveyed new creative approaches (totally positive answers) but not many agreed that the content was relevant to their teaching subjects.

Comments concerning the material underlined that the approach is less multidisciplinary than expected. More didactic input and more tools for the toolbox would have been desirable. This is one of the reasons why the consortium proposes to better prepare teachers to participate in the MOOC, as the course was intended to encourage participants to reflect on and develop the multidisciplinary didactical approach themselves later, not to provide readymade solutions.

The assignments in Week 5 were the ones that best enabled teachers to understand the learning material included. Videos, images, tables and recommended reading got a good score, quizzes were less popular in the evaluation. Weeks 4 and 5 were deemed most interesting.

The course was provided in English and participants involved in the course came from Austria, the Czech Republic, Germany and Italy. Response levels may have been affected by the choice of English as the project language, thus it was agreed to translate summaries of the content into the national languages to aid understanding.

For most of the participants there are topics that need to be improved especially in Weeks 2 and 4. Detailed suggestions came from questions 24.2, 29, 30 and 33 but comments are too technical and specific to provide a summary here. Of course, these comments were taken into account and contents were adapted accordingly.

Especially the Battery Systems module provided best links between natural sciences and their application in engineering fields in industry. 54.2% of participating teachers posted teaching ideas/materials and they considered the platform very useful for this purpose as well as for the transfer of knowledge and ideas.

The general evaluation of the MOOC was good. It also provided essential feedback regarding technical issues which was then implemented to improve the course.

The facilitators and moderators had the opportunity to evaluate the MOOC anonymously via a questionnaire. Suggestions for improvement are included in the section below "5. Lessons learned", in

the following we want to highlight the positive comments from the facilitators and moderators on the MOOC:

- *Everyone did its best in the given environment and circumstances.*
- *Thank you all for your hard work and collaboration before and during the MOOC.*
- *I think we have learned a lot! Considering it is the first project of this kind that we have done, the end product is acceptable. But there is room for improvement.*
- *Very interesting project.*
- *In general, everything worked well and brought some new aspects like how difficult it can be to simplify technical content for lower grades and untrained people.*

5. Lessons learned

In order to take stock of the lessons learned, at the end of the piloting phase and during the last project meeting, the partners were able to elaborate an internal evaluation of the work carried out in a recap workshop by answering the questions:

- What worked well?
- Which difficulties were encountered?
- What could be improved in the preparation phase?
    - Topics
    - Structure of the MOOC
    - Design of the MOOC
    - Guidelines for facilitators
    - Time management
    - Copyright
    - Dissemination of the MOOC / reaching the target group
    - Technical issues
- What could be improved in the implementation phase?
    - Work load for facilitators / moderators prior and during the MOOC
    - Hosting / maintenance of the MOOC
- What could be improved in the final phase?
    - Evaluation
    - Certification

Preparation phase:

The partners chose a good range of implemented topics in the MOOC. The structure was found to be usable and easy to understand, but probably too long - 4 weeks would be sufficient. Some feedback suggested using assignments such as online questionnaires/quizzes as a way to replace the forum and to involve participants in content learning. This comment also applies to the MOOC design, together with a proposal to shorten the introduction. It was really important to define guidelines for facilitators since this type of online exchange is not common in all institutions. The comments referring to the availability of budget for the development of the contents suggest to propose a higher amount of budget especially for the development of content and the toolbox, as well as translation of the content. The timetable foreseen by the project did not allow partners to spend more time on developing content. It should also be taken into consideration that, at certain times in the school year, teachers are too busy with exams or curricular activities or absent for mandatory holidays and therefore do not have time to participate in such a MOOC. Furthermore, it was suggested that it would be better to choose another starting day for the week's module (not Sunday). The amount of time required for researching copyright issues was originally underestimated by the partners. For the piloting phase, the dissemination was very important, thus secondary institutions were included as direct partners. Unfortunately, as in all schools, teachers are really busy during the year and participation in the piloting phase was an added burden on their already busy schedules. To ensure stable maintenance of the MOOC, a technician should be involved in the moderated phase of a MOOC. Further, to develop

appealing videos and presentations one should consider to involve experts in these fields into the project.

Implementation phase:

As regards the implementation, the workload for facilitators was very demanding especially prior to the MOOC implementation. During the MOOC moderation the facilitators did not encounter any difficulties during the MOOC even though MOOC users had the possibility to organize themselves freely and have access to online contents 24 hours a day, 7 days a week. In fact, this allowed the teachers to experiment with the contents at night or during weekends and facilitators were able to provide answers without limiting the training of participants. There were no prescribed rules for moderators, which gave rise to free interaction between them and the participants. In terms of the hosting / maintenance of the MOOC, there were no problems regarding the browser. Some teachers experienced difficulties regarding login and logout, but these issues were immediately solved by the system technicians assigned by FHJ.

Final phase:

The final week of the 6-week MOOC was reserved for evaluation and certification. Evaluation and certification questionnaires were only made available during this last week, which may have limited participation by those who were only interested in specific weeks/topics of the course. Participants appeared to be reluctant to take the final certification exam, perhaps due to the fact that it is certified by an external body or because they were not confident in their grasp of the subjects dealt with. As a result, few participants completed the final certification.

Based on the overall results of the projects, feedback collected in the lessons-learned workshop during the meeting in Graz involving all project partners, and the anonymous evaluation of the MOOC by facilitators and moderators, the following section proposes improvements which may prove useful for the development of subsequent courses made available on MOOC platforms.

- Arrange synchronous tutorials or working groups involving both universities and secondary schools, to better tailor the course contents to the curricular needs of secondary schools.
- Prepare content (lessons) for teachers.
- Workload for teachers maybe too high, shorten the MOOC.
- Introduce new didactical approaches for teachers / students and prepare more ready-to-use material.
- Provide a glossary of key (technical) terms for each week to overcome potential barriers to understanding.
- Adjust the MOOC starting time according to the teachers' availability
- Open the platform for teachers to interact with each other, to give some added feedback, share tools or upload useful materials themselves.
- Give teachers the opportunity to ask questions privately to the moderators / facilitators, by means of a private forum or direct messaging, for example.
- Provide a summary of the questions that were similar, with main points of the day, giving tips at the end of the day (FAQ page).
- Prepare teachers better for participation in the MOOC.
- Disseminate the MOOC with support from school principals

- Give some motivation, e.g. specific certification at national level, in order to involve teachers
- Develop an evaluation and certification system individually for each scheduled week
- Find out a way to make the certification and the final exam more useful for participants, i.e. to have it officially recognized at national level as part of continuing education.
- Dedicate more time to content development.

6. Possibilities to use the MOOC in the classroom

Some teachers involved in the project and after dealing with the ELIC MOOC piloting phase, experimented and/or planned a practical phase, following the course contents. Here are four examples of possibilities for further developing materials delivered via the MOOC for use in the classroom.

AUSTRIA - Project Electromobility - 10 Lessons teaching, 8th grade, science lab – The foreseen sequence was taught to a group within the topic science lab (Naturwissenschaftliches Labor) at the BRG Kepler Graz, in den 2nd semester 2018/19 (March – June), with a group of 12 students, age 14. With one hour per week we had about 12 hours at our disposal, and 2 hours for the visit to the FH Joanneum. The students had to collect their results in a portfolio. The outcome of one student shows the content in detail and the used MOOC materials (mostly in German).
AUSTRIA – provided the link with the content developed that could be easily followed at https://padlet.com/migu04/iep7dsg1jr4x.
GERMANY - Social and Environmental Impact of Internal Combustion Engines. Aims are to: discover pros and contras of the utilisation of ICEs; examine their social impact; examine their environmental impact; and discover possible future trends. The example was experimented by using contents included in the PowerPoint presentation of „Module 3 – Internal Combustion Engines (ICE); Lesson 5 – Social and Environmental Impact of ICE“.
ITALY - New mobility - Awareness and choices. The aim of the lesson is to make students conscious of the debate concerning a new sustainable model of mobility. Therefore, it is important to know the current way of producing energy based on fossil fuels and to be aware of the dangers of the global pollution and its effects on humans and the environment. The knowledge of the technical aspects related to that topic is achieved by getting specific skills in physics, chemistry, mathematics and biology within the geographical, political, economic and social context of our present status. It’s important to pay particular attention to the notions of raw material, source of energy, energy carrier and energy density applied to the current mobility system and related to the potential and the critical aspects of the E-mobility.

One of the aims of ELIC MOOC was also to make the teachers talk about their experiences and to use the course, in its forum activity, as a tool for exchanging good practices and contents. In addition to the experiments carried out by the teachers in the classroom, we collected a long list of tools available as online open resources that we have made available to the participants in the Toolbox at http://www.elic-mooc.com/?page_id=1107

7. ELIC Learning platform – MOOC

a. About the platform

The ELIC MOOC was created using the Content Management System (CMS) "Wordpress" (free download from https://wordpress.org/download/). The platform is updated on a regular basis, thus the version number changes regularly. The current version is 5.2.2, as of August 2019.

The Wordpress CMS is hosted on a Linux Server at FH JOANNEUM Gesellschaft mbH which is maintained by the Central IT Services department, using an Apache Webserver and a MySQL database. The Wordpress installation is maintained by the Institute of Automotive Engineering at FH JOANNEUM Gesellschaft mbH.

The active Wordpress theme is "Twenty Sixteen".

The following plugins have been installed to ensure stable maintenance of the MOOC:

- Akismet Anti-Spam
- Better Search Replace
- Gutenberg
- H5P
- Pie Register - Custom Registration Form and User Login
- UpdraftPlus - Backup/Restore
- WP GDPR Compliance
- WP Statistics

b. Quality procedures and guidelines

Before the active MOOC phase

The most important step before putting the MOOC online is to guarantee safety for the subscribers regarding data protection and further usage of MOOC content. The imprint of the MOOC shall contain strict rules complying with GDPR (General Data Protection Regulation) of the European Union and licensing of MOOC content.

The layout and usability of the MOOC were tested by the IT experts of FH JOANNEUM, as well as the project partners prior to the start of the MOOC. The content and design were updated on a regular basis to ensure that the MOOC was ready to go on the proposed starting date.

During the MOOC implementation

The technical and MOOC experts from FH JOANNEUM were available during the active MOOC to promptly react to requests from the subscribers as well as the facilitators and moderators.

The project team tried to implement feedback from subscribers as soon as possible. As an example, one subscriber asked for the transcripts of the videos in MOOC week 3, which were uploaded 3 days following to the request.

With these measures the project team tried to guarantee optimum quality of MOOC implementation and content.

After the MOOC implementation

The forums of the MOOC shall be open until end of 2019, meaning that the project coordinator is responsible for the regular review of the MOOC forums. As long as the forum is open, the quality of the comments and forum content shall be monitored. In January 2020 the forums will be closed and the MOOC will stay online as a static webpage. The content can be downloaded at any time, the forum content is visible, but subscribers as well as moderators and facilitators cannot interact in the forum anymore.

The data of the subscribers will be stored until end of 2020, if there are no other obligations of the funding agency.

Until 2021, all data from subscribers as well as forum contributions from all registered persons will be discarded. The MOOC contents will stay online.

c. How to transfer the MOOC – pre-conditions

Technical Pre-conditions

Wordpress can be hosted on nearly every server, however, if the site should be public, the server must have an official IP-Address (preferably IPv4 and IPv6). Detailed installation instructions are available from the Wordpress website. As an alternative to self-hosting one can make use of maintained Wordpress installations from commercial hosting providers.

Currently, the ELIC MOOC uses approx. 100 MB web space.

Expertise needed

- IT experts for server hosting and development in Wordpress, or transferring the MOOC to another server
- MOOC expert for developing the design and structure of the MOOC (should work together with the IT expert for Wordpress development)
- Experts for MOOC content development
- Staff familiar with online moderation
- Person familiar with data protection
- Legal expertise for copyright issues, imprint of the MOOC, licensing

Transferring the MOOC to another server

To transfer the MOOC to another server, the following steps would be necessary:

- Install the server with the necessary software (e.g. a Linux server, with an Apache webserver and the programming language PHP (with the required PHP modules) and a database (since currently a MySQL database is used, the same database on the new server is recommended)
- Create a virtual host and copy the data from the web space to the new server.
- Create a database and insert the data from a database dump from the old server (e.g. using Adminer or PHPmyadmin)
- Adjust the database configuration in wp-config.php

- Log in to Wordpress and check (and maybe change) the Wordpress address and site address in the settings (if the URL has changed)
- Check if absolute references to the old site address exist (by using a database dump) and change them in the database (using a tool like Adminer or PHPmyadmin).
- When the site is running on the new server, check the log files for error messages.
- Current Wordpress version include a 'Site health' tool (Tools→ Site health) where one can check for recommended improvements.

d. How to access the platform?

Administrators, Facilitators, Moderators

After the registration with a username, a password and the email address, the administrators, facilitators and moderators are able to access the so-called dashboard of the platform through allocation of admin or editor rights to them by the responsible technical expert. With admin or editor rights at the dashboard, people can create the front-end of the MOOC and manage the content via uploading of content (presentations, videos etc.), writing of text passages in the MOOC weeks and writing of posts at the home sub-page.

Learners

Learners can access the platform via a short registration with a username, a password and the email address. All new registrants receive the status of a subscriber, which allows them to view the MOOC contents (after login) and to post comments in the weekly forum and the assignments forums. Subscribers cannot enter the dashboard to alter the content or gain access to the list of subscribers.

e. Technical support

Technical support is needed during development, implementation, moderation and "afterlife" of the MOOC. The IT expert responsible for server hosting and maintenance of the Wordpress platform shall especially be available during the moderated time of the MOOC to ensure stability, smooth execution and security during the active MOOC.

f. Certification criteria

The test and certification of the ELIC MOOC is based on three main criteria:

1. Life Long Learning Strategy
   The European Commission and the Erasmus+ program emphasise the continuous education of teachers. The member states are asked to support this program and, for example, cities like Berlin started a mandatory continuous training program for teachers where teachers receive points. See https://www.news4teachers.de/2017/07/fortbildungen-punktekonto-fuer-jeden-lehrer-und-die-schulleitung-solls-kontrollieren-gew-buerokratiemonster/ .

2. Certification Approach
   European recognition requires certification based on a comparable scheme. This means that teachers across all regions of Europe will have a same type of exam for the same set of skills and the certificate will be the same across all regions.

For that reason, an ISO 17024 international standard for personal certification regulates how such exams shall be organised and that the exam body shall be separate from the training body. Also European certification platforms (e.g. ECQA European Certification and Qualification Association) developed exams and mapped them onto the ISO 17024 criteria.
In ELIC the ECQA certification system has been adapted (update of software programs of ECQA) to support MOOC based exams and certification. Attendees can register, do the exam and the certificate is generated and sent by email to the person.

3. Value of the Certificate
   ECQA provides a certificate which is based on ISO 17024 guidelines and is comparable across all European regions. ECQA certificates are used in various cases aleady (Certified Terminology Manager for all translators in the European Commission, Certified Functional Safety Manager for the automotive industry, innovative teacher certificates issued in Austria, Hungary, Solvenia, etc.).

Participants can register for and take the exam at :
https://www.ecqa.org/index.php?id=58&domain_id=123&organisation_id=191

European countries have different laws concerning certificates. The European Lisbon Treaty (2010) asked the member states to work on continuous learning programs for teachers and left the control of it to national states. This effectively means that it is a free choice for teachers to do the exam and receive a certificate.

8. Transferability options

In order to define the possible transferability options of the project contents, various actions have been implemented by project partners. We mainly organized: monitoring activities; collection of feedback from partners and participants of the project; options and opinions exchange meetings; targeted workshops. In the last phase of the project we involved a group of possible stakeholders, hereinafter the list, who could ensure a continuation of the activities carried out by ELIC. In addition, each partner has thought about how to support the project in the future. Finally, we have defined some possible general scenarios on how to ensure sustainability of the project outcomes.

a. Supporting letters by stakeholders

Following the guidelines provided by the document “ELIC Evaluation Process”, the project partners involved a list of stakeholders that are believed to be useful to support work done and to develop it in the future. Wherever possible, letters of support were sought by the stakeholders.
Below is the list of actors involved in the various countries.

b. Follow up activities by partners

The universities and secondary schools involved, will endeavour to include the online course and related materials in their own curricula/courses during the 2019-2020 academic/school year, either as part of a subject or as a complementary stand-alone programme offered. The course will be offered, at least, in English and in the partner's local language.

FH JOANNEUM

FH JOANNEUM (FHJ) will integrate the ELIC MOOC in the currently developed Moodle platform for FHJ e-learning courses. The ELIC MOOC will be available for the public as a DIY (Do It Yourself) online course. Additionally, FHJ could consider offering a revised second version of the MOOC with moderation and slight revision according to the feedback given in the piloting phase of the MOOC. Further MOOC platforms could be considered to enable a wider group of people to increase their knowledge of engineering (e.g. iMooX), however, the integration of MOOCs in larger MOOC platforms entails costs.

Parts of the developed MOOC content (e.g. videos on combustion engines) can be used during information events like the Open House Day of FHJ to attract pupils to a career in automotive engineering.

TU OSTRAVA

VSB-TUO will continue to support the ELIC MOOC by promoting it to its partners at a regional level to secondary schools and regional offices and organisations, at a national level in cooperation with the National Institute for Education and other institutions, as well as at a European level through university networks and also through partnerships within the DRIVES project, which is the blueprint project under the New Skills Agenda in the EU, and where VSB-TUO is project coordinator. The focus of the MOOC on the automotive sector strongly underlines the university's focus and expertise. As the automotive sector is rapidly evolving, VSB-TUO would like to continuously update the content of the MOOC together with other ELIC partners to ensure it is up to date and in line with the latest developments to facilitate direct access to the latest knowledge and information in this field and to promote engineering literacy.

HS DÜSSELDORF

HS Düsseldorf defined two different possibilities in terms of the project follow up. The first is related to pupils as a target group: the idea is to design an online training program, where (good) pupils, interested in STEM subjects, can do exercises, conducted by university/industry and can – if successfully completed- gain points which can then be (if possible) transferred to credits at the universities, if the pupils decide to start studying at the partner university. (Benefit for the pupils: challenged with real scientific exercises, gain ECTS credits in advance; Benefit for the university: already establish good contact to good and interested pupils and have the chance to gain them as future students).

The second possibility could be to hire an expert/researcher to design several lessons, where an expert from university/industry can be hired by a school and takes over a lesson at the school. Ideally brings

along some experiments (toolbox). The topics can actually be taken from ELIC. The teachers really liked that idea because they will get a break from teaching, receive the latest up to date science knowledge ideally supported by experiments. The students will also receive a break from the general teaching and get input from current industry/university research, which might support their wish to study an engineering subject.

CRAMARS

Cramars, is an adult training institution which focuses on the development of skills of a transversal nature or of specific professional skills necessary for job seekers in the reference area of the institution. Although engineering literacy is not the main focus of Cramars, the content developed within the ELIC MOOC and all best practices described will be very useful for people who have not finished their studies or who have just finished secondary school and have a specific need to gain knowledge and skills required by companies such as the company Automotive Lighting based in Tolmezzo. For this reason, Cramars will use the teaching materials and examples available online within its training courses for young adults and share them with local high and secondary schools, regional training institutions for adults, collaborating universities, as well as local stakeholders involved in training at company hubs. The main aim is to facilitate the understanding and the implementation of STEM subjects, which represent a significant obstacle and are one of the reasons why many secondary school students do not finish their studies.

ISCN – Austria

ISCN is a member of the largest Erasmus skills alliance, DRIVES, where future skills for the automotive industry are developed under the leadership of the European Automobile Manufacturers' Association (ACEA). FH JOANNEUM (project leader) and TU Ostrava are part of that alliance too. The suggestion from ISCN is to integrate ELIC into the DRIVES platform to promote it to manufacturers and schools.
ECQA is the certifier in DRIVES and the institution would move the ELIC course to the ECQA learning platforms.

ISIS FERMO SOLARI

ISIS Fermo Solari is part of a network of schools and companies that promotes industry 4.0 and automation. It will continue to promote the ELIC project at other institutes in the area and to disseminate, in collaboration with local companies in the sector, the engineering and scientific culture. At our institute an Automation and Industry 4.0 laboratory (LABMEC 4.0) has recently been set up in which we will host laboratories and workshops with companies and other schools. This will be a workshop that will certainly apply the multidisciplinary concepts developed by the ELIC project, thus continuing to spread the message and pursue the objectives of ELIC: technological innovation, sustainability and ethics, and development awareness.

BRG KEPLER

The teachers of the BRG Kepler institute, following their participation in the ELIC MOOC, have already implemented some experiments in the classroom, which have been widely successful, the contents of which are part of the ELIC Toolbox.

As for the continuation, the institute has already planned, for the next school year, to use the materials and suggestions coming from the MOOC on; use of experimental equipment (electricity, batteries, motors) that the institute can afford to finance within the project in physics and chemistry lessons; development of its own engine test bench, to measure the efficiency factors of electric and combustion engines; application of teaching materials and parts of the MOOC, in particular in NWL (Naturwissenschaftliches Labor).

These implementation programs over time and after some laboratory experiments may become a practice of continuous use in and by the institute's teachers.

PASCAL GYMNASIUM GREVENBROICH

Representatives of PASCAL Gymnasium are planning to inform the science teachers about the ELIC materials during a teachers' meeting at the beginning of the next school year. They will be informed about how to work with the materials during their lessons, how to work with the tablets (that were paid by the project) in class so that pupils, for example, can do their own research concerning the automotive topics. Teachers will get an inspiration from the best practice examples provided in the MOOC.

The institution will implement the matching topics in each specific school internal curriculum (physics, computer science, chemistry). When teachers plan their lessons using the school internal curriculum, they get ideas on how to use the materials and may be motivated to take a deeper look into the project. In the curriculum it is possible to insert links to the videos, for example, or add hints on materials that were developed by the project. This process has been anticipated by putting the digital materials on the school server so teachers can find tools easily. In addition, Pascal Gymnasium hopes to intensify the partnership with the Hochschule Düsseldorf for the benefit of all students.

c. How to ensure sustainability of the project outcomes?

ELIC MOOC resources developed in the framework of the project will be available until the project ending (September 2019) from the hosting learning platform (http://www.elic-mooc.com).

ELIC MOOC resources are licensed under Creative Common Attribution CC-BY-NC-SA 4.0-license or any other suitable license as permitted by Art 4.1 of the Intellectual Property Rights Agreement signed by the ELIC partnership.

Universities, secondary schools and other teaching centres will be invited to include the ELIC MOOC contents as part of a curriculum or as a complementary program for STEM teachers. As the ELIC MOOC may be taken in self-access form, they could also develop a recognition plan to incorporate the course into regular programs.

Teachers will also be encouraged to use the course in order to complete or reinforce the examples in STEM classes and/or to better raise their students' awareness of and interest in STEM subjects.

In order to implement and use the ELIC MOOC, universities and secondary institutions have three options:

1. **Option 1: An institution member of the ELIC project keeps using the current setting at http://www.elic-mooc.com.**
   FH Joanneum keeps the access to the ELIC MOOC (OER) in English and the summaries into German, Czech, Italian. This support from FH Joanneum will consist of free hosting and access to the course, with no further educational or ICT support beyond that provided by a specific project partner. Any partner can use the course through the FH Joanneum service.
2. **Option 2: An institution (from outside or inside the project consortium) sets up their own Learning Management System (LMS)**
   FH Joanneum provides a learning content package, ready to be downloaded and imported into another setting. Any institution inside or outside the project will be able to follow this scenario because it would just need a link to get access to the Moodle platform and there, institutions interested, can download the content. The registration, as well as other aspects such as users, roles, statistics, etc. will depend on the institution that imports it. The access link could be disseminated via the ELIC website, Facebook and the MOOC itself.
3. **Option 3: An external individual request to use the ELIC MOOC**
   With no further installation individual users can register in the ELIC MOOC and can follow it at their own pace, by running all activities. They can contact the project coordinator for further instructions, contact the partner university directly or access the MOOC through **http://www.elic-mooc.com.**

Finally, the project partners have the following additional suggestions for improving the transferability of the ELIC MOOC and involving further stakeholders:

- read the transferability guide
- identify funding for adapting the content to national needs (including translations)
- allow teachers to update materials themselves
- transfer contents to mobile devices and international networks (e.g. online platforms such as Science on Stage www.scientix.eu)
- provide, for the next users, a description of the MOOC with a list of recommendations and suggestions on how to build one
- provide translated material in national language (in addition to the ones foreseen by the project)
- give teachers new ideas on how to teach STEM subjects, providing a pedagogical section with tips and suggestions
- improve the toolbox
- hold meetings and participate at conferences to find further stakeholders
- get into contact with big companies to present the project
- present the project in schools
- develop other projects with school partners
- select new target groups in countries that are new to the MOOC concept and focus on presenting the project there
- organize further training of STEM teachers on the MOOC

Moreover, the concept to multiply ELIC MOOC assumes a new round of funding and new project partners for ELIC. Partners would be taken from existing university partnerships (e.g. Finland, France, Slovakia, etc.) and shall bring school partners with them into the project. Training courses shall be

implemented in each country, with specialists (facilitators and moderators from the first round of ELIC) acting as multipliers and training new moderators and facilitators (from the new partner universities and schools).

Training courses would take place in predefined locations throughout the project over a 12-month period. For example, the first training could focus on the MOOC and technical aspects of setting it up and running it, as well as the didactics of the format (with the training led by experts from both the technical and pedagogical side). The remaining training courses would focus on the content and trainers from each of the weeks would be responsible for disseminating practices and experiences from teaching that content (as well as plans to improve the content in conjunction with the new partners).

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9. ELIC partners and contacts

FH | JOANNEUM
Fahrzeugtechnik /
Automotive Engineering

FH JOANNEUM Gesellschaft mbH, Graz - Austria

FH JOANNEUM University of Applied Sciences was established in 1995. With its more than 40 degree programmes in the areas of Applied Computer Sciences, Engineering, Health Studies, Building, Energy & Society, Media & Design and Management, FH JOANNEUM is one of the leading universities of applied sciences (FHs) in Austria. FH JOANNEUM offers students sound academic training – our programmes are practice-oriented, project-based and interdisciplinary. We work in close cooperation with business and industry to put acquired knowledge into practice; we develop innovative solutions for topical issues in applied research projects and forge links to related disciplines. Our university's large network enables students to complete internships with leading companies and institutions and spend a semester studying at one of more than 200 partner universities around the world.

FHJ is one of the first universities of applied sciences in Austria to extend its quality management system with the European Foundation for Quality Management (EFQM) model. The entire university achieved the second level 'Recognised for Excellence' in 2016.

Research and development are a core area of activity for FHJ. As a university of applied sciences, FHJ carries out research with the aim of contributing to social development and solving complex problems and issues of our time. The applied research offered by FHJ ranges from the transfer of results from basic research to innovative services and developments. This ensures a close link between research and teaching and a high relevance for practical application. We see modern research as a multidisciplinary mission to be fulfilled not only within the individual institutes but also within and across the six departments.

FH JOANNEUM has already participated in a large number of EU projects as coordinator and partner. Therefore, the organization can rely on many years of experience and highly qualified staff when it comes to national and international projects. The activities range from Development of Training Materials, Social Media, and Internationalization through Regional Development, Entrepreneurship & Intercultural Competences to Quality Management in HE and Labour Market Policy Instruments.

The Institute of Automotive Engineering is part of the Department of Engineering. True to its motto "Dynamics starts in the head", learning, teaching and research take place in a practical and international context. One good example of this is the 'joanneum racing graz' project which is carried out as part of the Formula Student competition.

Our R&D activities follow a three-pronged approach: analysis and calculation, numerical simulation and measurement, testing and experiments. Research is focused on the overall vehicle. The Institute is equipped with state-of-the-art testing facilities and cutting-edge design and simulation tools.

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VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

TU, OSTRAVA – Czech Republic

VSB-Technical University of Ostrava (VSB-TUO) was founded in 1849, and has since grown into a modern institution, which provides tertiary education, offering the highest levels of education in technical and economic branches of study, based on the interconnection of science, research, education, and the creative activity that binds and enhances them. The University cooperates with educational and research institutions worldwide.

VSB-TUO is the fourth largest university in the Czech Republic with approx. 12,000 students studying in bachelor's, master's and doctoral degree programs in seven faculties and two all-University study programmes. University is awarded by the prestigious ECTS Label, a mark of the quality of implementation of the credit system in bachelor and master study programmes according to European standards. This label ensures that our administration of international students has undergone rigorous examination by an agency of the European Commission in order to receive this Label. VSB-TUO has more than one hundred accredited educational programmes.

Research and Development connected to education are integral to the activities at VSB-TUO. Our focus on applied research and close cooperation with industry informs the teaching activities at the University, ensuring relevance in a dynamic international scientific environment. The fact that we are one of the most successful universities in the utilization of European structural funds focused on research is not a coincidence. We are utilizing our excellent position in six areas to develop science and research for the future through the Centre of Excellence IT for Innovations, and other top centres. Through its institutes and faculties, the university is the member of PRACE, EFFRA, and other European and global professional alliances. VSB-TUO is one of the most successful Czech organizations concerning the national and international (European) funds focused on both education and research. It has been participating in a number of European (FP7, H2020, Erasmus+) projects as a partner or coordinator.

Faculty of Electrical Engineering and Computer Science of VSB-TUO

The ELIC project was implemented at the Faculty of Electrical Engineering and Computer Science (FEECS). It consists of approx. 2300 students and 420 employees. FEECS is one of the few faculties in the Czech Republic that tightly integrate the expertise in electrical engineering and computer science, resulting in a multi-disciplinary research environment that fosters both basic and applied research. It is the leading faculty of VSB-TUO in terms of research performance and has a wide international network of collaborating organizations.

The Faculty has become an important factor in restructuring the Ostrava region, which is largely focused on the automotive industry, electrical engineering and information technology. Co-operation with other academic, commercial and state institutions is relatively wide and it is interconnected with the teaching and specialized work of the teachers and students. The Faculty provides good quality education corresponding to European standards. All fields of study are also accredited in the English language.

The Faculty has succeeded in obtaining grants for large and interesting research and development projects, and educational projects as well. A number of the applied research and educational projects, solving problems in individual electrical engineering and information technology fields of study, is dominated by IT4Innovations - the Centre of Excellence and regional research Centre ENET. EU Blueprint project in Automotive sector – DRIVES is coordinated from FEECS. The faculty, also in cooperation with other VSB-TUO institutes and partners, is actively working, by numerous successful projects and activities, in science and technology popularisation at all levels, from early childhood education and care to lifelong learning.

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Hochschule Düsseldorf (HSD), Germany

Hochschule Düsseldorf, University of Applied Sciences (HSD for short) was founded on 1 August 1971 by combining several renowned regional educational institutions. Today, the institution is one of the largest universities of applied sciences in the German Federal State of North Rhine-Westphalia and offers a comprehensive and interdisciplinary range of subjects. Approximately 10.000 students are taught in 36-degree programs in seven faculties by nearly 200 professors.

HSD offers teaching and research in the interdisciplinary areas of design, technology, the social sector and business studies. The emphasis is put on architecture, design, electrical engineering, mechanical engineering and process engineering, media, social and cultural sciences and business studies. All degrees which can be obtained at HSD are Bachelor's or Master's degrees.

The University has around 80 European and around 30 international university agreements and actively promotes the international exchange of students and lecturers by participating in congresses and summer schools. The faculty of Mechanical and Process Engineering is one of the strongest research faculties within the state North-Rhine Westphalia.

Professor Niemann is managing director of the largest and most successful institute of the University. His research fields lie in the areas of

- Life Cycle and Services Management,
- Production optimization with innovative tools such as Eye-Tracking and miniature production plants.
- Furthermore, the team works on new digital application for Industry 4.0.
- Another research area is the field of engineering teaching and the transfer and communication of engineering topics.

The team includes 8 professors and up to 15 research assistants. The team has already participated in a several EU projects as partner and has strong partnership agreements with universities in South Africa, Malaysia, Mexico, Austria and Romania.

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CRAMARS, Tolmezzo - Italy

Cramars is a social co-operative that was born in 1997. Its mission is the development of human resources and marginal areas. Cramars develops social-economic research, seeks to include marginal communities and promotes equal opportunities projects. A professional team of coordinators, researchers and trainers supervised by a General Manager, develops and manages projects.

Cramars works in partnership with private and public institutions, universities and European associations, is accredited by the Friuli Venezia Giulia Region, and certified by ISO 9001.

Specifically, Cramars organizes and manages:

- ADULT EDUCATION – vocational training courses addressed to both employed and unemployed people, as well as to apprentices. Cramars also organizes specific short upgrading courses in the fields of computer sciences, new media, foreign languages and communication.
- APPRENTICESHIP – compulsory training courses addressed to apprentices employed as warehousemen, secretaries, construction workers, workers in paper factories and hide workers.
- VOCATIONAL TRAINING – vocational training courses, based on lifelong learning models, addressed both to employed and unemployed people in order to upgrade their knowledge. Courses offer theory lessons and practical experiences, all leading to a formal professional qualification.
- TRAINING INTERNSHIPS – personal training periods addressed to unemployed people for periods of three to six months in selected companies. During this period a company tutor follows and facilitates the interns' integration and learning process.
- EUROPEAN PROJECTS – Cramars participates in European calls for proposals and projects both as project partner or leader and manages research, vocational training courses, evaluation, guideline services and dissemination of good practices. Equal opportunities, social dialogue, employment, information technologies, education, local development and business creation are Cramars' main areas of interest.

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ISCN
International Software Consulting Network

ISCN – Austria

I.S.C.N. GesmbH founded in 2001 in Graz. The ISCN Group was formed 2010 with more sites. ISCN is one of 7 accredited partners of the VDA QMC (German Automotive Association- Quality Management Center) to train Automotive SPICE assessors. ISCN is a certified training body for ISO 26262 functional safety in Automotive and nearly all major suppliers in Austria and Germany attended ISCN classes. ISCN experts have experience with Automotive engineering standards and ISCN moderates a German working party of Tier 1 in Automotive industry to exchange experiences implementing Automotive SPICE, Functional Safety (ISO 26262) and recently cybersecurity (SAE J3061 and ISO 21434) since 2003 (kicked off by the Bavarian SW initiative, soqrates.eurospi.net, with partners like MAGNA, KTM, AVL, BOSCH, Continental, ZF, Elektrobit, etc.). ISCN experts have a Volkswagen SQIL qualification (SW Quality IMprovement Lead - SQUIL). ISCN developed capability assessment portals used across the Automotive industry by ZF Friedrichshafen AG, Continental AG, HELLA, BOSCH, Volkswagen, etc. ISCN coordinates EuroSPI (European Systems and Software Process Improvement and Innovation www.eurospi.net); EuroSPI is recognized by the German Automotive Association as a platform to collect experience credits for automotive assessor certification. ISCN is an accredited training partner (VET) for Automotive SPICE (1 of 7 worldwide) by German Automotive Association. ISCN is also a skills assessment tools provider for the ECQA.

ISCN is vice president of the (European Certification and Qualification Association) and technical director of EU Certificates Online Campus with a set of quality criteria and common certification rules, which are supported by training organizations from 18 European countries. So far more than 12000 were certified across Europe using the same European framework.

ISCN is working according to the ISO9001 principles and has incorporated a self-developed NQA Teamwork portal.

ISCN was coaching BOSCH Powertrain Systems for the e-motor and range extender concept used at Ford and VW, ISCN is currently the coach for Magna Powertrain who developed a 48 V hybrid and a 400 V e-motor concept for cars, and ISCN is coaching ZF since 1997 where hybrid concepts for trucks have been developed. This knowledge can be applied for the project.

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ISIS FERMO SOLARI, Tolmezzo - Italy

ISIS FERMO SOLARI is a secondary school based in Tolmezzo in the province of Udine.

Includes a scientific high school course in Applied Sciences; the Technical Technological Institute with courses in: Mechanics, Mechatronics and Energy; Electronics and Electrical Engineering; Chemistry, Materials and Biotechnology (Environmental and Health Biotechnology), Construction Environment and Territory (Wood Technology in Construction); the professional institute with courses: Industry and crafts for Made in Italy; Agriculture and rural development, development of local products and management of forest and mountain resources; Maintenance and technical assistance (maintainer of electromechanical systems).

ISIS FERMO SOLARI has a teaching based mainly on laboratory activities and learning by doing and project work.

The classes consist of 15 students up to 20 students and are therefore ideal work groups for both theoretical and practical activities. Currently around 700 students from the age of 14 to 18/20 are enrolled in our institution.

ISIS FERMO SOLARI has technologically advanced laboratories in all sectors in particular the laboratories of Mechatronics, Electronics and wood processing are equipped with numerical control machines and programmable in a perspective of competence development for Industry 4.0.
Multidisciplinary activities are a widespread approach in educational projects with a view to developing skills transversal to the disciplines.

Contacts with companies in the area, many of which are high-tech, are continuous and collaborative, particularly for student internships seen from the perspective of career and job orientation.
Finally, the institute has connections for various activities with the University of Udine and in particular with the engineering faculties.

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Bundesrealgymnasium Keplerstraße, Graz - Austria

The BRG Kepler is a traditional High School in the centre of Graz with a focus on information technology, science and maths. There are about 600 students between the ages of 10-18 and about 70 teachers.

Science is a core area, represented by additional subjects like the “Naturwissenschaftliches Labor” (science lab for secondary one, age 13/14) and “SCIENCE” (secondary two). Within these subjects a lot of projects and cooperation with universities and companies have been performed, thus BRG Kepler is one of only 19 schools in Austria with the Young Science quality seal, given by the Ministry of Science. In addition, there are a lot of activities and competencies in the field of e-learning.
Our students are successful in many national and international competitions, for example the mathematics Olympiad. The Robocup teams achieved striking success within the last few, with some teams wining silver and gold medals at the world championship.

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Pascal Gymnasium, Grevenbroich – Germany

Pascal Gymnasium is a young school. It was founded in the school year 1971/72 as a grammar school of modern languages and natural sciences. These academic focuses are still important today.
However, choosing the French scholar Blaise Pascal (1623-1662) as school patron demonstrates that the character of the school should be understood in a wider context: to us, Blaise Pascal is a role model for his universal talent in a wide range of subjects such as Mathematics, Physics, Philosophy and Theology; his French heritage points towards the international, European ambition of our school; his emphasis on emotions, along with his critical attitude towards a purely rational approach, shows the holistic and nurturing role of the school, which goes beyond mere academic teaching:
“Le coeur a ses raisons que la raison ne connaît point.” – “The heart has its reasons which reason does not know”.

Since 2011, Pascal Gymnasium has been an active UNESCO project school and therefore has a particular focus on working towards a culture of peace, environmental protection, sustainable development and a fair equilibrium between rich and poor.

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