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IMAILE
Innovative Methods for Award Procedures of ICT learning in Europe

IMAILE Challenge Brief

Grant agreement number: 619231

Co-funded
by the European Union

Project acronym: IMAILE
Project title: Innovative Methods for Award procedures within ICT Learning in Europe
Grant Agreement number: 619231
Coordinator: Halmstad Project manager Ellinor Wallin
Project co-funded by the European Commission,
Seventh Framework Programme
Funding Scheme: FP7 – CP –CSA CALL 8.2.A

Workpackage	**WP3 Framework of European joint PCP call for ICT/PLE**
Task(s)	Task 3.1: Developing a joint PCP process Task 3.2: IPR management Task 3.3: Common set of indicators
Lead beneficiary	**INOVAMAIS**
Editor/ authors	**Ellinor Wallin, Philip Holtkamp**
Quality reviewers	**Ola Sörensson, Patrik Engström, Frank Bonse; Laura Lamelas, Lauri Pirkalainen**

Dissemination level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has been funded with support from the European Commission in the context of the Seventh Framework Programme. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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The Challenge Brief

The Challenge Brief is the document presenting the challenge background on Personalized Learning Environments, stating the need and innovation gap identified under the IMAILE project and supporting the Invitation to Tender.

The Invitation to Tender to be soon launched is based on the pre-commercial procedure, meaning that is a competition-like procurement method enabling public sector bodies to engage with innovative businesses and other interested organisations in research and development projects, to arrive at innovative solutions addressing specific public sector challenges and needs.

Research and development services will be paid for at market prices, thus providing business with a transparent, competitive and a reliable source of early-stage financing, and the opportunity to establish an early customer, for a new solution. Since PCP focus on specific identified needs, the chance of exploitation of developed solutions increases.

The PCP method is suited to tenderers of all sizes, including small and medium-sized ones, as the contracts are of relatively small value and operate on short timescales.

1. Introduction and definitions

This brief contains the challenge background to the IMAILE (Innovative Methods for Award procedures of Innovative Learning in Europe) pre-commercial procurement (PCP) call for tenders launched by lead authority Halmstad Kommun at1 of October 2015.

PCP is a competition-like procurement method which enables public sector bodies to engage with innovative businesses and other interested organisations in development projects, to arrive at innovative solutions that address specific public sector challenges and needs. The new innovative solutions are created through a phased procurement of development contracts to reduce risk.

Research and development services will be paid for at market prices, thus providing business with a transparent, competitive and a reliable source of early-stage financing, and the opportunity to establish an early customer, for a new solution. Since PCP focus on specific identified needs, the chance of exploitation of developed solutions increases.

The PCP method is suited to contractors of all sizes, including small and medium-sized ones, as the contracts are of relatively small value and operate on short timescales.

The Challenge Brief is published beforehand the official launch of call for tenders on the 15 of September with the purpose to offer the potential suppliers a view of the expectations of the innovative solutions before publish the call.

Definitions used in IMAILE Challenge Brief

PCP Pre commercial procurement

PCP can be defined as *"public procurement of research and development services where the Contracting Authority or contracting entity does not reserve all the results and benefits of the contract exclusively for itself for use in the conduct of its own affairs, but shares them with the providers under market conditions. The contract, the object of which falls within one or several categories of research and development defined in this framework, must be of limited duration and may include the development of prototypes or limited volumes of first products or services in the form of a test series. The purchase of commercial volumes of products or services must not be an object of the same contract"*

Source **Definition from the Communication from the Commission "Framework for state aid for research and development and innovation", C(2014) 3282, 21, May, 2015**

Primary and Lower Secondary Education

IMAILE solutions should address students in Primary and Lower Secondary Education (ages 6 – 15 years). This definition is based upon the country reports produced by CEDEFOP about Vocational and Educational Training and Educational systems in Europe, available at: http://www.cedefop.europa.eu/en/publications-and-resources/country-reports/vet-in-europe-country-reports?search=&year%5Bvalue%5D%5Byear%5D=&country=SE&items_per_page=20

STEM

The subjects Science, Math, Engineering and Technology in Primary and Lower Secondary Education levels based upon the national curriculum of several EU Member States

STEM Scope of the IMAILE Project

While STEM stands for Science, Technology, Engineering and Mathematics, the IMAILE project will focus on the aspects of Mathematics and Science and more particular Mathematics, Biology, Chemistry and Physics. This is based on the availability and comparability of these subjects and related topics within the procuring countries as well as on the reduction of complexity. Within the IMAILE Project, STEM should thus be understood as subjects and topics related to Mathematics, Biology, Chemistry and Physics.

PLE

Personal Learning Environment in STEM for Primary and Lower Secondary Education as defined and agreed for the IMAILE project:

Common PLE definition in IMAILE

The IMAILE Personal Learning Environment (PLE) for STEM is an adaptive, accessible, and easy to use solution providing smart services for the realisation of personalised learning including individualised learning paths, support of different learning strategies, and intelligent tutoring for primary and secondary schools. The IMAILE PLE for STEM shall offer a single access point to repositories of freely available learning content, learning apps, services and tools for STEM education through the application of open standards. Through the provision of own communication and collaboration functionalities and the integration with widely used social media pages, the IMAILE PLE enables students to learn, share and interact with their friends, teachers, and other stakeholders such as their parents. The IMAILE PLE supports bring your own device (BYOD) through the provision of a device and operating system independent solution, and lifelong learning through the integration of an ePortfolio solution. Overall, the IMAILE PLE for STEM provides a highly motivational environment for formal and informal STEM education.

2. Objectives IMAILE project

The overall objective of IMAILE is to use the PCP process to identify innovative technologies and services which address the challenge of providing the next generation of Personal Learning Environments (PLE) in primary and lower secondary education within the subjects of Mathematics, Biology, Chemistry and Physics (STEM subjects).

Specific objectives IMAILE will:

- Prepare and evaluate joint PCP of PLE solutions within 7 EU countries
- Execute a joint PCP for one specific ICT-PLE call
- Enable/ monitor pilots for PLE solutions in 3 PCP phases
- Contribute to EU standards of PLE solution for primary and lower secondary school
- Promote both PCP as method for improvement of public service and PLE as innovative solution for education in Europe.

3. Background and preparation of the IMAILE project (needs assessment)

In 2013 IMAILE consortium identified the challenge of ***an increased demand of personalized learning in our European classrooms***.

By addressing this ***" initial"*** challenge identified in the European classroom the IMAILE consortium can also reach beyond and additionally create impact to common larger pedagogical and societal on EU level.

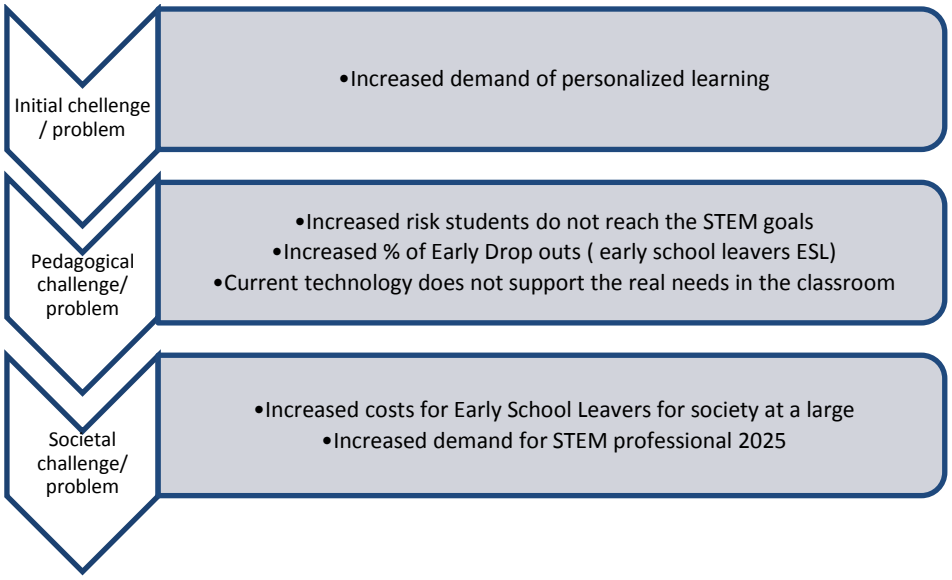

Figure 1 – identified groups of challenge and impacts

3.1 IMAILE needs analysis

A PCP must have the public procurers entities needs in focus. The IMAILE initial need analysis is based upon desk top studies and statistics on EU level to identify the societal challenges and active involvement of teachers and students to identify the pedagogical challenges.

During April - November 2014 IMAILE procurers have performed a sound needs analysis covering the procuring countries Sweden, Finland, Germany and Spain and reaching out at the EU level. The needs analysis is based upon the following methods:

I. Surveys and workshops with teachers in STEM (Primary/Lower Secondary) EU level
II. Survey and workshops with IMAILE procurers
III. Surveys to procurers outside IMAILE consortium
IV. Workshops with students (Primary/Lower Secondary)

The result is based on participation of 550 European teachers, 520 European students and procuring organisations representing 1/3 of EU member states.

3.2 Summary of need analysis

This table demonstrates a summary of the identified needs by the different groups of end users:

I. Teachers
II. Students
III. Schools
IV. ICT support, local , regional governments

Target group/users	Problem/need description
Teachers	STEM Course /Class planning and preparation hours Teachers spend a lot of time for the preparation of courses and classes. The time could be better used for direct communication and support of the students.
	Increased need for Teacher Student Communication. More interaction between teacher and student in and outside of classroom.
Teachers and students	Monitoring and Reporting of learning process It is critical that teachers can review the learning process of each student and create comprehensive reports to understand the specific needs and problems of each student. Additionally, student should have the possibility to review their own learning activities to reflect on their own learning activities.
	Assessment support Assessment of student progress and performance in one of the key tasks of teachers in the educational process. New approaches for assessment especially for STEM subjects have the potential to change the learning from learning by heart to productive learning which can increase the learning effectiveness. Teachers need support to apply these new assessment methods.
Students	Personalized learning Each student has preferences in terms of learning material and learning activities. While traditional teaching methods focused on a limited amount of learning styles, it is important that each student can follow their preferred learning path.
	Informal learning support Students should have the possibility to learn outside of the traditional school system focusing on subjects and topics of their own interest without monitoring or assessment of their teacher. This allows students to try different approaches without being afraid of making mistakes.
	Learner Records Storage and support of Life Long Learning Results and artefacts produced by the students should be stored and exportable to other systems to enable lifelong learning and a review of the learning process.

Schools	STEM specific learning activities according to curriculum STEM teaching and learning requires specific learning activities such as collaborative learning, learning-by-doing experimentation and project-based learning.
	Bring your own device Schools can't provide the devices for all students to user the software systems. Additionally, students have already experience with specific devices and would prefer to use a familiar device. It is therefore important that students can use their own device which includes both personal computers and mobile devices independent of the manufacturer and operating system.
	User support A new system requires a learning process for all involved stakeholders. Support for the users has to be provided to educate them on how to use the system. In terms of problems with the system, a direct support has to reduce potential times the system is not available.
ICT support in schools, local/ regional government	Data and user privacy As the system will store and analyse private data of minors, rigorous methods for data and user privacy have to be taken. This includes the provision of the right information to the right stakeholders.
	Interoperability Technologies have to be able to be integrated into the current and future software and hardware landscape at schools. This includes the exchange of data and information as well as the usage of services provided by external tools through a single access point with single sign on.
	Scalability Technologies have to be able to handle constantly and rapidly increasing amount of users and requests. Additionally, the functionality of the system has to be extensible based on new requirements.

3.3 The vision of IMAILE PLE Innovative solutions

Out from the needs analysis the IMAILE consortium has identified a vision that the innovative PLE STEM technology/solutions shall have both a short and long term impact:

Short-term impact

Teaching/Learning

- **Increase students' motivation** to learn STEM subjects
- Applicable to **all learning styles** according to the Learning and Teaching Styles (Felder & Silverman, 1988, revised in 2002): active/reflective, sensing/intuitive, visual/verbal and sequential/global.
- Provide with **creative, collaborative and motivating solutions for STEM education** based on actively engaging students.
- Create **more 1 to 1 interaction between teacher and student** in the classroom.
- Reduce **teachers planning hours**.

Assessment

- **Provide students with a personalised formative feedback and scaffolding**, based on their learning paths, needs and styles.

Short-term impact (cont.)

Technical issues

- Applicable to **all devices** (responsive design for computers, mobile phones, tablets…), our PLE solution should be a tool that can be easily used from the students' personal devices as well.

Mid-term and long-term impact

Teaching/Learning

- **Support all the students to reach their goals in a personalised way**.
- Lead to a real shift from **teacher centred learning** to **student centred learning** in STEM at schools.
- Develop a more **integrative approach to STEM education.**
- Support **connectedness with the wider community**, including families, other schools…
- **Support teachers and students** in primary/secondary education within STEM topics.

Assessment

- Create a **long-term educational European Digital Portfolio** that supports lifelong learning (and recognition) for the students.

Indirect long term impact on societal challenges

- Reduce the number of **early dropouts** and costs for ESL (early school leavers).
- Improve **student's motivation towards STEM subjects and careers** and increase STEM professionals until 2030.

3.4 Scenarios for the usage of IMAILE PLE in STEM heading 2020

Co-design and PCP processes are enabling a rapid change in school culture because all stakeholders are involved in the participatory design processes.

Following scenarios are forming a picture of the future when IMAILE PLE in STEM has been in use for several years. Scenarios are used to encourage discussion, help design processes and to support and guide decisions. Scenarios are also participatory tools where procurers are visualizing in the form of narratives desired activities and tenderers mirroring how their solutions are complementing scenarios.

Scenarios are descriptive and compiling requirements for STEM/ PLE but not giving straight answers about desired solutions and technologies. There is e.g. room for innovations in the era of visualizing learning paths, mentoring services, learning analytics and the use of gamification.

Here follows three short scenarios based upon the need analysis future vision on how IMAILE STEM PLE has helped a student, a teacher, and a parent and heading towards 2020.

Scenario A (Student)

First impressions

I remember very well when IMAILE STEM/PLE was introduced to me for the first time. My teacher said that the PLE will be my teaching assistant and my virtual mother from now on. First I had the chance to shape the personality and character of my teaching assistant (avatar). I named him Petri. Petri started to come out from time to time to ask questions or to give advices and recommendations. Petri has guided me to when and how I should work. A lot of things I would certainly have forgotten, if Petri was not there reminding and guiding me.

My first task was to tell Petri my timetable. By doing this Petri became aware of what and when I should study. I also told Petri my own hobby schedules and appointments. I chose in the beginning also my teachers, who are teaching me, from the complete list of our teachers. By doing this I was able to ask questions and to do the tasks assigned to me.

Time travelling

One of the best things with IMAILE STEM/PLE has been the fact that I can travel in time. I have been able to look backwards on what, how, when and with whom I have been working. I have also created many time capsules. Time capsule is a goal or a dream that is locked and can be opened on a specific date. I have written many goals for what I want to learn and achieve. I am now eighteen years old and last week I opened a time capsule which was locked and sent to the future when I was in the third grade. I was 10 years old then. I could read that at the age of eighteen I would like to play soccer in the best team of our city. It's funny that I just made a contract with the best team in our city, but in ice hockey. Most of the time capsules I have sent to the future have been locked for a considerably short time. Sometimes even just for a week.

Automatic time line has helped me especially in preparing for my exams. On a parallel timeline I have been able to see lessons, guidance of my teachers, comments and questions. This has helped me a great deal. I have e.g. looked at different videos about difficult topics over and over again. There are hundreds of video clips on my timeline because I remember things better from videos than images. Some of my friends have their timeline full of drawings and notes. I have also quite many mind maps there. I prefer to use digital pen for making mind maps and of course in mathematics, physics and chemistry. OCR (optical character recognition) has sometimes been a handy feature, but usually I use the virtual keyboard on my tablet. Sometimes I have used speech recognition and sometimes I have been recording audio notes. To find specific materials and courses I can use embedded intelligent finder. It recognizes keywords, titles, file formats and many other tagged identifiers.

System of Badges and Reward Points/Levels

Working with IMAILE STEM/PLE gives you credits and points. I have got points from regularity, good planning, solving difficult problems, helping others, etc. When you have enough points you can get access from one level to next. I just achieved the next level of study physics. I got access to purple level with a new badge. It is the best one.

Working together

I have also some common working material with my friend on my IMAILE STEM/PLE. If we have team work, we can send a time capsule of our group or team. Usually we have used recording features in the PLE so that we have recorded a short clip what we did, if we had any difficulties and what shall we do next. This has been a handy feature and we have watched or listened recordings before starting to work again.

As a senior student I have also been able to study courses in other schools and it's all nicely assembled into my timeline. I remember when I was teaching magic tricks to our group. I recorded some video guides and everyone made a small magician show in the end of the course. Some even asked other (really pro) magicians for good tips.

Portfolio

Last week I applied for a summer job and had a job interview. I used there my IMAILE STEM/PLE and the employer saw that I have been working hard at school and I can express myself in many ways and I can foreign languages as well. I got the job!

PLE can be opened and edited using any device that is online and has a web browser. It is good that I can also use it offline. Now I am finishing high school and I can have IMAILE STEM/PLE with me. I will continue to use it in the future in my studies and after that in my work.

STEM

We have used PLE for very interesting projects. Yesterday I was helping a teacher (Mary) together with two of my classmates a group of younger students with the theme of Flow systems. Mary began reading about "Wally the water drop" a story about the water drop that travels around the world. Then we had a discussion with these younger students about the story and its highlights.

After the story students participated in 4 different activities related to flow. Mary introduced each activity and we divided the pupils into groups; water cycle, morning traffic, migration, carbon cycle, food chain, ocean currents. The groups went from one activity spot to another to explore different kinds of flow with e.g. Human Body – application, Marinetrafic-application, Flightradar24 and YouTube: Watch Time Lapse – Street Traffic at night and YouTube: City Night Traffic.

I was mentoring the group "blood flow", which was great because I'm interested in human biology. The task for the groups was to make a mind map of the chosen topic. Each group introduced their mind map to the other groups, and got valuable feedback and ideas from their peers. The next phase was finding additional information about the topic and/or to make some experiments. Each group will produce a piece of art as a final product (a rap-song, a painting, a short film, a trailer, a digital story, a dance, flash mob etc. The final product will be filmed or photographed and uploaded to IMAILE STEM/ PLE as the different exploratory phases of the project.

I think that the project-closing event will be exciting and memorable. Here is the link to our documentation of the Mary's Flow system project: https://youtu.be/0CZHfmP_Vmg. First time I have an idea what I'm going to do when I'm older. I would like to study augmented reality and start my own company which helps people to recognize different plants and respect them.

Scenario B (Teacher)

Through the use of IMAILE STEM/PLE teachers have noticed that students are more active and engaged in designing their own learning strategies. IMAILE STEM/PLE has also been supporting better contact between student and teachers. Teaching and learning processes are now less teacher-centered. PLE has a surprising important role in the development of learning landscape of the 21st century education.

First Impressions

I have been waiting for a tool that would help me in supporting the learning processes of my students and which also facilitates my work to such an extent that I could focus more on my students for a long time. When IMAILE STEM/PLE was presented to our school for the first time, I understood that this might be the solution I had been longing for. It was also a good solution that we decided to bring IMAILE STEM/PLE into use for the whole school at same time.

Blended Learning

I am a physics teacher in lower secondary school and today just before the beginning of the lesson I had a quick look to IMAILE STEM/PLE. I was interested, how my students had captured the concepts of absorbing and releasing energy after their own research. I opened their own physics timeline and I realized immediately that the concept of energy releasing was still a little unclear - to some extent. I exported with one click the questions my students had made about the topic to a one video clip, and threw myself into the role as an external expert during the lesson. We had quite a lot of fun when I was trying to answer their questions. One question remained unanswered and we decided to make a shared mind map about this topic. We saved the mind map and every one made a time capsule of their own and added into it a reminder to their timeline. We shall work with it in September, but from a different perspective and we start by using Forum, Chat or Wiki (I haven't decided this yet).

Personalized learning

Tomorrow we are going to receive a new student in the class I teach. I watched today his learning processes in general, his skills as well as his student profile on IMAILE STEM/PLE. I noticed an interesting thing. He is a hard working student but surprisingly often he is underperforming in his work. After looking at the IMAILE STEM/PLE I think I now know why this has happened. I have good feeling about the meeting this afternoon with him and his parents.

Sharing

I looked this morning out of curiosity at how our teachers are working. I just have to wonder about the level of collaboration, co-planning and discussion we perform. It's excellent, that teaching and design processes are happening today in teams. Designing, reusing, recommending and sharing course- and lesson materials is so easy and it leaves more time for all of us to interact with each other.

Content creation

Next month I shall have an e-learning course to support the blended learning in my class. I shall create the learning path for my students in an IMAILE STEM/PLE course builder. Readymade templates are helping me to create the path and I only drag and drop files and other materials in the visualized learning path. It is easy to use tools like Text Editor (WYSIWYG), Video Uploader (VUP), Collaborative Writing Tool (CWT), and my own Learning Object Repository (LOR).

I use e-books, OER materials and my own documents (assignments, tests etc.) to create the combination to support individual learners.

Flipped classroom

For the next mathematic lesson I shall create a short video as a teaser to the students. With IMAILE STEM/PLE video/screen capture recorder I shall combine my PowerPoint slides with my voice and

create SOOC (Short Open Online Course) on the topic. I will send the link to my students via IMAILE STEM/ PLE as a quick message to the social media service, where he/she is active at that certain time. I also will give them a problem to solve for the next lesson combined with video recording. I also link the e-book chapter as flipped material for the students to prepare the lesson.

Parent collaboration

I send quick messages to parents to their e-mails and mobile phones as text messages. I also indicate the absence of students and get the explanation from the parents. In IMAILE STEM/PLE dashboard is always live schedule for everyone to see. Individual students and parents can see information about the tests, assignments, exams and other information connected to their dependent.

Evaluation

For the term evaluation I just collect the progress information from each student in the IMAILE STEM/PLE. All the assignments, tests, exams and other work has been graded or evaluated in the system and can be used by the teacher. The self-evaluation tool of the system also gives the students a grip on their development and strengthens their self-esteem

STEM

I think STEM education is about active learning and working with real-world topics. My goal is to deepen and clarify the students understanding e.g. about natural laws. The aim is to deal with the topics constructively with an age specific manner. In addition to a deeper understanding about the actual topic, I'm focusing on guiding students to find relevant information and how to make relevant experiments. The aim is to work cooperatively, and therefore this task also develops student's social skills. STEM as a whole enables students to make creative choices and to use each student's personal strength and know-how to enhance learning.

I'm trying to encourage students to exploit different professional sectors from the school community. STEM is usually project based and aims also at strengthening the use of technical devices and programs to enhance learning. Integration of external tools such as virtual labs, simulations, virtual experimentations are giving good and rich experiences of STEM content which is raising interest in STEM and possible future STEM career.

Scenario C (Other Stakeholders)

Use of IMAILE STEM/PLE has assisted parents to follow their children's studying, school activities and progress. Routine communication between home and school (events, absences, public notices, etc.) is still taking place on other communication tools, but IMAILE STEM/PLE gives a whole new perspective for monitoring the study-processes. It also makes it easier in several ways for the governmental level (both municipal and regional) management work, and may even drop annual

costs of education due to a more personalized monitoring and using technology efficient according to the needs of all end users.

Because IMAILE STEM/PLE is customizable various ways (easy to make your own designs for each city, school, administrator or user) it feels comfy, familiar and very personalized.

First Impressions

"*I don't know quite exactly if this is the result the use of IMAILE STEM/PLE but last year the teachers' days of sick leave started long into the fall after the summer break"*

"Now each student and teacher can now use their own device in their work and we are starting to get considerable savings in IT management revenues".

"Distribution of teaching and learning materials is also now with IMAILE STEM/PLE simplified and more straightforward."

Visualization

"The visualized path of learning processes has helped students and teachers to work more closely in direction towards the objectives. While saving of significant time and resources PLE has enabled to focus to the future competences. With the help of visualizations we have been able to focus on the semantic memory and the children as well as adults are now beginning to understand larger entities. Utilization of the semantic web, artificial intelligence, and gamification features have increased students' motivation for studying, and teachers have had more time and more relevant information for supporting learning and for designing their teaching. "

BYOD

As IMAILE STEM/PLE is using cleverly RSS feeds, we are better aware all the time of what is happening in schools right up to the individual level. Learning assistance and the differentiation for talented students has also become possible. Now it's also easy to target the right students to receive extra help in the very first place to avoid early drop outs. Knowing which students are at greatest risk for dropping out is the first step to reducing dropout rates. IMAILE STEM/PLE is challenging and supportive environment that keeps students in school and on track. In this way students are receiving appropriate education on their own level. We have also now been able to take full advantage of different mobile devices. BYOD (Bring your own device) - thinking is now realism which has become possible via use of HTML 5.

This technology has enabled video, audio, scalable vector graphics and MathML for mathematical formulas. IMAILE STEM/ PLE is also supporting several short-range communication technologies (Bluetooth, NCF, iBeacon etc.) so it can be used in collaboration and in project based work. Within short- range communication technologies teachers and students can share documents, photos and videos and simultaneous processes (writing, mind mapping, drawing etc.).

STEM

STEM education has developed into a revolutionary way to work and IMAILE STEM/PLE has been supporting that work effectively. It is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematic. (Tsupros, 2009).

4. PLE / STEM - State of the Art

Based upon the needs developed in depth and presented in section 3 of this Challenge Brief a second global analysis of the technology enhanced learning market has been performed. During November 2014 – June 2015 IMAILE consortium has verified solutions available to our identified needs and expected effects and as a conclusion an Innovation Gap has been identified.

Shortcomings exhibited by "off-the-shelf" solutions

The IMAILE market analysis has shown that no solution alone addresses the challenges and related features sufficiently. In particular, no solution combines personalized learning and predictive analysis with the integration of STEM content in terms of external learning object repository, multimedia content, and in particular the integration of STEM related serious games, external tools and web services. In more detail, not STEM PLE specific features such as features belonging to course creation, content creation, content management, communication, social, notifications etc. were addressed by most solutions.

The market analysis has also shown that no single feature or feature category is lacking in the solutions. Instead, a focus of specific solutions on different aspects can be seen. While some solutions have a focus on the content provision and management, others focus on the personalization of learning or the provision of STEM content. However, no single solution masters all different aspects.

Summarized, the market analysis has shown that a wide variety of different learning technologies exist on the market. However, none of the solutions analysed in either approach was suitable as the IMAILE PLE. While every solution had strength, also every solution was lacking in specific aspects. The aspects lacking in most solutions were the integration of STEM specific technologies such as serious games, virtual labs, and simulations and the focus on personalized learning.

4.1. Innovation gap – PLE/ STEM that goes beyond State of the Art

The IMAILE market analysis has shown that no solution currently available on the market can address all challenges, requirements and connected features. We can therefore conclude that a significant amount of research and development is required to achieve an acceptable fit between required features and implemented features in the solutions.

The analysis has shown, that in particular features related to the following aspects offer the biggest room for innovation:

- Personalization of learning and predictive analysis;

- Integration of STEM content and in particular the integration of serious games external tools such as virtual labs, and web services such as calculators;
- Gamification of learning;
- Metacognition to allow students to reflect on their learning process and learning styles;
- Interoperability through the application of open standards;
- Intelligent tutoring.

Additional to these categories, single features such as the integration of video recording and web conferencing, online office hours to provide scheduled times when teachers are available in the system, adaptability of individual user interfaces, offline/online synchronization, stealth assessment and a smart system to provide suggestions to parents how to support the learning of their children represent features lacking in many systems and thus providing room for further development.

However, all of these features were present in some of the solutions analysed in our RFI. The same result is confirmed by our desktop analysis, which showed that very specific solutions for most of the envisioned features exist. However, no single solution integrates all the envisioned features.

We can therefore conclude that the **innovation gap lies in the meaningful integration of existing features from different systems and newly innovative features** (e.g. related to the previously mentioned features) into a single environment. This means an integration that goes deeper than the provision of hyperlinks and iFrames but allows access to the business logic of all integrated services and tools. Through the data and functional integration of the features, web services and tools will not only allow the provision of different STEM related learning activities such as serious games and virtual labs within the same user interface, but also allow other services such as services related to monitoring, predictive analysis and personalization to access the user activities within these integrated services. As an example, the lose integration through hyperlinks doesn't allow a service to analyse the usage behaviour to access the activities performed on the linked paged or system. Therefore, all activities performed within the linked page or system will not be taken into consideration for any analysis of the learner.

4.2. IMAILE Innovation Gap conclusion

The innovation and satisfaction gap of IMAILE STEM/PLE can be illustrated as in figure 2. The following groupings of items are considered:

A. Desired (future) STEM PLE solution for schools;

B. Actual STEM PLE solution implemented in schools (business as usual);

C. STEM PLE Solutions available on the market.

Out of these grouping two gaps can be identified:

SATISFACTION GAP = A-B > 0 the used solutions does not match the desired solutions

INNOVATION GAP = A-C > 0 solutions available on the market does not the match desired solutions

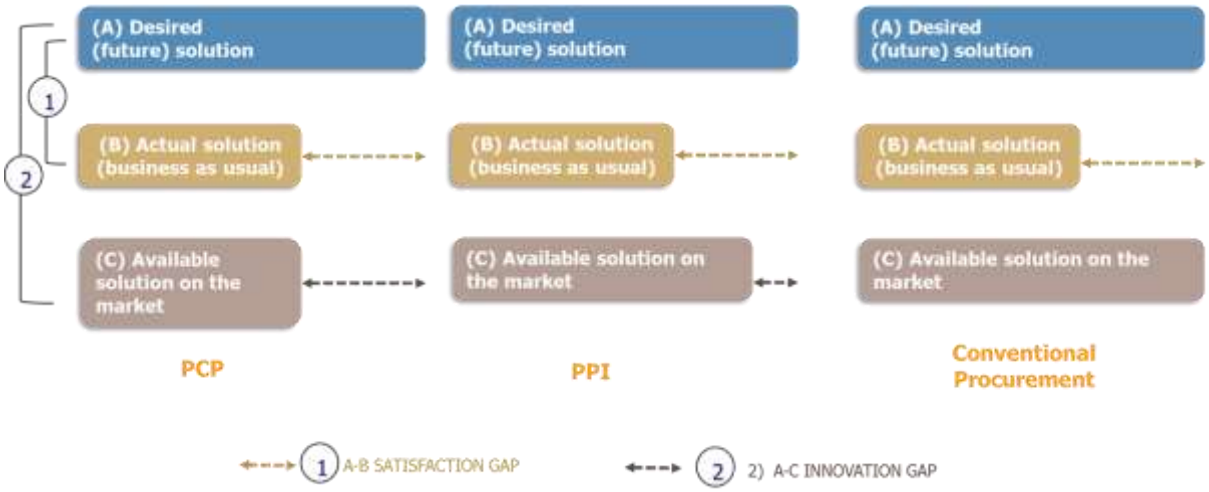

Figure 2-. IMAILE Classification of procurement developed by Sara Bedin Strategic Board

IMAILE Innovation gap

Summarized, the meaningful data, functional and user interface integration of different technologies and features as well as the integration and further development of features related to personalization of learning, integration of STEM content, metacognition, interoperability, and intelligent tutoring system represents the gap between the currently available solutions on the market and the envisioned IMAILE PLE for STEM.

5. IMAILE challenges identified

IMAILE PCP is based upon a common identified problem/challenge on EU level where the procurers seek innovative solutions from ICT suppliers.

> ***IMAILE procurers are looking for the next generation PLE in STEM for Primary and Secondary Education in order to support the challenge of an increased demand of personalized learning in the European classrooms.***

The IMAILE overall challenge is divided into several sub challenges

Challenges and expected impact	Identified content
Pedagogical Challenges **Direct impact**	Challenge 1 - Full implementation of personalized STEM learning approach for all students including SEN(special education needs) support Challenge 2 - Increase STEM motivation and students results using technology enhanced learning
Technical Challenges **Direct impact**	Challenge 3 - Technology applicable to **all devices** , Interoperability and scalability of innovative digital solutions
Societal Challenges **Indirect impact**	Challenge 4 - Labor market and increased demand of STEM professionals 2025 Challenge 5 - Costs and risks of Early school leavers for EU Member States

5.1 Illustration of IMAILE challenges and impact of innovations

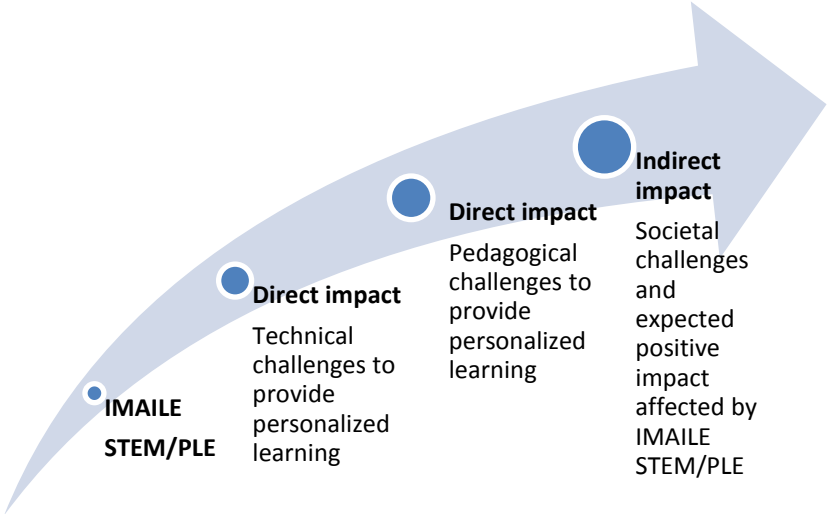

Figure 3 – how IMAILE PLE address technical, pedagogical and societal challenges directly and indirectly

The chain of effect and impacts

Using technology IMAILE choses an approach that first hand provides innovative technical solutions for teaching and learning, these solutions directly support pedagogical challenges and reforms related to STEM and personalized leaning in the European classroom. This new technology and pedagogical approach will in the long term indirectly address important societal challenges in the EU.

6. Detailed description of IMAILE challenges

As described in section 5 the initial IMAILE challenge of an **increased demand of personalized learning** is divided into 5 sub challenges.

Pedagogical Challenges

1 – Implementation of a full personalized learning approach in Primary and Lower Secondary Education

2 - Increase STEM motivation and students results using technology enhanced learning

Technical challenges

3 – Defined technical challenges

Societal challenges

4 - Societal challenge Labor market and increased demand of STEM professionals in 2025

5 - Societal challenge Costs of early school leaves for EU member states

In this section each challenge from 1 – 5 is described in a descriptive table and includes text based on the following structure:

I. Table of specific challenge
II. Challenge description
III. Problem
IV. Expected impact
V. Minimum requirements

6.1 IMAILE Classroom case

This classroom case is based upon the input from 140 teachers from 7 member states representing IMAILE consortium in 2013 and is used for setting the scene and create a case of our described challenges of this section.

In the IMAILE classroom case one teacher is responsible of 23 students and the extra planning time for students with special needs is calculated to 5 – 7 hours extra per week. The lack of time of the teachers reduces the time the teacher can spend with the students to understand their individual

needs, wishes and preferences. For the student, this means that they are not able to receive learning content and learning activities suitable for their individual needs and adjusted to their interests.

This classroom situation is the initial and average situation for our identified challenges.

I. Average size of student group/teacher in the EU classroom is 23
II. 20- 30% of the students requires personalized learning due to special needs
III. ALL students require personalized learning to perform better and get increased motivation to learn
IV. The personalized learning approach for children with special needs requires 5-7 additional planning hours/week for a teacher
V. Science, Technology and especially Math (STEM) are crucial topics where students risk to fall out school too early without the support of personalized learning

6.2 Pedagogical challenges

The pedagogical challenges are divided into 2 groups

1. Implementation of a full personalized learning approach in Primary and Lower Secondary school
2. Increased students STEM motivation and learning results for ALL

The challenges are grouped after involved target groups / end users described in the findings of the need analysis (page 8, 9 of this document)

- Teachers
- Students
- Teachers and students
- Schools
- ICT support and local/ regional governments

6.2.1 Challenge 1 - Implementation of a full personalized learning approach in Primary and Lower Secondary Education

Problem

Each learner has own preferences in terms of learning content and learning activities based upon their individual learning style. Traditionally, the educational system doesn't support this diversity. However, our analysis has shown that planning, assigning tasks, assessing and interaction with the students in a personalized approach requires time from the teacher. In IMAILE classroom case one teacher is responsible of 23 students and the extra planning time for students with special needs is calculated to 5 – 7 hours extra per week. The lack of time of the teachers reduces the time he/she can spend with the learners to understand their individual needs, wishes and preferences. For the

students, this means that they are not able to receive learning content and learning activities suitable for their individual needs and adjusted to their interests.

The following table provides an overview of sub-challenges, related to the full personalized learning approach, identified through the IMAILE needs analysis. For each challenge, a short description is presented.

Identified challenges	Description
STEM Course/Class planning and preparation hours	Teachers spend a lot of time for the preparation of courses and classes. The time could be better used for direct communication and support of the students.
Increased need for Teacher Student Communication.	More interaction between teacher and student in and outside of classroom.
Monitoring and Reporting of learning process	It is critical that teachers can review the learning process of each learner and create comprehensive reports to understand the specific needs and problems of each learner. Additionally, learners should have the possibility to review their own learning activities to reflect on their own learning activities.
Assessment support	Assessment of learner progress and performance in one of the key tasks of teachers in the educational process. New approaches for assessment especially for STEM subjects have the potential to change the learning from learning by heart to productive learning which can increase the learning effectiveness. Teachers need support to apply these new assessment methods.
Personalized learning	Each student has preferences in terms of learning material and learning activities. While traditional teaching methods focused on a limited amount of learning styles, it is important that each student can follow their preferred learning path.
Informal learning support	Students should have the possibility to learn outside of the traditional school system focusing on subjects and topics of their own interest without monitoring or assessment of their teacher. This allows students to try different approaches without being afraid of making mistakes.
Learner Records Storage and support of Life Long Learning	Results and outcomes produced by the students should be stored and exportable to other systems to enable lifelong learning and a review of the learning process.
Bring your own device	Schools can't provide the devices for all students to user the software systems. Additionally students have already experience with specific devices and would prefer to use a familiar device. It is therefore important that students can use their own device which includes both personal computers and mobile devices independent of the manufacturer and operating system.

State of the art and beyond

The market analysis of the IMAILE project has shown, that the majority of solutions provide various different options to support teachers in their preparation of classes and courses, facilitate the communication between different users and stakeholders, monitor and report the learning process of students, learner record storage, and support a variety of devices. However, the results of the IMAILE needs analysis show, that these features are not reaching the impact in terms of reducing the preparation hours and increasing the communication between teachers and students, and thus don't provide available time for the teachers to allow full implementation of personalization of learning. Therefore, the IMAILE PLE should improve existing solutions by increasing the simplicity and applicability of features related to the before mentioned aspects.

In contrast to this, the market analysis has shown that it provides very little support in the personalization of learning. While the majority of systems provide some sort of recommendations of learning content and learning activities, only very few systems analyse the usage behaviour and preferred learning styles of students. However, this analysis would be required for a meaningful personalization of learning as only through the results of the analysis suitable learning content and learning activities for each student can be identified. The analysis would additionally allow for an automation of the personalization by selecting suitable learning content and learning activities for each student. Therefore, more advanced approaches to learning analytics and predictive analysis to enable and enhance personalized learning and in particular the automation of personalized learning should be a key aspect of the IMAILE PLE.

Informal learning has the possibility to take the personalization of learning even further, as students are able to set their own learning goals unlike in traditional, curriculum-based learning. The market analysis has shown that most solutions support informal learning. However, the maturity of the available solutions is often not very high. The IMAILE PLE should advance the currently available solutions by providing opportunities for students to engage in self-directed, informal learning by setting own learning goals and creating their own learning paths.

Expected impact

Through the previously described important advancements of technological solutions, the IMAILE PLE will support teachers and students in personalizing the learning. While increasing the simplicity of specific functionalities such as contents and assessments will allow teachers to spend more time on the communication and support of students, automations of student analyses and learning path adaptation as well as recommendations based on the student analyses will provide highly valuable input for the personalization of learning.

Minimum requirements

To address the presented problem and reach the expected impact the IMAILE STEM PLE solution should provide at least fulfil the following requirements:

Description of minimum requirements Challenge 1 Implementation of a full personalized learning approach in Primary and Lower Secondary Education

• Provide functions commonly available in learning environments:
  ○ Different methods for synchronous and asynchronous communication
  ○ Integration with social media services such as Facebook and Twitter
  ○ Provision of support for different assessment methods
  ○ Integration of a persistent portfolio system to store all learning records for each student during and after the learning process
  ○ Ensuring access to the services independent of devices and operating system
  ○ Support of group and individual learning paths
  ○ Provision of monitoring and reporting functionalities of the learning process of groups and individual students
  ○ Provision of easy to use and intuitive approaches to course, lecture and content creation, management, and storage

• Enable the monitoring of user behaviour and performance in the solution including in integrated external services such as serious games, virtual laboratories and simulations
• Continuously analyse the usage behaviour and performance of each individual student to identify preferred learning styles, learning content and learning activities
• Provide recommendations to teachers and students on how to adjust the learning path of each individual student to fit their identified preferences
• Provide the possibility for students to review the results of the analysis regarding their learning preferences to enable the self-reflection on the own learning process
• Integrate and provide easy access to external sources for learning content, serious games and other relevant tools for STEM to allow teachers to include these in their planned courses and lessons
• Provides the possibility to add metadata in terms of STEM subject, topic, learning preferences and learning styles etc. to all learning content, learning activities, integrated external tools and web services
• Provide Wizards or other approaches to guide teachers through the steps for different aspects of the system such as creation of courses, lessons, content, assessments, and reports.
• Provide support of informal learning by allowing students to set their own learning goals and learning paths for topics of their interest outside of the curriculum
• Provide an Intelligent Tutoring System that supports students in their creation of own learning goals and learning paths by suggesting topics, content and activities based on the analysis of their learning preferences
• Provide the possibility to schedule online meetings with the teachers for students, parents and other stakeholders as a virtual version of office hours

6.2.2 Challenge 2 - Increase STEM motivation and students results

Students STEM results

This challenge is both based upon several current problems to be tackled as one to be supported by technology enhanced learning.

- Students general lack of interest in learning STEM (often detected in lower secondary education);
- The gender balance;
- Latest results in STEM according to PISA in our EU countries.

Students general lack of interest in learning STEM

The white paper published in the InGenious STEM project: "Science, technology, engineering and Math education in EMEA" reports that traditional teaching styles dominate math and science teaching in almost every country and student centered learning is rare. The report also states that there is a clear need for more contextualization of STEM content in schools. According to a report by OECD 20% of students are more interested in STEM when "real life" content is introduced alongside theory.

Without an understanding of how STEM serves society by the students our teachers will not be able to encourage them to work on STEM content and this is according to OECD particularly underlined for girls.

Recommendations are made to reform curricula of STEM to pay more attention to STEM specific competences in terms of 21st century learning. This could be done by introducing more societal context to support the students learning in STEM and integrate both agendas in the curricula. Even if many countries apply a centralized approach regarding curricula this should be done at school level by integrating STEM in inquiry based, problem solving collaborative projects.

To sum up guidelines are given in order to encourage students to learn STEM on European level. In the IMAILE project we will address the following 3 recommendations using a technological approach integrated in our STEM/ PLE solution.

I. Student centered teaching;

II. Contextualization of STEM in order to understand how STEM serves society;

III. Enhance and reform STEM curricula, pedagogy and assessment.

Imbalance in gender

It is well-known that, traditionally, women have been underrepresented in the fields of science, technology, engineering, and math. Some of the latest UNESCO data shows that, in North America and Western Europe, the average representation for woman in R&D is of 32%. A totally different situation is found in Central and Eastern Europe, where the overall average rises up to 40%.

One common and persisting trend is the underrepresentation of women among STEM University graduates: in 2012, graduates in STEM-related subjects account for 12.6 % of female graduates as compared with a share of 37.5 % among male graduates according to OECD.

Some recommendations on how to tackle this challenge could be supported by IMAILE STEM/ PLE.

- In school - STEM links in schools, lower secondary and primary with encouragement to real-world creative STEM projects;
- In wider society - inclusion of parents and communities in STEM careers experience in schools.

PISA results and ranking

Table of IMAILE countries PISA results and ranking in Science and Math 2009 and 2012

	Ranking Math 2012	Ranking Science 2012	Ranking Math 2009	Ranking Science 2009
Finland	12	5	6	3
Spain	33	29	34	36
Germany	16	12	16	11
Sweden	38	38	26	30

Sweden - Sweden's result dropped in Science and with the sharpest fall in mathematic performance over 10 years among the countries that have participated in all tests, with a drop in score from 509 in 2003 to 478 in 2012. Sweden performed below the OECD average in all both Science and Math. Additional information about Sweden is that the country is one of the highest ranked nations when it comes to ICT investment in Education

Finland - Finland, which received several top positions in the first tests, fell in all three subjects, but remained the best performing country overall in Europe, achieving their best result in science with 545 points (5th) and **worst in mathematics** with 519 (12th) in which the country was outperformed by four other European countries.

Germany - Students in Germany score 514 point in mathematics, on average – above the OECD average and comparable with performance in Belgium, Canada, Finland, Poland and Viet Nam. Students in Germany score 524 points in science, on average – above the OECD average and comparable with Australia, Canada, Ireland, Liechtenstein, Macao-China, the Netherlands, Poland, Chinese Taipei and Viet Nam. .However the latest results of the PISA shows a massive drop in both subjects compared to ranking in 2009.

Spain - Spain performs below the OECD average in mathematics, with a mean performance of 484 score points, and ranks between 31 and 36 among the 65 countries and economies that participated in the 2012 PISA assessment. Spain performs just below average in science: 496 points, ranking between 26 and 33. Science performance remained stable since 2006, improving slightly, but not significantly, from 488 to 496 points. Spain's performance in mathematics, reading and science

remains anchored just below the OECD average, despite a 35% increase in spending on education since 2003 and numerous reform efforts at national and regional levels.

Overall rankings Europe and global level (Rankings based on Math and Science, at age 15 EU versus global level)

1. Singapore
2. Hong Kong
3. Korea
4. Japan
5. Taiwan
6. Finland
7. Estonia
8. Switzerland
9. Netherlands
10. Canada

EU as a whole is lagging behind on its way to 2020 with distinct groups of high-performers in mathematics and Science: the East Asian countries, Shanghai, China, Hong Kong, Japan, Taiwan and South Korea.

Problem

The OECD economic think tank says the comparisons - based on test scores in 76 countries - show the link between education and economic growth.

The results of the PISA illustrate how the EU as a whole is lagging behind on its way to 2020 with distinct groups of high-performers in mathematics and Science. The declines of student's interest in STEM subjects are particularly noticeable at secondary level.

An average teacher in Primary and Secondary education has to prepare a class of 23 students in STEM studies and to keep them personally engaged and motivated with gender balance towards the subjects.

The following table provides an overview of sub-challenges, related to the increase of motivation for and results of STEM education, identified through the IMAILE needs analysis. For each challenge, a short description is presented.

Identified Challenges	Description
Motivation to learn and results decreasing for STEM subjects	The decline of pupil's interest in STEM subjects is particularly noticeable at the lower secondary school level. Math and Science results are lagging behind on EU level in latest PISA study.
STEM Course /Class planning and preparation hours with a personalized approach	Teachers spend a lot of time for the preparation of courses and classes. The time could be better used for direct communication and support of the learners.

State of the art and beyond

The IMAILE market analysis has shown that features related to STEM education are commonly not available in solutions on the market. While general pedagogical approaches such as project-based learning and inquiry-based learning are often supported, functionalities supporting the contextualization of STEM education, which was for example mentioned by the InGenious Project (see http://www.ingenious-science.eu) as a key factor for increasing the motivation to learn STEM, as well as the easy access to STEM learning content are commonly not available. The contextualization of STEM education could exemplary be handled through the usage of serious games or other external tools and web services such as virtual laboratories and simulations. However, the market analysis has shown that this integration was, if available, often at maximum a pure user-interface integration through the usage of iFrames and similar approaches. Therefore, the IMAILE PLE should provide integration not only on the user-interface but also in terms of data and functionality. Through this integration, the IMAILE PLE will allow services related to the personalization of learning to have access to the user behaviour and performance within those integrated serious games, web services and tools.

The gamification of learning also has the potential to increase the motivation of students. The market analysis has shown that in terms of gamifications, basic approach is available in some but not many solutions. The IMAILE PLE should therefore advance the gamification in both formal and informal learning.

Expected impact

Through the integration of sources for STEM content as well as the integration of STEM related serious games, web services and external tools and the easy access to these for teachers and students, the IMAILE PLE has the potential to decrease the preparation time for teachers. Additionally, these new and contextualized STEM learning activities could increase the motivation of students. Additionally, gamification approaches throughout the IMAILE PLE might increase the motivation.

The functional and data integration and the according possibility of including these in the personalization process have the potential to not only increase the motivation but also the performance of students. Through the personalisation of the learning, each student will be presented with learning content and activities fitting to their own learning preferences and potentially contextualized to scenarios relevant for the student. This can as a very high potential to get the student more involved in the learning and thus increase the performance.

Minimum requirements

To address the presented problem and reach the expected impact the IMAILE PLE should at least fulfil the following requirements. Hereby, previously described requirements are not repeated.

Description of minimum requirements Challenge 2 Increase STEM motivation and students results using technology enhanced learning
• Data, Functional and User Interface integration of STEM related serious games and external tools and web services such as virtual labs and simulations to allow access to the user behaviour and performance within the integration tools
• Continuously analyse the usage behaviour and performance of each individual student to identify preferred learning styles, learning content and learning activities in the main system but also integrated games, tools and services
• Provide badges and badge libraries as well as leader boards to enable the gamification of learning and provide possibilities to customize the available badges and requirements to gain badges
• Provide the support of group-based and project-based learning by allowing the creation of groups and related features for groups such as group calendars, collaborative writing, communication features within groups, group assessment etc.

6.3 Technical Challenges

6.3.1 Challenge 3 - Defined technical challenges

Problem

Procurers of technical solutions commonly already have an established landscape of software and hardware in place. These solutions might be from various different suppliers and can be in used for several years. For this purpose, it is highly important that any newly obtain system is interoperable with the existing hardware and software. This will ensure that the new system can communicate with the existing landscape and no additional costs for the exchange of old software and hardware is required. Additionally, it is highly relevant that the system can handle a high amount of users and organizations as well as a rapid growth. While a local or regional government might decide to try the system in a single school, it is possible that after a successful trial all schools in the reach of the municipality should work on the same system. This should be possible without any additional workload or costs for changes. Additionally, new approaches in teaching and learning might require additional functionality in the system. It is therefore crucial that these functionalities can be added at minimum effort and no additional solution is required.

Regarding hardware, in education, a trend goes towards bring your own device (BYOD) to allow learners to use any device in their possession to use learning technology, as schools often don't have the financial possibility to provide a device for every pupil This creates the challenge that software solutions have to be platform independent or version for different platforms with the same functionality have to be created. Another problem is based on the different regulations in the

procuring countries. The regulations can describe specific legal or technical issues which have to be fulfilled to be applicable as a solution in the public sector.

The following table provides an overview of sub-challenges, related to technology, identified through the IMAILE needs analysis. For each challenge, a short description is presented.

Identified Challenges	Description
User support	A new system requires a learning process for all involved stakeholders. Support for the users has to be provided to educate them on how to use the system. In terms of problems with the system, a direct support has to reduce potential times the system is not available.
Data and user privacy	As the system will store and analyse private data of minors, rigorous methods for data and user privacy have to be taken. This includes the provision of the right information to the right stakeholders.
Interoperability	Technologies have to be able to be integrated into the current and future software and hardware landscape at schools. This includes the exchange of data and information as well as the usage of services provided by external tools through a single access point with single sign on.
Scalability	Technologies have to be able to handle constantly and rapidly increasing amount of users and requests. Additionally, the functionality of the system has to be extensible based on new requirements.

State of the art and beyond

The market analysis has shown that many solutions on the market are not compliant with open standards. The IMAILE PLE instead should provide multiple interfaces based on the open standards provided by the various standardization bodies. The market analysis has also shown, that BYOD device is supported by the majority of solutions by providing access through web-browsers to the solution from any device. However, the availability and in particular the functionality of native apps for the solutions is lacking. The IMAILE PLE should go beyond the access through web-browsers by providing native fully functional applications for the main used devices and operating systems.

In terms of user support and data and user privacy, most solutions provide mature solutions. However, in terms of the data and user privacy it has to be ensured that the IMAILE PLE is compliant with European and national law of the procuring countries.

Expected impact

The interoperability of systems also reduces the lock-in problem identified by the European Commission (SWD 224 final, 2013; COM 445 final, 2013). A lack of interoperability can lead to a situation where the procurer is locked-in with the supplier, as systems of other suppliers cannot interoperate with the system. This can lead to poor procurement practices. Through ensuring that the IMAILE PLE is compliant with important open standards, this lock-in problem can be avoided. Through the compliance with important open standards, the IMAILE PLE will additional provide the possibility to enhance or enrich the functionalities of the system during the runtime.

By supporting common devices, the IMAILE PLE has the potential to reduce the costs of schools as they no or a reduced amount of devices have to be purchased to provide access for learners to the system.

Minimum requirements

To address the presented problem and reach the expected impact the IMAILE PLE should at least fulfil the following requirements. Hereby, previously described requirements are not repeated

Description of minimum requirements Challenge 3 Technical challenges

• Provide functions commonly available in learning environments:
  ○ Support the users through built-in help desks, documentations, manuals and tutorials
  ○ Ensure very high data and user privacy through secure data storages within the European Commission, Compliance with European and national data protection legislations, and access control to information
  ○ Provide possibilities to include REST and SOAP web services
  ○ Ensure high performance and low page loading times for increasing amount of users and activities

• Compliance with open standards (at least IEEE LOM, xAPI, LMS LIP, LMS LTI, LMS QTI, and SCORM)
• Provide the means for the integration of further external serious games, external tools and web services
• Ensure compliance with national public procurement laws and regulations on standardization such as (XML for public administration (XÖV), Standards on Architecture for e-Government Applications (SAGA), Barrier-free information technology regulation 2.0 in Germany, and the Swedish procurement act LOU)

6.4 Societal challenges

The societal challenges are listed in the challenge brief as important information to describe the effect of the situation and IMAILE challenge as a whole.

Suppliers are expected to take these challenges into account and address them in their work, however only the **indirect** impact is described in the section regarding societal challenges.

6.4.1 Challenge 4 - Labour market and increased demand of STEM professionals 2025

According to the report prepared by DG Internal policies Labour market situation in STEM-related jobs employment of STEM skilled labour is increasing and around 7 million job openings are forecast until 2025. At the same time a high numbers of STEM workers are approaching retirement age. The same report states that a major concern about the supply of STEM skills rely on two basic facts:

- the proportion of students going into STEM is not increasing at the European level;
- the underrepresentation of women persist.

With exact numbers the demand for STEM professionals and associate professionals is expected to grow by 8 % between 2013 and 2025, whilst the average growth forecast for all occupations is 3 %. This growth factor is to be considered by encouraging STEM studies.

However the labour situation remains with an Estimated STEM employment growth 2013 – 2025 and over 1 million additional jobs are expected to be created from 2013 to 2025 in EU28. This means that by 2025, there will be 7.7 million STEM professionals and these professionals have to start to be prepared in Basic Education otherwise Europe will be lacking in growth and innovation on a global level.

Problem

This societal challenge arises from the insufficient numbers of STEM graduates due to negative perceptions of STEM occupations according to the report prepared by DG Internal policies. According to their analysis and based upon other reports most STEM occupations is not gender neutralize for professional occupations. The decline of pupil's interest in STEM subjects is particularly noticeable at the secondary school level and among girls. All IMAILE procurers have previously worked with this challenge on national and local level but with no satisfactory result. Halmstad as lead procurer has focused on this challenge in a 3 year Interreg IVA project 2010 – 2013 identifying this challenge as a serious threat to cross border growth.

Identified Challenge	Description
Labour market and increased demand of STEM professionals in 2025	According to the report prepared by DG Internal policies Labour market situation in STEM-related jobs employment of STEM skilled labour is increasing and around 7 million job openings are forecast until 2025. At the same time a high numbers of STEM workers are approaching retirement age.

State of the art and beyond

The IMAILE market analysis has shown, that solutions on the market are not addressing the specific requirements of STEM education sufficiently. While specialized solutions for different topics in STEM exist, these solutions commonly don't offer general functionalities such as course planning, communication features etc. By providing an integration approach for personalized learning for STEM, the IMAILE PLE should allow the contextualization of STEM education to show the applicability of STEM in real world problems.

While the current technological solutions are not fit, other approach such as projects promoting STEM and improving the image of STEM and STEM careers in Europe (e.g. InGenious Project) or projects building communities of stakeholders involved in the STEM education (e.g. SCIENTIX) are showing promising results.

Expected impact (indirect)

Through the provision of personalized STEM education within the IMAILE PLE, students will see the importance of STEM topics as well as their applicability for real world problems. The IMAILE PLE has the potential to enrich currently taken approach such as InGenious and SCIENTIX by providing a platform in which learners can in a playful environment experience how topics related to STEM can have an impact on the society. This has the potential to increase the interest towards STEM and thus increase the amount of students striving for a STEM degree and becoming STEM professionals.

Minimum requirements

To address the presented problem and reach the expected impact the IMAILE PLE should at least fulfil the following requirements. Hereby, previously described requirements are not repeated.

Description of minimum requirements Challenge 4 Societal challenge Labor market and increased demand of STEM professionals in 2025
• Provide suitable means to contextualize the STEM education to real world issues and problems of interest of the students e.g. through the integration of suitable serious games and other external tools
• Align the approaches with other activities for STEM (such as SCIENTIX) to allow the exchange of information and reaching of synergies e.g. through the integration of learning content repositories available or the integration of community building features providing by these activities

6.4.2 Challenge 5 - Costs of early school leaves for EU member states

The effect of early drop outs and early school leaving (ESL) are a major challenge for society in large in a long term perspective in all EU member states.

The following information is gathered from the study - Overview and examples of costs of early school leaving in Europe by Education and Culture DG.

In order to measure the costs of ESL the study is based upon several cost elements related to:

1. Unemployment, income, welfare
2. Loss of tax revenues
3. Crime
4. Poor health and substance abuse
5. Personal situation
6. Pension

The source and the report states that lifetime costs of ESL per person range from the region of EUR 100,000 – EUR 200,000 up to EUR 1.1 million.

Problem

The problem for society at large is described in the summary of the same report and a conclusion that early school leaving is linked to unemployment, social exclusion, and poverty

I. Lifetime costs of ESL per person range from the region of EUR 100,000 – EUR 200,000 up to EUR 1.1 million.
II. The European wide study into the cost of NEETs found that annual bill of the problem is approximately EUR 100 billion, corresponding to 1% of GDP. A weekly cost of the problem is in the region of EUR 2 billion.
III. In the context of financial pressures, it is particularly important that policy makers make the right choices in terms of the investments they choose to focus on. These studies suggest that there are significant long-term savings to be made from investments in reducing ESL.

IMAILE procurer Viladecans represents SPAIN who leads the EU with the highest school dropout rates for the fourth year running, with 21.9% of 18-24 year olds leaving education early.

Identified Challenge	Description
Costs for Early school leavers	Early drop outs start early in the Education system Lifetime costs of ESL per person range from the region of EUR 100,000 – EUR 200,000 up to EUR 1.1 million.

State of the art and beyond

There exist several actions, projects and implementation of action plans all over Europe to tackle this problem. The problem is so high defined as a risk to the European society that it is described as one of EU: s 7 flagship initiatives. According to the information of the Europe 2020 target on early leavers from Education and training report from 2013: http://ec.europa.eu/europe2020/pdf/themes/29_early_school_leaving_02.pdf

The latest Education and Training Monitor showed that there are nearly **5, 5 million early school leavers** across Europe and that the average unemployment rate amongst them is about 40%. The early dropout rate should be lower than 10% in 2020.

Building on the results of two previous Thematic Working Groups on Teacher Professional development and early school leaving the European Commission has assigned a working group and program that will look at: *the collaborative approaches inside and around the schools that can support schools in their ambitions to provide educational success for all, and prevent and reduce early school leaving*.

Advances in technology and in particular on learning analytics and predictive analytics are starting to be integrated into solutions on the market, but commonly are still immature. While the common approach is to use these methods to analyse the learning preferences to steer the personalization of learning and provide meaningful recommendations, an additional aspect would be to identify

learners showing early signs and risks for dropping out. The IMAILE PLE should therefore provide these types of analyses as well as suitable notification and warning mechanisms to ensure that involved stakeholders such as teachers and parents are aware of the situation and counter measures can be initiated. While the majority of solutions on the market provide access for parents to the system to allow the monitoring of the learning process of their child, solutions commonly don't support the parents in trying to support the learning of their kid and identifying potential countermeasures in terms of problems and risks. The IMAILE PLE should consider providing a sort of parent support system to not only inform parents about problems and early signs of drop out, but also suggest methods and activities to work against the drop out.

Expected impact (indirect)

Through the usage of technology to identify early signs of drop out, notifying relevant stakeholders and the suggestion of counter measures, the IMAILE PLE has the potential to strongly impact the dropout rates at schools. This has to be done in collaboration with the existing actions and projects to ensure to align the activities and enrich the results.

The provision of personalized and contextualized learning has as previously described the high potential to increase the motivation and results of learners in STEM education. Increased motivation and better results again could also have a significant impact on the dropout rates.

Minimum requirements

To address the presented problem and reach the expected impact the IMAILE PLE should at least fulfil the following requirements. Hereby, previously described requirements are not repeated.

Description of minimum requirements Challenge 5 Societal challenge Costs of early school leaves for EU member states
• Provide the means to identify early signs for drop-outs e.g. through the analysis of activities in the system, completion of assignments, and performance
• Provide automated notifications for relevant stakeholders such as teachers and parents when early signs of drop-out are identified
• Provide a smart parent support system that gives guidance for parents with children underperforming or at risk of dropping out in terms of providing suggestions on which countermeasures should be taken and how the parents could support their child's learning