



## Impact report and legacy plan

Deliverable report 8.2

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## 1. INTRODUCTION

TEMI is coming to an end in July 2016 after three and a half year. 924 teachers have participated in the innovative teacher training programme that was put in place in the initial year of the project and then rolled out until June 2016 in nine countries and more, with the opportunity to run training in Belgium and Switzerland as well at CERN.

While the internal evaluation report (D7.4) looks at the impact on the teachers who did the full TEMI training, this report firstly focuses on the impact of TEMI on follow up projects, the impact on teachers and STEM professionals who were introduced to the methodology at the TEMI Congress and other events such as the ECSITE conference and the TEMI play “Light Mystery”.

Secondly, we describe the project legacy through the materials produced during the project and which carry the TEMI methodology and its applications further.

## 2. PROJECT IMPACT

### A. TEMI IN FIGURES

924 teachers were trained through the TEMI training programme delivered by the 9 TEMI project partners: UMIL, UniHB, UL, SHU, HBV, UniVie, Weizmann, Leiden, CUNI. The trainings were delivered in the partners’ nine countries (Italy, Germany, Ireland, England, Norway, Israel, The Netherlands, Czech Republic) plus Switzerland through CERN and Belgium with ESA. Partners also made an effort to run the TEMI trainings in different locations in their country whenever possible.

Quoting the Internal evaluation report (D7.4), “the global satisfaction of teachers after the TEMI trainings is high – all the rates in the last period are above 80% of satisfaction. [...] Implementing the TEMI way, more than 80% of the teachers reported observing a better motivation in their students.”

### B. FOLLOW UP PROJECTS AS EVIDENCE OF TEMI IMPACT

There is no TEMI 2 project as such in the pipeline at the moment, however all training partners have follow up projects in place that will make use of the TEMI methodology and innovations. This is due to the positive results and impact of the project observed by partners when delivering the training cohorts. Therefore the TEMI ideas and innovations will carry on and develop beyond the seed EU Fp7 funding.

### I. UMIL

UMIL will continue the TEMI trainings as they received requests to do so. In Italy, each teacher has a budget for courses and trainings as part of their CPD. Therefore TEMI trainings could be sustainable and paid through the teachers' CPD budget. The theatre show "Light Mystery" could also become a self-sustained show thus promoting TEMI. UMIL has produced kits to be distributed among the TEMI partners and to schools linked to TEMI. These kits support the local production of the show Light Mystery, through school drama groups.

### II. UNIHB

At Bremen University, part of the TEMI training has become an integral part of a practical course on experiments in chemistry teaching. For the next 3-5 years at least, all chemistry student teachers in Bremen will undergo this training.

Additionally, part of the TEMI training has become a course for in-service training in the GDCh-In-Service Teacher Training centre at UniHB. We will offer further half-day courses on the TEMI teaching ideas in the coming years and on request by schools and teachers.

### III. UL

The UL TEMI team plan to offer taster workshops through the Irish Science Teachers Association (ISTA) local branches in the 2016-17 year. These will be 2 hour workshops at ISTA branch meetings nationally. Additionally, UL intends to bring and circulate copies of the three modules developed as part of the project. These modules have been developed for the Irish Transition Year which is a curriculum free year between our version of GCSE and A-level (Junior Cycle and Senior Cycle in Ireland). UL will continue to disseminate these modules to teachers and schools. We intend to have a TEMI focus during the annual Chemistry demonstration workshops run each summer in UL. This is a week-long residential course run for 10-12 in-service teachers. UL will focus on the TEMI approach, demonstration and showmanship. UL will work to give Irish science teachers access to the bank of TEMI materials (>150) developed as part of the project. They also intend to publish and have TEMI teachers publish TEMI lesson ideas in Irish science teacher magazines (Chemistry in Action & Science (ISTA Journal/Magazine)). We plan to offer the TEMI workshop to 4th year PSSTs each year prior to their school placement. The UL TEMI Google + online forum will be maintained and opened up to teachers who participate in the future TEMI taster workshops and nationally, through fora such as the ISTA, the PDST, and EPI\*STEM and SSPC Teacher CPD courses and websites.

### IV. SHU

Sheffield Hallam University is focusing on training the trainers. The UK National STEM Centre will host TEMI lesson plans and the TEMI mascot. The SHU team is looking to embed TEMI in other

science education programmes and is working on an event for primary school teachers in charge of development of curricula.

#### V. HBV

In Norway, enquiry is a part of the national science curriculum, known as the «budding researcher». The HBV TEMI team had the opportunity to present TEMI to policy makers in the Norwegian Directorate for Education and Training and built a closer relationship with national institutions. A great investment by the government is put in CPD in science and maths, through the “Competence for quality” project and TEMI has been included in the teachers’ science curriculum. Additionally, 20 million NOK is put into the project «science municipalities», where HBV will also continue to communicate the TEMI methodology. HBV plans to continue using the TEMI methodology in our CPD-courses. This will ensure that approximately 30 new teachers will be introduced to TEMI annually.

In April 2016, HSN arranged a science conference with the aim of sharing the TEMI methodology, with a special emphasis on mysteries, showmanship and the 5E-model. Approximately 400 teachers and HSN students participated in the conference, among them several TEMI teachers and their colleagues. With funding from the governmental investment on CPD in science, the HBV team plans to arrange annual science conferences, where TEMI will be communicated. Teachers will get the chance to test TEMI lesson plans, and get the tools they need to plan their own lessons the TEMI way. It is also thought that TEMI lesson plans or methodology can act as a base for future master theses and research.

#### VI. UNIVIE

University of Vienna started a follow-up workshop already in March 2016. ‘Mysteries in Practice’ (MiP) is a continuing professional development course and aims to establish a Community of Practice regarding inquiry-based learning in chemistry education. Four times per semester, the UNIVIE-team works together with former Austrian TEMI teachers. The intentions of the meetings are theoretical deepening on the one hand and the planning and implementation of as well as the reflection on inquiry-based learning on the other hand. MiP offers the teachers the opportunity to extend their professional knowledge and to share materials, ideas and experiences with motivated colleagues in a friendly and appreciative atmosphere.

In addition to MiP, the UNIVIE-team will offer TEMI one-day-refreshing workshops. The first workshop will take place in April 2017 in Klagenfurt (Carinthia). Furthermore, brief education activities for teachers and the publication of further teaching materials based on the idea of TEMI are planned. There will be a presentation on possibilities to create Engage-phases (including Showmanship) at a conference of Austrian chemistry teachers in April 2017. Additionally research on enquiry-based science education will continue at the University of Vienna in the course of a dissertation project, which examines especially the Explore- and Explain-phase of the 5E-model.

Current information and materials already published can be found on the website of the Austrian TEMI-team (<http://aeccc.univie.ac.at/>).

#### VII. WEIZ

The Weizmann Institute will incorporate TEMI in their activities and training because it fits perfectly the Israeli curriculum. Teachers who were exposed to TEMI keep using the methodology and disseminating TEMI through their peers.

#### VIII. LEIDEN

Leiden University is planning to use the TEMI Book of Science Mysteries and the TEMI mysteries lesson plans all now translated in Dutch in their next teacher training programme. Leiden will incorporate the TEMI methodology in their future teacher trainings with Universe Awareness and Space Awareness.

#### IX. CUNI

Charles University Prague has translated the TEMI Book of Science Mysteries into Czech and will embed TEMI in their training, using the methodology booklet and the mysteries. The legacy carries on as well through TEMI teachers now training other teachers.

### C. IMPACT ON OTHER TEACHER TRAINING CENTRES AND STEM AMBASSADORS

A TEMI Congress was organized in April 2016 with the aim of gathering teachers who participated in the training across Europe, together with policy-makers and STEM ambassadors. The event was therefore an opportunity to get additional science teachers with interest in STEM dissemination to be introduced to the TEMI methodology. Marco Nicolini, representative for Science on Stage and Brussels-based teacher was completing at the time a Master thesis in which he mentioned the TEMI approach. He was asked to bring a copy of the TEMI Book of Science Mysteries at the oral evaluation to discuss as it was mentioned in the thesis.

QMUL also invited to the Congress teachers who had not been yet exposed to TEMI, as well as university teachers from Zilina, Slovakia, responsible for CPD and didactics, Daniela Sršňíková and Petra Laktišová. They had previously heard about the project at the EMINENT conference in Barcelona and were very keen to discover more about it. They returned captivated by the TEMI approach and communicated straight away within the University of Zilina. They report: "According to the knowledge gained, the major impact of TEMI on our educational activities was reflected in a significant increase of the students and teachers' interest in learning English/German through implementing TEMI innovative methodology. However, this positive effect was partially counterbalanced by the general lack of belief of some of our colleagues who still prefer traditional

way of teaching. We then offered TEMI workshops and presentations in the hope of changing the non-positive attitudes of proponents of traditional methodology and to support those teachers who like the idea of using mysteries and 5E cycle to capture students' imagination and motivation. Following the presentation of TEMI project outcomes and experiences, especially the model of the Gradual Release of Responsibility, we all found out that there is a vital need to transfer the responsibility for learning from the teacher to the student, even if we teach students at university." "TEMI Congress was inspiration not only for us who took a part in it, but also for our colleagues who were informed about it later on. Especially young researchers and teacher were fascinated by 5E method and how easy it is to present foreign languages via Science using stories and mysteries. We would like to continue with workshops for teachers, students at all levels, stakeholders and policy makers."

Daniela and Petra went on to use ideas gained at the congress for the Zilina STEMI Discovery Week. A short video shows the event and how students respond to their "engagement" approach. <https://www.youtube.com/watch?v=StT6MMDDx0o&feature=youtu.be>

They also worked on how to implement the TEMI approach into the activities of a summer camp for children, on the topic *English and German wrapped in science*. The camp took place in July 2016. <http://www.ucv.uniza.sk/ucv/?ur1=3&ur2=193&ur3=0>

It is particularly interesting to see that the TEMI approach is used at Zilina University to link the learning of both science and languages, at university level and primary school children.

The impact of TEMI goes well beyond the secondary school teachers initially targeted in the Description of Work.

#### D. IMPACT ON EUROPEAN SCIENCE CENTRES AND SCIENCE MUSEUMS

The Ecsite Annual Conference is the most prominent meeting of science engagement professionals in Europe, bringing together 1,000 professionals from all over Europe. TEMI has organised a reverse session and invited Aniello Mennella, professor at the University of Milan (Italy), Blazej Dawidson, head of Science and Art Events Lab at the Copernicus Science Centre (Poland) and Malka Yayon, Chemistry Teacher at Katzir High School (Israel) to bring their experience about "Spectacular science: controversial?".

Theatrical plays, magic shows, stand-up comedies, mystery games... are tools used to engage the public in science centres, but also in schools and research institutes. On the one hand, they represent an effective engagement tool, in particular for underserved audiences. On the other hand, they risk to reflect an old-fashioned view of communication, a way to "make the pill easier to swallow", or to take attention away from the social implications of science. Projects like TEMI and PERFORM are exploring spectacular science in a Responsible Research and Innovation perspective. They are developing an articulated methodology based on the use of mysteries and performing arts in different learning environments, such as science centres (PERFORM) and the classroom (TEMI). Considerations from a science centre explainer, a scientist and a teacher will spark a discussion on

the controversial use of spectacular science for public engagement. The issue is not new, but needs a continuous update to overcome stereotypes, avoid disconnecting science learning from the real world, and stimulate a dialogue between science centres and other relevant actors such as teachers and researchers.

The panel was well received by the participants: the room was full and many interesting reflections emerged from the group discussions. Overall the audience agreed that TEMI makes good use of showmanship as it is part of the investigative and learning process and now only to create a sometimes misleading "wow" effect. The editors of Spokes – the ECSITE online magazine – decided to take readers off the beaten ECSITE 2016 conference track and to ask five speakers whose unusual or edgy contributions intrigued the board to share their main message and conference highlights. Prof. Mennella was selected to describe his experience at the conference and his contribution to the TEMI reverse session "Spectacular science: controversial?"

#### E. TEMI ADAPTED "LIGHT MYSTERY" THEATRE SHOW: IMPACT ON THE AUDIENCE

The Light Mystery live show was mainly used as a dissemination tool to inform about the existence of the TEMI project and to convey the TEMI themes.

During the project, the show was performed nine times, one of them in English during the final TEMI congress in Leiden, and it was addressed to general public, and particularly suggested to teachers and students.

The fact that the participation to the show was free and open to the general public made it difficult to collect feedbacks. However, there was evidence that the show reached its purpose in conveying the TEMI contents, in particular to teachers. This understanding was possible thanks to the comments that were collected after the show. The Milan team received about 50 emails and also oral comments confirming the interest for the show from teachers. As an example, they were recently contacted by a high school headmaster, who, together with a physics teacher, wanted to propose the Light Mystery show to his school, after attending a replica in Lecce. They first say: "Marina, Marco, Nicola: it was literally, or better ... scientifically extraordinary! Lighting and spectacular, in every sense. I also bring you radiant comments by so many friends, colleagues and teachers who have enjoyed a pleasant evening!"

Teachers wrote: "Beautiful evening, the show wowed everyone ... no limits of 'age' and scientific knowledge Congratulations!". "Congratulations to the researchers / actors ... beautiful evening that wowed everyone present." "I loved the "very human" experiment on the uniform motion yesterday. There was a large involvement of the public!

Many email contained the attempt to find an answer to some of the open questions proposed in the show. The authors received many valuable solutions to the mathematical mystery of how to make the number 7 out of exactly four 2's, using simple mathematical functions!

Teachers in general demonstrated much interest for the theatre and its use for didactical purposes, as it is also confirmed by the high participation to a course on scientific theatre organized for students accompanied by their teachers. Although the course was activated in 2006, the Milan team had evidence of an increase in the number of subscriptions in the past year, which they attribute to the success of the Light Mystery Show and the appreciation of the TEMI approach.

In order to facilitate the use of the show with school classes, the authors elaborated the script, inserting comments and suggestions for teachers helping them in finding inspiration for their lessons. The booklet "Theatre as a means of supporting the teaching of science: Light Mystery - A script with added comments" was sent to all the partners of the projects and given to all the teachers who attended the show in Leiden. It is presently used in Italy with the teachers attending the courses and its effectiveness will be tested in the following.

### 3. PROJECT LEGACY

#### A. TEACHING THE TEMI WAY

The TEMI methodology booklet was fully completed in its English version in spring 2015 and booklets printed for all partners for distribution and use in their cohorts. The booklet has been a reference document and be used by all training partners. It was translated in Norwegian, Dutch, German, Czech, Italian and French. All 900 + TEMI trained teachers have received the booklet as part of the training. Another 220 copies were handed out to participants of the TEMI Congress in Leiden in April 2016.

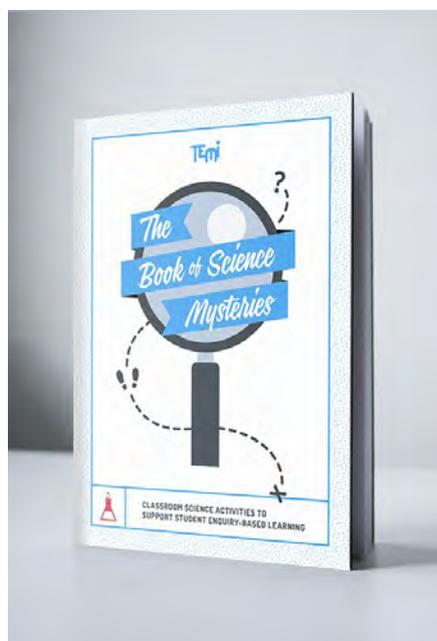


#### B. THE TEMI BOOK OF SCIENCE MYSTERIES

The TEMI Book was published in December 2015. All mysteries were provided by the teacher training partners, selected because of their popularity in the training cohorts with teachers and

country relevance to the curriculum. Each mystery is a classroom resource that can be solved the TEMI way, following the combined use of the TEMI 4 innovations: mystery, showmanship, 5E and Gradual Release of Responsibility. The book was distributed to all participants of the TEMI congress and is also translated into Dutch and Czech, used in English in the other countries. The draft version of the book was presented to teachers at a Scientix meeting with a special session where participants provided feedback. There were also several opportunities for TEMI partners to review each other classroom resources. It was designed professionally and circulated to organizations such as the UK STEM Centre and other STEM networks. 220 copies were printed for the TEMI congress.

Beyond TEMI, the TEMI reference catalogue is available on repositories such as TES (<https://www.tes.com/>), MERLOT – multimedia educational resource for learning and online teaching (<https://www.merlot.org/>), the UK National STEM Centre resource department, OER Commons (<https://www.oercommons.org/>) and SCIENTIX.

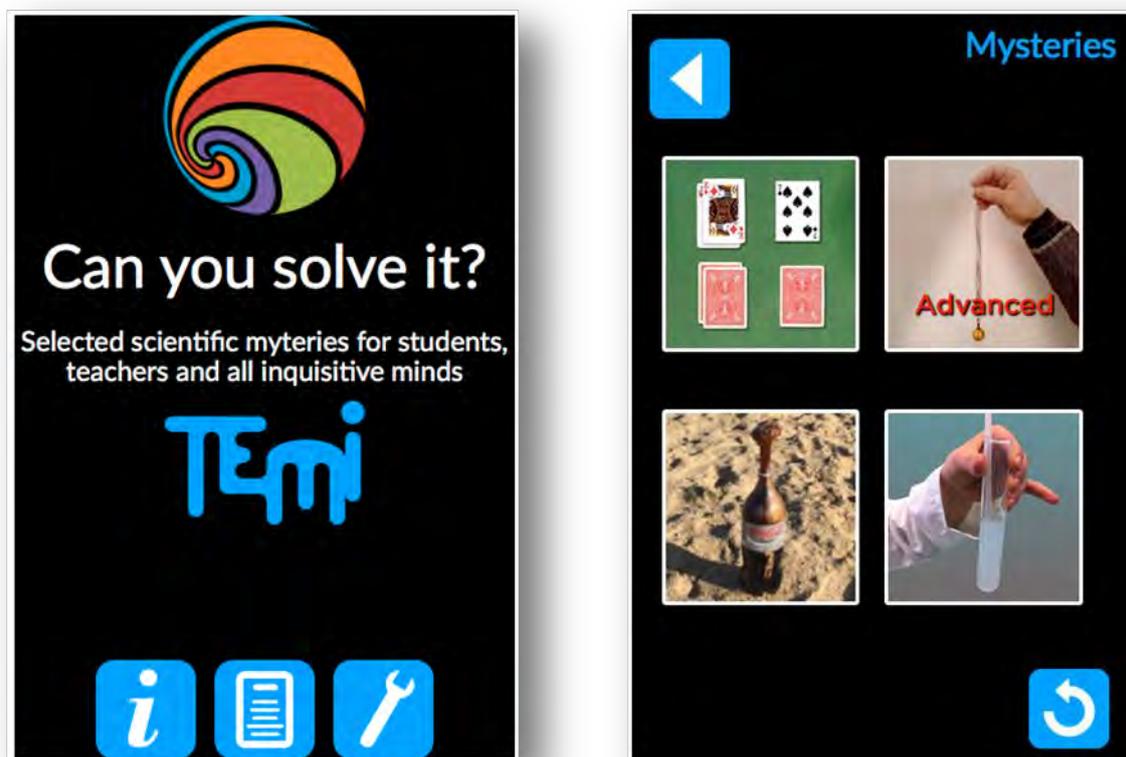


#### C. THE TEMI WEBSITE

<http://teachingmysteries.eu/en/> will carry on with a protected domain name and the site behind transferred to QMUL to ensure it lives on for at least 5 years. The website contains all the project news, TEMI developed mysteries, the book and methodology booklet, with translations.

#### D. THE TEMI APP

The TEMI app contains 17 mysteries provided by the TEMI partners. The app is an extra tool for teachers to browse selected scientific mysteries and solve them following the TEMI approach. It is available on the Apple app store and Google Play. The TEMI app is being promoted to all 900+ TEMI teachers and 220 Congress participants.



#### E. MASCOT

TEMI produced a mascot as part of its communication tool, to raise the profile of the project at large events, as a curiosity to stop the crowd. It is the Heron's horse, a piece of engineering designed by Heron of Alexandria (10-70BCE), a Greek engineer considered to be the greatest experimenter of antiquity. The mascot shows the mechanism that allows the blade to pass through the neck, while the head and body remain joined. The original piece showed an arrangement of a horse and a herdsman, cutting through the neck of the horse, the horse continuing drinking water from the cup which was held in his hand. Heron's horse was used in temples and helped priests create a sense of mystery.

Two sculptures were produced by London based artist Tim Sargent. One was donated to the UK STEM Centre in York, England. The Centre is visited annually by about 6000 people, mostly teachers, students and researchers. The horse sits prominently in their resource centre as a reminder of the

TEMI project. It will continue bring the attention onto the TEMI project and its outputs, the TEMI booklet and book available at the centre. The 2<sup>nd</sup> sculpture will be displayed in the main hall of the Queen Mary University of London. Plaques have been produced to point out to the project website and other resources.



## F. THEATRE SCRIPT AND KITS

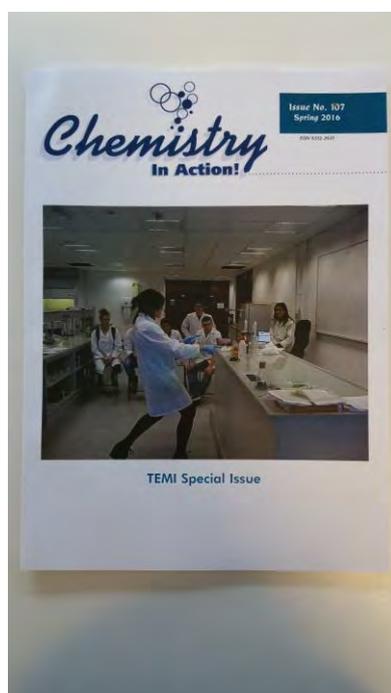
The UMIL team produced a script with added comments of the TEMI adapted show. Entitled *Light Mystery: a script with added comments –theatre as a means of supporting the teaching of science*, the script is a resource for science teachers and drama teachers to use in the school. Comments are adapted for use with young audience.

Additionally, UMIL produced kits based on the mysteries used in the training cohorts, with instructions and some basic tools/equipments that schools can request on loan to work with in their classes, and that can also be used for scientific theatre activities with the help of the booklet.

Dissemination of the theatrical booklet and take up of science theatre is already happening in Italy, with the TEMI workshop and following the GIREP-EPEC conference. Play, theatrical booklet (commented script) and kits all support the know-how, contacts and the scientific prop lists so that partners, TEMI teachers across Europe and schools can perform the show in full or in part of it on their own. This will support the legacy of TEMI, its approach and in particular the one of showmanship.

## G. CHEMISTRY IN ACTION SPECIAL EDITION

A special edition of the magazine Chemistry in Action was produced under the direction of Peter Childs at University of Limerick. The magazine was distributed to chemistry teachers in Ireland and also to TEMI teachers through the training partners. With the contribution of all TEMI training partners, it gives practical examples of TEMI applications in the classroom and how the TEMI training was carried out in the different countries.



## H. MORE IN THE PIPELINE...

At the final TEMI project meeting in June 2016, partners discussed **potential projects post TEMI**:

- a collaborative paper for peer reviewed journal (TEMI training partners)
- a symposium at ESERA 2017 – Dublin (Weizmann, UMIL, CUNI, SHU, HB)
- Dissemination of TEMI in 2016 at EuCheMS 2016, IOSTE 2016, ERICE 2016 and Scientix (Sterrenlab & CUNI)
- Sterrenlab to continue tweeting about TEMI

**TEMI partners would like to explore other ideas:**

- Study the impact of storytelling & IBSE on student motivation (Limerick, UMIL – showmanship, SHU – drama in science)
- Exchange of students between partners as a way of maintaining partnerships and developing TEMI content – via ERASMUS
- University of Limerick got the opportunity to collect a lot of data and there were discussions on how to exploit them further.

## 4. CONCLUSION

This report details the impact and legacy of the TEMI project, ranging from teachers trained, culture change in partners and their future training, high quality online resources both digital and print disseminated to a range of locations and evaluation reports for policy makers. The project was ambitious and has to the greater extent accomplished its objectives.

TEMI has been a very ambitious project, large scale, with more than 920 teachers trained. It was a difficult exercise for the consortium, with building and testing the new TEMI approach by the training partners as well as refining training with teachers at each cohort and producing new resources at the same time.

Rolling out the training courses across Europe has generated a great outcome with a wealth of experience and resources developed in each location to suit local curriculum and needs.

The impact of TEMI on teachers is very positive (ref. WP7 Evaluation reports ) and the take up and integration of the approach in routine training programme is a testament to the fact that the TEMI approach does make a difference and should be developed further.

TEMI offers professional and personal development to teachers while focusing on the interest and curiosity of students. With more than 900 TEMI trained teachers and now also new trainers cascading the approach, with great interest generated through networks such as CERN, ESA, ECSITE and SCIENTIX, we are confident the TEMI approach to teaching is only beginning and will carry on across Europe with great results