New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION
3rd Edition

TEMI: Teaching Enquiry with Mysteries Incorporated. An Insight from Ireland

Joanne Broggy, Peter Childs, Orla McCormack, Beulah McManus, Anne O'Dwyer

National Centre for Excellence in Mathematics and Science Teaching and Learning and Department of Education and professional Studies, University of Limerick, (Ireland)

Beulah.Mcmanus@ul.ie

1. Introduction

Harnessing the emotional power of magic, myth and mystery is one of the latest trends in science education. TEMI, the EU-funded FP7 Science in Society project is attempting to promote enquiry-based teaching to help young students across Europe develop a passion for science. The aim of this 3 year teacher training project is to help transform science and mathematics teaching practice across Europe by giving teachers new skills to engage with their students, exciting new resources and the extended support needed to introduce effectively enquiry based learning into their classrooms. Innovative 'Enquiry Labs' and workshops are being developed among teacher training institutions and teacher networks across Europe which will be based around the core scientific concepts and emotionally engaging activity of solving mysteries, i.e. exploring the unknown. It is intended to train 6 cohorts of 10-12 teachers over the course of the 3 year project, in each country, in a series of two one-day workshops. A spoke-and-hub model for coordination and delivery allows the project to both respond to local country needs and to maintain an overall EU wide sharing of best practices. The central hub of this project is the coordinator Queen Mary University of London, while the spokes comprise of 13 partners from 11 countries (see Table 1).

Table 1. Consortium of the TEMI project

TEMI Partners
Queen Mary, University of London - UK
Università degli Studi di Milano - Italy
Bremen University - Germany
University of Limerick - Ireland
Sheffield Hallam University - UK
Hogskolen I Vestfold - Norway
University of Vienna – Austria
Weizmann Institute - Israel
Leiden University - Netherlands
Charles University Prague - Czech Republic
Sterrenlab - Netherlands
TRACES – France
Cnotinfor - Portugal

2. Engaging the disengaged: the TEMI approach

The TEMI project is based on the 5E model of enquiry [1], as shown in Figure 1.

Figure 1. The 5E model for enquiry

In this model the lesson proceeds through a number of stages (Table 2), of which the first one is Engagement. The particular focus of the TEMI project is on this stage of the lesson. Unless students are engaged and motivated, and have their curiosity aroused so that they start asking questions: "Why? How? What if?", then there will be no real enquiry. The idea behind TEMI is to use mysteries, or unusual or discrepant events, to capture the students' interest and lead them into the 5E process.

Table 2.The stages of the 5E model [1]

Engagement	Students' prior knowledge accessed and interest engaged in the phenomenon
Exploration	Students participate in an activity that facilitates conceptual change
Explanation	Students generate an explanation of the phenomenon
Elaboration	Students' understanding of the phenomenon challenged and deepened through new experiences
Evaluation	Students assess their understanding of the phenomenon

2.1 What is a mystery?

In science education, a mystery is a phenomenon or event that provokes the perception of suspense and wonder in the learner, in order to initiate an emotionally-laden "want to know"-feeling, which leads to an increase in curiosity and which initiates the posing of questions by the students, to be answered by enquiry and problem-solving activities [2]. Such mysteries, which have a scientific basis and explanation, are also known in the literature as discrepant events. There is a massive literature describing discrepant events and their role in science education [3][4].

A mystery is a good mystery for a classroom enquiry if:

- it can be investigated and explained scientifically and is within the competency of the students involved,
- it provides affective engagement for the students,
- it generates curiosity and leads to student questions,
- it 'problematises' or makes knowledge and enquiry skills part of the answer to the mystery,
- it covers a sufficient part of the nationally assessed curriculum to justify time spent,
- it is simple enough to be a 'discrepant event', and generate cognitive conflict,
- the time between mystery and answer is limited (1-2 lessons),
- it is introduced by a pedagogy that relies on the mystery itself.

A mystery is a bad mystery for a classroom enquiry if:

it provides engagement for the teacher only, but the students are not excited,
it generates little curiosity and the teacher has to do all the work,
it is answered by science concepts that are too difficult for students to grasp,
it is peripheral or unrelated to the subject content of the curriculum,
it is too complex, so that students explain it away as 'magic' (a trick that I don't need to explain).

The various partners are tasked with developing lessons around such scientific mysteries, introducing them to practising science teachers, who will try them out in schools and evaluate their effectiveness in engaging their students. The Irish programme is described in the next section.

3. Experience in Ireland

The TEMI team in the University of Limerick have been working for 6 months with 4 pre-service science teachers, who are in their final year of study. Three of these students, as part of their Final Year Project (FYP), have developed a set of classroom teaching materials in the form of TEMI lesson plans and activity sheets in the areas of chemistry, physics and biology respectively (for both the Junior Cycle – general science, and the Senior Cycle – single subject science). The fourth pre-service science teacher, however, has developed an 8 week science module for Transition Year science students, *Scientific Mysteries*, which includes physics, chemistry and biology units. (Transition Year in Ireland is an optional year between Junior and Senior Cycles, which is intended to broaden the students' educational experience by providing a bridge to *"help pupils make the transition from a highly-structured environment to one where they will take greater responsibility for their own learning and decision making"* [5]).

All of the developed TEMI classroom material has been trialled by pre-service science teachers from the University of Limerick, while completing their final teaching practice placement. Some of the material has also been piloted by a number of in-service science teachers in advance of the first workshop. This material will be revised, based on feedback from the teachers and FYP students, and will be used as bank of resources for all participants involved in the TEMI project.

3.1 Recruitment strategies employed

The participants for cohort 1 include the 4 pre-service science teachers and 5 in-service science teachers from 5 second-level schools in Ireland. The in-service science teachers were recruited in the following ways:

1. The TEMI project was publicised through an insert in issue #99 of the journal *Chemistry in Action!* and also in *SCIENCE*, the official journal of the Irish Science Teachers' Association (ISTA). This informed a large number of science teachers and allowed those who were interested in participating in the project to contact the UL TEMI team.
2. Science teachers, known to the team members to be enthusiastic and willing to try new ideas, were invited to join the project, subject to the support of their school.
3. It is also intended to run short TEMI workshops at science teachers' conferences to recruit new participants.

For interested participants, an invitation letter, consent form and information sheet describing the TEMI project and the requirements involved in participation were then sent to school principals, who were asked to nominate a teacher for the workshop. Each of the participating schools (teachers and principals) completed and signed an agreed Commitment of Participation in the TEMI project. This detailed the necessary involvement of the Science teacher in the TEMI project.

3.2 TEMI workshop design

The quality framework that will be used for the workshops in UL has been developed by the working team in Sheffield Hallam University in London, and has been developed as a result of piloting a two-

day workshop-based programme with secondary school science teachers in the UK. There will be a specific focus on the "transformative power of practice" [6] in the workshops where participants will be strongly encouraged to become actively involved in the workshop, in order to maximise the chance that they will know how to implement enquiry when they return to their classrooms.
By participating in the workshops teachers will:

- become familiar with the 5E model of enquiry,
- evaluate the newly developed curriculum materials.
- learn to use mysteries to engage students in structuring their ideas,
- develop their role as an expert in working scientifically (not as a dispenser of knowledge),
- practise generating their own TEMI-style lessons in a collaborative exercise,
- reflect with peers, scientific researchers and curriculum developers.

The timetable for Day 1 of the first workshop is shown in Table 3 below.

Table 3. Timetable for Day 1 of the first teacher training workshop

Agenda
Session 1 • Welcome & Introduction Vision for TEMI TEMI in Ireland Feedback about TEMI in TY • TEMI Enquiry Lesson Simulation Rolling Uphill (Engage and Explore) • Explore the 5E model of enquiry
Session 2 • Teaching to Motivate Two ways to teach Density Feedback from classroom experience Importance of Motivation
Session 3 • What is a Mystery? • Design TEMI Lesson TEMI Lesson Planner Available resources Present and share ideas with whole group • Pre-service Teachers- Final Year Project: Immediate reflections & insights
Session 4 • TEMI Lesson Resources Biology / Chemistry / Physics/TY Where to source ideas • Developing Shared Community of Practice Google + Forum • Tasks for Workshop 2 Details of teacher's responsibilities before next workshop in April 2014 • Review / Feedback / Questions

In the first Teacher Training Workshop, participating teachers will be provided with a resource folder containing all of the necessary documents for their participation in the TEMI project. The contents of

this folder include a list of all TEMI contacts and participants in Ireland, previously developed TEMI ideas, Lesson Planner templates to guide development of their own lessons, as well as selected relevant literature about IBSE and the 5E model.

Following this first workshop in January 2014, the in-service teachers will be asked to complete a number of tasks in advance of the next workshop in April. They will be invited to choose from the bank of developed TEMI classroom materials and will be required to implement at least 5 of these lesson ideas in their own classes. Once the teachers have become familiar with the TEMI teaching approach, they will then develop and implement at least 2 new TEMI lessons.

It will be important to gain feedback from the teachers' experiences of teaching enquiry with a TEMI focus and so teachers will keep a reflective diary, in which they will be asked to complete a one page reflection after the implementation of each TEMI lesson. Pupil questionnaires will act as another form of data collection tool and teachers will be requested to administer these to their pupils at the end of their TEMI lessons. The feedback and data attained through this will be used to inform the changes and improvements for the subsequent workshops.

The second day of the workshop, which is due to take place in April 2014, will focus on the sharing of experiences of implementing the TEMI approach, and evaluating the effectiveness of the approach, as well as generating new ideas.

3.3 Sustainability

In order to ensure the sustainability of this IBSE project, it is intended to adopt a cascading mechanism, whereby more than one teacher from each participating school (through the 6 cohorts) will be invited to take part in the project. For example, Teacher 1 from School A will participate in cohort 1 and Teacher 2 from School A will participate in cohort 2. In this way both teachers can support each other to sustain their implementation of the TEMI teaching approach. It is hoped that this will also help to establish a TEMI approach to enquiry in their schools. Participating teachers will also be encouraged to share their ideas and resources with other science teachers in their school, and thus diffuse the TEMI approach into the school's science teaching and learning programme.

In addition to this, a TEMI Google discussion forum and TEMI Google drive folder have been developed. The aim of the Google Forum is to allow teachers to easily interact with each other online and to share their experiences of implementing TEMI lessons. The TEMI Google drive folder, which is an online cloud storage facility, will serve as a storage bank for the curriculum materials. This will be continuously added to by the participants and team members throughout this project. It is intended that all involved members of the TEMI project will continue to use and develop TEMI-style materials after their own workshops and all participants will be able to use the resources after the project has ended.

On a final note, there is great potential for a significant impact of this TEMI project on the national science curriculum in Ireland. Currently, a new Junior Cycle education framework has been developed, which is centered on placing learners "at the centre of the educational experience" [7]. This framework focuses on "Key Skills" such as "Being Creative" and "Managing Information and Thinking" [8], which directly align with the objectives of this TEMI project.

There are also proposals in place for developing the Senior Cycle science curriculum. Draft syllabi have been produced in the three main sciences; physics, chemistry and biology, and these too have been based upon "Key Skills" like the "Critical and Creative Thinking" skill [9]. The focus on "Key Skills" in the proposed educational frameworks creates a strategic opportunity for the implementation of the TEMI teaching and learning approach nationwide.

References:

[1] Bybee, R., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson, J., Westbrook, A., Landes, N. (2006). *The BSCS 5E Instructional Model: Origins and Effectiveness.* Colorado Springs, Co: BSCS.

[2] TEMI (2013), 'What is a mystery?', [online] available: http://teachingmysteries.eu/en/resources/ [accessed 13 Jan 2014].

[3] Liem, T.L., 1990. *Invitations to Science Inquiry*, 2nd. Ed. Science Inquiry Enterprise

[4] O'Brien, T., 2010. *Brain-powered science: Teaching and learning with discrepant events*. Arlington, VA: NSTA Press

[5] Department of Education and Science (1993), Transition Year Programme, Guidelines for Schools, Dublin: Department of Education.

[6] Lemov, D., Woolway, E., Yezzi, K. and Heath, D. (2012) *Practice Perfect: 42 Rules for Getting Better at Getting Better*, San Francisco: Jossey-Bass

[7] Department of Education and Skills (2012) *A Framework for Junior Cycle*, Dublin: The Department of Education and Skills.

[8] NCCA (2013) *Key Skills of Junior Cycle*, Dublin, available online: http://www.juniorcycle.ie/NCCA_JuniorCycle/media/NCCA/Documents/Key/Key-Skills-Overview-Feb-2013_screen.pdf [accessed 20 Sept 2013].

[9] NCCA (2012) *Senior Cycle Science: Report on the Consultation, Dublin, available online:*http://www.ncca.ie/en/Curriculum_and_Assessment/Post-Primary_Education/Senior_Cycle/Consultation/Science_Consultation_Report.pdf [accessed 20 Sept 2013]