

Involving Pre-Service Science Teachers in the TEMI Project

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1. Introduction

TEMI (Teaching Enquiry with Mysteries Incorporated) is now in its second year of a 3½ year FP7 project. The key idea behind TEMI is to train teachers to use mysteries as a means of engaging students in the inquiry process (see website <http://teachingmysteries.eu/en/>).

Second-level education in Ireland is currently a preoccupied with coverage of course material and preparation for examinations.[1] Consequently, important activities and innovative teaching approaches 'are ignored because the system places undue pressure and stress on students [and there is] a narrowing of the curriculum arising from the tendency to teach to the examination results and an undue focus on the attainment of results'.[2] Within such a context, it can be difficult for teachers to stop focusing on the direct transmission of knowledge and teaching towards the exam.[3] However, the context is changing in Ireland. The National Council for Curriculum and Assessment (NCCA)[4], are proposing to introduce changes to lower secondary education that would see the emphasis moving from summative assessment to more student-centred pedagogical approaches and more use of formative assessment of students' work. Furthermore, proposed changes to lower and upper second-level Science aim to introduce a new and increased focus on teaching through enquiry.[5] The work of TEMI in Ireland was presented in NPSE in the 2014 conference.[6] The project aims to encourage In-Service Science Teachers (ISSTs) to develop an understanding of Inquiry-Based Learning (IBL), as well as developing an understanding of the benefits of utilising such approaches. One of the unique aspects of TEMI in Ireland has been the involvement of Pre-Service Science Teachers (PSSTs). The UL team have worked with nine PSSTs over the past two years.

2. PSST Involvement

The engagement of PSSTs, and the ways in which they were engaged in the TEMI project, is fundamental to introducing IBL in Irish schools. This paper explores the benefits of involving PSSTs in such a project. This work is in addition to working with cohorts of ISSTs, who are the main focus of the project, while aiming to equip both groups for proposed curriculum changes in Ireland.

Two groups of PSSTs are involved in the TEMI project. The first group, had continuous involvement, working closely with the UL team to develop an intervention strategy. This involves the development, trialling and evaluation of their TEMI materials for their effectiveness. During their time on School Placement (SP) the PSSTs trial and evaluate their TEMI materials and are in constant contact with their Final Year Research Project (FYRP) supervisors (all of whom are on the TEMI project team).

The other group of PSSTs involved in the project were involved on a "one-off" basis, where they attended a workshop prior to commencing their final year SP. The purpose of this 3-hour workshop was to introduce them to the TEMI approach to teaching science and provide them with a model of how they could implement IBL using mysteries. The TEMI project is based on the 5E Model of Enquiry.[7] In this model the lesson proceeds through a number of stages, starting with Engagement, in which phase mysteries, unusual or discrepant events are used to capture the pupils' interest and lead them into the 5E process. This workshop was attended by 38 PSSTs and they were asked to comment on their experience at the end of the workshop through the use of a questionnaire. The PSSTs were also invited to attend a focus group on their return from SP to see if they had used the TEMI approach and if so, to comment on their experience. Both groups of students were self-selected.

3. Continuous Involvement of the PSSTs

3.1 Action Research Projects

Action Research (AR) is a process of practitioner-directed inquiry into classroom practice, and is widely regarded as an effective vehicle for helping teachers to improve their teaching and strengthen their pupils' learning.[8] The practitioner plans and implements a change designed to address an identified concern. Implementation of the change is carefully monitored, and data is collected and analysed to understand the impact of the change.[9] Research into the impact of the use of AR in teacher education indicates that student teachers can benefit significantly from engaging in the process of inquiry and reflection that AR demands.[10] AR is increasingly being adopted by pre-service teacher education programmes.[11, 12]

In UL, AR is introduced to prospective teachers in their FYRP. The TEMI project provided a suitable opportunity to involve PSSTs in AR, which could be carried out before, during and after their final year SP. The PSSTs (n=9) have planned lessons, involving the development of IBL classroom materials, trialled and evaluated these materials during SP. Participating in the systematic inquiry process required by AR, has led the TEMI PSSTs to recognise, and become better equipped to articulate, their personal theories of practice, explaining what they are doing and why they are doing it.

3.2 Professional Learning Community

Professional Learning Communities (PLCs) promote collaboration and integration between teachers and external agencies.[13] A PLC is a means for facilitating professional development. There are five common characteristics of a PLC: [13,14]

1. Building the foundation on teachers' shared values and vision.
2. Promoting collective responsibility for student learning.
3. Increasing reflective professional enquiry.
4. Promoting collaboration.
5. Integrating collective and individual learning.

A PLC can be described as a suitable '*vehicle*' for engaging both schools and teachers in examining professional practice and implementing reform-based change in the classroom.[13] The implementation of the TEMI project in Ireland provides a unique opportunity for ISSTs and PSSTs to collaborate in their professional development as part of a PLC. The PLC that was established in the TEMI project involved the collaboration of three different groups of professionals: the PSSTs, the ISSTs and the Science Education/Teacher Education Researchers on the project team. The PSSTs facilitated the ISSTs in sourcing and developing ideas during the workshop. The ISSTs were able to share their classroom experience in developing and using ideas. The Science Education Researchers facilitated such discussions in the face to face TEMI Teacher Training workshops as well as on the virtual PLC, which was developed using a Google™ platform.

3.3 Collaboration of PSSTs with CSTs while on school placement

Co-operating Science Teachers (CSTs) allocate some of their Science classes to the PSSTs during their 10 week SP. CSTs have a significant role to play in working with PSSTs during SP.[15] The period of SP not only provides PSSTs with an opportunity to be involved in classroom teaching but it is also a time where they can apply educational theory in a variety of teaching situations and contexts.[16] Traditionally, the CST would be seen as the 'expert' and the PSST as the 'novice'. However, the PSSTs, who were involved in the TEMI project, had an opportunity to model best practice in teaching their IBL lessons while on their school placement. The PSSTs experience also sought to begin the discussion in schools on the use of IBL, in particular the use of mysteries (as unique to TEMI) in teaching science, as a possible teaching approach that can be used to support the reform currently taking place in Irish curriculum. The PSSTs evolved as TEMI ambassadors, by informing their CSTs about the project. The impact of the influence of the PSSTs has been evident by the increased interest of CSTs to become involved in the TEMI project from the schools where the PSSTs were on placement.

4. One-Off Involvement of the PSSTs

4.1 Benefits of the TEMI workshop and intentions to incorporate mysteries while on school placement

Of the 38 PSSTs, 3 had heard of 'discrepant events' in science education, before being introduced to the term in the TEMI workshop. Having participated in the workshop, all of the PSSTs felt that they gained an understanding of '*how to structure mysteries into a lesson*', '*how to question*' and '*ideas and activities for lessons*'. Others indicated that they had gained a greater appreciation of '*the importance of pupil engagement*', '*the importance of good questioning*' and '*the benefits of using mysteries as an engagement tool*'. One dissenting voice indicated that he had learnt "*nothing new*" from the workshop because he believes that "*it's a given in education at this point that science needs more inquiry*". All of the PSSTs (n=38) intended to apply what they learnt in the TEMI workshop on SP. Most of the respondents found the 5E Model to be a useful tool for promoting pupil engagement. Some PSSTs commented on how the TEMI teaching approach would "*make [teaching] more fun for both teacher and pupils. A lot of pupils tend to dislike science because it is 'boring', this aims to change that.*" In addition to this, the PSSTs believed the workshop had provided them with '*effective teaching resources and ideas*'.

4.2 The reality – the extent to which PSSTs incorporated mysteries while on school placement and reflections on the workshop

8 of the 38 PSSTs participated in two small (n=4) focus group discussions following the 10 week SP. A number of PSSTs identified specific mysteries they used and developed. One PSST explained how she developed mysteries relating to blood:

"I was teaching a theory based class on blood. I would start the lesson off with a scenario or a case study with simply things 'like Mary was feeling unwell and she went for a blood test and the results came back with low white blood cells'. They hadn't done white blood cells so they then had to think what the white blood cells do then in the body. It got them thinking and it was everyday things".

The PSSTs felt that that '*the mysteries got pupils thinking*'. Another PSST found the 5E planner '*kept [her] focused*'. One PSST suggested that they had to introduce another '*engage*' activity at a half-way point of the lesson in order '*to get their [the pupils'] attention again*'.

Particular issues and challenges emerged in relation to the PSSTs' ability to integrate mysteries into the lessons. PSSTs indicated that pupils were not used to engaging in such types of activities and the PSSTs struggled to motivate them to participate fully. Some suggested that involvement depends on the pupils' interest in Science, class time available and academic ability of the pupils: '*some wouldn't have enough knowledge to come up with ideas as to why something was happening*'. After frequent exposure to mysteries, pupils '*figured out*' that the mysteries often related to the '*not obvious answer*'. Others felt that pupils disengaged from the process after the '*engage*' activity and didn't enjoy or participate as well in the remaining parts of the 5E model. Therefore, sometimes the scientific theory underpinning the mystery wasn't sufficiently explored.

The PSSTs suggested that the TEMI workshop came '*too late*' in their initial teacher education programme. It was suggested that perhaps the concept of mysteries should be incorporated into course modules in their undergraduate programme i.e. subject pedagogy, to allow more exposure. It was suggested that PSSTs needed time to '*go away, try it out and come back*'. PSSTs particularly liked the aspects of the workshop where they engaged in mysteries and it was suggested that perhaps enabling them to participate in more mysteries would be beneficial. Having a repository of resources available to PSSTs was also viewed as important.

5. Discussion and Future Work

Enabling teachers to work together in a collaborative manner, where they are provided with opportunities to '*discuss their beliefs about teaching and learning with one another, critique their own practice, systematically test new ideas, and share their findings with one another*' [17] are viewed as effective approaches to teacher development. Furthermore, providing opportunities for ISSTs and PSSTs to work together has been proven to be effective: '*The only way for beginners to learn to be both educators and activists is to struggle over time in the company of experienced teachers who are themselves committed to collaboration and reform in their own classrooms*'. [8] Such collaboration has the potential to bring about meaningful learning and professional development for both ISSTs and PSSTs. [8] The extent of collaboration in the TEMI project between Science Researchers and Educators, ISSTs and PSSTs was limited due to the short nature of the AR projects, the CPD

workshops and the SP. However, the active involvement of the participants in this exploratory study is encouraging for the future.

A number of the comments and suggestions from the PSSTs who participated in the one-off workshop highlighted the limited ability of such short-term approaches to bring about effective change. Their suggestions for improvement reflect the approaches taken with those involved with TEMI on a more 'continuous' basis. Concerns have frequently been expressed about teacher development that adopts a 'one-off' approach.[18] Such approaches can result in fragmented and incoherent teacher development,[19] which doesn't result in significant changes to pedagogical practices or belief systems around teaching and learning. It has been suggested that there is a need to have a sustained and intensive approach to teacher development.[20,21] where teachers are exposed to a series of related experiences over an extended period. Furthermore, following participation in the teacher development activity, follow-up support should be provided. Such an approach has been deemed an '*indispensable catalyst of the change process*'. [22] The continuous involvement of PSSTs, described here, is aiming to adopt such an approach. While it is not feasible, due to time and financial constraints, to engage the whole cohort of PSSTs on a continuous basis, the UL TEMI team propose to implement a number of changes to the current 'one-off' workshop. Based on the PSSTs feedback, TEMI will be introduced to PSSTs in their third year, prior to their school placement in fourth year. A further follow-up sessions will be provided for PSSTs prior to SP. This will ensure that PSSTs are provided with some opportunity to '*go away, try it out and come back*'. In the coming year the TEMI team will also focus on collecting more data from those involved in the project on a continuous basis. The inclusion of a reflective task, as part of their FYRP, as well as a post-SP focus group, exploring all aspects of their involvement in TEMI, will enable the team to determine how effective this continuous approach is in altering PSSTs' pedagogical practices. While the approach adopted in this regard is well supported in the literature, the team will endeavour to collect first-hand data from PSSTs to corroborate this.

The involvement of PSSTs in the TEMI project, on both the continuous and one-off models, has been beneficial to their professional development, and also to the ISSTs and UL Team involved in TEMI project.

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