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Implementing Inquiry-Based Learning in the Irish Language Science Classroom, Using Engaging Interactive Resources Embedded in the Inspiring Science Education Project Lesson Authoring Tool

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Abstract
This paper chronicles the experiences of the lead author, a practicing science teacher, and his colleagues in an Irish-Language secondary school's science department, during their participation in the European Inspiring Science Education (ISE) project. The ISE project aims to promote the inquiry-based learning methodology amongst science teachers across the European Union, and to enhance the learning experience of students by incorporating engaging eTools and interactive resources into the science lesson. The ISE project provides a five-stage inquiry approach for teachers to model. Exemplars of lessons based on this inquiry model are also provided on the project's online platform, the ISE Lesson Authoring Tool. Interactive simulations and other online resources are embedded within the lessons; students can use the lessons to progress independently through the content at their own pace within a science class. To implement the ISE lessons in the aforementioned school, two of the lessons provided, on light and the Eratosthenes experiment, were translated into Irish and carried out with several class groups. In addition, teachers in the school created their own lesson on mass, volume & density on the ISE platform, and various student groups performed these lessons. This paper reflects on the experiences of the science teachers in observing the classes, and lessons learned by the teachers to be borne in mind in the future when designing lessons on the Lesson Authoring Tool.

1. Introduction
Inspiring Science Education (ISE) is a European project across fifteen countries involving over 5,000 science teachers, with the aim of making science teaching and learning more engaging and relevant to students. The project is inspired by the 2007 "Rocard Report" [1] which encouraged the adoption of Inquiry-Based Learning (IBL) by science teachers, to challenge the belief held by students that science is not interesting or relevant to their lives.
Inquiry-Based Science Education can be described as a process in which students are involved in "making observations; posing questions", "planning investigations" and "proposing answers, explanations and predictions" [2]. The model of IBL proposed by the ISE project consists of five stages:

1. Orienting & Asking Questions, the topic of the lesson is introduced, assumptions the students may have are challenged, and questions they may have are formulated;
2. Hypothesis Generation & Design, during which the students develop one of their questions into a hypothesis;
3. Planning & Investigation, in which the hypothesis previously developed is tested;
4. Analysis & Interpretation, where the students analyse the data collected from their investigation and refute or confirm their hypothesis;
5. Conclusion & Evaluation, when the students communicate their findings.

Smithenry [3] describes four main types of inquiry: confirmation, in which teachers give the students the question, the answer, and the method of confirming the answer; structured, where the teacher gives the students the question and the method for finding the answer, but not the answer itself; guided, where the students are given a question, and then expected to find a method of determining the solution; and open inquiry in which students are given the freedom to determine their own question to be investigated. However, Smithenry [3] describes the first two types as "cook-book" inquiry, due to the recipe-like nature of the information provided to students.
The ISE project envisaged that science teaching could be made more engaging not only by enabling teachers to use IBL in their science classrooms but, by also adopting the use of interactive

simulations and other digital resources, so that the students would become more engaged and be allowed to discover scientific phenomena for themselves. This further facilitates the implementation of inquiry learning in the science classroom, negating the need for sometimes costly physical laboratory equipment, and removing the possibility of a student harming themselves or others during the course of a practical class.

2. The ISE lesson authoring tool

To facilitate the adoption of the inquiry-based learning methodology amongst the science teachers participating in the ISE project, a Lesson Authoring Tool was developed. This online tool provided a framework for teachers to see how a lesson could be broken down into the five stages of inquiry, as adopted by the ISE project. Exemplars of best practice were created by the ISE partners, and these lessons were made available on the Lesson Authoring Tool. Each lesson consisted of several aspects: embedded video material to spark interest in the lesson, questions to guide the students in their thought processes, directions for students in practical issues such as recording data, links to online simulations and interactive resources, and multiple choice assessment questions to gauge the students' understanding. By using the ISE Lesson Authoring Tool, it is possible to build a lesson on the online platform, give the students access to it, and allow them to work through the lesson, answering the questions and designing and carrying out an investigation at their own pace. Participating teachers were also instructed in how to use the Lesson Authoring Tool to clone the provided lessons and adapt them for their own use.

3. Use of ISE lesson authoring tool in author's context

The lead author of this paper teaches science in a co-educational secondary school in Dublin. The school is an Irish-language immersion school, in which all instruction and interaction takes place through the medium of the Irish language, which although is the first official language of Ireland, is a minority language in the country. The use of English-language resources is strongly discouraged, whenever there is an Irish alternative.

The ISE Lesson Authoring Tool, as previously alluded to, allows teachers to clone the lessons provided by the ISE project, or created by other teachers, and alter them to suit their own situations. In this case, it was possible for the lead author to take two lessons developed by ISE and translate them into Irish. This makes the school in question the only school participating in the ISE project using lessons in the Irish language. One of these lessons was based on the Eratosthenes experiment; this worldwide experiment takes place each year at the Spring equinox and participating schools are encouraged to upload their experimental results to an online platform where they can be shared with other schools across the globe. The second lesson translated was based on Light; this lesson was developed as part of the 2015 UNESCO International Year of Light. Additionally, the teachers in the school created a lesson on Mass, Volume and Density.

Three teachers conducted the lessons with their respective classes. The classes and lessons taught were chosen according to several factors. These included access to the computer laboratories in school, available time in the subject plan for the year, content of lesson coinciding with the material being learned in class at the time, age of the student corresponding to the lesson, and suitability of the weather. The lead author therefore implemented the Eratosthenes experiment with his senior (16/17 years old) chemistry students. Two other teachers in the school implemented the lessons on light and density with some of their junior (12 - 14 years old) students.

4. Observations and discussion

Some of the following observations relate to difficulties encountered due to local factors, others due to the ISE Lesson Authoring Tool itself. These will be discussed in turn.

4.1 Access to computers

In a school of approximately 600 students, with two computer laboratories, it proved difficult to gain access to the computer rooms at the times desired. Due to the nature of many of the lessons provided on the Lesson Authoring Tool, one single 40-minute period is not enough to complete required tasks. Given that each class group of students in the school has two 40-minute classes and one 80-minute class per week, the teachers were limited to that 80-minute double class period to carry out the ISE lesson. If there happened to be other class groups timetabled to use the computers labs at that time,

for instance taking computing classes, then there would be no opportunity for the chosen group to undertake the ISE lesson. It was discussed whether this could be overcome if the school had iPads for use by students. However, in that case many of the interactive simulations found online would not work, as they work on the flash platform, which is not supported on iPads.

4.2 Time constraints

Due to the nature of the science curriculum in Ireland, and the fact that there are high-stakes terminal examinations, it can be difficult to find the time to engage in interesting 'extra-curricular' activities [4]. Although conducting a lesson using the ISE Lesson Authoring Tool is not 'extra-curricular' in the strictest sense of the term, is can be difficult to justify using an 80-minute double class period, which amounts to half of the weekly time allocated to science, for something which is not directly relevant to the science curriculum. The science teachers in the school agreed that while it would be good for the students to experience a science class outside of their usual setting and engaging in some thought-provoking activities, some teachers felt they did not have the time to conduct the lesson with their class group as they felt they were behind other class groups in their yearly plan.

4.3 Guided inquiry vs. open inquiry

The lead author and teachers found, in both using provided lessons and attempting to design our own, that it can be difficult to judge the amount of written instructions provided to the students in the Lesson Authoring Tool. As described by Smithenry in section 1, confirmation and structured inquiry are "cook-book" inquiry, and when compared to the ISE five-stage model of inquiry, do not correlate very well with the types of activities described therein. The difficulty arises when a concept is being explored that a student will very rarely 'discover' independently.

The Eratosthenes experiment lesson is quite text-heavy, as the 'average' second-level student is unlikely to devise the method of conducting the experiment. When the lead author conducted this lesson with his students, the students were reluctant to read so much material. This is a feature of many of the lessons provided on the ISE Lesson Authoring Tool. For the students to be able to undertake the investigations intended by the author, so much instruction is needed that the lesson is no longer either a guided nor open inquiry lesson, but has become a structured inquiry.

The alternative is to have a completely open lesson, but it was found with the junior students undertaking the lessons on light and density that many students did not understand what was expected of them. They had no problem in following the instructions as given to them, but once asked to form a hypothesis and devise an experiment, they simply opened the simulation and spent long periods 'playing' with the simulation.

4.4 Teacher questioning

Related to section 4.3 above, it was found that in some instances, the stronger students completing the light and density lessons managed to conduct reasonable experiments, and upon questioning reported interesting findings. However, weaker students needed constant questioning from the teacher in order to guide them towards how they might investigate some property of either light or density of materials. It could be argued that these questions and prompts could be included in the lesson when it is being designed, however from our experience of the Eratosthenes experiment, and others in the Lesson Authoring Tool, those lessons which are text-heavy tend to be off-putting to students. The teachers have agreed that additional prompting and questioning should be left to face-to-face as and when required.

5. Conclusions

Based on the authors' observations, the teachers came to some conclusions about how best to design lessons for their own situation. Although a local issue, the difficulty of having access to a computer laboratory or a mobile laptop trolley is one that is fundamental to using a resource like the ISE Lesson Authoring Tool. This is a situation that will require the cooperation of school management to address. The lessons should address specific aspects of the science curriculum, rather than being additional things that, whilst interesting in their own right, do not add to the students' understanding of required material. The lessons should provide enough guidance for students to complete the investigation independently, perhaps with the use of optional prompts that can be requested on-screen, whilst at the same time avoiding text overload. Lessons may need to be adapted from one class group to another, bearing in mind the relative strength and weakness of the students in each group. The authors have

also realised that while the lessons are mostly self-guided, a certain amount of one-on-one teacher input is required when conducting these lessons.

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