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Collaborative lesson hook design in science teacher education: Advancing professional practice

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Abstract

This article documents the process of collaboratively developing lesson hook e-resources for science teachers to establish a community of inquiry and to strengthen the pedagogy of science teaching. The authors aim to illustrate how the development and application of strategic hooks can bridge situational interest and personal interest so that lessons may become more meaningful and enduring. Qualitative data from both teacher educators and pre-service teachers involved in the design process, participant research journals, and data from six focus group sessions, illustrate the systematic reflection involved in producing effective and transformative hooks to support teachers and promote deeper student engagement and learning. Key findings reveal a pedagogical model of hook design, the complex elemental make-up of a science hook, the value that this teaching tool adds to the science classroom, and finally, the beneficial outcomes of collaborative resource design between student and staff in pre-service teacher education programmes. These hook resources aim to move beyond simply capturing student attention toward voluntary self-engagement, and have significant potential to serve as a pedagogical tool for teacher educators, as well as pre-service, newly qualified, in service, out-of-field, and experienced science teachers, to increase student academic performance, third-level science enrolments, and science careers.

Keywords: lesson hooks; science teacher education; e-resources; science teaching methodologies; situational interest

Introduction

The aim of this research was to create a space where pre-service science teachers, could think collaboratively about how to communicate science and build an understanding that a part of being a science teacher is more than just a deliverer of the curriculum through a skilled application of pedagogy, but also involves teaching with a conscious aim to develop student interest in science. The rationale behind this project arises from the authors' frustration that despite the innumerable resources readily available to Irish pre-service teachers, they often struggled to adapt them to the curriculum or develop a pedagogy to engage students from the outset of the class. While the research on lesson hooks or anticipatory sets in classroom pedagogy is minimal (Hunter 1994, Lemov 2010, McCrory 2011, Jewett Jr 2013, Riendeau 2013), to the best of our knowledge there has been no scholarly work on the pedagogical value of designing lesson hooks with teacher education students as a tool to strengthen professional practice and student engagement.

This article provides examples of how science teacher educators might work closely with pre-service teachers to develop practitioner-based solutions that increase participation and interest in science within the classroom. Initially, the collaborative investigation was designed to generate localised data about the elemental make-up of effective science hooks to bridge pupil's situational and personal interest. The intention was also to highlight the added benefits of pre-designed lesson hooks for science teachers, and to illustrate the potential of lesson hooks to embed an enduring understanding of science. However, the examination of the data in this article will be abbreviated and used as the foundation for a more detailed discussion regarding the process of establishing a community of inquiry, centred around an intensive investigation of lesson hooks, as a valuable approach to strengthening the pedagogy of science teacher education.

Hooking pupils on science

How is it that pedagogical instinct is so often crushed by the weight of assessment and curriculum and that lesson success depends on the teacher's ability to capture the interest of the student from so many other competing interests? As McCrory (2011, 94) notes: 'most teachers instinctively seem to recognise the need to interest their pupils in the classroom, yet they often complain that the [...] assessment-driven classrooms will always take precedence over the need for any longer-term affective outcomes'.

Learning and information processing are influenced by emotion, therefore heightened responses to stimuli play a role in learning (Pintrich 2003). Teachers can appeal to a wide range of emotions through their science teaching – curiosity; anticipation; uncertainty; surprise; wonder; sense of imagination; amusement and amazement (McCrory 2011). There is a need to incorporate these affective qualities into science education because 'by increasing the emotional reward pupils gain from learning science, they will be more motivated to study science in school and also more likely to engage with science in their everyday lives' (McCrory 2011, 96). Students are more likely to pay attention to, learn about, and remember, events that provoke emotional responses (Reisberg and Heuer 1992; Woolfolk et al. 2008) or that are related to their interests (Renninger 2000). Engaging student interest in the learning process through disruptive pedagogies, be it through emotional triggers, critical questions, connections to everyday/prior knowledge, or spontaneous explosions, not only catches their attention and clears the way for engaged learning, but also opens an avenue for the teacher to embed a life-long appreciation of science (Smith and Matthews 2000). If a 'hook' of a lesson is defined as a short introductory pedagogical moment that captures what is interesting and engaging about the material to be covered and puts it out front (Lemov 2010), and if we understand that lesson hooks draw upon elements of student emotion and/or interest in an

effort to entice the learner into the lesson and engage them in the topic, then we come to see that the ‘hook’ of the lesson can function as a powerful pedagogical tool on several levels.

Unfortunately, in many secondary science classrooms, the teachers who dare to teach Boyle's Law or Bernoulli's Principle inevitably prepare themselves to face drooping eyelids and cavernous yawns (Templeton 2008). Even though interest has been recognised as an important condition for learning, educators continue to wrestle with the difficulties of working with academically unmotivated students (Hidi and Harackiewicz, 2000). Far too often, pre-service and newly qualified teachers tend to wrap themselves in *either* their knowledge of the subject, *or* familiar and safe pedagogical theories. This protective positioning creates a blind spot for the critical importance of the hook of the lesson. As a result, if hooks are written into the lesson plan at all, it is often done so procedurally and not strategically. When writing lesson plans, teachers often focus on the detail of the lesson content, the aims, goals, objectives, activities, demonstrations, and assessment, and as a result they neglect to skilfully ‘sell’ the lesson to the students from the beginning.

While a hook may be as simple as a photo, a short story, a short video clip, a basic demonstration etc., it needs to be a *strategic* teaching tool that engages students immediately. Teachers often struggle with the creation of lesson hooks, or provide such basic hooks that the lesson fails to be captivating and dynamic. While teacher educators may explain the importance of a hook, the design and development of hooks is not often given sufficient time, and teacher educators assume that pre-service teachers will be able to attend to the demands of this complex pedagogical feature on their own. In order to be truly effective and strategic, there is a need for greater clarity regarding exactly what it is teachers need lesson hooks to do, and how they might be created, individually or collectively.

Interest plays an important part in the learning process, determining in part what we choose to learn, and how well we learn this information (Garner 1992; Alexander and Jetton 1996; Schraw and Lehman 2001). Interest affects the use of specific learning strategies and how we allocate our attention. It also affects our emotional engagement in a task and the extent to which we engage in deeper processing (Schraw and Lehman 2001). *Personal interest* is characterised by an intrinsic desire to understand and reengage with a particular topic that persists over time (Hidi and Renninger 2006; Hidi 1990). In contrast, *situational interest* is assumed to be transitory, environmentally activated, and context-specific; it refers to ‘focused attention and the affective reaction that is triggered in the moment by environmental stimuli’ (Hidi and Renninger 2006, 113). Situational interest is a kind of spontaneous interest that appears to fade as rapidly as it emerges (e.g. student reaction to an explosive demonstration), and is almost always place-specific (Schraw and Lehman 2001). In classrooms, teachers have to rely more on situational interest as it is difficult to tailor lessons to each learner’s personal interest (Woolfolk et al. 2008). Situational interest is perceived to be very effective in the science classroom as it is more likely to engage larger numbers of students at once (McCrorry 2011). Research also suggests that situational interest and designing environments to ‘catch’ and ‘hold’ student interest may foster the development of personal interest (Hidi and Harackiewicz 2000). Greater interest leads to more positive emotional responses to the material, then to greater persistence, deeper processing, better remembering of the material and higher achievement (Schraw and Lehman 2001; Pintrich 2003). Britzman (2009) has noted that attention occurs because of pleasure. Indeed, this is a very seductive theory, but not always easy to achieve in the classroom because of the fact that situational interest is so temporal. While a teacher may spark situational interest in a particular lesson with an explosive demonstration, this flash of interest may be difficult to sustain throughout the lesson, and even more difficult to maintain throughout the academic

year. Therefore, there is a need to consider a pedagogical intervention that can effectively bridge situational interest to personal interest to foster catalytic self-engagement.

One such model that presents a cumulative framework from situational towards emerging and well developed personal interest is Hidi and Renninger's (2006) Four-Phase Model of Interest Development. It provides us with key instructional conditions that support this transition. The Phases of 'Triggered and Maintained Situational Interest' are supported by learning environments that involve teachers organising external support for engagement, through, for example the effective use of technology, project-based learning, cooperative group work, and one-on-one tutoring. The phases of 'Emerging and Well-Developed Individual/Personal Interest' are supported by learning environments that include interaction and challenge that leads to knowledge building; and instructional conditions that provide opportunity for pupils to generate and seek answers to their own curiosity questions. According to Hidi and Renninger (2006), the earlier stages of the model are predominantly externally supported (in an educational environment, by teachers), and later stages, not exclusively, but are predominantly internally supported. In the shift from internal to external support, the students' development of a knowledge and skill base in generating curiosity questions, is significant. "Such questions enable students to connect their present understanding of content to alternative information" (Hidi and Renninger 2006, 122). While the development of personal interest may seem a utopian teaching and learning dream to most teachers, we believe that achieving this level of engagement is dependant on the high quality of the hook that opens the lesson. Therefore, we decided to work closely with a small group of pre-service science teachers to systematically design effective lesson hooks that ultimately would change pupils' relationship with science (For more on behavioural change and science engagement, see Domegan, McCauley and Davison 2010).

Research method and methodology

In order to engage our pre-service science students in sustained inquiry and regular cycles of reflection on science lesson hook design, we adopted a Practitioner Action Research (PAR) approach (Kemmis et al. 2014). The collaboration of practitioners who were committed to rethinking their pedagogical practise was a move toward the co-construction of personally relevant theory (2006). Furthermore we agreed that the product of the research would lead to the production of science hook eBooks that would serve as resources for other teachers nationally and internationally.

Seven pre-service teachers from the 2011-2012 science teacher cohort agreed to participate in the project. The students were asked to collectively design a series of lesson hooks for the science classroom aimed at 12-15 year olds¹. The participants were divided up into three pairs, each pair being assigned either biology, physics or chemistry. The seventh member took an overall co-ordination role, and also supported the sub-teams in terms of design and implementation when needed.

The students were informed from the outset that the process of developing the hooks and e-resources would be documented and that they would also be filming some of their hooks and creating eBooks as a resource for science teachers. The lecturers were mindful of the potential ethical issues that might arise when researching with students so the project did not commence until the academic assessment of all the students had been completed, in order to minimise conflicts of interest in voluntary participation. The research was designed to maintain a mentoring relationship and strengthen the pre-service teachers' professional development as beginning teachers.

Peer-learning, and regular reflection on the design of effective science hooks, central to the PAR approach, helped to produce rich data about the value of sustained collaborative

inquiry. The importance of collaboration arises from the epistemological belief that individual understanding is strengthened and made more meaningful by interacting with others in a learning community (Johnson et al. 1991). As Sherman and Webb (1988, 7) note, qualitative research has the aim of ‘understanding experience as nearly as possible as its participants feel it or live it’. Therefore, as researchers we were aware that documenting the process was as important as the production of data, and the creation of the teaching resource. As part of the design process the pre-service teachers and lecturers reflected and recorded their thoughts throughout the project in a research journal, in which they also created a series of sub-sections for each hook and reflected upon ‘The process of coming up with the hook’, in addition to reflecting on ‘What makes this hook work?’. Concurrently with this, the pre-service teachers developed a storyboard for each hook to begin to map out the visual and textual elements of the eBook chapters.

Focus group meetings were held at the end of each week with the intention of formatively feeding the design process. With the permission of all involved, these meetings were audio recorded and supplemental notes were taken. Focus group methodology was chosen over other data collection methods, as it provides the opportunity to document attitudes, feelings and beliefs that are more easily revealed in a social gathering setting (Gibbs 1997). The value gained by each sub-group within the broader research team from listening and responding to each of their peers’ design concerns and engaging in the activity of verbalising the creative procedure was a valuable part of the design process itself and fostered an inquiry-based learning approach that mirrored the scientific method. This cyclical process of inquiry was dominant in weeks 1-3 in the conceptual and scientific design of each hook. A ‘spirit of inquiry and discovery, a real experimental and investigative approach’ was inspired (Childs 2007, 18), thus exploiting student’s understanding of the Nature of Science as it allowed the pre-service teachers to practice science, as well as learn it, approaching

‘authentic scientific activity’ (McNally 2010). Engaging in focus groups maintained an ongoing dialogue between peers and teacher educators that further strengthened the reflexive practice of the student teachers.

Each focus group meeting (six in total, approximately 1 hour in duration) was moderated by two project leaders and the pre-service teachers were asked key reflective questions in terms of the ongoing design process and formalising planning for the upcoming week. The final focus group meeting was held with the distinct goal of eliciting concluding thoughts on the design process, the final product, and brainstorming ideas for future projects. A synopsis of the lead questions asked at each focus group meeting is presented in Table 1 below.

Table 1. Overview of lead questions from focus groups

[Insert Table 1 near here]

Qualitative analysis was carried out on the transcripts of the focus groups and on the research journals. The qualitative analysis of the interview transcripts borrowed principles from the constant comparative coding process. Detailed word-by-word, line-by-line analysis was conducted to look for ideas and concepts in the data that offered insight into the value of the collaborative development process and the creation of effective lesson hooks. This process of open coding resulted in the data being reassembled in order to identify relationships and the dimensions of the categories (intensity and frequency) were analysed. Data collected via focus groups were cross-checked with data from research journals and the extant literature in order to obtain a more informed and comprehensive overview of the perceptions of the design team in relation to the hook design process.

The hook design process

Despite our PAR approach that facilitated collaborative peer inquiry, inevitably a number of obstacles were encountered as part of the hook design process. These ranged from problems in the initial development of the core idea for each hook, relating the science concept to everyday life, coming up with an appropriate opening, sourcing suitable copyright free imagery, limiting the material to suit the target audience and difficulties capturing concepts on video (Summative Feedback, Focus Group 6). But, as is often the case, ‘the splinter in your eye is the best magnifying glass’ (Adorno 1978, 50). Grappling with these diverse difficulties allowed all of us to better appreciate the detail and effort that is needed to design an effective lesson hook. However, because the research design process involved numerous opportunities for sharing and brainstorming, the team overcame many of the barriers they encountered. In fact, throughout the design process, on numerous occasions, members of the team commented that, although the days were long, it did not feel like work. They spoke of the scientific freedom that their inquiry-based approach to the design process allowed, an ideal in science teaching:

I really like the opportunity to be a real scientist, all day long...the excitement of the investigative process! Real science experiments, the not knowing and finding out was brilliant! It was great to get to ask questions, like ‘Are cornflakes really attracted to magnets?’ and then explore.

(Eithne, Chemistry, Focus Group 6)

While teacher education students are often consumed by planning lessons and the unpredictable dynamics of the classroom, participants articulated the joy of being immersed in the scientific method and the power of co-investigation. Each cycle of the research allowed fresh perspectives to consider and apply towards improving the hook design.

A summary of notes taken at the first three focus group sessions revealed the key steps involved in the hook design process and are listed in Table 2 below,

Table 2. Overview of the hook design process

[Insert Table 2 near here]

According to Linn, Davis and Bell (2004), inquiry is “the intentional process of diagnosing problems, critiquing experiments and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers and forming coherent arguments” (Linn, Davis and Bell 2004, 4). As illustrated above, the three stages (1. identify and investigate, 2. explore pedagogical strategies, and 3. evaluate and create) reveal a PAR collaborative-inquiry model.

Communities of practice: strategic collaboration

Communities of practice refer to the ‘ways in which individuals participate in shared practices and extend their expertise through their participation’ (Teaching Council 2010, 23). The Teaching Council of Ireland recognises that a move towards communities of practice challenges traditional teaching approaches and requires a shift in thinking, yet advocates that the process necessitates rich opportunities for teacher learning (Teaching Council, 2010). The fact that students are actively exchanging, debating and negotiating ideas towards the co-creation of a teaching resource increases their investment in learning; they are encouraged to become critical thinkers, and as a result of working in small groups, tend to learn more of what is being taught and retain the information longer (Dooly 2008). The participants were challenged to work closely and intensely with their peers and lecturing staff to produce effective lesson hooks for use by a broader community of science teachers and consciously

understood that their contribution to each focus group was linked to the future success of others. This created a greater sense of ownership of their learning and a greater collective investment in the application of meaningful reflection (Schön 1987).

During the final focus group discussion, all student team members echoed that they would like to be involved in future design projects in light of:

the investigative style of the project, the comradery with those involved, the opportunity to interrogate the curriculum in depth, and the extensive technology skill-set acquired including voiceover software, text editing skills, keynote software and eBook creation training.

(Summative Feedback, Focus Group 6)

This suggests a very positive experience and explicit list of the professional development experienced by the participants including their knowledge of the curriculum, related science topics, digital literacy and scientific inquiry skills.

Although not initially envisaged, the focus group sessions became much more than eliciting methodological feedback from the participants on the process, they also acted as a reflexive ‘think tank’ for the community of practice. They encouraged an informal discussion in relation to the specific topics identified (Beck et al. 1986), yet in agreement with Kitzinger (1995) it also emerged that the focus group consciously used the group interaction as part of the method, and in so doing they advanced the design process. As with many focus group discussions, there were often dominant voices within the group (Smithson 2000), yet these tensions were transient, and diplomatic negotiation shaped the final product.

Results and discussion

Elemental make-up of a science hook

The data collected helped us to better understand the core elements of science lesson hooks. These details provided the foundation for participants to apply their pedagogic content knowledge (Shulman 1986). Participants' prior knowledge of hook design was minimal, but when faced with the collective task of designing lesson hook resources they drew on their knowledge of the curricular elements and their pedagogic prior knowledge to co-construct, trial, and re-design hooks with the intent to trigger, shift, and transform student interest.

Articulating the elemental make up of hooks was very valuable to the team because often times it is assumed that students have a common understanding of the concept of a 'hook' and that a lesson 'hook' is a straightforward concept. Unfortunately, however, this assumption often flattens the understanding of hooks to being simply a clear introduction to the lesson instead of a well thought-through strategic tool to engage the learner. Participants identified five core elements that were essential for effective lesson hooks:

- **Arresting Introduction:** Something physical, visual, or cognitive that grabs attention; Invites interest in unknown or unfamiliar
- **Grounded in Prior Knowledge:** Connecting with relevant, real-life examples
- **Foster Questioning:** Strategic questioning to tap deeper levels of interest and engagement
- **Curriculum Linked:** Appealing design may appear to be unconnected to curriculum, but teacher makes link apparent to students
- **Foreshadows Lesson:** Snapshot of extended lesson to follow; condensed concept to be unpacked pedagogically

Because the process of collaborative design is at the forefront of this article, the data that shaped these five elements will be discussed in relation to how the participants came to

appreciate the elemental make up of effective hooks, rather than a detailed discussion of the specific elements.

While our pre-service teacher participants began with the common perception of a lesson hook as a brief opening ‘trick’ to grab attention before the ‘real’ curriculum-led lesson is rolled out, discussion in PAR focus groups helped students to refine the different ways that the hook could be designed so that it would arrest the attention of students and focus them on the lesson to follow. A hook was described by one of the pre-service teacher-researchers as ‘something physical, visual or cognitive that grabs pupils’ attention’, ‘engages students, captures their imagination’ and ‘introduces a new topic’ (Sarah², Biology Group, Focus Group 4). It was acknowledged that in order to provoke situational interest they would have to draw on their recent experience of working closely with 12-15 year old students.

The design teams felt that a hook ‘must be exciting’ and should ‘build on prior knowledge’ and should be ‘based on, or related to, everyday life examples’ (Stephen, Physics, Focus Group 2). Despite the fact that interest is related strongly to prior knowledge (Tobias 1994; Schraw and Lehman 2001), when considering how to build these elements into the design of the hooks, the participants understood the need to ground the hook in a constructivist approach (McNamara, O’Hara and Rousi 1998; Piaget 1971). Participants talked through the different ways that their hooks could facilitate an active engagement by pupils to elicit and build on their prior knowledge (Kerr, Beggs, and Murphy 2006). Linking science to everyday life has been frequently suggested as a way of making science more relevant to students (Campbell and Lubben 2000; McNamara et al. 1998) and an important pedagogical tool for motivating students (Andrée 2005). Hooks therefore should generate situational interest by designing environments that not only ‘catch’ and ‘hold’ student interest and attention, but also embed it in their mental schema by building on prior knowledge and connecting with relevant real-life examples. As an example of how the participants’

collaborative inquiry led to a more sophisticated understanding of lesson hooks, the Enzymes chapter within the Biology eBook starts with probing questions that compare breast milk with baby formula, and encourage pupils to think of other applications of enzymes, for example, in biological washing powder, its role and impact. In this way, unfamiliar concepts become familiar in an appealing way due to connections with the everyday.

Through collaboration and peer learning, the team members in various focus groups built up a more complex understanding of hooks. They broadened their understanding of the function of a lesson hook beyond a momentary enjoyable distraction, toward the co-construction of a teaching tool that would encourage student interaction and provide a challenge that leads to knowledge building:

When designing the hooks, we realised that the novel idea, was only the beginning. In weekly focus group meetings, we had to continually reflect on how the hook could be used effectively in the classroom. This involved looking closely at the curriculum, using a variety of teaching techniques to support different kinds of learning, and in a sense, trying to step into the headspace of our students.

(Paul, Biology, Research Journal)

In considering how the design team might apply their hooks in classroom practice they reflected that questioning and discussion built into the hooks could be used to draw out prior knowledge from pupils and link the relevance of the hook to everyday life, supporting correct concept formation. According to Renninger (2000), the vibrant interplay between curiosity questions and the phases of interest can result in successively deeper levels of engagement and learning. Although curiosity is primarily discussed in relation to triggering situational interest, Arnone et al. (2011) assert that it should be studied as a motivator at each deepening level of interest. The use of a questioning/discussion strategy was highlighted by the design team as one of the key methods to bridge the divide between situational and personal interest.

With the ‘Sink or Float’ Hook [within the Chemistry eBook], students watch a quirky video clip where items, in different forms [e.g. Diet/Regular Coke, ball/flattened bluetack, peeled/unpeeled satsuma] are dropped into a large fish tank. The reaction of each item is noted. A large vat of salt is then emptied in. The video could be paused here to draw anticipation. What will happen next? Density is a difficult topic to explain at the best of times. The sight of everyday objects acting in very different ways should evoke curious questions. The aim is to grab student attention, surprise them, force them to wonder and question.

(Eithne, Chemistry Group, Research Journal)

As Eithne points out, teachers have to identify and act on various strategic ‘short moments’ where the potential for engagement is the most ripe. Furthermore, Eithne’s reflection here illustrates complex metacognitive awareness as a product of her engagement within the learning community.

Participants were cognisant of the need to ensure the lesson hook was clearly connected to the curricular demands of the lesson but recognised the tensions and contradictions between the curricular content and the task of translating it into an appealing and effective hook. This intersection between curriculum and creativity is the point where many hooks fail; the commitment to the content of the lesson can easily overpower the creativity of the hook. An example of the creative application of curriculum is evident for example, in the video hook within the Energy Conversions chapter of the Physics eBook; students build a simple steam engine using a drink can, water, straws, twine and a blow torch/Bunsen burner.

Although the design team found it a challenge at times, they felt that ideally, a hook needed to comprise of a ‘condensed and concise snapshot of the lesson to follow’ (Sarah, Biology Group, Focus Group 3), in order to adequately introduce and frame the upcoming lesson. They needed to plant the seeds of situational interest that could be drawn out as the

lesson progressed so that the hook could mature into a more sustained interest of the lesson topic. If hooks, should ‘make learning fun’ and ‘appeal to all learners’ (Maria, Chemistry, Focus Group 5), then they should trigger and maintain situational interest, whereby unfamiliar concepts are made familiar through fun and engaging activities, in an effort to entice the learner. However, the participants were aware that hooks need to do more work than just provide an appealing carrot, they need to be designed in such a way that pupil interest is truly hooked, not momentarily, but for the long term, so that students see that it is in their interest to engage with knowledge about science. This is not easy to embed in the hook design, but what became apparent to the participants was that if the hook design focuses too much on the goal of capturing just the first five minutes of a class it may be too much to reproduce and sustain in every lesson throughout the year. Therefore, participants aimed to ensure the design of the hooks included elements that could sustain interest over time, or could plant the seed of interest for future science classes. For example, the Atmospheric Pressure chapter in the Physics eBook asks a number of higher order questions that also have inter- and cross- curricular components, which may capture student interest again when teaching other related topics.

As illustrated above, the elemental make-up of an effective hook is a complex process, from the initial step of designing the topic introduction to incorporating thought provoking questions. Although effort is required, the value outcome revealed by this research may be quite significant for the teacher and learner.

Value added by hooks

As teacher educators concerned about pre-service teachers’ infrequent use of effective lesson hooks, we provided a space for a practitioner-based inquiry that would allow for a collaborative study and design of hooks that led to the production of a teaching resource. In

addition to developing a greater understanding of hook design best practice, we were interested in the extent to which participating in the research strengthened our pre-service teachers' understanding of the value of lesson hooks as a pedagogical tool. Briefly, they articulated their perception of the 'value added' by hooks to a science teacher's teaching and learning environment in the seven ways outlined below:

Supports time poor teachers

Teachers often have limited time to design and create resources. 'With pre-created hooks, teachers can assess how engaging the hook is and adapt it to their students, rather than starting from scratch, and it allows them more time to plan and prepare for the remaining class' (Kate, Biology Group, Focus Group 5). The incorporation of these hooks acknowledges the fact that teachers have autonomy over their pedagogical design and aims to provide them with an innovative ignition to spark student curiosity.

Strengthens teachers' knowledge across science subjects

In science teacher education, teachers often specialise in one or two science areas and therefore are often less passionate teaching all science subjects at lower secondary level. 'The set of support and explanatory notes with each science hook may support the teacher that lacks confidence in one/two of the junior science disciplines' (Pauric, Physics Group, Focus Group 5). The support material which explains the science behind each hook in a concise way may serve less confident, out-of-field science teachers well, especially those teaching at junior cycle.

Serve as a numeracy and literacy resource

hook eBooks support teachers in addressing new curricular demands related to numeracy and literacy across the curriculum. ‘The resources give strategies to target literacy and numeracy, highlighting key scientific terms, and encourage pupils to consider the topic from a math perspective’ (Eithne, Chemistry Group, Focus Group 5). Addressing these skills within hook eBooks may be viewed as a timely and welcome addition to a teacher’s resource set.

Encourages whole class participation

eBooks include critical questions and peer tutoring approaches to foster greater interest and information retention. As such they incorporate ‘a variety of questioning techniques, including peer tutoring, and may be useful in developing in students a positive attitude towards science by making science more appealing’ (Kate, Biology Group, Focus Group 5). These questions could be used to promote whole class participation, with the use of probing strategies, these questions could be used to inspire further discussion beyond the curriculum and inspire students to consider science careers.

Advances in the use of mobile technologies in classrooms

Take up of tablet technology in classrooms in Ireland has been dramatic (Weckler 2014). The hook eBook may act as a versatile resource for teachers and students in this regard (McDonagh and McGarr 2015), and can act to trigger situational interest (Hidi and Renninger 2006).

Acts as a teacher instructional video

Teachers could show hook eBook videos to students or use it to plan and develop their own investigations and teaching hooks. By carrying out the experiments shown in the hook videos, teachers can increase the confidence their pupils have in them, ‘a little bit of

showmanship can show the class how skilled the teacher is in the topic' (Stephen, Physics Group, Focus Group 5). Research has shown that pupils' learning is connected to how they relate to the teacher's personality and the nature of the teacher's interactions with the pupils; every action carried out or not carried out by teachers has significance for students (Van Manen 1999). Teachers' enthusiasm demonstrates that the teacher cares about what they do and that they want to share this with their students (Darby 2005).

Clarifies and corrects misconceptions in science

Student misconceptions about science are often difficult to change. Video elements could be incorporated into concept clarifying teaching methodology like Peer Instruction (Mazur 1997), where a video clip may be followed up with a question, engaging students through a multiple choice format to clarify their understanding of the science

In articulating these seven areas where lesson hooks can enhance science teaching, participants demonstrated a greater awareness regarding the potential impact hooks can have on learning. As teacher educators some of these points seem obvious advantages of the use of lesson hooks, but through discovering this themselves, our pre-service teachers had a greater appreciation of the significant value investing in this kind of pedagogical innovation.

Science hooks – The final product

This collaborative research project produced a range of thirty-five syllabus-focused hooks aimed at 12-15 year olds. The hooks were produced as a movie clip with associated supporting pedagogical materials and hosted on a national teaching resource website. In an effort to support the rapid influx of mobile technologies into the schools, each resource was also developed into an eBook (Physics, Chemistry and Biology) and available for free

download on the iBookstore (<http://tinyurl.com/SciHookBooks>), eliciting over 3,000 downloads worldwide within the first five months. Two sample screen shots from the Chemistry and Physics hook eBook collection are illustrated in Figures 1 (McCauley and Ó Grádaigh 2012a) and 2 (McCauley and Ó Grádaigh 2012b).

[Insert figure 1 near here]

Figure 1. A screen shot of Chapter 12 from the Chemistry hook eBook: Air.

[Insert figure 2 near here]

Figure 2. A screen shot of Chapter 6 from the Physics hook eBook: Density.

The three resource sets were also translated into Irish, to support science teaching in Irish language schools³.

Conclusion

The data produced from this research helped better define elements of effective lesson hooks and also highlighted the added benefits of these pre-designed hooks for practicing science teachers. The design of science hook eBooks set out to not only develop situational interest, but also to create a bridge between situational and personal interest, that is, to move beyond simply capturing pupils' attention toward a more sustained interest in science. The video design and supporting materials include some curiosity questions to support this goal, the ideal outcome being that pupils would in time respond and add value with their own questions. It was also hoped that the various styles of hooks used would mitigate an element of boredom which can sometimes result from the continuous use of habitual teaching

techniques. In short, introduce the material in a way that inspires and excites so that pupils take the first step in learning willingly (Lemov 2010).

This project created a space for pre-service teachers to work collaboratively with teacher educators to produce a science hook toolkit for teachers and science educators. A PAR cyclic design process was utilised to develop the lesson hooks, following an explicitly collaborative peer inquiry methodology in its three stages: (1) identify and investigate, (2) explore pedagogical strategies, and (3) evaluate and create. This cyclical process that mirrors the scientific method proved to be valuable in engaging creative discussion within and between the sub-groups. The participants understood that their inquiry and collaborative design of lesson hooks would be made into resources for teachers nationally and internationally, and as such their connection to the curriculum were strengthened, they had a greater commitment to producing quality examples, and their pedagogic content knowledge, and professional practice was strengthened. In addition, the participants' reflections on the hook design also reveal a metacognitive process, evidenced by their reflections on the science, curriculum and pedagogy and their articulation of the significant 'value added' by the use of lesson hooks.

Although it may be unrealistic to recommend that individual science teachers take time to develop strategic hooks for each lesson, this research illustrates the value of greater collaboration between science teachers in planning lessons across the curriculum and the value of shared resource development. While we hope that the product of this research will serve as a valuable resource to science teachers, we believe the addition of workshop sessions involving concentrated collaborative inquiry into lesson hooks would be a useful addition to teacher education curriculum. Incorporating lesson hook design into the regular formative assessment of teacher education demands that students work together to consider how to condense core elements of a science lesson, and allow an unpacking of knowledge and a

demonstration that is, at its core, an act of conscious science outreach and promotion (Davison et al. 2008). In this way the promotion of science becomes embedded in the way teacher educators teach science teachers and in the way science teachers teach science.

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Notes:

1. This age group was chosen as this is the tier of education that student teachers primarily engage with in their practice teaching year.
2. All participant names are pseudonym.
3. The authors see the value of translating the eBooks into different languages, in addition to the Irish series. Translation aside, there is still benefit from having these pedagogical resources in many foreign language classrooms where the books could be used in the fusion of teaching English through Science. Recent download stats (2015) indicate that the eBook series has over 10,000 downloads from more than 50 countries, many of which do not have English as their first language, therefore promoting their capability as a resource for science teachers internationally.

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Tables for Science Hooks Paper:


Table 1. Overview of lead questions from focus groups

Meeting	Lead Questions
Focus Group 1-3 (5, 11, 18/6/12)	<ol style="list-style-type: none"> 1. What is a science hook? 2. How does each hook catch and hold student attention?
Focus Group 4 (25/6/12)	<ol style="list-style-type: none"> 1. Discuss the hook design process (critical examination of each step) 2. When should these hooks be used in practice?
Focus Group 5 (2/7/12)	<ol style="list-style-type: none"> 1. Discuss the value added to classroom practice 2. What is the most successful element of a good science hook?
Focus Group 6 (9/7/12)	<ol style="list-style-type: none"> 1. Identify challenges during the hook design process. 2. Identify key skills/benefits from your participation in this project?

Table 2. Overview of hook design process

Steps	Hook design process for each topic:
Identify and investigate	<ul style="list-style-type: none"> • Identify topic. Review multiple resources. Discuss with science/education colleagues • Consider syllabus and pupil prior knowledge
Explore pedagogical strategies	<ul style="list-style-type: none"> • Design Teams brainstorm how teaching concept will trigger learners' interest and develop a creative approach through discussion within and across team pairings • Provide teams with laboratory space, materials, chemicals, apparatus and develop inquiry capacity • Hook: Attention/Interest/Engagement. Incorporate questions to awaken pupil curiosity
Evaluate and create	<ul style="list-style-type: none"> • Develop storyboards and peer review • Create hooks with film and animation experts • Further process of peer review to fine tune and modify

Figures for Science Hooks Paper



*** Air video**

Demonstration of the force exerted by atmospheric pressure

Method

'Anti-gravity ball'

Completely fill the bottle with water and then place the ping pong ball on top. Slowly turn the bottle upside down and observe and explain result

'Magic bottle'

Make small holes in the plastic bottle using a pin. Then insert screws into the holes without exerting too much force with may crack the bottle. Fill the bottle with water (add food colouring to improve contrast). Secure the lid tightly on the bottle and remove screws and observe result. Then remove lid and observe the water flowing out

Tips

It is important not to crack the bottle when inserting the screws as this will not achieve the desired results. The bottle should be strong with a simple shape. For the anti-gravity ball, the bottle must be glass and the larger the bottle the easier the demonstration is.



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School of Education, 2012

Figure 1. A screen shot of Chapter 12 from the Chemistry Hook iBook: Air



Methodology

Materials

- ✓ 1000ml graduated cylinder
- ✓ Pipette
- ✓ Blue food colouring
- ✓ Fairy liquid
- ✓ Honey

- ✓ Maple syrup
- ✓ Water
- ✓ Cooking oil
- ✓ Methylated spirits
- ✓ Milk

Method

Preparation:

Before this experiment, plan exactly how much of each liquid you are going to place into the graduated cylinder. 100ml is a good amount.

Demonstration:

The honey creates the lowest level of the tower and can be squeezed into the graduated cylinder. The maple syrup can be directly poured on top of the honey. The fairy liquid can be poured directly onto the maple syrup. Note that all of the rest of the layers need to be pipetted into the graduated cylinder so that the liquids don't mix. Add a layer of milk. The milk has to be full fat milk or else it will mix with the water layer. If the milk is fresh, it should float on the fairy liquid. If it's old, its density increases and it will go below the fairy liquid layer. Add a layer of water. The water needs to be dyed with food colouring so that it stands out in the cylinder. Add a layer of oil. The final layer added is

Figure 2. A screen shot of Chapter 6 from the Physics Hook iBook: Density