Mind the Gap: Using Lesson Study to Develop Cross-Sector Landscapes of Practice in Science and Engineering

Lynne Bianchi, Peter Green, Julie Jordan and Deborah Ralls

Acknowledgement to Diane Harris

Key words: university teaching excellence, pedagogy, transition, professional learning

A. Introduction

This report offers information and reflections on the cross-sector professional development project, 'Mind the Gap', that took place between January 2017-July 2018. The project focused on the cross-fertilisation of teaching practice and pedagogical design between teachers in primary, secondary and Higher Education STEM subjects. It built on the successful CHERIL-funded study, 'Across the Divide' (Ralls, Bianchi & Choudry 2018), in seeking to explore the ways in which the quality of STEM teaching and learning in HE can be influenced through participation and engagement in cross- sector collaborative professional development between primary and secondary school STEM colleagues.

The study builds from the 'Across the Divide' project which focused on establishing how teachers in schools and academics in universities could participate in professional learning. In this project participants gained insight and experience of each other's teaching settings and enabled professional dialogue and observation of student learning. These first exposures to university-school engagement for the purpose of pedagogical improvement gave rise to participants reporting a positive influence on their awareness, knowledge and appreciation of teaching practice in STEM in other sectors. The project's outcomes recognised that these experiences lay the foundations for a professional 'learning eco-system' in STEM education (Hannon, 2009; OECD, 2015), where space was afforded and valued by educators from primary schools, secondary schools and universities in a shared endeavour to improve their own and each other's understanding and practice of STEM education.

To extend the impact of such learning, the authors used the principles of Collaborative Lesson Research (CLR) which draws on authentic Japanese Lesson Study (Lewis, 2002; Lewis & Hurd, 2011) with a group of volunteer academics and postgraduate students from the Schools of Chemistry, MACE, Materials and EEE who had shown interest in pedagogical design to investigate the improvement of their teaching practice in collaboration colleagues from primary and secondary schools. Facilitated by staff with expertise in STEM Education and Lesson Study, three working groups came together over the course of 18 months. The groups included at least one academic, one primary or secondary school teacher and one postgraduate student. The groups discussed learning, identify common interest and student goals, co-develop and co-deliver 'research lessons' based on agreed shared areas of pedagogic development. The protocols and principles of CLR provided a framework to promote and sustain reflection on the learning gains for themselves and their students in this process.

The project was researched to gain insight into the motivations of all teachers in this process, their experience of lesson study and the impact on their practice. This was organised by a project Research Associate, following University ethical guidelines and approval, so that the project outcomes could be academically communicated publication.

B. Context and the framework for professional engagement

The project addressed the desire for university academics to share in inclusive and reciprocal professional learning relationships with academic colleagues and school teachers from different education sectors and educational institutions. It was guided by the Trajectory of Professional Learning (Bianchi 2017) in order to support participants to collaborate in shared ambition to strengthen the quality of teaching and learning provision in science and engineering education from primary school to university.

The distinctiveness of this project is in the way it builds on the work of authors such as Gibbs et al 2015; Ryan, & Tilbury 2013; Lundin 2018 and McCune 2018 in their focus on the development of HE pedagogic practice. The *cross-sector* approach to the collaborative process for teaching development is something that offers new knowledge into the sector. As such, the study explores how teachers can be supported to change from short-term participation in activities together, to longer-term collaborative experiences focused on teaching improvement, impacting on pedagogic change/innovation specifically within the HE context. It was of also of key interest to identify the salient outcomes from the endeavour to improving STEM teaching quality in primary and secondary school classrooms, so as to evaluate whether there assets arising from the collaboration are as impactful to teachers as they are to academics.

'Mind the Gap' is considered both innovative and timely in that it takes place at a time when, in parallel with countries across Europe, academic institutions in England are required to review and reflect on the quality of teaching and professional development in Higher Education, in line with the Teaching Excellence Framework (TEF) consultation (2016) and in response to student feedback obtained through the National Student Survey (NSS).

Project designers sought to consider how academics and teachers could be supported and inspired to develop reflective and 'collaborative' practice, in what were very busy professional lives for all involved. The Trajectory of Professional Development (TOPD: ref. Figure 1) offered the study a framework to consider how the participants could change from participating together in a project, e.g. turn up and talk with limited out-of-prepared meeting engagement towards collaborative and shared endeavour the TOPD framework describes 5 stages of professional engagement in learning, where participants can self-identify as 'pre-engagers' to 'connectors'. It explains the changes that the project team wanted to stimulate where individuals took increased ownership to share practice and collaborate by learning with and from each other. The focus was solely on describing, questioning and developing each other's teaching routines in classrooms and lecture theatres, where using research questions, literature and evidence to inform and justify changes in personal professional practice. In this way the participants engaged in joint

professional development with 'Lesson Study' chosen as a quasi-scientific approach to enable this change.

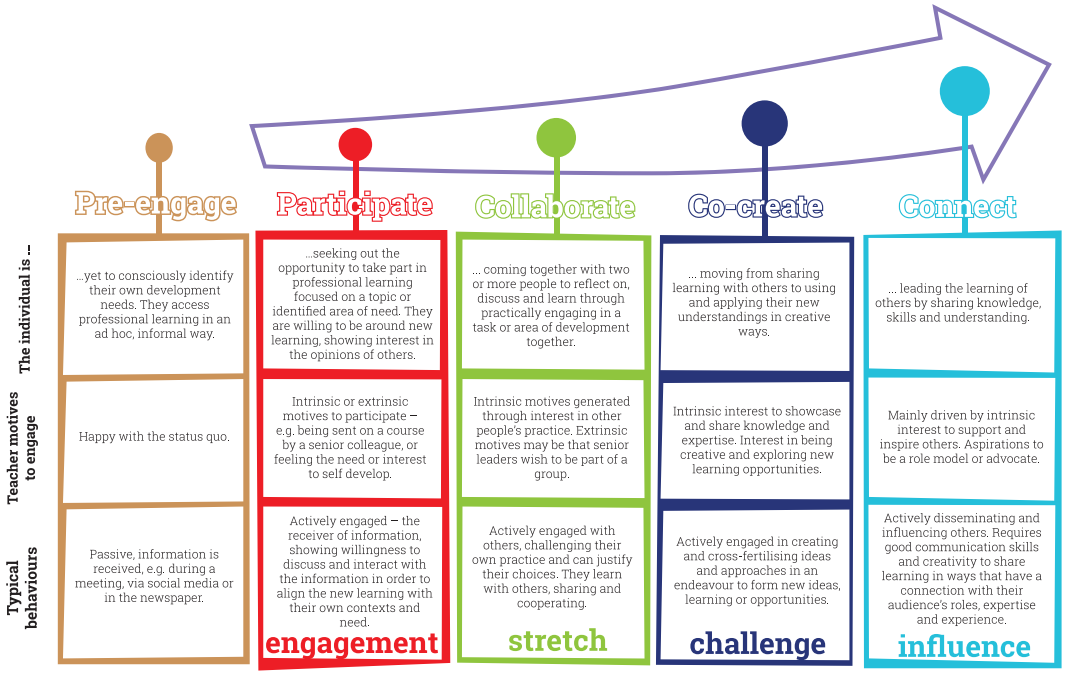

Figure 1: Trajectory of Professional Development

The ambition for different sectors of education to work together was ambitious as the realities of work-life pressures saw a range of logistical and cultural difficulties arise. In respect of genuine school-university partnership, Smedley (2001) reports that although there have been high expectations at different times in a variety of countries, subsequent evaluations have shown poor success rates due to a 'litany of barriers' which she groups under four main headings: (i) organisation, (ii) division of labour, (iii) time constraints and (iv) apprenticeship orientation (ibid, p.193). Added to this list, Greaney et al. (2014) note the divergence in the priorities of schools and universities where the former are required not only to increase their use of evidence-based practice but also to establish hubs of subject specific expertise and universities are required, by the allocation of their research funding, to focus on public engagement and impact.

Greaney et al's literature review (2014) examined school-university partnerships across different types of education systems and the extent to which they have been studied over recent decades, and although they found a wide variety in the main research foci, there was some commonality in the areas of research: (i) widening participation of under-represented groups in universities, (ii) increasing participation in STEM (science, technology, engineering and mathematics) to increase the number of students entering university in these subjects, and (iii) examining pre-existing school/university relationships i.e. initial teacher education, continuing professional development and/or collaborative research (ibid, p.6).

Greaney et al. (2014) also consider the complexities beyond the basic logistical issues, noting the more complex challenges associated with the differences between the cultures, in particular the accountability structures, operating models and languages. These features drive not only the behaviour of the organization but also that of the individuals who work there and they suggest that for collaboration to succeed it requires commitment from both partners and acceptance that a long time frame is needed in order to build trust and make a difference (ibid).

For a partnership to be successful, Greaney et al. (2014) advocate a number of requirements: (i) that the collaboration is design-led rather than hierarchical, (ii) that there are various types of leader (strategic prioritizers, boundary-crossers, opinion shapers and 'blended professionals' who work across the institutional boundaries), and (iii) the creation of a 'third space' which is not 'owned' by either partner and so more creative solutions may be explored. However, Greaney et al. (2014) advise that even if all these suggestions are taken on board and the cross-sector collaboration is working well, a lack of high-level vision and the resulting vagaries in policy and funding in England can hamper and/or disrupt the partnership. Consequently school-university partnerships are widely viewed as neither coherent nor sustained (ibid).

C. Lesson Study and Collaborative Lesson Research

In order to establish a high-quality CPD offer for all participants it was identified that a specialist in Lesson Study would be recruited to the project team. Although the approach was commonly used within the institution for other areas of educational focus, the project designers sought to gain depth around the 'best' practice/research and evidence in science and engineering education, with particular focus on primary and secondary school experience.

In this way a specialist was recruited with the remit to:

- consider how the authentic LS approach could be used with academics and teachers, as a mechanism to support their professional engagement to move from participating in CPD to collaborating effectively.
- practically embed the wider principles of Collaborative Lesson Research (CLR, Takahashi & McDougal 2016) which seek to take into account how the institutional structures and practices impact on lesson study

LS as a model of professional development came to the attention of educators outside of Japan through the publication of The Teaching Gap (Stigler and Hiebert, 1999) alongside the high achievements of Asian students reported in the International Trends in Mathematics and Science Survey (TIMSS, 1999). Research studies carried out in Japan and increasingly in Hong Kong, Singapore, the USA, UK and Sweden suggest that the approach is a powerful model which leads to improvements in teacher and student learning (Lewis 2000, Lewis, and Takahashi 2013, Elliott 2009, Dudley 2012).

The term 'Lesson Study' can describe a variety of ways of working with a range of interpretations but it is an approach that can be used across all sectors of education, from early years through to higher education. It is generally used to describe teachers identifying an area of interest or concern that they will then work on together (Fernandez et al., 2003). Teachers work collaboratively to write detailed lesson plans and, having carefully observed the resulting lessons being taught, they then discuss and review their findings together in order to develop and improve the lessons (ibid, 2003).

'Lesson Study' is also about improving teaching techniques, increasing pupil progress and developing broader pedagogic approaches but by adopting wide-ranging and well-articulated ways of working to examine practice (Fernandez et al., 2003). Moreover, LS enables primary and secondary schools, colleges and universities to collaborate in implementing the studies (Lewis & Takahashi, 2013). It is a relatively new way of working in England and has only very recently been adopted in some English schools.

Originating in Japan in the 1870s where it is used extensively, it has more recently been adopted in Singapore, Hong Kong, China, US, Sweden and Canada (Dudley, 2014). Lesson Study is of significant importance in Japan where it is used to reform school curricula and enables Japanese educators to facilitate major curriculum changes (Lewis & Takahashi, 2013). In order to achieve this, there are three main factors: (i) regional and national subject expertise can be accessed by school-based lesson study groups, (ii) the learning routines in Japanese schools facilitate systematic study, improvement, and dissemination of practice, and (iii) policy structures that enable implementation (ibid). Research studies carried out in Japan and increasingly in Hong Kong, Singapore, the USA, UK and Sweden, suggest that Lesson Study is a powerful model of continuing professional development that leads to improvements in teacher and student learning (Lewis, and Takahashi 2013, Elliott 2009, Dudley 2012).

Bjuland and Mosvold's (2015) enquiry into LS looked at teacher education, where they identified three key components of the lesson study process. These are: (i) that the lesson to be studied should be approached from a research perspective i.e. there should be a research question aimed at the teachers' own learning, (ii) that pupil learning needs to be carefully observed which requires meticulous planning and implementing, and (iii) that the structure of the lesson is appropriate for lesson study (ibid, p.89). However, it is important to consider that, even where these three components are present, the prevailing classroom culture may not be conducive to new and/or experimental pedagogical approaches (Benson & Knight, 2009). To explore this further, Vrikki et al. (2017) focused on in-service teachers' discussions accompanying the trial of a challenging form of pedagogy in the context of lesson study. In much the same way that Greaney et al. (2014) found relationships to be the most important factor in school-university partnerships, Vrikki et al. (2017) found collaboration and peer support through dialogue to be the most influential on professional learning. They also reported that the teachers' own contributions to the discussions (either sharing their own reasoned thoughts and ideas or building on what others had said) were of significant importance (Vrikki et al., 2017).

There are two types of Lesson Study ; as a *'practice based approach'* to master specific teaching strategies (a school-based LS group selects a familiar strategy to teach subtraction, taken from a textbook or teacher guide) or as a *'research orientated'* approach to foster collaborative classroom enquiry and encourage educators (teachers) to make informed and personally identified choices in practical, classroom based situations (Inagaki, 1995). It is the latter *'research orientated'* and classroom based enquiry approach to professional development built into this project in order to enable cross sector collaboration in STEM teaching and learning.

Project designers grew in their understanding of the landscape of practice in this area, and worked with the specialist to consider a practically viable means through which the academics and teachers could embrace LS, when time-limited and working across different educational sites.

Advice lead to the exploration of Collaborative Lesson Research (CLR) as a means by which the project participants could embrace the principles of LS, in order to undertake and investigation, using live lessons, to answer shared questions about their teaching and learning. Takahashi & McDougal define these as the principles of CLR which are offered as their experience shows that authentic Japenese LS can often be interpreted in different ways in different countries and settings. As such the principles offer teachers the opportunity to be guided by LS in designing research lessons. The principles are defined as having:

1. A clear purpose
2. *Kyouzai kenkyuu* (where teachers gain knowledge and insight into the topic area and student thinking)
3. A written research proposal
4. A live research lesson and discussion
5. Knowledgeable others
6. Sharing of results

(Takahashi & McDougal,2016)

The specialist supported the project team to use a formal process of LS designed using the CLR principles as a way of facilitating cross-sector collaboration in the design, delivery and reflection of taught sessions to improve the teaching and learning experience in university science and engineering provision. It offered a quasi-scientific approach to managing the shift from teachers engaging as 'participators' to a collaborative process of professional learning towards improvement.

***Research question**:*

Can the structures and practices of effective 'Lesson Study' support the professional development of Higher Education teachers by working collaboratively with cross sector colleagues from primary and secondary schools?

D. Methodology

'Mind the Gap' adopted a qualitative case study approach focused on identifying the impact of cross-sector collaboration on teaching and learning in science and engineering in HE settings, involving 12 participants. A positive deviance approach was adopted which resulted in recruiting academics and school staff who had experience of professional collaboration within their own sectors, had experience of using Lesson Study or could be identified as 'influencers' in their work places. In essence, the project worked with individuals who were interested and willing to find pathways through to learning with cross-sector colleagues, and who voluntarily opted to take part. In this way the methods aligned with Greaney's writing about successful partnership working where the project looked to creation a 'third space' not 'owned' by either partner where creative solutions may be explored.

The reach of the project was kept small, with a total of 12 participants: five academics, five schoolteachers (two secondary school teachers teaching ages 11-16 and three primary school teachers teaching ages 4-11). Inclusion criteria for participants were as follows:

- academics teaching science and engineering subjects at University of Manchester
- postgraduate science and engineering students at the University of Manchester, aligned to a project academic
- primary and secondary school teachers with subject responsibility for science associated with the SEERIH network of schools

The 'study team' was designed by two principal investigators (a senior academic within the School of Electronic and Electrical Engineering and a science educator). A Research Associate also made up the project team, alongside the expert advisor on LS. Three triad groups were defined by the 'study team' which consisted of a mix of teachers, academics and university students. One of the triads did not have a student member due to recruitment issues.

A project research plan was devised to align with each stage of the project. Ethical approval through the University Research Ethics Committee was gained, resulting in clear information about the purpose and type of involvement to be provided to all participants. At each stage of the research it was explained how the research task would proceed, how any findings were likely to be used and participants were invited to ask any questions. The names of schools and individuals were changed to preserve anonymity and confidentiality and all devices used to store any form of data were password protected. University protocols regarding data collection, analysis and storage were adhered to.

The project and research ran concurrently. 4 stages of activity were undertaken with Stage 2 and 3 repeated twice during the course of the project term. When repeated the cycle of activity related to 'School-based' Lesson Study (ref. Table 1).

	Stage	Actions	Intended outcomes	Data collection method
Recruitment & intro	**Stage 1A**	Recruit participants, general introductions	Inform and engage participants in the collaborative approach to research. Clarify shared areas of interest that suit both sectors.	Research QUESTIONNAIRE 1 (Learning Journey)
	STAGE 1B	Identify project themes based on previous work & triad relationships		Research FOCUS GROUP 1 (Identity)
Group Formal training	**STAGE 2**	Formal input on Lesson Study and the relevant process and protocols. Group	Increase awareness and knowledge of the process of LS Formalise group make up Collectively agree the level of formality to be adopted within the LS process.	Research FOCUS GROUP 2 (Collaboration)
Collaborative Research Cycle Activity	**STAGE 3A**	Co-planning Research Lesson **(Cycle 1: University, Cycle 2: School)**	Collaborate to design, teach and review a research lesson. Identify and link with existing literature Establish the role of the Knowledgeable Other Receive on-going expert input and training. Ethical Approval for classroom observation (where needed)	Research Lesson Proposal QUESTIONNAIRE 2 (Planning experience)
	STAGE 3B	Co-teach/observe Research Lesson		Lesson Plan Lesson Observation Schedules Post-lesson debrief notes
	STAGE 3C	Co-reflection/ Debrief, including Knowledgeable other		Teacher Reflection Notes, Focus Group QUESTIONNAIRE 3 (Activity experience)
Group review & dissemination	**STAGE 4**	Whole group review of Cycle, review of group learning outcomes and progress. Dissemination	Summarising and articulating outcomes in a range of formats, including posters, presentations and reports.	Focus group notes

Table 1: Project and research process

All project meetings included opportunity for joint planning time away from other work commitments. The creation of dedicated 'space' for professional learning was valued drawing away from classrooms, lecture halls, staffrooms and offices etc. Three project leaders drew insight and expertise from an external expert. One project lead took responsibility for the research strategy for the study, and all three acted in the capacity as 'Knowledgeable Other' within the LS process. The external expert introduced rigorous structures and protocols for LS, with an awareness and appreciation of the need to adapt to the participant's engagement and cross-sector make up.

The research strategy (ref. Column 4 of Table X) involved focus groups discussions during meetings and electronic questionnaires hosted on the secure University 'Select Survey' system. In this way data was qualitative, including participants' responses to questionnaires, written artefacts (such as the Research Lesson Proposal Appendix 1), focus group discussions notes and field notes. Data was reviewed and hand-coded by the project leaders to identify common themes in participant responses, seeking to identify the impact of LS on professional learning.

F. Findings

Table 2 provides an overview of the resulting three LS groups, noting the participant make up, research theme and enquiry question. The last column lists the documentation prepared by the group to support their planning, undertaking and review of the LS process. In addition to this, the groups also engaged in self-organised face-to-face meetings and maintained regular correspondence via electronic mail.

Group	Participant Make up	Research theme: LS focus	Enquiry Question	LS Planning and Review Activity
A	Post Graduate Student Engineering Senior Lecturer Engineering Senior Lecturer Secondary Teacher Primary Teacher Knowledgeable Other	To improve student engagement in an engineering lecture environment using collaborative learning strategies	Can we improve engagement, experience and learning outcomes through collaborative learning in a university lecture environment? Using collaborative structures to increase participation.	• Collaborative Lesson Plan
B	Post Graduate Student Chemistry Senior Lecturer Chemistry Lecturer Secondary Teacher Primary Teacher Knowledgeable Other	To develop students' confidence to question and problem solve	How does the type of question (open/closed) impact on the quality and quantity of the conversation between students? (in different positions in the lecture theatre?) Quality - pupils conversing about question in detail and staying on topic (maybe going beyond) Quantity - number of responses, duration of conversation on question	• Research Lesson Proposal • Lesson Plan • Post Lesson Debrief • Lesson Observation Response Sheet • Research Literature Summary • Range of raw Observation Data • Participant Reflection (Teacher) • Lecturer's Powerpoint Slides
C	Materials Lecturer Primary Teacher Knowledgeable Other	The link between teacher questioning and student engagement	Do questions generated by students raise student engagement? (or is it just questions themselves?	• Research Lesson Proposal (University) • Research Lesson Proposal (School)

Table 2: Overview of Lesson Study Groupings and areas of focus

Appendices provide examples of group proformas which are aligned with the CLR principles. These provide insight into the planning, observation and review activity undertaken by the academics and teachers. These documents were completed collaboratively and are available on request from the authors, including:

- Research Lesson Proposal
- Lesson Observation Response Sheet
- Post-lesson debrief
- Research Literature Summary

G. Discussion

The study actively engaged HE academics, teachers and postgraduate students in a collaborative research process to develop teaching practice in STEM education. By sharing professional expertise, experience and approaches, three groups worked to design lesson cycles and formulate pedagogical approaches to support cooperative student learning, teacher questioning and student questioning.

The data reveals how academics, teachers and post graduate students responded to the LS activities as a form of collaborative professional learning, with insight into how the project impacted on the teachers' thinking and practice about teaching and learning in STEM.

Five key themes emerge from the data.

i) **Academics, teachers and students changed from participating in CPD to collaborating in shared professional practice, through the use of LS and in particular the use of a range of 'boundary objects' to scaffold their dialogue and actions.**

Lesson Study offered participants a formalised approach to collaborative professional learning. Key resources, that drew on CLR principles, enabled dialogue, planning and discussion at each stage, giving structures to enable the group to more from participatory to collaborative behaviours. In effect the proformas, e.g. Research Lesson Protocol, Lesson Plan etc. were effective 'boundary objects' to support participants to talk and reflect with purpose and focus aligned solely to improved student outcomes. The creation of such objects was tailored for use within this project in order to suit the choice made by participants about the degree to which they wanted to make notes in writing about their shared endeavour.

> *It's more collaborative. More of a discussion and more explanation of everything. More thought…It [Lesson Study] focuses my mind on thinking about each element of my teaching (Academic, post planning questionnaire)*

> *The lesson study process has actually been quite eye-opening for me - so infrequently do I get the opportunity to sit outside of my own teaching, to look into it and to ask questions such as 'what if this happens...?' and 'why would that be done in that way?' It has made me realise how important these reflective moments are* ***(Academic, post planning questionnaire)***

What can be seen across all groups is the selection of some of the boundary objects more than others. They were used mainly as starting points for discussion prior to face-to-face meetings, others as reflective personal write up tools after meetings. Questions arise as to the necessity for groups to complete the activity once started, or whether it matters most that the lesson is undertaken and verbally debriefed.

ii) **LS stimulated a high order of reflection before, during and after teaching. The shared reflective processes lead to increasingly specific learning outcomes leading the design of the lesson.**

Time and space for reflection on practice emerged as both a luxury and a challenge for those involved. Teachers found engagement more normal to their everyday practice, whereas academics noted the challenge of fitting the project into their practice.

> *I learnt to reflect and plan to apply different teaching practices. (**Academic post planning questionnaire)***

Professional dialogue and challenge was valued, and space created by the project designers through half day meetings. Undertaking these on the University site made these more readily attended for academics.

> *I learnt the most from conversations in the room - from discussions in our team and from discussions with other teams. Being challenged on our lesson plan really helped crystallise, for me at least, how qualitative data will give us the deeper analysis of what is really happening, whilst quantitative data will provide a surface impression of the entire room. This idea that quantitative data is the only representative measure is so pervasive in our Faculty - it often leads to degradation of what quality actually is **(Academic, post planning questionnaire)***

Group's reflections were influenced by having read recent research literature on the topic. This is a principle of CLR that was found to be useful, however poses additional demands on those involved. Questions arise as to whether the effectiveness of a LS can only truly be realised if the level of understanding about an area of focus is lifted through reading and researching contemporary thinking.

iii) Collaboration with cross sector colleagues added a difference and vitality to lecture and lesson design that was novel, professional challenging and 'stretched' the boundaries of current practice.

Some teachers explained that collaborative engagement with colleagues was a regular feature in schools, and LS was used regularly in one school. They described how collaboration with peers enabled an increased focus on students' learning within a lesson observations, whereas 'normal collaboration' takes place through planning and resource making and training.

HE academics described how LS supported their change from individualised teaching planning practices to a shared and collaborative model. In explaining that 'there is not much discussion at university as we are so busy. We divide it up and just start writing lectures' the demands on teaching time are evident. However when embraced, and indeed embraced because of the additional stimulus of working with teachers from outside HE, the benefits are reported as being impactful on personal and student outcomes.

Lesson Study has been a very useful experience so far. I have found working with secondary school and primary school teachers very useful to improve my knowledge and understanding and inform my approach to teaching so far. It has been both challenging and enjoyable ***(Academic, post planning questionnaire)***

I have had the privilege to work with some excellent educators at the university on several projects. I have to admit that I feel like I am working with the experts now I have interacted so much with the school teachers involved in the program. They have undergone a lot more training than we have and are adept at identifying problems and aware of appropriate solutions that can be used to address them….The involvement of people with different teaching experiences and training from all different levels of education is fantastic for discussing, analyzing and identifying potential solutions to the problems we are faced with. I have no doubt that I am going to learn a lot during the project that will have an impact throughout my career ***(Acadmic post planning questionnaire)***

The allocation of 'roles' within the LS evolved through negotiation. Teachers evidently adopted the writing up of notes and creation of documentation related to the LS, whereas academics engaged in verbal inputs in group meetings.

iv) **Improved confidence in teaching and research into teaching due to greater knowledge of pedagogy**

Postgraduate students who had teaching roles within their Faculty School described how they gained confidence in planning and delivering lectures as a result of the LS experience. By engaging with research literature based on their topic focus (questioning) and collaborating with fellow academics and teachers there was a direct enhancement of teachers' pedagogical repertoire. Some report ongoing interest to continuing to experiment and review learning.

Discussions on 'questioning' helped develop my knowledge. Furthermore we were able to plan a lesson that will directly target our question instead of adapting a lesson previously used ***(Postgraduate, post planning questionnaire)***

I still lectured to my class but we used peer assisted learning techniques within the lecture environment to try to improve student engagement… This has helped by showing that students can become more engaged in the lecture environment by using different teaching strategies (specifically - peer assisted learning and whole group feedback) ***(Academic, post delivery questionnaire)***

With regard to the TOPD framework, it could be considered that these participants in fact were swiftly moving from collaborate to co-create, in seeing to review and redesign learning experiences to stretch tuition norms.

This has allowed me to deliver my first lecture a couple of weeks ago with more confidence and I found including these structures was hugely beneficial. It got the

students engaged from the outset and allowed me to quickly gauge the level of existing knowledge before starting…I would try to include at least one of these structures in each lecture delivery. I would like to see how these are applied in smaller classes in the next round so the techniques could be applied to tutorials. I would also like to see how these could be applied with more practical activities ***(Postgraduate student, post-delivery questionnaire)***

Feedback from participants also described how they grew in their understandings of 'Lesson Study' as well as the topic focus and indeed themselves as teachers.

*I learn more about the different ways in which students are taught at primary and HE level. Also the different ways in which evidence can be collected for a Lesson Study. (****Secondary teacher, Planning activity questionnaire)***

In particular this quote from a secondary science leader demonstrates how their identity as a teacher leader also was strengthened through the process of LS with cross-sector colleagues.

Quite often the things that I can take for granted in my role as a teacher shouldn't be taken in such a way. The injection of cooperative structures in the lecture did generate good discussion about the topic and provided opportunities for students to be more involved in the learning process. This happens as a matter of course in school lessons and it is sometimes easy to take this for granted. ***(Secondary teacher, post delivery questionnaire****)*

v) **LS offers HE mechanisms to improve student experience and teacher/academic learning.**

This study has demonstrated how HE engagement with primary and secondary teachers can be guided in LS through the use of the CLR principles. LS has been a means to embrace the principles of CLR, to focus clearly on improving student experience and outcomes. At a time where judgements on HE teaching practice are in the spotlight through TEF, LS can support academic managers to stimulate peer-to-peer support for colleagues within and beyond the University.

Lesson Study helps to give small and manageable changes in the classroom that are sustainable and will improve both teaching and learning, instead of where you go on a course, get given lots of new ideas and most get forgotten quickly. As LS takes place over a period of time, the activities/ideas used are more likely to become embedded and not just a fad. ***(Secondary teacher, post delivery questionnaire)***

Academics described challenge with the process, in terms of the logistical integration of the activity into the working day, but not in terms of the LS's strategic goals.

I think that staff need to be allocated workload time to do these kinds of reflection. Currently our job demands are too great to do this kind of reflection and it has been

extremely difficult and required a lot of out of hours working to take part in the project (but I feel it has been a good use of time in my own personal development but also how I will feed into school teaching groups to change our programmes in the future.) ***(Academic, post delivery questionnaire)***

Suggestions were offered as alternatives from the approach, noting that maintaining a critical group of practitioners who can offer advice and guidance from an outside/different perspective was of value.

It is notable that the use of an external specialist with in-depth knowledge of LS and CLR was found to have great bearing on the success of the experience. Whereas the choice of a subject specialist was not compared to a non-specialist in this study, project designers draw on the recent Wellcome Trust (Cordingly et al, 2018) publication in highlighted the benefits of subject specialist CPD. Where all parties have in-depth knowledge of the context of practice, it is considered that the authenticity and credibility that that brings leads to increased confidence and trust in the techniques being suggested.

H. Conclusion

Mind the Gap has demonstrated how cross-sector collaboration could be engendered using Lesson Study, and the wider principles of Collaborative Lesson Research. This study has offered a focused exploration of how the structures and practices of effective 'Lesson Study' can support the professional development of Higher Education teachers by working collaboratively with cross sector colleagues from primary and secondary schools. The interaction was maintained with a small group of teachers, over two research lesson cycles.

Their descriptions of impact note how the coming together with professionals from another sector stimulated new ways of looking at their teaching practice and greater reflection-in and on-practice. Indications that academics and postgraduate students learnt both about their pedagogy and also about their own identities as a teacher of learners is worthy of further research. Teachers and academics reported higher levels of critical reflection on their pedagogical practice because of the LS process. The formal process of LS also meant that the collaboration was design-led rather than ad-hoc and therefore potentially hierarchical. Such creation of a 'third space' for learning which was not 'owned' by any particular group, enabling more creative teaching and learning solutions to be explored was resultant of the experience (Greaney et al. 2014).

Lesson Study's focus on collaboration at each stage of the process: identifying priorities, research, planning and reflection, created critical discussions on teaching and learning practice in the university context. However, the time required was a challenge, and noted by academics as potentially unsustainable unless built into their academic workload model. They found the relationships with cross-sector colleagues to be supportive and constructive and something that should be sought to be sustained. The change in practice from participant to collaborator saw peer support through dialogue proving to be highly

influential on professional learning (Vrikki et al. 2017; Bianchi 2017). The use of an external specialist as well as project researcher stimulating reflection through focus groups and questionnaires enabled participants to reflect on their own that the teachers' own contributions to the discussions, sharing their own reasoned thoughts and ideas or building on what others had said (Vrikki et al., 2017).

Many ongoing questions related to the desirability and feasibility of both cross sector and LS activity emerge from this study. Three are offered here for greater consideration:

- What interest is there for LS and/or the principles of CLR become embedded in the professional learning and development of all teaching staff within a HE setting?
- What alternative CPD provides academics with opportunities to work with cross-sector teachers, and how do they compare in process and outcomes?
- Should all teachers, whether in HE or mainstream sector teaching, have supported by their organisations an active profile of continuous professional development in subject and pedagogic practice?

To summarise in the words of one academic,

> *Reflecting on my experience the project has been truly transformational in the way I will seek to learn from educators in primary and secondary schools in the future; I guess, arrogantly I assumed I would not have a lot to learn and it perplexes me a little that I thought this way. I intend to continue to work collaboratively with primary and secondary teachers in the future to develop my scholarship of teaching and learning and promote engagement from colleagues to do the same.* ***(Academic, post project informal conversation)***

References

Bjuland, R., & Mosvold, R. (2015). Lesson study in teacher education: learning from a challenging case. Teaching and Teacher Education, 52, 83-90.

Cordingly, P., Greany, T., Crisp, B., Seleznyov, S., Bradbury, M and Perry, T. (2018) Developing Great Subject Teaching; The Wellcome Trust Available at https://wellcome.ac.uk/sites/default/files/developing-great-subject-teaching.pdf

Dudley, P. (2014). Lesson Study: a handbook. Available at http://lessonstudy.co.uk/wp-content/uploads/2012/03/new-handbook-revisedMay14.pdf accessed 20 July 2017.

Elliott, J. (2009) *Lesson and Learning Study: a globalizing form of teacher research.* Paper presented at the British Educational Research Association Annual Conference, University of Manchester, 2-5 September 2009

Fernandez, C., Cannon, J. & Chokshi, S. (2003). A US–Japan lesson study collaboration reveals critical lenses for examining practice. Teaching and teacher education, 19(2), 171-185.

Gibbs, P., Cartney, P., Wilkinson, K., Parkinson, J., Cunningham, S., James-Reynolds et al (2015) Literature review on the use of action research in higher education Educational Action Research, Vol 25: 3-22.

Greany, T., Gu, Q., Handscomb, G., Varley, M., Manners, P. & Duncan, S. (2014). School-University Partnerships: Fulfilling the Potential Summary Report. Swindon and Bristol: Research Councils UK and National Coordinating Centre for Public Engagement.

Hannon, V. (2009), *'Only Connect!': A new paradigm for learning innovation in the 21st century*, Centre for Strategic Education, London

Lewis, C. (2002). *Lesson study: a handbook of teacher-led instructional change*. Philadelphia: Research for Better Schools, Inc.

Lewis, C., & Hurd, J. (2011). *Lesson study step by step: how teacher learning communities improve instruction*. Portmouth: Heinemann.

Lewis, C. & Takahashi, A. (2013). Facilitating curriculum reforms through lesson study. International Journal for Lesson and Learning Studies, 2(3), 207-217.
National Student Survey (NSS). Available at: https://www.officeforstudents.org.uk/advice-and-guidance/student-information-and-data/national-student-survey-nss/

Lundin, M., Bergviken Rensfeldt, A., Hillman, T. et al. Int J Educ Technol High Educ (2018) 15: 20. https://doi.org/10.1186/s41239-018-0101-6

McCune, V. (2018) Experienced academics' pedagogical development in higher education: time, technologies, and conversations, Oxford Review of Education Volume 44: 307-321,

OECD (2015). *Schooling Redesigned: Towards Innovative Learning Systems*. OECD Publishing, Paris.

Ralls, D., Bianchi, L. & Choudry, S. (2018) *Across the Divide: Developing Professional Learning Eco-Systems in STEM Education*, Research in Science Education.

Ryan, A. & Tilbury, D. (2013) Flexible Pedagogies: new pedagogical ideas, Higher Education Academy. Accessible at
https://www.heacademy.ac.uk/system/files/resources/npi_report.pdf

Schön, D. (1983). The Reflective Practitioner, How Professionals Think in Action, New York: Basic Books.

Smedley, L. (2001) Impediments to Partnership: A literature review of school-university links, Teachers and Teaching, 7:2, 189-209, DOI: 10.1080/13540600120054973.

Teaching Excellence Framework (TEF) consultation (2016). Available at:
https://www.gov.uk/government/collections/teaching-excellence-framework

Vrikki, M., Warwick, P., Vermunt, J. D., Mercer, N. & Van Halem, N. (2017). Teacher learning in the context of Lesson Study: A video-based analysis of teacher discussions. Teaching and Teacher Education, 61, 211-224.

Appendix

Research Lesson Proposal (2.0)

Name of Lesson Study Group "And Then There Were Two"	**Research Theme** The link between questioning and engagement
Enquiry Question Do questions generated by students raise student engagement? (or is it just questions themselves?	
Date of Research Lesson 12th June 2018 (11am)	**Teaching Group** Class 5Y (21 students)

About the topic and pedagogical challenge

About the Topic and Pedagogical Challenge

The idea of student / pupil engagement has a long history reaching back to the work of John Dewey in the 1940s. There is a diverse body of educational research has shown that academic achievement is positively influenced by the amount of active participation in the learning process. Teacher / lecturer questioning is one method of increasing active participation. The pedagogical challenge for the teacher and the lecturer is to frame these questions so that they bring about the desired engagement, because poor, confusing questions will kill that spark of engagement just as quickly as, good, stimulating questions will create it. Careful thought needs to be given to the type of question (open or closed), where it sits in Bloom's taxonomy, and the area of knowledge of skill base that the question intends to create a buzz about. Also, there are the abilities of the students to take into consideration. Are the they second language (i.e. English) learners? Are their language skills developed enough (do they have "basic" English skills)? Are the students able to engage with such questions and are they equipped to answer them?

Interest vs engagement

For this project we are concerned with those students who actively engage with the lecture as opposed to those who are just interested in it.

Interested students will listen or may follow the lecture via their media device. They may also follow the slides on the screen or the movement of the lecturer around the theatre (should they decide to move). They will be interested but will be passive learners.

Engaged students on the other hand, will do something as a result of their interest. They will ask questions (put their hand up), discuss ideas and questions with the lecturer (as she moves around the room) or with their peers, their attention may move between the different components of the lecture (lecturer, slides) or change focus when a more engaging activity, question or important information is presented. Making notes can be seen as a part of either group, but in the case of engaged students, it is part of a dynamic process and in response to a stimulus (mentioned above). They will be active learners.

Assumed prior knowledge of students

- Children have been working on the Science topic Forces for approx. 6 weeks.
- They have built on the basic forces of push, pull and twist (from Y2) by adding gravity, friction, air resistance and mass in Y5.
- Children have developed their scientific enquiry from Y1 to include forming scientific questions, recording results and explaining findings using scientific ideas.
- In Y5 they are learning about dependent and independent variables.

About the enquiry question

What evidence or sources are being used to inform the design of the research lesson?

- *Through experience of using questions to create an educational "buzz" amongst the students and so improve their enjoyment and understanding of the lecture and lecture course.*
- *Through use of Kagan Structures in the Primary phase as a vehicle for questioning and improving engagement of passive learners.*

What background research has been carried out, how has this helped to shape and inform the enquiry question?

Background reading

- *New Modes of Teaching and Learning in Higher Education (2014)*
- *Student Engagement Literature Review (2010)*

Improving engagement has many benefits and many champions. Across Europe, there is a greater need to improve student outcomes, persistence and success due to the ever-increasing number and variety of Higher Ed providers beyond the traditional University. In Primary and Secondary education, there are ever increasing demands greater and greater levels of progress from the Government (via OFSTED) with consequences for those who do not meet these lofty ambitions.

The student engagement literature review is clear on the many benefits of engaging students. These range from the individual student, through the student body as a whole, to the culture of the institution itself. The students are more likely to pass, more likely to stay from one year to the next (and not drop out) and more likely to find the experience of benefit and of relevance. The institution benefits through having a high impact practice with a high cost-benefit ratio (not 100% sure about this, as we don't do cost benefit ratios so it's a guess whether its high or low, maybe its low cost-high benefit? - to be edited)

How have the group arrived at the enquiry question?

During our group discussions, we found that a common method used by each member of the group to engage the students that they work with was to use a variety of questioning strategies. Anecdotally, this has been found to engage children and students and create a buzz where they are actively involved and asking questions of their own. Such lessons will often result in improved learning and outcomes for the students involved. This also appears to work on an individual level, where engaged, question asking pupils are more likely to understand than the quiet, passive learner.

How this research lesson will address the research question

This should explain the new teaching strategies that will be used in the lesson to respond to the research question. The strategies should link to the focus of the lesson.
In the lesson the teacher will…

- Model the use of Diamond 9 to rank scientific shoe factors.
- Model the link between factor choice and question choice.
- Model writing own question
- Model link between data and Science Explanation Cards (scaffold for explanation)

The teacher will not…

- Decide questions, explanations and ideas for the children.

The teacher will use most of their time to… .

- Supporting the groups by keeping their focus on the investigation
- Supporting their understanding by questioning the science behind the children's observations.

The Research Lesson	
Goals of the lesson	*The children are going to carry out an investigation focused on what makes the best training shoe. They will need to* • *Decide which factors are the most important when choosing a shoe (scientifically)* • *Choose (or create) a question about trainers that they can investigate* • *Carry out the investigation, recording suitable data to answer their question* • *Explain their findings using scientific understanding of Forces*
Lesson Structure	*How many students, how will the seating be arranged e.g. mixed ability groups. How long is the lesson? What resources will be required? How will the students demonstrate their learning?* • *There will be approx. 21 children.* • *They will be arranged in mixed ability groups of 4.* • *The lesson will last for 70 mins.* • *The children will show their learning by explaining the results using their understanding of Forces.* *The lesson will use the following approximate timings* • *Introduction to lesson (review Forces, decide important factors) – 15mins* • *Decide on the question and what is to be measured – 10 mins* • *Carry out the investigation – 20 mins* • *Share and reflect on the investigation – 5 mins* • *Explaining the data – 10 mins* • *Share conclusions – 5 mins* • *Conduct survey to capture children's views on questions and science*

	investigations – 5 mins

Lesson Flow			
	Main Learning Activity, Content, Anticipated Responses *Describes the major events and flow of the lesson.*	**Teacher support** *Show strategies, questions, or statements that the teacher may need to make to help students during the lesson.*	**Points of Consideration, Relationship to Research Theme** *Identify* **(***a) what the teacher will look for (formative assessment) (b) what observers should look for to determine whether each segment of the lesson is having the intended effect.*
Introduction and Overview *Describe how the main task(s) of the lesson will be set up e.g. by providing students with a contextualised problem out of which a scientific problem or learning opportunity may arise.*	Children investigate which scientific factor makes the best shoe. They will have a list of factors (each on a card) that they will rank using a **Diamond 9**. They will use this ranking to help determine their investigation question.	Support groups making decisions. Do you all agree? What should you do if you do not?	Children successfully decide which factor is the most important (using Diamond 9 ranking).
Posing the Task *Describes in more detail how the main task (s) will be presented to students.* *Indicate here whether the task (s) will be written on the board, handed out as a worksheet, or introduced to the students in another way.*	The children will be presented with several possible **investigation question cards** (and some blank cards) from which to choose. Groups make their choice and decide how and what to measure. They carry out their investigation and record their investigations and record their data.	Which factor do you think is the most important? How will this factor be different in a shoe? How can you measure this factor?	Children will successfully choose a question for their investigation. Will more able children be drawn to writing their own questions for the group? Will groups prefer to use prewritten questions?
Anticipated student responses *Identify a range of possible student responses and reactions.* *How will the teacher deal with predicted responses and reactions?*	**Groups may fail to agree on question.** Teacher and TA will check that each group has decided. **Children will be unsure what to measure or how to measure.** Teacher and TA will check that each group is sure – support if necessary.	Use **Working in a Group** checklist. Support decision making process so that they reach a decision.	Children successfully carry out investigation and record their data.
Summing up *This section may describe how the teacher will summarize the main ideas of the lesson.*	The children will reflect on their investigation and what they found out. They will then explain the data using their understanding of Forces (children will be able to choose **Science Explanation Card** that best fits their investigation). The class will then share their conclusions and decide which is the best shoe? Conduct a **survey** to capture children's feelings towards questions and science investigations.	Children will need modelling and scaffolding to make sense of their findings. Sharing their findings allows other groups to learn from their peers.	Children can explain their data using understanding of Forces. Children show increased levels of interest in Science investigations through responses to survey.

Post Research Lesson Debrief	
This section should include questions, to be discussed as group after the lesson, in particular, discussions of the effectiveness of the lesson in terms of the planning team's research goals. It should include at least one question specific to the research theme and enquiry question and at least one about the specific learning goals. For example: *a) Did the lesson successfully*	<u>Research theme</u> • Does questioning raise student engagement? Unquestionably, yes. Questions encourage children to think about their learning, to take next steps, or apply it to new situation or context. More able children are the most ready to engage with questioning as they are often the most confident and the most knowledgeable. They are also more likely to be the risk takers, the ones who are most likely to take an incorrect answer as the step before they learn something new. In the case of this lesson, techniques including partner talk and "think, pair, share" gave more children the confidence to try out their ideas and explanations in front of the class (having already tried them out within the safer confines of their partner / table group. Scaffolding (using the Diamond 9 sorting activity) also added to the confidence level of the children. It provided

promote student-to-student discussion? (i.e. the theme) *b) Do students understand that …? (i.e. the subject matter, learning goals)* *Include any other questions that the planning team hopes to explore through this lesson and the post-lesson discussion.*	them with both the language and the ideas behind the lesson and supported them in answering the questions posed. Allowing the children to volunteer answers was interspersed with selection of individuals. This tested their understanding of the learning and also helped them frame their ideas into a form that could be investigated. The children were very enthusiastic about their investigations, with a very high proportion on task throughout the task. The results from the survey showed that the percentage of children who ask "what happens if…?" type questions increased form 31% before the lesson to 53% after the lesson. Interestingly, the percentage of children who didn't ask these questions fell from 28% before to 6% after. More children felt supported and empowered to ask such questions and took the opportunity to do so. <u>Enquiry Question</u> • Do questions generated by students raise student engagement? (or is it just questions themselves?) From this enquiry, the data would suggest that the answer to this question depends on how confident a scientist the child is. The children were presented with some adult-generated questions based on the scientific factors from the Diamond 9 sorting activity. They also had some blank question cards which they could use to generate their own questions. From discussions with the children, it was quickly established that the middle ability and less able predominantly used the adult-generated questions and it was the more able and higher ability children who tended to choose their own questions for investigation. The results from the survey showed that the percentage of children who "like adding their own ideas to investigations" increased from 69% before the lesson to 80% after the lesson. Also, the percentage of children who did not like using the own ideas fell from 21% before the lesson to 0% after. The less able children were able to use the adult-generated questions and add some of their own ideas to their investigation. Supplementary questions • Does the learner's language (English as an additional language) affect their engagement? Discussions with children who are still developing their understanding of English revealed that they welcomed the adult-generated questions. One child said that they "found it much easier to use your questions" and another said that they found it "hard to make up my own". These children were able to think of ideas of the features of a shoe that they might investigate but were not confident enough of skilful enough to invent their own questions based on these ideas. By contrast, those children whose language was sufficiently developed were often very motivated to generate their own questions or adapt their own from pre-written ones. By contrast, the children with less developed language skills found that the language structures provided in the lesson gave them one less thing to think about and so allowed them to start using thoughts and ideas of their own to enhance their work. • What should we now do knowing what we know? To further support the less confident children, we will introduce partly scaffolded questions. These will provide the necessary language structure but also give the children some freedom to use their own ideas within this structure.