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How is a resource for changing teachers' assessment practice in primary science successfully disseminated, shared and enacted within a primary school?

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A thesis submitted in partial fulfilment
of the requirement of Bath Spa University
for the degree of Doctor of Philosophy

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Institute for Education, Bath Spa University

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Abstract

Many researchers in the field of education aim to inform and improve the pedagogical practice of in-service practitioners through the successful dissemination of their research outputs. Commonly used modes for dissemination include online availability and face-to-face presentation. It is not known which dissemination modes are most effective for a research team, nor what social learning opportunities, characteristics within a teacher workforce, or wider workplace factors might influence how practitioners respond to and engage with such research outputs.

This three-part mixed methods study addresses these wider issues through the evaluation of the dissemination of the TAPS pyramid, a resource designed to help primary practitioners to evaluate and improve their assessment practice in primary science. It is situated within sociocultural assumptions of learning as a socially constructed process and draws upon King's (2003) three levels of dissemination activity as a theoretical framework.

Quantitative analyses of download and dissemination event data demonstrate a positive interaction between both online dissemination and dissemination by event; analyses of survey data show variation in engagement with the resource based on job role and experience; expansive workplace characteristics are shown to be significantly linked to reports of whole school use; transactional communication is shown to enable the transfer of new knowledge; and informal learning contacts are valued by participants.

The findings are used to elaborate King's model of dissemination by specifying the activities, inhibitors and enablers of dissemination for action. It is concluded that dissemination of research outputs is facilitated by interactive communication at each stage, entails formal and informal learning opportunities, and its success can be enhanced by the evaluative and leadership skills of the knowledge broker, as well as the wider characteristics of the school as a workplace.

How is a resource for changing teachers' assessment practice in primary science successfully disseminated, shared and enacted within a primary school?

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Hopwood-Stephens (2018a)

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1 Introduction

1.1 Introduction to the research problem

Many academics in the field of educational research wish to effect change with their findings by influencing the practice of in-service teachers. But what is the best way to reach these practitioners with innovations that are derived from research? What aspects of the dissemination process might influence how this target audience interprets and engages with the content of these research outputs? And, if one of these practitioners attempts to disseminate the resource within the walls of their own school setting, what mediating factors might enable or inhibit their attempts to effect changes to practice at a schoolwide level?

1.2 Background to the study

This study addresses these questions by evaluating the dissemination and impact of an educational research output designed to help primary practitioners evaluate and improve their assessment practice in primary science, known as the TAPS pyramid (Davies et al., 2014). The Teacher Assessment in Primary Science (TAPS) project was set up in 2013. It was funded by the Primary Science Teaching Trust (PSTT) and was run by academic staff working in the field of primary science at Bath Spa University.

The TAPS pyramid was based upon the recommendations of the Nuffield Foundation working group on primary school science assessment (Nuffield Foundation, 2012). The working group had met in response to concerns about the removal of national testing at the end of Key Stage 2, but also to discuss a more appropriate means of assessing pupil progress than written testing (Newton, 2009). Noting the particular suitability of formative assessment for the ongoing evaluation of children's practical scientific skills, the Nuffield Foundation recommended that formative assessment be used to collect a wide range of formative data about individual pupils' understanding in primary science. These rich formative data could then be used to produce summative teacher judgements of pupil progress such as end of topic summaries, end of year reports to parents and school level reporting of overall progress against curriculum outcomes. The suggested flow of the formative data from the classroom to the internal and then external reporting levels was illustrated using a triangular diagram (Nuffield Foundation, 2012; p.21), as shown in Figure 1.

The stated aim of the TAPS project team was to operationalise the Nuffield Foundation's data

flow diagram (Davies et al., 2014) by specifying the assessment activities that would comprise each layer. They achieved this through a process of Design Based Research (Brown, 1992), whereby the project team provided TAPS pyramid prototypes to a group of expert teachers in the project schools. Their feedback was used to further specify the assessment activities and improve the research output's design. By involving primary practitioners in its creation (Davies et al., 2017) the team aimed to design a resource which was both derived from research and applicable to teachers' pedagogical needs (Hemsley-Brown and Sharp 2003). The TAPS pyramid has been publicly available as a download since 2015 on the Primary Science Teaching Trust website. It has also been actively promoted to its target audience at events, with audiences ranging in size from five to three hundred, by members of the project team and primary science specialists.

1.3 Aims of the study

At the commencement of this study, the geographical distribution of downloads of the resource was not known and so it was impossible to quantify the possible impact of the dissemination events in the dissemination strategy pursued. There was no empirical analysis of its impact upon the assessment practice of those using it, and there was also no data upon the factors within schools which might enable or inhibit attempts to apply its content to the evaluation and improvement of assessment practice at a schoolwide level.

This study has therefore been designed to evaluate: the relative impact of the dissemination modes used by the project team to reach in-service primary practitioners; the ways in which the research output has been interpreted and enacted and its impact upon assessment practice; the mediating factors within primary schools which can influence the schoolwide implementation of research outputs; and the format and nature of the learning opportunities available to teachers attempting to change their assessment practice through their engagement with a publicly disseminated research output.

In doing so, this study will address the research questions and also provide an elaboration of King's (2003) three levels of dissemination for educational research outputs to in-service teachers, the third level of which, dissemination for action, is under-specified in the literature. Recommendations, as derived from the empirical analyses, will also be made to academic research teams intent on influencing the practice of in-service primary teachers, as well as to school leaders wishing to enable the schoolwide engagement with and enactment of research

findings intended to improve an aspect of pedagogical practice.

1.4 Paradigm and theoretical focus

This research is situated within a sociocultural paradigm of learning as an inherently social activity that is comprised of two parties attempting to share ideas across a knowledge boundary (Akkerman and Bakker, 2011), but which takes place within a socially constructed context and is therefore also subject to the influence of tacit, distal messages and workplace norms (Rogoff, 1990; Wertsch, 1991). In addressing the research questions, this study will consider key sociocultural concepts such as the role of talk in boundary crossing, the process of adaptation, and the role of intersubjectivity in the successful dissemination of new ideas within a primary school which result in changes to teachers' practice.

This is a mixed methods study and was conducted within the Explanatory Sequential Mixed Methods (ESMM) model (Creswell, 2013). A macro to micro approach to understanding and investigating the research problem (Layder, 1993) was employed, from the global and national mapping of distribution data; to an online survey of participants who had engaged with the resource to change their assessment practice; to the qualitative case studies of schools where the resource had been used to change practice.

A model for the dissemination of educational research outputs (King, 2003), which posits three levels of dissemination activity, is used as a theoretical framing device. It is used as a starting point because dissemination for action, one of King's specified levels, is the level of dissemination activity which is most likely to result in changes to practice (King, 2003) but it is also beyond the control of the research team (Southwell et al., 2010), and at present, the activities for achieving dissemination for action are under-specified in the literature.

The following inter-related fields of scholarship are drawn upon during the study as conceptual frameworks for the dissemination process: knowledge transfer within organisations, including boundary transfer processes (Carlile, 2004) and the nature of knowledge transfer contacts between colleagues (Aalbers, Dolfsma and Koppius, 2014); organisational learning, in terms of the structure and characteristics of the meetings held to support the development of teacher practice (Vescio, Ross and Adams, 2007) and the characteristics of the wider workplace itself (Hodkinson and Hodkinson, 2005); and communication theory, to consider the nature of the communication (Harris and Nelson,

2008) between colleagues attempting to change their practice.

1.5 The structure of this study

This study has been conducted in three interlinked steps. The first quantitative step addresses the gap in knowledge about the dissemination strategy pursued by the project team. While it is known that the TAPS pyramid has been downloaded in 45 different countries and was promoted at a series of dissemination events in England (Hopwood-Stephens, 2018a) the possible interaction between online and face-to-face dissemination modes and their relative effectiveness is hitherto unknown. This study provides a robust statistical analysis of the interaction between different dissemination modes, and in doing so, makes recommendations derived from empirical evidence for research teams intent upon disseminating their resources to in-service teachers.

The second step addresses the lack of empirical evidence of the resource's impact upon assessment practice. Reports have emerged from the schools involved in the design of the TAPS pyramid about the different ways that the resource has been used (see Qureshi and Petrucco, 2018), but little is known, beyond anecdotal reports, about how it has been interpreted and enacted in schools within the rest of the country. This study increases knowledge in this area by contributing statistical and descriptive analyses, based on a survey of one hundred users, of its interpretation and impact upon assessment practice (Hopwood-Stephens, 2018b). Within this survey data, the nature of workplace learning and the characteristics of the workplace itself are also examined for their possible influence upon whole school adoption of a research output, and these findings are applied more widely to improve our understanding of the factors which might influence the schoolwide enactment of a new resource to evaluate and improve an aspect of pedagogical practice.

The third, qualitative step of this study comprises two case studies of schools where dissemination for action (King, 2003) had been achieved, through the internal transfer of new knowledge derived from the TAPS pyramid to change assessment practice among all staff. The thematic analyses will investigate what social learning and communication processes enabled this transfer of knowledge and transformation of practice, including the role of informal contacts (Aalbers, Dolfsma and Koppius, 2014) and transactional communication (Harris and Nelson, 2008). The role played by the Science Subject Lead in obtaining and disseminating new and expert knowledge will also be considered.

1.6 Structure of the thesis

This thesis is structured as follows:

Chapter 1: Introduction. This brief initial chapter introduces the problem that this study addresses, provides a background to the research output being studied, outlines the research paradigm and design, and explains the structure of the rest of this document.

Chapter 2: Literature review. This chapter will situate the study within sociocultural theories of learning and review the literature in four areas related to the research questions for this study. The research questions will be introduced at the end of each section and then fully specified at the end of the chapter.

The first section will examine the theory and practice of disseminating innovations derived from educational research to in-service teachers, including commonly used modes of dissemination. The second section will look at the curriculum subject of primary science, considering the broader context within which it is taught, including Initial Teacher Education (ITE) provision for assessment practice, current assessment and curriculum policy and how recent changes to these may have affected its status. The resource at the centre of this study, the TAPS pyramid, will also be considered in terms of its intended purpose and the wider educational context within which it is intended for use. The third section of the literature review focuses on professional development for in-service teachers and how it can be provided, examining two possible frameworks for its effectiveness: the characteristics of the staff meeting held to support professional learning and the characteristics of the workplace within which the learning takes place. The fourth section of the literature review considers the role of knowledge transfer mechanisms in the dissemination of new knowledge amongst colleagues working in a primary school and considers what mechanisms, discussion fora and types of communication might enable this transfer. The literature review concludes with a clear and cumulative mandate for inquiry and the research questions, specified in full.

Chapter 3: Methodology. This chapter provides a rationale for the selection of an Explanatory Sequential Mixed Methods (ESMM) research design, explains the flow of research activities and provides an overview of the data collection methods. A rationale for selecting the theoretical framework is given, and the conceptual frameworks employed in Steps 2 and 3 of this three-part study are outlined.

Chapter 4: Step 1. This chapter will outline the first quantitative stage of this three-step research study, which addresses RQ1. It will examine the relative effectiveness of online and face-to-face dissemination modes employed by the TAPS project team. The methods, analysis and a discussion of results pertinent to addressing RQ1 will follow.

Chapter 5: Step 2. This chapter will outline the second quantitative stage of this three-part research study, which was devised to address RQ2 and RQ3. Online survey data will be analysed to explore how the resource has been interpreted by its users, the impact that its use has had upon assessment practice, and other factors significantly linked to reports of whole school changes to practice, including workplace and meeting characteristics. The introduction will recap the conceptual frameworks employed and the methods will follow, with the analyses presented as descriptive and then statistical. A brief discussion of the results pertinent to addressing RQ2 and RQ3 will follow.

Chapter 6: Step 3 methods

This chapter is the first of two to outline the third, qualitative stage of this three-part research study, known as Step 3. This final step of the research was designed to address RQ4. This first chapter will make reference to the conceptual frameworks employed during this step of the research, before outlining the methods and rationale for the collection and analysis of qualitative interview data and documentary analysis. It will also describe how the interview questions were derived and the analytical process used to code the interview data.

Chapter 7: Step 3 analysis and discussion

This chapter is the second half of the account of Step 3. It contains the thematic analysis of the qualitative data from both case studies and a brief discussion of the findings. Each case is presented as follows: contextual data about the school used in the case study; a vignette of the Science Subject Lead's (SSL) career history and interpretation of the TAPS pyramid; a thematic analysis of the interview data for all participants; and a summary of findings. The themes, identified as cross-case or single case, are presented in a reference table and a brief discussion follows of the findings with reference to answering RQ4.

Chapter 8: overall discussion

This chapter will start with a summary of key findings from each step of this three-part study

before drawing them together to elucidate the overall findings that can be derived from the study as a whole, locating them within the wider literature. Dissemination for action, King's (2003) third level of dissemination activity for educational research outputs aimed at in-service practitioners, will be elaborated with reference to the empirical findings of this study. The limitations of the study will be considered.

Chapter 9: contributions to knowledge and recommendations

This final chapter will explain how the state of knowledge has changed as a result of this study. Recommendations derived from the empirical analyses will be made for academic research teams wishing to reach in-service primary teachers with research outputs, as will recommendations for primary school leaders who wish to enable their staff to adopt new initiatives to improve an aspect of practice at a schoolwide level. Possible areas for future research will be identified.

1.7 Writing conventions

The following acronym, SSL, is used frequently as a shortened version of Science Subject Lead. Unless the author is referring to a specific participant in the research, the pronouns “she” and “her” are applied throughout this thesis to refer to generic SSL or class teacher roles. This is due to the fact that seventy-five percent of teachers are female (Department for Education, 2018), but does not indicate any unwillingness on the part of the author to acknowledge the vital role that male teachers and male SSLs play within the state maintained primary education system.

1.8 Appendices to this thesis

The Appendices for this thesis are provided online, on the BathSPAdata website. A reference is given in the main text whenever supporting documentation has been provided. The Appendices for this thesis can be found at the following URL:

<https://doi.org/10.17870/bathspa.8066321.v1>

2 Literature Review

2.1 Introduction

This literature review is structured as follows. The research will be situated within sociocultural theories of learning and reference will be made to specific tenets which pertain to the dissemination of resources to in-service practitioners. A model for the dissemination of research outputs derived from educational research will then be introduced and critiqued. Next, the focus will shift to the derivation of the research questions. Each research question will be specified in response to a demonstrated lack of knowledge within the existing literature.

With regard to the first research question, relevant literature from the field of dissemination of educational research outputs is related to a research team's intention to disseminate their resource to a target audience of in-service primary teachers. For the derivation of the second research question, the dissemination of a resource to help in-service primary practitioners evaluate and improve assessment practice is considered in terms of the wider context of Initial Teacher Education (ITE), current national assessment policy and the status of primary science in the primary curriculum. With reference to the derivation of the third research question, the dissemination of new knowledge about assessment within a primary school is considered in terms of workplace and meeting characteristics which might inhibit or enable this process. For the fourth research question, knowledge transfer concepts from the field of organisational learning theory are considered with reference to exploring and specifying the possible processes which can achieve dissemination for action (King, 2003) within the walls of a primary school.

At the end of the literature review, a summary will present a cumulative warrant for the study and the research questions will be restated in full, with their associated sub-questions.

2.2 A sociocultural perspective on learning

This research is situated within the theoretical assumptions of sociocultural theory (Vygotsky, 1978); in particular, that learning is an inherently social activity shaped by the context within which it takes place. It also draws upon collaborative dialogue between individuals in a group-learning context to co-construct new knowledge (Littleton and Mercer, 2013).

Sociocultural theory is consistent with the ideas of social constructivism, insofar as it views

learning as the result of an individual interacting with others in their environment to construct their knowledge, but it differs insofar as it considers the social system within which the learning is happening as instrumental to the process (Scott and Palincsar, 2013). As such, it pays attention to the discourse, norms and practices associated with the learning experience (Popp and Goldman, 2016), as well as the characteristics of the physical and social setting within which it takes place (Wertsch, 1991).

Sociocultural theory posits that the relationship between thinking and social activity “is a vital, distinctive characteristic of human cognition... which underpins cognitive development” (Mercer and Howe, 2012: p. 12). Furthermore, it assumes that learning takes place on two planes (Vygotsky, 1978): the intermental, when people interact socially to share and compare ideas, and the intramental, when the knowledge which has been co-constructed is internalised and appropriated. Learning through social interaction is thought to be such a rich learning experience because, as learners participate in joint activities and bring their divergent experience to bear on problem solving, they co-construct new knowledge (Bonk and Kim, 1998). Diverse theories that explain learning between adults use sociocultural concepts to explain how this process takes place (Engeström, 2010; Fuller and Unwin, 2004; Lave and Wenger, 1991; Siemens, 2005).

2.2.1 Underpinning dissemination with key concepts from sociocultural theory

The literature on sociocultural theory is expansive and its learned scholars are many. It is not the intent of this author to describe its entirety. Instead, the following concepts from sociocultural theory will be highlighted as having particular relevance to this study.

Of perhaps the greatest significance to this study is the idea of language as a mediating tool for learning. As teachers learn socially, from and with each other on the intermental plane, to improve aspects of their assessment practice with reference to the TAPS pyramid, the possible discussion and sharing of expertise allows for knowledge distributed throughout the group to be shared publicly (Littleton and Mercer, 2013). The function of language in this process is not only to transmit information from one mind to another, but to also co-construct new knowledge. Language also allows an individual to check their understanding (Hutchinson and Huberman, 1994; Aalbers, Dolfsma and Koppius, 2013). However, learning does not only take place through verbal exchanges, but also through the tacit, distal influences of guided participation (Rogoff, 1990). The messages that a teacher absorbs from their place of work or

the attitude of their colleagues may also influence how they respond to a new initiative or new tool.

As information is shared between individuals, the ideas being received are internalised and transformed to some extent by the receiver, a process which is also known as appropriation (Scott and Palincsar, 2013). Appropriation is also an important concept to this study, because it entails the adoption and use of a socially available tool by the user, according to the user's needs (Leontiev, 1981). Or in the case of the resource being studied here, interpreting it and adapting its purpose to either the requirements of the individual teacher or the aims of the school.

And finally, intersubjectivity, also expressed as group sense (Ryder and Campbell, 1989), concerns the establishment of common aims and sense of collective endeavour (Mercer and Howe, 2012) between those in a group who are working towards a shared goal.

Intersubjectivity is a useful means of understanding the sense of collective endeavour which might play a role in the implementation of the TAPS pyramid at a school level, or indeed, of its failure to make a difference to practice at a school level. In their overview of the social and cognitive processes that underpin learning, therefore, these key tenets from sociocultural theory provide a useful base from which to explore the successful dissemination of a resource to and among in-service teachers, resulting in changes to practice.

2.3 The dissemination of educational research

2.3.1 What is dissemination?

In contrast to diffusion, which is the passive, untailored and untargeted spread of information (Primary Health Care Research and Information Service, 2017), the process of disseminating research outputs to a target audience:

“goes well beyond simply making research available through the traditional vehicles of journal publication and academic conference presentations. It involves a process of extracting the main messages or key implications derived from research results and communicating them to targeted groups of decision makers and other stakeholders in a way that encourages them to factor the research implications into their work.”

(Canadian Foundation for Healthcare Improvement, 2016, p.2).

This definition of dissemination is central to the conception and design of this study, because

it entails not only the distribution of information to specific groups who might be interested in it, but also the active engagement of the target audience with that information which can result in a deliberate change in behaviour as a result. This chimes with the view of King (2003) who states that if we wish to disseminate our new knowledge to influence practice, “we need to have some strategy in place to enable us to share our information, resources and ideas with those who are at the chalkface of teaching, learning and assessment. Dissemination is therefore about communication, and effective dissemination can only be achieved through effective communication.” (King, 2003, p.97).

2.3.2 A model for the dissemination of educational research outputs

Dissemination theory for educational research is derived in great part from medical and social science research dissemination (see National Center for the Dissemination of Disability Research, 2001), as well as more recent research into the effective dissemination and embedding of innovative ideas in higher education institutions (Southwell et al., 2010; Gannaway et al., 2013). As exemplified by the definition provided by the Canadian Foundation for Healthcare Improvement above, dissemination theory for research outputs hinges upon an assumption that learning is a socially constructed activity, mediated by communication between the disseminator and the target audience.

In her model for the dissemination of educational research outputs to in-service practitioners, King (2003) describes three levels of dissemination:

- Dissemination for awareness
- Dissemination for understanding
- Dissemination for action

These levels of dissemination activity will be briefly explored in relation to the dissemination strategy for the resource being studied.

Dissemination for awareness entails bringing a research output to the attention of the largest possible audience through a relatively passive dissemination activity, such as advertising or posters. Making the TAPS pyramid available online as a download can be classed as dissemination for awareness. However, a teacher might become aware of the TAPS pyramid after seeing it promoted online, but choose not to engage any further with it, guided by the

assumption, formed from their workplace, that it would not be supported by the leadership team. Another potential user might discover it online and simply choose not to engage with it. These examples are given to show that dissemination for awareness can be achieved without any further engagement with the resource, or consequent impact upon practice.

Dissemination for understanding is the second level described by King (2003), whereby the research output is presented directly to its target audience. Typical activities for dissemination for understanding include talks at conferences, seminars and workshops; Klein and Gwaltney (1994) previously separated this type of face-to-face dissemination into *choice*, which entails a large conference audience and minimal to no interaction between the presenter and the audience, and *exchange*, which entails the exchange of feedback and questions between the presenter and the audience, who can ask clarifying questions and, in learning more about the resource and its intended purpose, can reflect upon its possible application to their setting (Hutchinson and Huberman, 1994).

The role of language as a mediating tool is more significant in dissemination for understanding, and it is linked to appropriation insofar as the target audience might be enabled to decide upon how best to apply this new idea to the specificities of their setting. Dissemination for understanding can be controlled by the project team, who can act as or choose the linking agent for their innovation (Louis, 1980), and it has been shown to have an increasing impact upon the practice and behaviours of the output's target audience (Southwell et al., 2010), making it perhaps a more desirable strategy for successful dissemination than dissemination for awareness. It is worth noting, however, that dissemination for understanding has been achieved when the resource has been presented to the target audience and they leave with more detailed knowledge about its possible use. Once again, this does not result in the recipient of the information necessarily engaging any further with the resource, or changing their practice as a result of doing so.

Dissemination for action is the ultimate aim of many project teams, because its outcome is the use of the research output to change practice in some way (King 2003). However, it is also the level of dissemination over which the research team has the least, or even no, control (Gannaway et al., 2013). In some circumstances dissemination for action can be mandated at an institutional level (Southwell et al., 2010), but when a research output is disseminated to education professionals to apply to their practice and share within their school settings, it can be argued that dissemination for action is driven by these individuals and their vision for how

the resource might be used, and not driven by the research team.

It is therefore of great interest to both research teams and school leaders alike to understand more about what dissemination for action entails – what its activities might be; what sociocultural theories of learning might be apparent within these; what might be the enablers and inhibitors of dissemination for action among teachers changing their assessment practice – and yet this is the least specified level of King’s model for levels of dissemination. She notes that “dissemination for action... will involve methodologies that enable users to adapt and use the information, idea or resource in their own context,” (King 2003, p. 101) and provides “faculty workshops and one-to-one consultations” (ibid.) as possible examples of activities, but these examples refer to the dissemination of research outputs in the context of higher education.

The processes of dissemination for action, to and among primary practitioners, remain underspecified in the existing literature. Clarification of what dissemination for action entails within a school, and the factors which enable or inhibit it, would be a useful contribution to existing knowledge.

2.3.3 Potential problems with dissemination of research outputs to in-service teachers

Five factors in the successful dissemination of research outputs have been summarised by Kirst (2000) as: trust in the source of the innovation; the appropriateness of the mode of dissemination; the format of the resource or innovation itself; the message conveyed by the innovation; and the characteristics of the recipient. Of course, a list of five criteria for effective dissemination practice might also indicate that there are at least five ways in which to get a dissemination strategy wrong.

This assumption appears to be borne out by the literature on dissemination of resources to in-service teachers; a correctly targeted audience might reject an innovation if it is poorly explained (Moore, 2006), hard to use (Shkedi, 1998) or perceived to irrelevant (MacLellan, 2016). Taking a “one size fits all” approach to devising the content of a resource runs the risk of ignoring the varying contextual, workplace and interpersonal factors within schools that result in the same resource transforming practice in one setting and failing in another (Hargreaves, 1999).

If the resource is disseminated effectively and in a readily interpretable format, there are further possible hindrances to the key findings of the research team being discovered by the target audience, however. Research teams need to be mindful of the workload pressure identified for in-service teachers (Sellen, 2016) and the lack of time that they feel they have for searching for useful resources or attending professional development events (ibid.). Furthermore, the interpretation and intended purpose of a research output can change as it passes through various intermediaries on its way to the target audience (Ansari et al., 2010), perhaps resulting in an appropriation of its intended purpose (King, 2003) which is at odds with the research team's original aims.

On the assumption that the target audience of in-service teachers has been reached and the resource is perceived by them to be useful and relevant to their practice, a climate of readiness for change among those receiving the innovation is also helpful (Southwell et al., 2010) alongside the visible support of the leadership group for the changes required (Smith, 2011). This visible support can guide the participation of teachers, as they receive tacit messages that the proposed changes to practice have value and it will be of benefit to replace their current knowledge with the new frameworks (Rogoff, 1990; Carlile, 2004). And once the resource has been interpreted and enacted by the teachers in some way, Stevens (2004) considers the provision of ongoing support to also be an important factor for the changes to practice to become embedded, as opposed to temporary.

2.3.4 Dissemination as the transfer of knowledge over a cultural boundary

It is interesting at this point to consider the cultural differences between the world of research and the world of the primary school. In the interventions devised by academic research teams to develop teachers' assessment or pedagogical practice in the teaching of primary or equivalent age-range science, time is in abundant supply: participants are provided with months of expert tuition off-site (Hondrich et al., 2015); extensive opportunities to watch skills being modelled and to discuss practice (Serret et al., 2017); or support in the form of workshops and skills development for up to two years (Smith, 2014).

Schools, on the other hand, are judged on an annual basis upon the outcomes for their pupils and have to submit updates on pupil performance during the academic year for scrutiny by the schools inspectorate and the local authority (Department for Education, 2018b). It can be argued that this places schools under pressure to demonstrate an impact upon pupil

performance within the space of one academic year, and furthermore, this is within a crowded primary curriculum that requires the teaching of eleven compulsory subjects (Department for Education, 2014).

It is therefore possible that another problem in disseminating research outputs to in-service teachers might arise through the expectation among research teams that schools will be able to find sufficient time to dedicate to the interpretation and enactment of the resource in question. But if it is true that, “the costs of information consumption rise unacceptably as potential users face the task of extracting information relevant to their setting, presenting it succinctly and interpolating the significance for their institutional needs” (Moore, 2006; p.xi), the resource’s relevance to practice (BERA-RSA, 2014), helpful design (Shkedi, 1998) and the school leadership’s ability (or willingness) to provide ongoing support for its use (Stevens, 2004) become further potential obstacles to successful dissemination.

In summary therefore, we might conclude that the dissemination of research outputs to in-service teachers, far from being the simple casting of intellectual seeds onto the breeze as the etymology of the word implies, is a complex, multi-staged process of socially constructed learning that involves human interaction, communication and effortful meaning-making to engender success. As such, the dissemination of research outputs is a process containing both the opportunity to effect changes to the behaviour of a target audience and the risk of failing to do so. It follows that a study into the successful dissemination of a research output to in-service teachers can provide some useful insight into how this process might work.

2.3.5 What makes a dissemination strategy successful?

As we have seen, the dissemination of educational research outputs involves the active process of extracting and communicating the key messages from research to a target audience in such a way that the audience uses the ideas to modify their practice. It has also been argued that dissemination is an interactive and communicative process, requiring interaction with the output’s target audience. This might be during the design stage to ensure that it meets a need recognised by the teachers who will use it (BERA-RSA, 2014; Hemsley-Brown and Sharp, 2003); or through some form of face-to-face presentation once it has been finalised, during which the target audience learn about the output and consider its possible application to their setting (Hutchinson and Huberman, 1994; Fincher, 2000). Given that it is widely recognised in the literature that the final stage of successful dissemination is the use of the resource by

the target audience effect changes to behaviours or practice (King, 2003; Gravestock, 2003; Southwell et al., 2010; Gannaway et al., 2013), research teams might also consider the interactivity of their planned dissemination strategy. After all, simply telling someone that they should change their teaching style does not automatically lead to a change in practice (Fincher, 2000); nor does making a resource available result in its accurate interpretation and use (Cooper, 2014). The interactive characteristics of two dissemination modes which are commonly used by academic research teams will be explored next.

2.3.6 Dissemination modes for reaching in-service teachers with educational research

If changing teacher practice is the goal, a compelling argument can be made for choosing a dissemination mode that reaches the appropriate practitioner audience. Two potential modes of dissemination have been identified by Southwell et al. (2010) for putting educational research outputs into the hands of practitioners: dissemination of the resource through face-to-face event and dissemination of the resource through passive online availability. An inconclusive view of the impact of both modes exists in the literature, however. The key benefits and disadvantages of each mode will be outlined below.

2.3.6.1 *Dissemination of research outputs by event*

The potential issues in the dissemination of research outputs identified earlier suggest that the dissemination process might be more effective if the resource being disseminated were contextualised or explained in some way to its target audience. This can be achieved by disseminating through events such as conferences, talks, seminars and workshops. This approach is considered by Hutchinson and Huberman (1994, p.27) as the most effective, because it is, “a ‘constructivist’ one, whereby research and other kinds of specialised knowledge are exchanged between researchers and professionals in a mutually constructed social context”.

As such, dissemination by event can involve the deliberate and careful selection of a target audience working in the same subject area and pupil age-range (Gravestock, 2003) and involve the original project team presenting their innovations. Dependent on the size and interactivity of the event, the audience can ask clarifying questions of the linking agent presenting the resource (Louis, 1980) and reflect upon its possible use and application in their setting. This process also facilitates the consideration of its use against their own values and

beliefs, thus meeting to some extent the affective and motivational dimensions involved in a teacher's decision to adopt a new practice (Creemers, 1986; Korthagen, 2017). Significantly, dissemination events aimed at teachers permit teachers to learn with and from their peers, which has been shown to be a strong teacher preference (Gassenheimer, 2013) which is stable over time (Hood, 1990).

It also, rather fortuitously, involves disseminating a resource to an audience of professionals who have much experience of explaining new ideas to others. This means that the dissemination of the resource may continue beyond the walls of the event itself, when the member of the target audience returns to their work setting with the research output. Indeed, some researchers go as far as to recommend that academic research teams only target the most gifted communicators and opinion-formers among in-service teachers, so that the research team's message is best understood and best communicated (Valente and Davis, 1999).

While Walter, Nutley and Davies (2005) found dissemination events such as seminars and interactive approaches to presenting new ideas could support changes to teacher practice, Stevens (2004) is critical of dissemination by events which provide a showcase of research to a large and generalist audience, deriding them "dog and pony shows" that "seldom promote substantial change" (Stevens, 2004, p.34). Shoenberg (2000) also decried conference presentations as akin to "scattering seeds randomly over unprepared ground, where few if any will take root and thrive" (p.1). Instead, he advocates the purposeful selection of a small, interested audience, because "if the soil is right and the plants are well fed and watered they will grow and continue to propagate". (ibid.)

In summary, dissemination by event offers the project team the chance to explain their resource to the target audience, and depending on the type of event it may also offer the audience an opportunity to ask clarifying questions and consider the resource's application to their setting (Hutchinson and Huberman, 1994). It is possible that this dissemination strategy might make the achievement of dissemination for action more likely, as the target audience take the innovation into their schools and enact it in some way. However, dissemination by event reaches a smaller audience and is relatively costly and time-consuming to arrange when compared to online dissemination and reaches a smaller potential audience, as explored below.

2.3.6.2 Dissemination of research outputs online

Online dissemination can be used by educational researchers intending to reach as wide an audience as possible, and on the basis of cost and facility it is an appealing mode to a project team with a limited budget (Cooper, 2014). The advantages to disseminating research innovations online include access to a potentially global audience (Bryman, 2015), low production costs and the comparative ease of releasing updates (Wulf, 1996). Online dissemination is increasingly used by academic teams to disseminate findings and outputs; an international survey of nearly two thousand researchers found that social networking sites were reported as being highly useful for the dissemination of research (CIBER, 2010).

The verdict in the literature on its effectiveness as a mode for dissemination is mixed, however. While online dissemination of innovations appears in the guidance of many large organisations (EU2020, 2014; World Health Organisation, 2014), it is not considered by those organisations to be an adequate dissemination strategy on its own. This is primarily because making a research output passively available on the internet does not guarantee that it has been seen by its intended audience (Cooper, 2014). But even if the target audience has found it, the relative lack of explication that is possible for resources discovered online (Brindley, Walti and Blaschke, 2009) mean that even though the research team disseminating the resource have achieved dissemination for awareness, “access to data does not automatically expand... knowledge; the availability of information does not intrinsically create an internal framework of ideas” (Dede, 1996; p.199). In other words, dissemination which results in changes to practice might require more than simply placing the resource in view of those that might use it. It might require some kind of social interaction to explain its purpose and possible use, and the provision of the opportunity for potential users of the resource to experience the cognitive conflict (Doise and Mugny, 1986) of discussing its application against the existing frameworks and ideas.

In conclusion, online dissemination has many advantages of cost and reach, but its key weakness is the limited opportunities for explication or clarification of the resource to its potential user base (Brindley, Walti and Blaschke, 2009). This in turn might have an impact upon whether the potential user chooses to use the resource and, if they do, how they use it. Similarly, dissemination by event has been argued in the literature to be a more effective means of communicating a research output to a target audience by permitting reflection upon its possible application (Louis, 1980) and enabling the adaptation process (King, 2003) but

the audience reached by this mode will be limited by the size and frequency of events (Klein and Gwaltney, 1994), which in turn will be restricted by resources, both financial and physical.

It is interesting to note that although recent institutional dissemination guidance (EU Horizon2020, 2014; World Health Organization, 2014) frequently recommends a bimodal approach of dissemination by dissemination event and online availability, nothing has been found in the existing literature which examines the possible interaction between these two modes. There are also no evaluations in the literature of how both of these modes might have been used to disseminate an innovation to in-service primary teachers and their relative effectiveness, a gap in the knowledge to which this study will contribute by addressing the research question below:

RQ1: What was the relative impact of online and face-to-face dissemination modes?

2.4 Disseminating research about assessment to primary practitioners

The successful dissemination of research outputs to in-service teachers might be desirable for academics seeking to influence practice, enhance the reputation of their institutions and progress in their careers. But when attempting to define the factors and mechanisms involved in the successful dissemination of a resource to in-service primary teachers to improve their assessment practice in primary science, we also need to consider the shifting conditions within which primary teachers work. This section of the literature review will briefly consider the status of primary science within the National Curriculum, changes to national assessment policy, the proliferation of routes into teaching and the variability of ITE. The design and purpose of the TAPS pyramid will be positioned within this shifting educational context, before the second research question will be specified.

2.4.1 Primary science: curriculum, assessment and status

Science has been taught as a core subject in the primary curriculum since 1989 (Parliamentary Office of Science and Technology, 2003). Teachers cover learning objectives for both subject knowledge and the development of practical scientific skills (Department for Education, 2013). The primary science curriculum is organised by year group and is taught in topics, with learning outcomes grouped by subject knowledge and scientific inquiry skills

(Department of Education, 2013). The groundbreaking research of Black and Wiliam (1998a; 2001) into the use of formative assessment led to the recognition that it was particularly applicable in the teaching of science (Black and Harrison, 2004; Hodgson and Pyle, 2010). This is partly because the skilful teaching of science involves establishing children's existing ideas and alternative frameworks for scientific concepts (Ollerenshaw and Ritchie, 1997), but also because the scientific process skills which are taught in primary science are hard to evaluate through written testing or written work alone. As such, they can be better observed when a child is engaged in scientific discussion or investigation (Nuffield Foundation, 2012; Harlen and Qualter 2014).

Previously, a pupil's progress in science was assessed using the levelling system (Task Group on Assessment and Testing, 1988) whereby teachers used best-fit statements to describe a pupil's progress at the end of a topic. There were also summative, high stakes national tests for all pupils at the end of their primary education. The ranking of schools' performance in these national tests for core subjects, at a school level and regional level, led to a focus upon preparing children to succeed at the written test of scientific knowledge (Harlen, 2008) however, and a reliance upon regular written testing to ascertain progress during the academic year (Assessment Reform Group, 2008). Concern about how the national tests were distorting coverage of the primary science curriculum (Tymms, Bolden and Merrell, 2008) and focusing on retention of facts rather than scientific understanding (POST, 2003) was expressed within a wider and ongoing debate about the extent to which national high-stakes testing captured a child's real understanding and ability (Wiliam, 2003; Wiliam, 2011). This culminated in the abolition of national testing for all Year 6 pupils in primary science in 2009.

The Wellcome Trust (2011; 2014) reported a consequent diminution in the status of primary science, with school leaders dedicating less teaching time to a subject which, although still described as core (Department for Education, 2013), was no longer subject to national testing. Funding and prioritisation within the curriculum were also negatively affected by this change in status (CaSE, 2014); indeed, the Chief Inspector of Ofsted has more recently expressed concern about the dominance of the other two core subjects in the primary curriculum and what she sees as the consequent reduction in time spent teaching science (Ofsted, 2018). This tension between the core status of science and the pressure felt by head teachers to demonstrate excellent performance in curriculum areas subject to national testing has led some to conclude that the priority given to primary science within a school's curriculum is

more dependent upon the enthusiasm of the head teacher or Science Subject Leader than the subject's core status (SCORE, 2013).

2.4.2 Current assessment policy and Initial Teacher Education (ITE) in assessment

Current assessment policy in state-maintained English primary schools requires that teachers use a range of formative assessment data to reach summative teacher-based judgments of progress (Department for Education, 2014; Commission for Assessment Without Levels, 2015), rather than the previous regime of teacher levelling according to best-fit statements (Task Group on Assessment and Testing, 1988). It has been argued previously that this type of assessment led to a closed pedagogy (Tymms, Merrell and Bolden 2008) and a conception of the class teacher as an executive technician, enacting protocols for pedagogy and assessment without understanding the theory which underpinned them (Winch, Oancea and Orchard, 2015).

The government's decision not to provide or endorse a national assessment framework to support this change in assessment practice, however, has meant that schools had to develop their own (Department for Education 2014). This has left school leaders with more autonomy than before to choose whether to prioritise improvements to assessment practice in primary science, and if so, what resources or guidance to refer to.

This lack of a central, mandated framework, coupled with the expectation that schools would find their own way, could be viewed as a recognition of teachers as reflective practitioners working in unique settings, capable of self-actualisation (van Veen, Zwart and Meirink, 2012), or as respecting the professionalism of teachers (Tierney, 2015). It should be noted, however, that there is limited evidence to support the notion that teachers are already using formative assessment strategies or teacher judgment competently in primary science (Hodgson, Pyle and Shamsan, 2009; Murphy et al., 2013). This might be because, over the past three decades, assessment of progress in primary science had previously been a centrally standardised process of levelling and written testing (Harlen, 2008). This has left many teachers deskilled in the area of forming a teacher judgement, and led to the skill of using teacher judgment from a range of sources to judge pupil progress being lost (Assessment Reform Group, 2008).

Thus, the success of this revised approach to assessing pupil progress in primary schools

relies upon the appropriate and informed deployment of formative assessment. The recent Carter Review of Initial Teacher Education (2015) questioned the assumption that teachers were thus prepared, however, demonstrating instead a variability of competency within ITE providers for teaching the theoretical and technical aspects of formative assessment. Specifically, gaps in teacher trainees' knowledge about the principles and purposes of formative assessment were, "the biggest weakness in the whole framework for initial teacher training" (ibid., p.9).

The Carter Review also highlighted the many routes into qualifying as a teacher, each with their bespoke provision of training in assessment (Whiting, 2016). Such proliferation of routes to qualification can lead to a non-standardised outcome in teacher formation. This can be further compounded by the various regulations and requirements to which a school must adhere, depending on its status as a state maintained school or private institution.

A plausible outcome of these issues is a teacher workforce containing diverse levels of assessment literacy and experience of using formative assessment to produce a teacher judgment of progress. Indeed, the need for teaching staff to receive professional development to improve their assessment skills has been noted by parliamentarians (House of Commons Education Committee, 2017). This recognition of need does not just include newly and recently qualified teachers who have pursued diverse training paths into teaching through institutions providing variable levels of initial teacher training in assessment, however. It also includes longer-serving in-service teachers, who learned to assess progress using the levelling systems described above and may need support to address the changing demands upon their role (Thurlings and den Brok, 2018).

2.4.3 The design and purpose of the TAPS pyramid

As discussed in section 1.2, the TAPS pyramid (see Figure 1) was produced as a visual, exemplified representation of the Nuffield Foundation's ideas about the flow of formative assessment data through a school (Davies et al., 2017). The Nuffield Foundation's original conception of the base of the pyramid being formed by "a wide range of assessment processes [to] provide a rich and extensive source of information on individual pupils' learning" (Nuffield Foundation 2012, p.21) has been exemplified as various formative assessment activities for class teachers and pupils to engage in during the teaching of primary science, also known as the *blue layers*. The *yellow layer* activities of the TAPS pyramid indicate how

that formative assessment data could be used to produce reliable summative judgements of pupil progress over time. The assessment activities in the *green layers* indicate how those judgements could be “collated at the level of class or whole school” (ibid.), and used to report internally and externally on pupil progress in the subject.

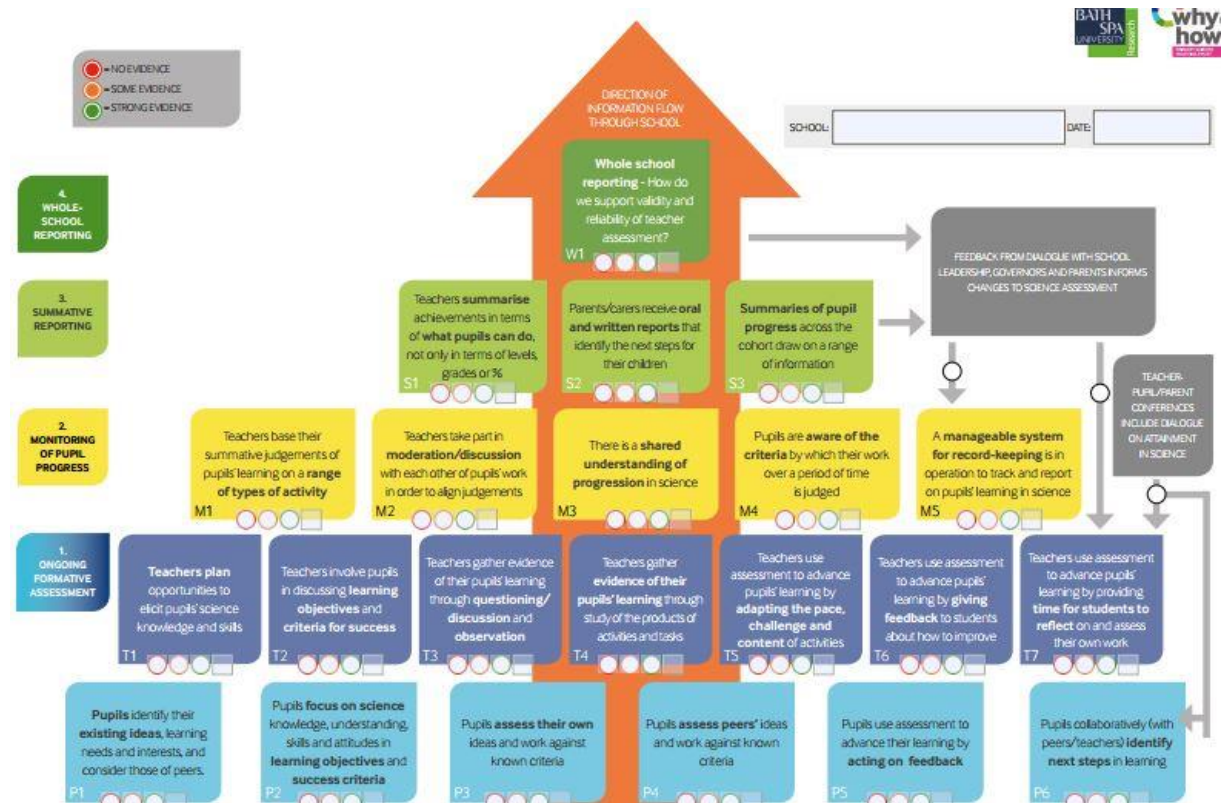


Fig. 1: The TAPS pyramid

As already seen, changes to assessment policy between the publishing of the Nuffield Group’s recommendations in 2012 and the public dissemination of the TAPS pyramid in 2016 meant that the previous centrally administered system for evaluating pupil progress in primary schools, known as levelling had been abolished. It could be argued therefore that the TAPS pyramid represents not only a guide to the various assessment activities which schools can engage in, but also an assessment framework for using teacher judgements to describe pupil progress which is in keeping with current assessment policy (Department for Education 2014).

The schools which were involved in the design and prototyping of the TAPS pyramid were known as the *project schools* and the teachers within them were supported by visits from a member of the TAPS project team (Earle et al., 2016) to interpret and enact the TAPS pyramid in their schools. The first phase of the project lasted for three years, during which the

project schools had a visiting tutor from the TAPS team who would periodically visit to find out how they were using prototypes of the TAPS pyramid and note the project school's feedback on its usability.

This iterative design process is reflected in the stated purpose of the TAPS pyramid, which has subtly changed over the lifecycle of the project. TAPS project literature initially suggests that the purpose of the TAPS pyramid is to operationalise the findings of the Nuffield working group, referring to it as a model of “best practice in science teacher assessment” (Davies et al., 2014; pp.21). The naming of the TAPS pyramid itself is as follows: “Analytical frame for case-study data (and whole school science assessment self-evaluation tool)”. This suggests it was first seen as a tool for the project team to use in conjunction with the project schools, although the reference to whole-school evaluation indicates the possible scope for its use by others outside of the project.

Half way through the project, the name of the pyramid is simplified to “Science assessment: school self-evaluation tool”, and it is described as:

“a whole-school self-evaluation tool ... to support schools in identifying strengths and weaknesses in their assessment systems and provide an exemplified model of good practice.” (Davies et al., 2015; pp.2)

The final publication of this phase of the TAPS project describes the TAPS pyramid as a “framework to support Science Subject Leaders in identifying areas for development in school assessment systems”; and a “structure to support school self-evaluation” (Earle et al., 2016, pp.2).

What emerges from this analysis is that there was more than one possible use for the TAPS pyramid in schools attempting to use it – post-levels assessment framework, exemplification of formative assessment strategies suitable for teaching science, whole-school evaluation tool - and no attempt on the part of the project team to impose one interpretation or usage upon those who engaged with it.

2.4.3.1 A resource with a fundamentally open character

The TAPS pyramid is therefore a resource which has several possible applications, such as a tool for evaluating formative assessment practice, a post-levels assessment framework or a

checklist of formative assessment strategies for class teachers to apply during teaching (Hopwood-Stephens 2018b). As such, it would be considered to be an object with a fundamentally open character (Nordholm, 2016).

To exemplify this, an example of an object related to science assessment that is closed in character could be the guidance booklet for teachers marking the Standard Assessment Test, or primary science SAT (Department for Education and Skills, 2008). This guidance booklet provides a list of allowable answers for each question, along with instructions on what type of answers to reject. It gives written instructions to the teacher about how to proceed with marking and how to calculate the final grade. It is intended to provide clear and unambiguous guidance that the primary school teacher can use to correctly mark the science SAT papers, without requiring further discussion or explication (Akkerman and Bakker, 2011). The TAPS pyramid, on the other hand, as a resource with a fundamentally open character requires some effort from the receiver to engage with it, and can be used in different ways to improve assessment practice.

Participant accounts of how the TAPS pyramid has been used within these project schools exist; amongst other uses, the TAPS pyramid has been used to develop teachers' moderation practice (Rodger, 2018); to judge pupil progress in working scientifically (Mepsted, 2018); and to develop teachers' assessment of pupil progress through assessed practical activities (Barber, 2018). However, the range of interpretations and uses that it has been put to in schools throughout the rest of the country is currently unknown. It should also be noted that the project schools received the support of the project team and attended development events to support its use, which may have influenced the project schools' interpretations and their decisions on how to implement it.

While this by no means invalidates their accounts, it is nevertheless the case that teachers and Science Subject Leads throughout the rest of the country did not receive this support. A study that explores how the TAPS pyramid has been interpreted and used beyond the project schools, and whether various user groups engaged with it differently, would therefore be a useful addition to knowledge. Furthermore, little is known about the use and impact of the assessment frameworks that were developed as a response to the government's change in assessment policy in 2014 (Department for Education, 2014). A study which evaluates the interpretation and impact upon practice of one such assessment framework would therefore be a useful addition to the literature.

For these reasons, RQ2 sets out to address the following question:

RQ2: How might a disseminated research output be interpreted and enacted by its users?

2.5 The role of workplace learning in the dissemination of research outputs

As we have seen, the TAPS pyramid is a resource designed in collaboration with practitioners to assist them with evaluating and improving assessment practice in primary science. It was disseminated by the research team via a bimodal strategy of online availability and presentations at dissemination events of various sizes. It could be used by individual teachers to identify gaps in practice, or at a whole school level to evaluate practice across the school or as a framework for meeting new assessment policy objectives. In each instance, its application to adjust some aspect of assessment practice would mean that dissemination for action, King's third level of dissemination activity, had been achieved.

Dissemination for action therefore requires a member of the target audience to adequately interpret and enact the content or messages of the resource that they have received.

Dissemination for action at a school level, however, requires the target audience member to take the resource into their school setting and persuade the school leadership to support its implementation in some form; the new knowledge would then need to be transferred effectively from the knowledge holder to her colleagues (Carlile, 2004).

This part of the literature review will focus on two key aspects of workplace learning for in-service teachers: the characteristics of staff meetings held to support professional development, and the characteristics of the wider workplace known to be supportive of professional development. This section will conclude with the third research question.

2.5.1 What makes a valuable workplace learning opportunity for in-service teachers?

There is a frequently expressed view within the literature that teachers learn from and with their peers (Desimone, 2009; Gassenheimer, 2013; van Veen, Zwart and Meirink, 2012; Yamtim and Wogwanwich, 2014); indeed, that teachers using each other as learning resources might be a preference which is stable over time (Hood, 1990). It is also known that teachers value new knowledge or innovations that help them to address issues which are relevant to them and their situation (Hemsley-Brown and Sharp, 2003; Vanderlinde and van Braak, 2017), and changes to practice can result from situated, relevant and reflective learning

experiences (Winch, Oancea and Orchard, 2015; Desforges, 1995), whereby knowledge *of* practice is augmented by the application of this new knowledge, resulting in knowledge gained *in* practice (Cochran-Smith and Lyttle, 1999). We might thus construe teacher learning as primarily a work activity with learning as a by-product (Eraut 2007).

A review of the literature on primary (or equivalent age-range) teachers changing their pedagogical or assessment practice in primary science shares this assumption that learning is a socially constructed activity which takes place between minds as well as within them (Littleton and Mercer, 2013); social learning activities such as reflective discussion (Hondrich et al., 2015; Serret et al., 2017), small group work (Davies et al., 2017), interactive teaching (Buczynski and Hansen, 2010) and collaborative planning (McNew-Birren and van den Kieboom, 2017) are provided as a key part of the intervention. Furthermore, Smith (2011) notes that attempts to change assessment practice have the biggest impact upon school assessment culture when the criteria for good assessment practice are discussed, defined and agreed by the whole staff.

Taken with what is already known about teachers' preferences for learning from and with each other, this indicates that dissemination for action amongst a group of teaching professionals intent upon changing their assessment practice would include some aspect of social learning opportunity. But, despite the fact that "a significant proportion of teacher learning occurs through collaborative interactions with others" (Hodkinson and Hodkinson 2005, p116), and teachers' participation in collaborative activities is recognised as having a positive effect upon morale and teaching practice (Bolam et al. 2005), teaching can nevertheless be considered an isolated profession with scant opportunity for group learning (Little, 2003; DuFour 2004).

2.5.2 Communities of practice: a model for incidental learning

The Communities of Practice (CoP) concept for workplace learning (Lave and Wenger, 1991) might seem appropriate to this study; after all, teaching colleagues attempting to improve their assessment practice through their engagement with the TAPS pyramid can be said to share a domain of interest, to be members of a community and to be practitioners of the same profession (Lave, 1991). There are some reasons why this model is inapplicable, however, which are outlined below.

The first problem is that learning for the participants in a CoP is incidental, with learning being either “the reason the community comes together or an incidental outcome of members’ interactions” (Wenger-Trayner and Wenger-Trayner, 2015, p.2) Furthermore, Lave (1991) suggests that the structure, purpose and frequency of meeting for CoPs can be *ad hoc*, adding that “no one sets out to inculcate [knowledge] into a group of learners” (p. 71); indeed, CoPs may form with no desire to change practice or norms, and no shared concern for improvement (McLaughlin and Talbert, 2006). This study is looking at the purposeful effort of teachers to change their assessment practice, and while some members of staff at a school will be more motivated than others, the idea of the learning being incidental to their efforts rather than a key aim is problematic.

The CoP model also assumes that all newcomers to a group are novices with no experience, and that the longer serving staff have mastered the knowledgeable skills (Lave, 1991) required. Given the relative isolation within which teachers work, and Lave’s own view that teachers’ skills have been decomposed the point of meaninglessness (ibid.) an argument could be made that there is neither opportunity for teachers to learn through observation of longer-serving staff, nor any clearly defined set of knowledgeable skills for the newcomers to learn. Teacher workforces are also diverse in age, training and skills acquisition, especially in the face of regularly changing assessment policy and guidelines (Department for Education, 2014) and the new and recently trained arrivals to a staffroom may already have the skills that the other longer-serving staff need (Hodkinson and Hodkinson, 2003).

2.5.3 Purposeful teacher learning and the staff meeting

A model for purposeful teacher learning is therefore required, which takes account of the format within which teachers often learn. Professional development of teachers in English mainstream primaries typically takes place through In-service Training (INSET) days, or staff meetings. Staff meetings tend to be held on a weekly basis with all teachers attending, and cover a mix of matters relating to administration and practice. Staff meetings can be an effective forum for sharing ideas and learning, but the effectiveness of meetings can be affected by factors such as: the limited communication skills of the meeting leader (Klein 2005); a fixed agenda which is not responsive to teachers’ concerns (Lotriet 2017); or using the time to discuss administrative matters instead of aspects of teacher practice (Keeble 2016).

Teacher learning is of critical concern to school leaders, however, because they increasingly find themselves held accountable for the development of in-service teachers' skills to meet the changing demands of the teaching profession (Department for Education, 2014). Recent changes to school funding in England have also resulted in many schools receiving less money than previously, which in turn has reduced the budget available for professional development. This has led to reduced access to external training, and more in-house alternatives for teacher development (Teacher Development Trust, 2017).

2.5.4 Meetings that support teachers' professional learning: the PLC model

It is well known that regular meetings of teaching staff can be highly beneficial to the development of practice when there are opportunities for reflection, discussion of practice, collaboration and a focus on improvement of learning outcomes for students (DuFour 2004; Feger and Arruda, 2008). The characteristics of effective staff meetings with professional development as an outcome have been identified in the literature on professional learning communities, or PLCs, within schools. Newman (1996) defined an effective PLC within a school setting as having the following characteristics: shared values and norms; a clear and consistent focus on student learning; reflective dialogue; a focus on collaboration; and deprivatisation of practice. The use of PLCs to develop the practice of teaching staff is well researched (see Stoll et al. 2006) and can lead to improvements in teacher practice and student outcomes.

The characteristics of an effective PLC meeting are considered to be:

- Shared values and norms
- A focus on collaboration
- A clear and consistent focus on student learning
- Reflective dialogue between teachers about curriculum, instruction and student development
- Deprivatisation of practice

(Vescio, Ross and Adams, 2007).

However, the effectiveness of a PLC or PLC-like meeting between teachers will be limited by their members' horizons of observation (Little, 2003); the communication and interpersonal

skills of those attending; the skills of those facilitating the exchanges between those attending (Wood 2007); and the extent to which there is a supportive atmosphere and an inclusive process (Graham 2007).

Cornerstone research into using formative assessment to improve teaching and learning in primary schools (Black and Wiliam, 1998a; Black and Wiliam, 2001) has been applied successfully to the assessment of primary science (Black and Harrison, 2004). While the researchers do not mandate a PLC to assist in the ongoing development of teachers' assessment literacy, the need for one is implied (*italics added by author*):

“Those taking on the development of formative assessment need to *work in a team*. That team must *have a plan*.... The team must have *support from the faculty and/or the school*. The team must be helped to *find time to talk with one another* at length, to *share experiences, successes and disappointments*...they should also have *access to outside advice*.” (Black and Harrison, 2004, p.20)

Each characteristic of the effective PLC, as defined by Vescio, Ross and Adams (2007) above, is contained in this recommendation. It therefore follows that the nature and format of the staff meetings that are held to support teachers' professional learning in primary science assessment might affect the learning that takes place within them. The model of the PLC to support teacher learning will be returned to as a conceptual framework in the Methodology chapter of this thesis.

2.5.5 Workplace characteristics as an influence on professional learning

It is already acknowledged in the literature that the learning which might take place within the school as a workplace can be influenced by many factors, including the learning opportunities or affordances made available to employees in the first place (Billett, 2001), the learning dispositions of the teaching staff which might influence how they respond to the opportunities made available (Hodkinson and Hodkinson, 2003) and individual teachers' beliefs about their role and responsibilities (Gamlem, 2015). It is also the case that workplace norms and expectations can shape an individual teacher's decisions about work and their assumptions of autonomy (Nias, Southworth and Yeomans, 1989). The facilitation of collaboration and autonomy in decision making are frequently identified in the literature on organisational learning (Senge, 1990; Hord, 1997) as enabling factors for workplace learning. This has led to

the characteristics of the workplace itself, as a place that inhibits or encourages professional learning, being defined as expansive or restrictive (Fuller and Unwin 2004). This model has been further refined for application to schools as workplaces within specific characteristics, which will be explored in more detail below.

2.5.6 Teacher learning and expansive workplace characteristics

Attention has been paid by researchers in organisational and managerial science to the qualities or characteristics of the organisation within which an individual works and the extent to which it enables or inhibits learning (Senge, 1990; Billett, 2001; Kools and Stoll, 2016). Within this sits the cornerstone research of Fuller and Unwin (2004) who defined approaches to workforce development through the *expansive–restrictive continuum*. This listed twenty characteristics of workplaces which, depending on whether the employee experienced the expansive or restrictive end, would enable or inhibit professional development. The continuum included aspects of workplace learning such as technical skills being widely distributed or polarised; workplace learning envisaged as part of career development or static; innovation important or unimportant; and cross-boundary communication encouraged or discouraged. These continua were reviewed and refined by Hodkinson and Hodkinson (2005), following their extensive research into workplace learning for teachers. They argued that schools, as the workplaces within which teachers learned, had specific expansive and restrictive characteristics and created ten expansive-restrictive workplace continua from Fuller and Unwin’s original list (Table 1).

Expansive	Restrictive
Close collaborative working	Isolated, individualist working
Colleagues mutually supportive in enhancing teacher learning	Colleagues obstruct or do not support each others’ learning
An explicit focus on teacher learning, as a dimension of normal working practices	No explicit focus on teacher learning, except to meet crises or imposed initiatives
Supported opportunities for personal development that goes beyond school or government priorities	Teacher learning mainly strategic compliance with government or school agendas
Out of school educational opportunities including time to stand back, reflect and think differently	Few out of school educational opportunities; only narrow, short training programmes
Opportunities to integrate off the job learning into everyday practice	No opportunity to integrate off the job learning
Opportunities to participate in more than one working group	Work restricted to home departmental teams within one school
Opportunity to extend professional identity through boundary crossing into other departments, school activities, schools and beyond	Opportunities for boundary crossing only come with a job change
Support for local variation in ways of working and learning for teachers and work groups	Standardised approaches to teacher learning are prescribed and imposed
Teachers use a wide range of learning approaches	Teachers use a narrow range of learning approaches

Table 1: expansive-restrictive continua for schools (Hodkinson and Hodkinson, 2005; p.124)

In their analysis, they noted teachers' limited opportunities to reflect upon and discuss practice, due in part to teaching workloads, but also to a restrictive organisational structure within schools which inhibited rather than enabled opportunities for teacher learning. Their criteria for schools as expansive workplaces map closely to those of Fuller and Unwin, with an additional emphasis on: collaborative working; a mutually supportive learning atmosphere; and a focus on teacher learning as part of normal working practice. Conversely, a restrictive workplace for teachers could involve: isolated working conditions; limited opportunities to develop skills and work with others; and no ethos of professional learning for teachers.

Of course, there are other reasons why initiatives to change teacher practice sometimes fail; the initiatives might be blocked by the teachers themselves who remain unpersuaded of their merit (Terhart 2013) or by staffing hierarchies which inhibit changes to practice (Nawab 2017). And as we have seen, the quality and structure of the designated learning activities that take place to support the teachers' adoption of a new initiative could reasonably be expected to play a role in its successful implementation.

But the nature of the workplace itself might encourage or inhibit professional learning among in-service teachers, by not only enabling or restricting certain activities conducive to learning, or influencing the provision or content of the learning activities. Although Hodkinson and Hodkinson's (2005) expansive workplace framework would seem relevant to the study what factors influence whole-school changes to assessment practice among English primary school teachers, nothing can be found in the current literature which examines the role of the expansive workplace in the adoption of new frameworks or initiatives among primary teachers.

As explained in section 2.5.3, it is also the case that many school leaders deliver professional development to their teachers through staff meetings. There is a need, therefore, to clarify the staff meeting characteristics which might contribute to a whole-school change in assessment practice. This in turn would furnish a greater understanding of what dissemination for action entails within a primary school.

RQ3 of this study has therefore been derived from these identified gaps in knowledge:

RQ3: In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

2.6 Achieving dissemination for action within the setting of the primary school

As previously discussed, the third level of dissemination of innovations for use by in-service practitioners is dissemination for action (King, 2003). The target audience has been reached; the innovation has been presented in a sufficiently interactive way for the end user to interpret its purpose and possible use(s); the innovation is taken away and enacted in some way which changes practice (Fincher, 2000). In some dissemination strategies, such as informing teachers about the requirements of the Prevent programme (HM Government, 2015), once the members of the target audience have the information they need to understand the aims of the programme and apply the protocol correctly, the dissemination is complete.

But in the case of the TAPS pyramid, the target audience for dissemination is not necessarily the end point for the dissemination process; that person in the audience could then choose to disseminate the knowledge contained in the resource amongst her colleagues within a school. It therefore follows that the achievement of dissemination for action in this circumstance is dependent to at least some extent upon the skills of the Science Subject Lead (SSL) as they articulate the benefits of changing assessment practice in accordance with their interpretation of the TAPS pyramid's contents.

In the following section of the literature review, therefore, the concept of knowledge transfer (Argote et al. 2000) will be introduced to explore what dissemination for action entails. Key ideas from the field of knowledge transfer within organisations will be drawn upon as possible mechanisms to explain the successful transfer of new knowledge between colleagues within a work setting (Aalbers et al., 2013; Carlile, 2002; 2004). A model for exploring the type of communication between colleagues attempting to change their practice through social learning will be considered (Harris and Nelson, 2008), as well as the currently specified responsibilities of the Science Subject Lead in bringing innovative practice about assessment to her colleagues. A research question to address the gaps in knowledge identified at the end of this section will be given.

2.6.1 Knowledge transfer

Knowledge transfer is a concept originating in organisational learning theory (Argote et al., 2000; Argote and Ingram, 2002). It seeks to explain how new information, sometimes referred to as an *object*, is communicated from one person or group to another person or group,

sometimes referred to as *actors*. There is a wealth of research upon knowledge transfer between actors at the intra-organisational and inter-organisational level (Swart et al., 2014; Baumfield and Butterworth, 2007), looking at knowledge transfer either from the procedural standpoint, such as how it takes place (Carlile, 2002), or from a structural standpoint, such as what factors within an organisation or place of work might enable or inhibit knowledge transfer processes (Sveiby and Simons, 2002).

2.6.2 Knowledge transfer: defining the boundary and the process

In order to transfer their new knowledge effectively, the actor will need to do two things: firstly, define the knowledge boundary that exists between them and the person or group that they are trying to transfer their knowledge to (Akkerman and Bakker, 2011), and secondly, use a transfer process which is appropriate to the boundary type. Carlile (2004) specified three boundary types, each increasing in complexity. If the knowledge could be passed across the boundary from one actor to another, without recourse to explication or new language to explain the concepts and ideas contained, then the boundary type was *syntactic*, and the process required to pass the knowledge over was a *transfer*.

If, however, the novelty of the knowledge being transferred is high, it may not only require explication and the development of a shared lexicon to articulate and describe it, but the relinquishing of existing knowledge which is invested in current practice. Transferring new knowledge across a pragmatic boundary is clearly the most challenging, and yet this might be the boundary type encountered by an SSL who is attempting to persuade her head teacher or colleagues to use formative assessment strategies to form a teacher judgment of progress against a backdrop of low assessment literacy (Carter Review, 2015), limited access to training (Richardson, 2017) and a subject with a diminished status in both the school and national curriculum (Wellcome Trust, 2011). This explains Valente and Davis' (1999) view that researchers will get the best results when their innovations are aimed at a target audience comprised of articulate people who exert sufficient social influence and authority to spread them amongst their peers.

An interesting link can be made here between what Nordholm (2016) calls a formal broker and what Louis (1980) calls a linking agent; both are actors with detailed knowledge about something which they wish to transfer to others. As such, another link can be made between this concept in the literature on dissemination and the literature on organisational learning

theory, and the teacher formatively assessing the knowledge among her pupils before and during science instruction (Hodgson and Pyle, 2010), or the SSL considering how to best present and explain the TAPS pyramid to her colleagues. In each of these roles, the actor is assessing the understanding and knowledge present among their audience in order to articulate the purpose and value of the new knowledge that they hold. The more accurate their evaluation of the knowledge boundary and the more appropriate their choice of transfer mechanism (Carlile, 2002; 2004), the more likely it is that the audience for this new knowledge will be able to understand and receive it.

It is therefore worth considering the assumed role and skills of the SSL in the final stage of dissemination, when the knowledge she holds is transferred from her to her colleagues.

2.6.3 Knowledge transfer and the role of the Science Subject Lead (SSL)

A review of the guidance for SSLs in English primary schools shows that the ability to formatively assess the assessment literacy of their colleagues and devise appropriate interventions to develop their knowledge has not been explicitly identified as their responsibility. In 2001, the Department for Education and Skills produced a Subject Leader Appendix to the Teachers' Standards Framework (Department for Education and Skills, 2001) which expected all subject leads, irrespective of the curriculum area, to "Evaluate the teaching of the subject in the school [and] use this analysis to identify effective practice in and areas for improvement and take action to improve further the quality of teaching". (ibid., p.2). No explicit mention of formative assessment is made anywhere in this document, nor the Subject Lead's responsibility (or otherwise) for its effective use among teaching staff of any subject.

In science-specific guidance produced by education trusts, it is recommended that the SSL should have a secure understanding of both formative and summative assessment practices for primary science, as well as advocating for their subject (Wellcome Trust, 2010). More recently, however, Ofsted opined that "there was plenty of management, including of resources, but not enough leadership of the subject [of primary science]." (Ofsted, 2013: p.22), which implies that the Wellcome Trust's recommendations are not being fulfilled by all SSLs. As such, the role of the SSL as the person responsible within a school for the evaluation of assessment practice and the design of suitable interventions to develop her colleagues' assessment literacy is not made explicit in governmental guidance. Nor is it made obvious that the SSL has a specific responsibility to bring innovative practice in the field of

primary science to her school.

Unsurprisingly, the development of a SSL's subject knowledge and subject leadership skills through high quality professional development is widely advocated (see Wellcome Trust, 2014). Her access to this training might be limited by the reduced funding available for science (SCORE, 2013), however, and further exacerbated by ongoing cuts to school funding (Richardson, 2017) which in turn have severely curtailed the training and development opportunities for her colleagues. It is plausible that, within schools where there is little money to go around, the SSL has become a *de facto* leader of professional development for the subject of science without having benefited from subject-specific training which allows her to execute this role effectively, or without them possessing the requisite skills to evaluate and assist the professional development of others in the subject.

It is of interest, therefore, to identify the ways in which the SSL might support her colleagues' professional development regarding the schoolwide enactment of TAPS pyramid, and equally, what her colleagues feel had been done to help them. The specific role played by SSLs in schools where this resource has reportedly been implemented at a school level are not yet known, however.

2.6.4 Knowledge transfer and the role of formal and informal contacts

The role of workplace characteristics (see section 2.5.6) and staff meetings (see section 2.5.4) in the successful dissemination of new ideas about assessment practice in primary science have already been considered as possible factors in achieving dissemination for action within the walls of a primary school. But, when considering the learning opportunities that might be available to a teacher attempting to change their practice, it is important to also consider the spontaneous contacts that arise between colleagues as well as the formal contacts which are mandated by their job role.

Aalbers, Dolfsma and Koppius (2013; 2014) have investigated the role of social contacts between employees in the successful intra-organisational transfer of innovative knowledge. These social contacts were categorised as informal, such as those that arise spontaneously between colleagues, and formal, such as contacts that are mandated by job role and responsibilities (Adler and Borys, 1996). They claimed that innovative knowledge is best

transferred between individuals in an organisation where frequent contacts of an informal and a formal nature exist, because colleagues who enjoyed frequent informal contacts with each other exchanged more information, from a wider range of sources, with more people (Soda and Zaheer, 2012), leading to a higher level of reliability of information and a clearer understanding of expectations (Aalbers, Dolfmsa and Koppius, 2013). This in turn led to greater innovativeness within the organisation (Hansen, Mors and Loras 2005) and trust between individuals, a factor which has been identified elsewhere in the literature as crucial to effective collaboration between teachers and principals in US schools (Tschannen-Moran, 2000).

The schools in this particular study are based in England, however, and their workplace cultural norms might differ from those of a business organisation (Aalbers et al., 2014) let alone their characteristics as workplaces as specified by Hodkinson and Hodkinson (2005). Evidence that teachers engage in both formal and informal contacts with each other can be found in the literature (see Nias, Southworth and Yeomans, 1989; Gassenheimer, 2013; Hodkinson and Hodkinson, 2003), but it is not known whether teachers need access to each other's knowledge through informal contacts as well as the mandated learning opportunity of the staff meeting when schoolwide changes to practice are attempted. Applying the concept of formal and informal contacts in the transfer of new knowledge about assessment among primary school colleagues would expand our existing understanding of the mechanisms of achieving dissemination for action, making a useful addition to the literature. As such, the role of informal contacts in the transfer of new knowledge about assessment practice in primary science will be returned as a conceptual lens in Chapter 3.

2.6.5 Knowledge transfer and communication style

The literature upon formal and informal contacts stops short of defining the nature of the communication itself, however; what is the style of communication within those different types of contact, and how might that be linked to the quality of the learning that takes place within it? One way of investigating this is to consider the communication style of the formal and informal contacts that are held between teachers attempting to change their primary science assessment practice in some way.

Harris and Nelson (2008) have defined three styles of communication: linear, interactional

and transactional. Linear communication entails a sender passing information to a receiver without there being a feedback loop which lets the receiver indicate if they understand, disagree or have anything else to add. As such, linear communication is often viewed as representing a power imbalance between the sender and receiver (Gavi, 2013). Interactive communication is a two-directional style of communication as it involves feedback from the actor receiving the information and may result in additional clarification or exemplification from the actor sending it (Schneider and Arnot, 2017).

Transactional communication, on the other hand, is “complex, dynamic, irreversible, ongoing, contextual and simultaneous” (Harris and Nelson, 2008, p.17) This style of communication not only allows the receivers of the new information to challenge, query or add to it, as with interactive communication, but it also equals the power imbalance inherent in linear communication (and somewhat evident in interactional communication) by permitting all actors to play the role of sender and receiver simultaneously. Furthermore, it assumes that situations are dynamic and changing, and that communication between actors continues over time (Barnlund, 1970).

This communication model has been applied successfully to understand the nature and effectiveness of communication between schools and the wider community in the UK (see Schneider and Arnot, 2017), but it has not yet been applied to the categorisation of the communication experienced within schools between the teachers themselves, or within the learning opportunities that they received to support the development of their assessment practice. Its application to the study of communication between teachers attempting to change their practice would make a useful contribution to knowledge, and as such it will be returned to in Chapter 3 as a conceptual framework for the research.

This final section of the literature review has considered the literature on knowledge transfer with particular regard to how dissemination for action might be achieved within a primary school. The role of the SSL has also been shown to be potentially instrumental to the success of this process; as such it would be helpful to examine this role with specific reference to the internal dissemination of the TAPS pyramid within primary school settings. The format and nature of the communication that takes place between colleagues during learning opportunities has also been identified as a possible influence upon learning, suggesting that the identification of learning opportunities provided with reference to the TAPS pyramid, as well as teachers’ perceptions of their value in relation to changing assessment practice, would

be a useful addition to knowledge. The final research question is therefore as follows:

RQ4: How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?

2.7 Research questions

Four research questions have been specified, with reference to gaps in the existing knowledge, throughout the literature review. They are specified in full below, with their associated sub-questions which address the four main research questions within the specific context of the TAPS pyramid's dissemination.

RQ1: *What was the relative impact of online and face-to-face dissemination modes?*

1a) What was the relative impact of each dissemination mode used for the TAPS pyramid?

1b) What evidence is there for one dissemination mode influencing another?

RQ2: *How might a disseminated research output be interpreted and enacted by its users?*

2a) How has the TAPS pyramid been interpreted?

2b) Does dissemination mode make a difference to interpretation?

2c) What impact has the TAPS pyramid had upon the assessment practice of those using it?

2d) What evidence is there in the data for the practice of different user groups being influenced differently?

RQ3: *In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?*

3a) Do specific meeting characteristics play a role in school-wide implementation of the TAPS pyramid, and if so, what are they?

3b) Do specific workplace characteristics play a role in the schoolwide implementation of the TAPS pyramid, and if so, what are they?

3c) What other factors, if any, are significantly linked to reports of the TAPS pyramid being implemented at an individual or schoolwide level?

RQ4: *How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?*

4a) What opportunities to learn about assessment practice with a colleague or group of colleagues are identified by participants in the case study schools?

4b) How do participants value these learning opportunities, and to what extent are these perceptions common within and between cases, and within and between job roles?

4c) What is the nature of communication between colleagues during these learning opportunities?

4d) What sources of information and guidance are named by the participants in the case study schools for innovative approaches to assessment in primary science? Do they differ between roles?

2.8 Chapter summary

This literature review has situated the study within a sociocultural paradigm and a model for the dissemination of research outputs has been discussed (King, 2003) both with specific reference to the dissemination of the TAPS pyramid but also the need to elaborate the specifications contained within it for achieving dissemination for action. The importance of dissemination of research outputs to project teams wishing to share their findings has been demonstrated, but also the lack of knowledge as to the relative effectiveness of two commonly used dissemination strategies: dissemination by online availability and dissemination by event, has also been shown.

It has explored the ways in which professional development for in-service teachers is necessary to accommodate changing expectations and demands of the role, including responding to the recent changes in assessment policy which require the provision of teacher judgments of progress based on a range of formative assessment data. The lack of empirical knowledge about how the TAPS pyramid has been interpreted and used, nor of its impact upon assessment practice, has been highlighted. It has also outlined some of the reasons why schools are increasingly providing teacher training in-house and in doing so has considered the possible importance of the structure and characteristics of those meetings. The wider workplace within which teachers operate and its possible expansive or restrictive nature has also been considered as a possible influence upon school-wide changes to practice, but

attention has been drawn to the lack of published research which explores the role and significance of staff meetings and workplace characteristics upon the school-wide adoption of new assessment practice.

Conceptual links have been demonstrated between the practice of formative assessment and the practice of effective knowledge transfer. The role of the SSL in achieving dissemination for action within a primary school for research innovations has also been considered, especially in terms of her skills of evaluating existing knowledge and articulating new ideas to her colleagues. An argument has been made for the application of related, and yet hitherto unapplied, concepts from organisational learning theory to explore and specify the mechanisms of dissemination for action, namely the role of formal and informal contacts in knowledge transfer. A lack of knowledge within the literature has been identified as regards the nature of the communication within the formal and informal contacts shared between colleagues attempting to change their assessment practice within a primary school.

As such, a cumulative warrant has been provided for this research study, which will investigate all of these aspects by answering the research questions in section 2.7. As such, the findings will be of relevance to academic research teams intent upon achieving dissemination for action for their resource, but also for school leaders wishing to enable in-house professional learning amongst their staff.

2.9 Outline of the next chapter

In the following chapter, the methodology and theoretical framework for the study will be outlined. A rationale for selecting a mixed methods design, and for locating the study within sociocultural theories of learning, will be given. The structure of the study will be justified and the theoretical framework will be explained. The conceptual frameworks which have been used in each step will be introduced to the reader and a rationale for their selection will be provided. A summary of the data collection methods will be given, along with a guide to the research question(s) addressed by each step of this three-part study.

3 Methodology

3.0 Introduction

In the previous chapter, a warrant for the research was established through the review of relevant literature and four research questions were identified which the design of this three-part study will address. This chapter of the thesis will provide a rationale for choosing a mixed methods design as well as explaining why an explanatory sequential mixed methods model (Creswell, 2013) has been employed. The validity and reliability of the data will be considered with reference to the design. The study will be located within a sociocultural perspective upon learning and the theoretical framework will be explained. A rationale will also be provided for the conceptual frameworks that have been selected at each step of this three-part study.

3.1 Paradigm and approach

Ontologically, this research has been conducted according to the assumption that reality is socially constructed through the activities and communications of social subjects (Gardner and Coombs, 2009), who interact on an intramental, social plane and then internalise their experiences upon an intermental, psychological plane (Scott and Palincsar, 2013).

Epistemologically, the assumption has been made that an individual's perceptions and experiences can best be understood through attempting to understand the settings within which these interactions take place (Wertsch, 1991) as well as those individuals' descriptions of lived experience (Watts, 2014).

Rather than seeking to demonstrate an ultimate truth, therefore, this study will explore and demonstrate the different interpretations and uses of a research output within the complex social context of a primary school, while increasing our understanding of the underlying factors which can enable or hinder in-service primary teachers' changes to science assessment practice. As such, this research draws upon sociocultural theories of learning (Vygotsky, 1978; Wegerif, Mercer and Dawes, 1998) within an interpretivist paradigm.

In order to answer the research questions with appropriate depth and rigour, a pluralistic approach to discovering new knowledge (Tashakkori and Teddlie, 2010) will be taken, encompassing evaluation, survey and case study within a mixed methods design. The rationale for this decision is given below.

3.2 Research Design

Traditionally, educational research has been conducted within a qualitative or quantitative design, with “quantitative involving only numbers, [and] qualitative involving anything else” (Symonds and Gorard, 2008, p.1). Each design had its own rules about the methods and analyses appropriate to it, and each had its advantages and limitations. Yates (2004) recognises that qualitative data collection and analysis can provide a detailed description of an individual’s experience and understanding of an aspect of their social world, while also exploring the ambiguity and complexity of subjective experience by looking at “why things are happening, rather than how often” (Yates, 2004, p.138). Qualitative interviewing, a commonly used method within case study, also provides a rich archive of descriptive material drawn from a participant’s reality (Newby, 2014). This would be of great value to this study’s aims of understanding how the TAPS pyramid has been interpreted and enacted, as well as exploring the subtle differences between teachers’ perceptions and beliefs.

Another aim of this study, however, is an evaluation of the effectiveness of the dissemination strategy for the TAPS pyramid, which in turn relies upon the aggregation of disparate sets of numerical and spatial data. A qualitative approach to collecting these data would be inefficient at best and incomplete at worst. A qualitative approach to analysing these data would be equally absurd, given that an effective analysis would entail the calculation, comparison and ranking of numerical values (Field, 2015). Equally, the collection of as much data about interpretation and use of the TAPS pyramid, from as many users as possible, is best achieved through the collection of closed survey data (Bryman, 2015) which can be quantified and subjected to rigorous statistical testing. Hence, the collection of quantitative data is also required.

But a purely quantitative approach would be equally insufficient to the task of answering the research questions as a purely qualitative one, as there would be no qualitative data to provide a deeper understanding of the human motivations and reasoning which underpinned the seemingly significant patterns in the quantitative analyses.

In the face of the clear inadequacy of a purely qualitative or purely quantitative design, we might conclude that “the opposition (not the distinction) between quantitative and qualitative research is mistaken” (Pring, 2003, p.55); indeed, that pursuing a single method design would amount to “methodolatry” (Curt, 1994) and result in an inadequate analysis based on limited

data. For these reasons, a mixed methods design, which “combines elements of qualitative and quantitative research approaches...for the broad purpose of breadth and depth of understanding” (Johnson, Onwuegbuzie and Turner, 2007; p.118) has been selected. Such a design can result in enriched understanding by allowing a methodological flexibility to select methods to serve the research questions.

3.2.1 Explanatory Sequential Mixed Methods Design

The consideration of the requirements listed above has led to the selection of the explanatory sequential mixed methods (ESMM) research design (Creswell, 2013). The ESMM research design entails the collection of both quantitative and qualitative data.

Specifically, ESMM entails an initial, large collection of quantitative data which are analysed to provide a general picture of the issue being investigated and also pointers for the next step of the research, before a further, smaller collection of qualitative data is made to provide further detail including a richer contextual understanding of the initial analysis (Creswell and Plano Clark, 2008). The participant sample for the qualitative data collection is drawn from the same pool as the sample for the quantitative data collection, thereby ensuring continuity between findings. This design would illuminate the overall quantitative findings to: “penetrate situations in ways that are not always susceptible to numerical analysis” (Cohen, Manion and Morrison, 2000, p.181) while permitting a degree of triangulation of the findings across both databases (Morse, 1991).

Figure 2 below provides a visual model for the flow of research activities in an explanatory sequential mixed methods design, using mixed methods notation (Tashakkori and Teddlie, 1998).

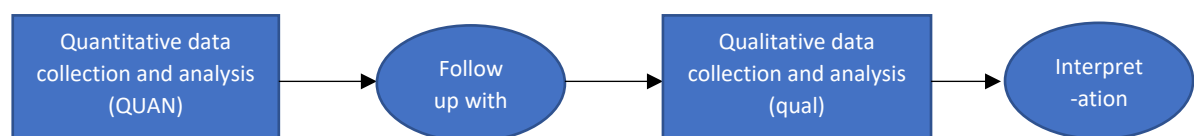


Fig. 2: The flow of research activities in an Explanatory Sequential Mixed Methods design, using mixed methods notation (after Tashakkori and Teddlie, 1998)

The upper case ‘QUAN’ indicates the greater role that the larger sample of quantitative data will play in an ESMM research project, and the lower case ‘qual’ shows that the qualitative sample of data will be smaller. Its equal importance in reaching a deeper understanding of the quantitative data is shown by the equivalent size of the shape in the research sequence,

however (Creswell, 2013).

Following the ESMM design allows for triangulation, thus increasing the validity of the conclusions drawn by comparing different perspectives and also minimising the inherent bias in each method (Greene, Caracelli and Graham, 1989). It also permits a macro to micro approach to constructing understanding (Layder, 1993). This is appropriate to the increasing granularity of the research questions, which range from information about where the TAPS pyramid has been downloaded, to generalisations about use and impact, to specific and nuanced details of individuals' perceptions and the characteristics of school settings.

Thus, RQ1, which seeks to evaluate the relative effectiveness of two commonly used modes of dissemination for educational research outputs can be addressed through the analysis of numerical and spatial data sets, and any patterns identified can be reported with confidence following the application of statistical models to check for significance. Equally, RQs 2 and 3, which aim to identify trends in the interpretation and use of the TAPS pyramid, as well as factors significantly linked to reports of whole school use, can be addressed through the rigorous statistical analysis of quantitative data, and findings can be reported with confidence of their significance. RQ4, however, which seeks to uncover and specify the nature and patterns of communication between colleagues in a primary school setting, can be addressed far more fully through the collection and analysis of qualitative interview data, wherein the participants are invited to reflect upon their experiences and share their perceptions. This will result in a fuller understanding of the process of dissemination, but also the human as well as mechanical factors involved in achieving dissemination for action (King, 2003), which is arguably the ultimate goal of research teams attempting to influence the practice of in-service teachers.

Figure 3 represents the flow of research activities for this study, within an explanatory sequential mixed methods design.

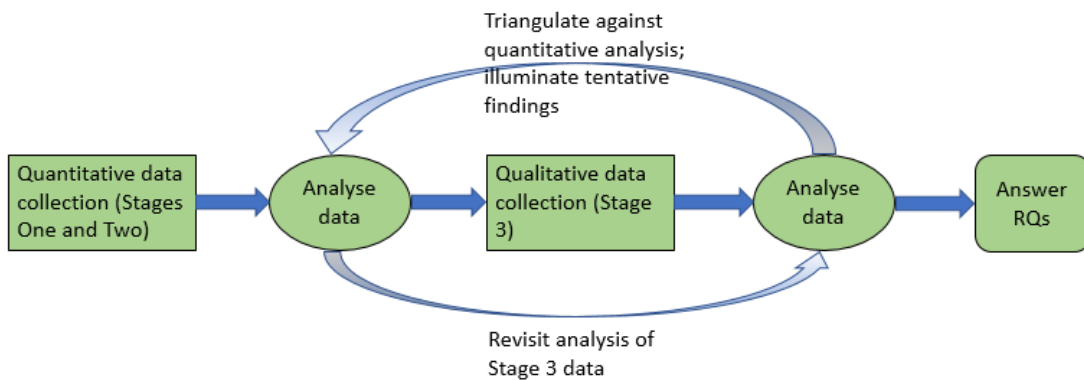


Fig.3: diagram to show research activities in this three-part research study

3.2.2 Rationale for using an ESMM design

It is, of course, possible to conduct a mixed methods research study in the opposite order, collecting the qualitative data first and using the outcomes of that analysis to inform the aims of the quantitative data collection (Creswell, 2013). However, such a design would not allow the formulation of interview questions which were informed by the outcomes of the users' survey, nor enable the solicitation of volunteers for the case study through the online survey. This would lead to reliance upon the TAPS project team to identify suitable schools, which might therefore have received some support from the project team. The integrity of the data would thus be contaminated by any additional supports they had received, or any sense of loyalty to the project team which inhibited the provision of truthful responses to the interview questions (Kanuha, 2000).

It could also be argued that this research could be conducted within a convergent parallel model of mixed methods research - where both the qualitative and quantitative data are gathered simultaneously (Creswell and Plano Clark, 2008) – but the constraints on time and resources presented by a doctoral researcher working alone make this model much harder to execute with the level of analytic rigour required. There would also be no opportunity to use the outcomes of one analysis to inform the collection of the next set of data, meaning that opportunities to follow up on what Stake (2005) calls foreshadowed problems would be missed.

3.3 Methods of data collection

Table 2 offers an overview of the methods used throughout the study. It also indicates the

type of analysis that the data will be subject to and the research questions that the associated analyses will address.

Data type	Collection method	Analysis	RQ addressed
Numerical download data for the TAPS pyramid, by month and city	Collected via third party software from PSTT website	Quantitative: descriptive and statistical significance	RQ1
TAPS pyramid dissemination event data, by city and month	Collected via email and manually aggregated by city and month	Quantitative: descriptive and statistical significance	RQ1
Online survey data from users of the TAPS pyramid	Via third party online survey software	Quantitative: descriptive and statistical significance	RQ2 RQ3
Semi-structured interviews	Face to face, at case study schools	Qualitative, using thematic analysis	RQ4 RQ2 and 3 (triangulation)
Documentary analysis of relevant documents for the case study schools	Collected from publicly available documents online	Comparative content analysis	Providing triangulation for analyses of case study data

Table 2: data collection methods for the study

3.3.1 How the methods address the research questions

The first step of data collection will look for a relationship between the location of dissemination events and download activity, applying statistical models to quantitative data sets. In doing so, the analyses will address RQ1: *what was the relative impact of online and face-to-face dissemination modes?*

The second step will use data collected from an online survey of TAPS pyramid users to provide a descriptive analysis of the impact of the TAPS pyramid upon assessment practice, addressing RQ2: *How might a disseminated research output be interpreted and enacted by its users?* Statistical models will also be used to analyse a sub-set of the data for significant relationships between workplace factors, learning opportunities and reports of whole-school use. In doing so, the resulting analyses will address RQ3: *In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?*

The final step will deploy a thematic analysis of qualitative interview data from two schools to identify and articulate the themes relating to the fora and mechanisms for disseminating new knowledge about assessment amongst teaching colleagues within a primary school. In doing so, it will illuminate the process of dissemination within a school and the role and

nature of social learning opportunities, addressing RQ4: *How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?*

As stated earlier, this study is conducted within an ESMM design, meaning that quantitative data is collected and analysed first, and the findings of that analysis are used to inform the subsequent collection and analysis of qualitative data. As such, the outcomes of Step 1, in terms of what can be learned about the possible influence of one dissemination mode upon another, will be used to inform questions relating to discovery and learning opportunities for the TAPS pyramid. It is also hoped that the outcomes of the Step 2 analysis will provide evidence of some factors which appear to influence the uptake of the TAPS pyramid at a school level. These, in turn, will be used to shape the questions being asked in Step 3 so that a fuller picture of how dissemination for action works within a school can be achieved.

3.3.2 Validity and reliability in ESMM research

The concerns regarding validity and reliability of research conducted within an ESMM design relate to the collection and analysis of both types of data. According to Creswell (2013), the ESMM model entails distinct phases of data collection, with the outcomes from the quantitative analysis feeding into the design of the qualitative data collection, so that the final step of data collection and analysis builds on the former, providing further detail but also illuminating the previous findings.

He therefore cautions against the researcher invalidating the outcomes of the previous quantitative stage by drawing upon different samples during the qualitative stage. And while the qualitative database in an ESMM design is necessarily smaller than the preceding quantitative database (Morse, 2010), Creswell also warns against invalidating the results by making the supplementary database too small. For this reason, two qualitative case studies were conducted instead of one. This not only permitted cross-case comparison, it also provided a wider range of participants and perspectives upon which to draw, allowing for some tentative generalisation of perspectives across job roles and years in service. The schools for the case studies were also selected from participants in Step 2 of this research project, ensuring that the link between the samples was not broken.

In order to ensure the validity of the conclusions drawn from the analysis of each database, and therefore also the way in which the outcomes of one step of the research inform the aims

of the next, the assumptions and principles of rigorous data collection and analysis for each data type must be adhered to (Tashakhori and Teddlie, 2010). This step-by-step analysis of data according to its rules, before considering the outcomes of the steps of research as a whole, prevents the researcher from assembling what Morse (2010) refers to as data soup. It also allows the researcher to focus on the quality, rigour and appropriateness of each of the research methods selected (Symonds and Gorard, 2008). Thus, each stage of this three-step study has its own separate chapter where the measures taken to ensure the validity and, where appropriate, the trustworthiness of the data are set out, along with the analyses and a discussion of the results from that step of the research study. The generalisability of qualitative findings is discussed in section 6.5.5 of Step 3 of this three-part study.

As recognised by its proponents, however (see Biesta 2010; Cameron, 2011), the value of a mixed methods design is that the researcher can take a sophisticated approach to answering complex questions by explaining quantitative results with a follow-up qualitative analysis, thereby better understanding the complex issues involved by incorporating the perspectives of individuals. For this reason, the outcomes of each step of the research will also be considered in combination at the end of the thesis, with the links between them explored and the implications discussed, in the General Discussion in Chapter 8.

3.4 Theoretical perspective and conceptual frameworks

A theoretical framework is the theory and specific tenets within it that underpin a piece of research (Grant and Osanloo, 2014) whereas the conceptual framework demonstrates the concepts, beliefs and assumptions that guide the research plan and analyses (Miles and Huberman, 1994). As explained in section 2.2, this study draws upon specific tenets of sociocultural theory to explain and understand the process of effective dissemination of research outputs to in-service primary school teachers. In the section below, a brief rationale is given, with reference to the literature review, for the theoretical and conceptual frameworks selected.

3.4.1 Theoretical framework for the dissemination process

A model of dissemination of educational research outputs has been selected to understand and frame the dissemination activities of the TAPS project team. As explained in section 2.3.2, King (2003) built upon the previous work of Klein and Gwaltney (1994) by rationalising their

four levels of dissemination activity for educational research outputs to three: *awareness*, *understanding* and *action* (ibid.).

King's (2003) three levels for dissemination of educational research outputs to practitioners are therefore used as a theoretical starting point for understanding the successful dissemination of research outputs to in-service teachers. However, as previously discussed, the processes and activities of dissemination for action are under-specified in the existing literature. The empirical findings of this study will therefore be used to elaborate King's model by exemplifying the processes and activities of dissemination for action within the walls of a primary school.

3.4.2 Conceptual frameworks for Step 2 of the study

The following conceptual frameworks will be applied to Step 2 of this three-part mixed methods study.

3.4.2.1 *The Professional Learning Community (PLC)*

As previously explored in section 2.5.3, in-service teachers increasingly receive their professional learning through in-house provision. That doesn't mean that learning magically occurs through teachers simply sitting and talking, however. Neither does holding a staff meeting automatically imbue it with the characteristics of an effective one (DuFour, 2004) and nor does sitting around the same table automatically foster collaborative dialogue (Galton, Simon and Croll, 1980).

An appropriate conceptual framework to apply to the characteristics of purposeful learning among in-service teachers is the Professional Learning Community, or PLC. In comparison to the incidental learning in a CoP, participants in a PLC will purposefully engage in activities which focus on student engagement and development (DuFour, 2004). Their collaborative effort should impact upon student outcomes directly related to the topic being explored, and as such, those outcomes should be used to evaluate the effectiveness of the teachers' intervention (Feger and Arruda, 2008). Based upon their review of the literature pertaining to PLCs within which professional learning could take place, the five key characteristics of PLCs which will be referred to in this study are:

- Shared values and norms
- Focus on collaboration

- Clear and consistent focus on student learning
- Reflective dialogue between teachers about curriculum, instruction and student development
- Deprivatisation of practice

Vescio, Ross and Adams (2007).

These characteristics will be used as a conceptual framework in Step 2 to explore the characteristics of the staff meetings that might be provided to support participants' use of the TAPS pyramid, and to investigate the extent to which those characteristics might be linked to reports of schoolwide changes to assessment practice as a result of interacting with the resource.

3.4.2.2 The school as an expansive – restrictive workplace

As explained in section 2.5.6, Hodkinson and Hodkinson (2005) developed a set of criteria to describe schools as workplaces and to categorise the extent to which they enabled or inhibited workplace learning. Five of the criteria, selected for their relevance to the adoption of a new assessment framework, will be used in in Step 2 of this study to explore the extent to which these workplace characteristics might be linked to reports of schoolwide changes to practice following engagement with the resource being studied. These will be specified in section

3.4.3 Conceptual frameworks for Step 3 of the study

The following conceptual frameworks will be applied in the third step of this three-step mixed methods study.

3.4.3.1 Organisational learning theory: the role of formal and informal contacts in the transfer of new knowledge

The first conceptual lens for Step 3 of the research is Aalbers, Dolfsma and Koppius' (2014) idea that multiplex social contacts between employees, of both an informal and formal nature, promote the effective transfer of innovative knowledge between individuals within organisations (see section 2.6.4).

The fact that teachers engage in both formal and informal contacts is not disputed (see Nias, Southworth and Yeomans, 1989), but it is not yet known which of these different contacts

might be identified by teachers as part of their learning process for adopting a new assessment framework, nor how useful the teachers consider these types of contact to be. The application of this concept to the data in this study will illuminate the extent to which informal and formal contacts aid the spread of innovative knowledge within the workplace of the primary school.

3.4.3.2 *Communication theory: three models of communication*

We have seen how we might frame the types of contacts between individuals communicating new knowledge within a school, but those categories do not inform us of the *nature* of communication within those contacts. The second conceptual lens for Step 3 of the research is therefore drawn from Harris and Nelson's (2008) three levels of communication: linear, interactive and transactional (see section 2.6.5).

These levels will be used to categorise the nature of the communication during learning opportunities that are provided in the case study schools with reference to the TAPS pyramid. These models are of relevance to the research for the following reasons. Firstly, they offer three distinct styles of communication that entail progressively more interaction between the sender and receiver of the messages. Secondly, these communication styles have parallels in the world of education and learning: the transmission style of teaching compared to the dialogic style (Alexander, 2004), whereby knowledge is co-constructed by all participants over time, rather than being a closed set of facts which needs to be passed from one brain to another. Thirdly, they have already been used to successfully examine and categorise the nature of communications between schools and families (see Schneider and Arnot, 2017) so could reasonably be applied to the communication between colleagues *within* schools, working for the same organisation but in different roles and with differing levels of authority and power. Fourthly, they are easy to understand, and can be used by the researcher to ask interview participants to categorise the nature of the communication during the learning opportunities that they have had relating to the TAPS pyramid.

There is a gap in the existing literature for research which explores teachers' perceptions of learning opportunities and their value through the lens of these communication models. By applying this theory to the communication that takes place within schools and between colleagues learning how to use an artefact to improve an aspect of their assessment practice, the research will illuminate the nature of the communication processes within primary schools between teachers attempting to change their assessment practice in primary science using the

TAPS pyramid.

3.5 Chapter Summary

In this chapter, a rationale for the use of a mixed methods design has been given, in the form of an Explanatory Sequential Mixed Methods design (Creswell 2013). King's (2003) three levels of dissemination has been given as a theoretical framework for the study of how the TAPS pyramid has been disseminated and enacted within primary schools, but attention has been drawn to the fact that only the third level of dissemination – known as dissemination for action – is likely to result in changes to behaviour or practice, yet this stage is under-specified, both in King's original model and in the wider literature which has been published since. It has been stated in this chapter that a key aim of this study is therefore to specify the activities and mechanics of dissemination for action within a primary school setting; in so doing, a useful contribution will be made to the existing literature.

The conceptual frameworks which will be applied to structure the analysis of the data during Step 2 and Step 3 of the study have been outlined. These are:

- The criteria for effective staff meetings aimed at changing practice (Vescio, Ross and Adams, 2007)
- The expansive-restrictive workplace continuum for schools (Hodkinson and Hodkinson, 2005)
- The role of formal and informal social contacts that exist between individuals working within the same organisation (Aalbers, Dolfsma and Koppius, 2014)
- The style of communication between individuals, using Harris and Nelson's (2008) three levels.

It has been noted that these conceptual frameworks have been drawn from the related fields of organisational and communication theory, and deliberately so, for the potential contribution that they might make to the understanding of how dissemination for action takes place within the walls of a school. The stated aim of this research is to discover how a resource for changing teachers' assessment practice in primary science is successfully disseminated, shared and enacted within a school. These choices of theoretical and conceptual frameworks are congruent to the research questions and will help to frame the research design, while also informing the methods and analyses employed.

3.5.1 Outline of the next chapter

In the following chapter, the first step of this three-part research study will be set out. A brief introduction will contextualise the first step of the study with reference to relevant parts of the literature review and the gaps in the knowledge which will be addressed by Step 1. The methods, results and a brief discussion of the results from Step 1 will follow. Readers are reminded that each step of this three-part study will be presented in its own chapter, along with a brief discussion of the results for that part of the study, before an overall discussion chapter considers the results as a whole.

4 Step 1 of the study

4.1 Introduction to Step 1 of the study

The review of relevant literature in section 2.3 has highlighted both the potential benefits of disseminating research outputs via an online or face-to-face event strategy, but it has also highlighted the relative inadequacy of using just one mode.

At the time of writing, the interaction between these two modes of dissemination remains an unexplored area of inquiry.

Step 1 of this three-part study addresses the following research question and its associated sub-questions:

RQ1: What was the relative impact of online and face-to-face dissemination modes?

1a) What was the relative impact of each dissemination mode used for the TAPS pyramid?

1b) What evidence is there for one dissemination mode influencing another?

This chapter outlines the methods, data collection and analysis, results and discussion for Step 1 of this three-part research study into the dissemination and enactment of the TAPS pyramid. As described in chapter 3, this study has been conducted within an Explanatory Sequential Mixed Methods design (Creswell 2013). The data collected in this first step is therefore quantitative.

The Appendices for Step 1 can be found at <https://doi.org/10.17870/bathspa.8066321.v1>.

4.2 Step 1 Methods

Two types of quantitative data pertaining to the dissemination of the TAPS pyramid were collected:

- Download data for copies of the TAPS pyramid downloaded from the Primary Science Teaching Trust website
- Dissemination event data for events during which the TAPS pyramid had been presented to an audience

The collection, preparation and validation of each type of data is outlined below.

4.2.1 Download data

Data collection: Evaluating the influence of dissemination events upon internet downloads of a research innovation is a hitherto unexplored area in the field of education. But researchers in the fields of economics and science have noted that creating public interest in research outputs increases internet views and downloads (Winkelman et al., 2006; McKenzie and Özler, 2011). Thelwall (2017) describes using download totals of a given resource as a useful indication of the potential number of users of the resource in question, and although downloads have been shown to be a weak indicator of academic citation activity (Thelwall and Kousha, 2016a), download totals have been used effectively to represent the impact of a research output on a case by case basis (Plume and Kamalski, 2014; Ball and Duke, 2015). For this reason, a count of TAPS pyramid downloads has been used to demonstrate the potential user base for the TAPS pyramid.

Data collection: Google Analytics was used to collect the date and location for each download of the TAPS pyramid. A reporting procedure that removed duplicate IP addresses for concurrent downloads was used to give a more accurate figure for individuals accessing and downloading the resource (Dreissen, 2016; Sullivan 2016). No identification of the person downloading the resource was possible from these data, so it was not possible to seek participant consent, but given that no identifying data was included, it was also not considered necessary.

Data preparation and coding: downloads of the TAPS pyramid with no defined location were removed from the data before coding. All downloads made in the UK were then coded by month of download, country and county, using the ceremonial counties list (Lieutenancies Act, 1997). Downloads with non-UK locations were coded by month of download and country. These downloads were classified as International.

Validity and reliability: accuracy of the data download was established by running the data collection and preparation procedure twice to ensure that the same totals were reached each time. The following assumptions have been made about the download data:

- It is assumed that the third-party software used to collect the data functioned correctly and provided a full set of download data.

- While concurrent downloads from the same IP address have been removed from the data, it is still possible for an individual to download the TAPS pyramid at a later date on the same device. While this could lead to a slight artificial inflation of the download figures, it should be remembered that many teachers share computers at schools in the UK. It is therefore conceivable that two different teachers downloaded the TAPS pyramid from the same machine during the specified time period.
- The researcher acknowledges downloads of the TAPS pyramid can be obtained by means other than a download from the Primary Science Teaching Trust website, such as via email attachment from a colleague. However, this did not form part of the project team's dissemination strategy so it is outside the scope of this study.

4.2.2 Dissemination event data

Data collection: dissemination event data was requested from a population comprising the TAPS project team and people identified by the TAPS project lead as having been involved in disseminating the TAPS pyramid through their contacts at the Primary Science Teaching Trust and Primary Science Quality Mark (two organisations that promote the effective teaching of science in primary schools). In total, twelve people were contacted.

Those who were contacted were asked to supply the date, location and audience size of any event where they had presented the TAPS pyramid to an audience of teachers. Participation was voluntary. Those who chose to participate submitted their dissemination event data via a prepared spreadsheet.

Data preparation and coding: Each dissemination event was manually coded by county, date and audience size. Audience sizes were defined as follows: small (1-25 attending); medium (26-50 attending); and large (51 or more attending). The dissemination event data was then aggregated to create a complete list of all of the known dissemination events during the data collection period.

Validity and reliability: the accuracy of the aggregated data was established by running the data coding and preparation procedure twice to ensure that the same totals were reached each time. The following assumption was made about the dissemination event data:

- Although the TAPS pyramid may have been demonstrated and shared by individuals

outside of the population identified by the project lead for this study, these individuals could not be known to the researcher and therefore have not been included.

4.2.3 Data collection period

This study used download and dissemination event data collected over a one year for the period of 1st August 2015 to 31st July 2016, for the following reasons. Firstly, it had not been possible to reliably count downloads, nor ascribe a geographical location, to each TAPS pyramid download until the website had been redesigned to incorporate third party metrics. Secondly, the TAPS project team had been trialling and developing the design of the TAPS pyramid during 2014 with the project schools, and between Summer 2015 and Autumn 2016 began to promote it actively among primary science interest groups. Other interested parties also disseminated it during this time period.

4.3 Analysis of Step 1 data

A descriptive analysis of the relationship between the two data sets is presented to address RQ1a and evidence of an interaction between both modes is demonstrated. A statistical analysis of the data then follows, to examine the possible significance of the patterns found in the descriptive analysis and address RQ1b.

4.3.1 Descriptive analysis of download and dissemination event data

A figure for the potential user base in different parts of the UK was generated from download frequency and location. This was then compared to the frequency and size data of known dissemination events in UK counties (no known dissemination events occurred outside the UK). The data were then manually analysed for correlations between the total downloads over one year for each county and the presence of dissemination events; the frequency of dissemination events; and the size of dissemination events. International downloads were ranked by frequency per country.

4.3.1.1 Downloads of the TAPS pyramid

Once downloads with undefined locations (n=96) and those made outside of the UK (n=134) were removed from the data the total unique downloads for the TAPS pyramid during the year from 1st August 2015 to 31st July 2016 was 2,764.

4.3.1.1.1 *International downloads*

134 international downloads of the TAPS pyramid were made in 45 different countries, comprising 4.8% of the total. By country, the most downloads were made in Spain (n=10), followed by Singapore (n=9) and the United Arab Emirates (n=9). In twenty of the forty-three countries, only one download was made. The TAPS pyramid was downloaded in countries where the first language is not English, as well as in English-speaking countries. By continent, the most downloads of the TAPS pyramid occurred in Asia, where 61 copies were downloaded. 40 were downloaded in Europe, 12 in Oceania, 11 in the Americas and 10 in Africa. A table of the results can be found in BathSPAdata (Step1: 4.3.1.1.1).

4.3.1.1.2 *UK downloads by country*

As demonstrated in Table 3, most downloads of the TAPS pyramid took place in England (n=2675), with download activity in all but two of the 48 English counties. In Wales (n=37), download activity occurred in just over half of the Welsh counties, and in Scotland (n=37), download activity took place in less than one third of the Scottish counties. In Northern Ireland (n=15), download activity was found in less than half of the Northern Irish counties.

UK Country	Counties where Downloads Made
Wales	9/16
Scotland	9/34
Northern Ireland	3/8
England	46/48

Table 3: counties where download activity detected, by UK country

Expressed as a percentage, 97% of UK downloads were made in England. The combined totals for Scotland, Wales and Northern Ireland make up 3% of the total downloads of the TAPS pyramid during the period studied.

4.3.1.2 *UK downloads by county*

The table in BathSPAdata (Step 1: 4.3.1.2) summarises UK downloads by county, showing monthly and overall totals. The counties are ranked by total downloads, from most to least.

The map in Figure 4 summarises the data visually, showing the distribution of downloads, by county.

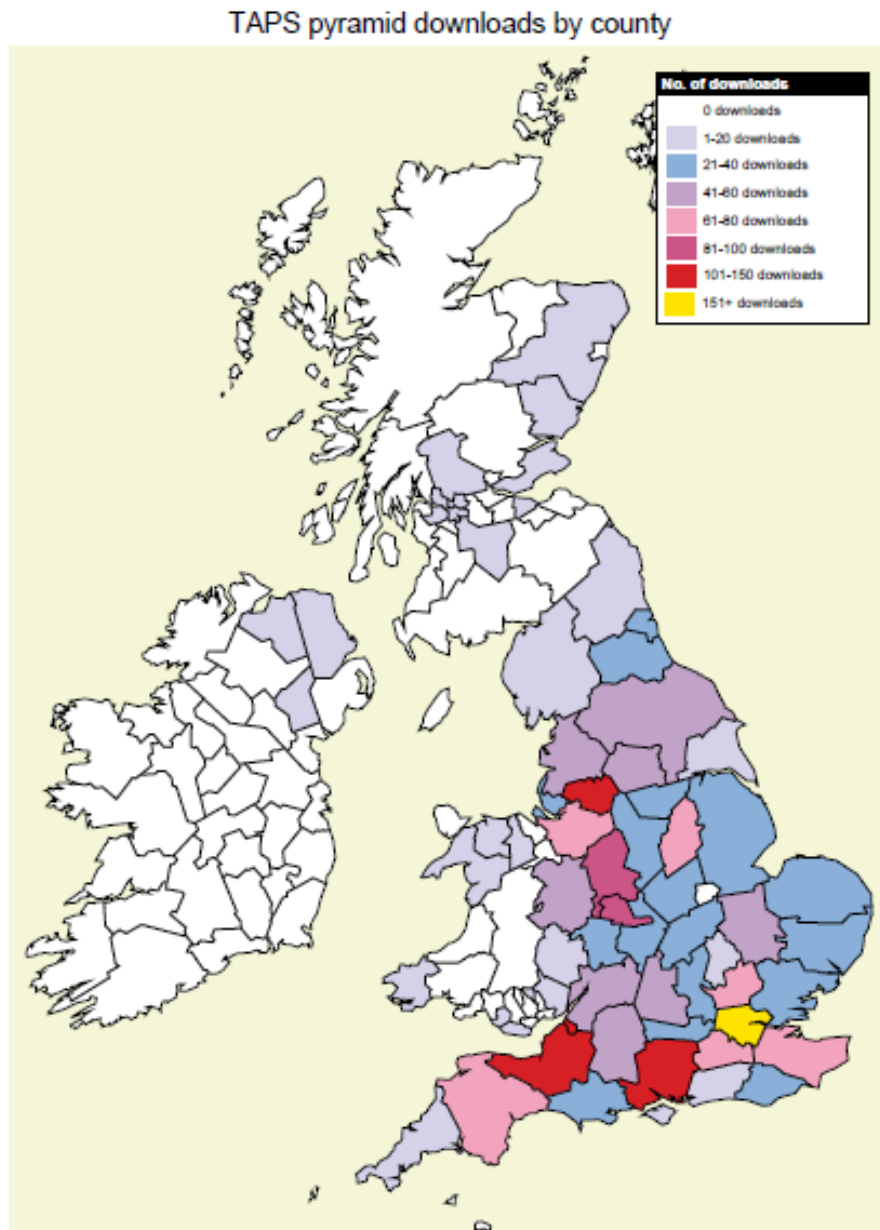


Fig. 4: map to show distribution of TAPS pyramid downloads

The county where the most downloads of the TAPS pyramid were made is Greater London (n=534). This is almost four times as many downloads as those made in Hampshire (n=144) which is ranked second.

London has a population of 8,173,000 (Office for National Statistics, 2011), which should be taken into consideration when noting its ranking. But while Greater Manchester and the West Midlands, the second and third most populous English counties, also appear high in the

download rankings, so do Somerset and Bristol, which have much smaller populations. This suggests that total download ranking over the specified time period is affected by factors other than population size alone.

4.3.2 Dissemination Events

4.3.2.1 *Dissemination events by UK country*

51 dissemination events were recorded for this study. The vast majority (n=50) were held in England; the one remaining event was held in Northern Ireland.

4.3.2.2 *Dissemination events by county*

Dissemination events were held in 21 of the 48 possible English counties. The county where most dissemination events were held was Greater London (n=8), followed by Dorset, Wiltshire, Somerset, Gloucestershire and Devon, where four were held in each county. In counties where dissemination events were held the median was 2 events and the mode was 1 event. The mean frequency has not been given as the number of events was not a continuous variable. The map below summarises the data visually, showing the distribution of dissemination event, by county.

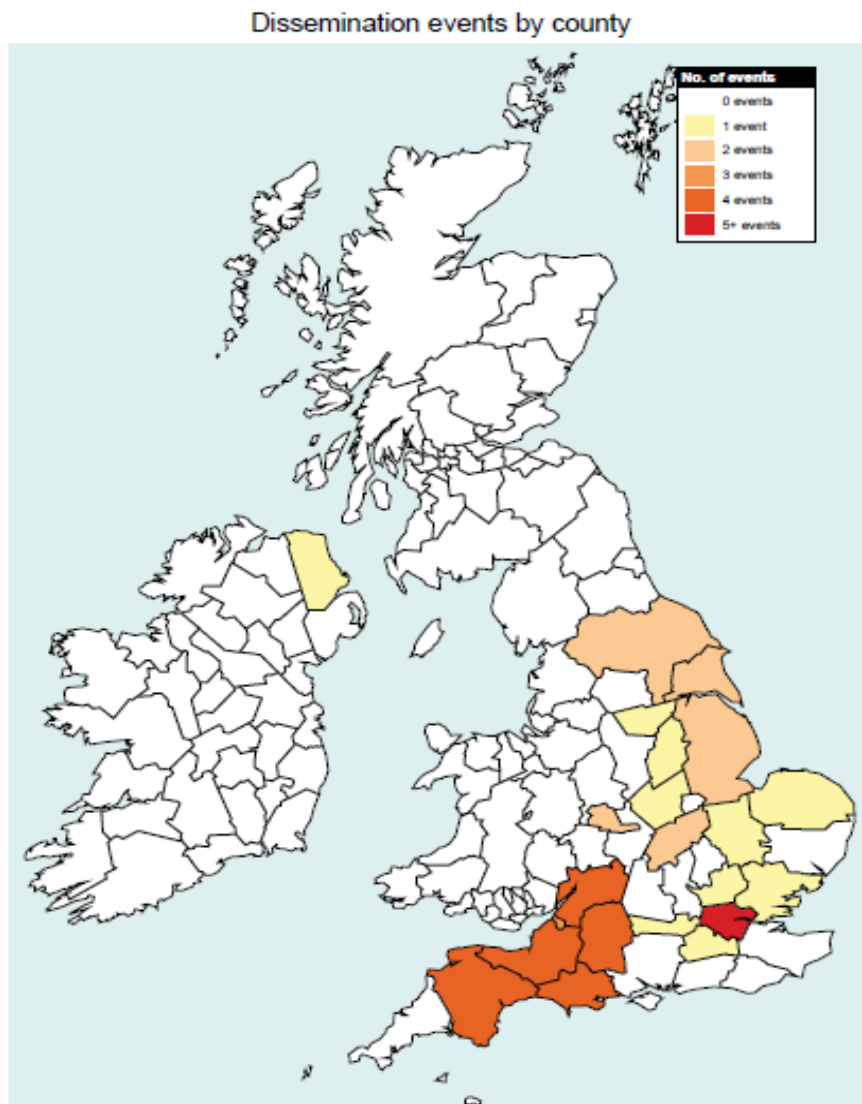


Fig. 5: map to show distribution of dissemination events for the TAPS pyramid by UK county

4.3.2.3 Dissemination event by audience size

Small dissemination events were held most often ($n=28$, mean attendance=12.2), followed by medium sized events ($n=15$, mean attendance=32.8) and large events ($n=7$, mean attendance=140).

The mean attendance for large events was significantly higher than for either of the other size of events, due in part to two of those events having estimated audiences of 300 each. A table showing dissemination event location, date and audience size can be found in BathSPAdata (Step 1: 4.3.2.3).

If the total audience figures are combined, 1817 people are known to have attended dissemination events for the TAPS pyramid during the time period studied. Even if a one to

one relationship between attending an event and making a download is assumed, this still does not explain the additional downloads recorded during the time period, suggesting that other factors are influencing download activity.

4.3.3 Interaction between the two modes of dissemination

Part of the research question being answered by Step 1 of this research is, “what evidence is there for one mode influencing another?” The following patterns in the data suggest that there is an interaction between the two dissemination modes of online and face-to-face presentation of the TAPS pyramid.

Firstly, the graph in Figure 6 plots UK download frequency and dissemination event frequency across the time period studied. Although the relationship between the two data sets is not linear, the pattern of peaks and troughs in activity is broadly similar, suggesting that one may be influencing the other. They also match the UK school year, with dips over the Christmas, Easter and Summer holidays. This suggests that the TAPS pyramid had been disseminated to its target audience of practitioners working in primary schools.

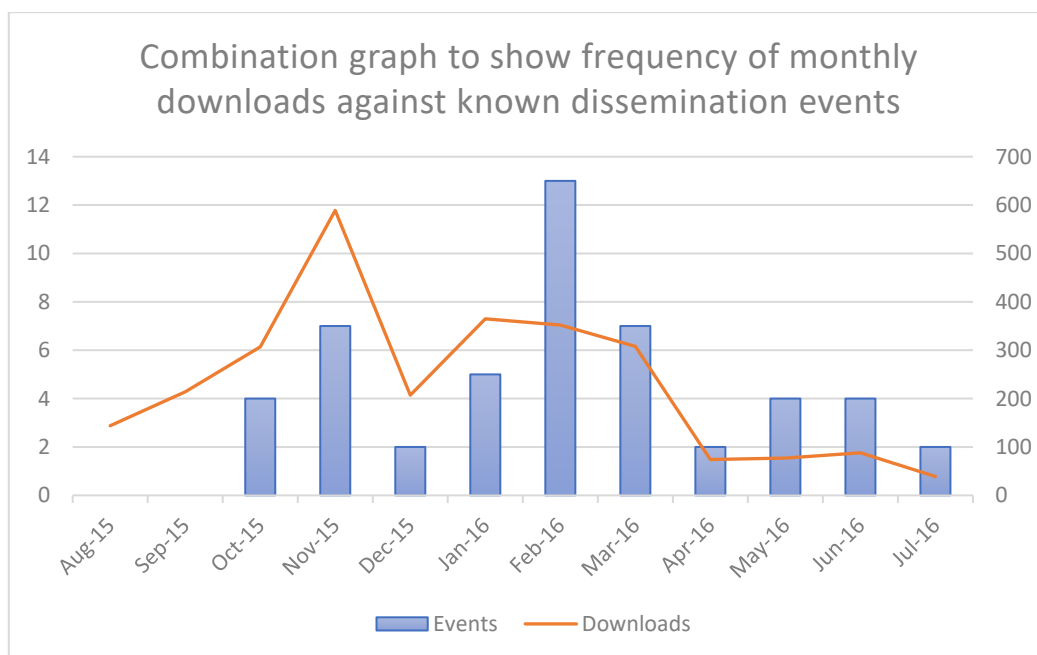


Fig. 6: Combination graph to show monthly frequency of downloads and dissemination events.

Secondly, the map in Figure 5 shows the distribution of dissemination events by UK county. When compared to the map in Figure 4 showing download distribution, the counties in which there were few or no downloads of the TAPS pyramid generally correspond with counties

where there were no dissemination events. Thirdly, when the counties are ranked by download totals and whether dissemination events were held or not, it can be seen that seven out of the top ten counties for downloads were also counties where dissemination events were held.

The correspondence between both data sets in the graph is not exact, and there are several possible reasons for this: there may have been other dissemination events which were not made known to the researcher; the county in which an event was attended may be different to county in which a subsequent download was made; there may have been a gap of days or weeks between attending the event and downloading a copy of the TAPS pyramid.

However, an overall trend in the data suggests a link between counties where dissemination events were held and counties where downloads were made, indicating that one dissemination mode – dissemination by event – is influencing the other mode, dissemination online. This, in turn, provides a warrant for analysing the data for statistical significance.

4.4 Statistical analysis of Step 1 download and dissemination event data

The following hypotheses were generated to test RQ1b:

- Hypothesis 1: Number of downloads increases when dissemination events are held in a county
- Hypothesis 2: Number of downloads is positively affected by the frequency of dissemination events held in a county
- Hypothesis 3: There is a significant difference between the number of downloads made between counties where small-medium sized and large sized events have been held

4.4.1 Testing rationale for the statistical analysis of the Step 1 data

All statistical analyses were carried out using IBM SPSS version 22. Non-parametric tests were used in each instance, due to groups in the data containing less than thirty, meaning that the assumptions inherent in parametric tests were broken (Bryman, 2015). Non-parametric tests rely on ranking the values in the data and this has led to them being described by some as less powerful than their parametric counterparts. It can also be argued, however, that ranking the values provides a more cautious interpretation of significance and therefore

reduces the risk of committing a Type 1 error (Field, 2015), whereby an effect is erroneously reported as significant. As such, the tests used in this step of the study are considered appropriate to the size of the samples, as well as providing a reliable indication of significance.

For hypothesis 1, the Mann-Whitney U test for independent samples was used to investigate the hypothesis that there would be a statistically significant increase in downloads in counties where dissemination events had also been held. This would be expected if dissemination events are a more effective way of communicating the value of research outputs to a target audience than online availability alone. The data from each of the 48 English ceremonial counties were divided into two groups, Yes to Events and No to Events.

For hypothesis 2, the Kruskal-Wallis test for independent samples was used to investigate the hypothesis that there was a positive relationship between the number of dissemination events held in a county and the number of downloads made. This would be expected if Hypothesis 1 were true. The data were divided into three groups: 0 events, 1-2 events, and 3 or more events. The fact that there were more than two groups in the data made the Kruskal-Wallis test appropriate.

For hypothesis 3, the Mann-Whitney U Test for independent samples was used to investigate whether there was a significant increase in the number of downloads made in counties which held dissemination events with large audiences. This would be the case if there were no qualitative difference between smaller and larger events, the effectiveness of the dissemination event thereby being a function of the audience size, rather than the interactivity and discussion made possible by smaller sized events. The data were divided into two groups: counties where dissemination events had been held which included large events, and counties where dissemination events had been held that did not include large events. This grouping allowed the testing that larger events might result in more downloads, while accommodating the fact that a mix of event sizes was found in several counties, thereby preventing the researcher from testing each event size separately.

The median score was reported to indicate the central tendency as it is relatively unaffected by skewed distributions and extreme scores at either end of the data set. It is also considered more appropriate than reporting the mean for non-parametric tests (Field, 2015).

Although non-parametric tests can be slightly less sensitive, this should be balanced against a

reduced likelihood of committing a type 1 error when interpreting the results (Sheskin, 2004).

4.4.2 Preparation of the data

In order to prevent outliers in the data from affecting the accuracy of the statistical models used for analysis, a winsorising procedure was used to substitute outlying values with the next highest value from the data set (Zimmerman 1995). This was used in the case of download data for Greater London ($n=574$) which was almost four times higher than the next value ($n=144$ for Hampshire). At almost four times the size of the next highest value, it would have biased the statistical models used, providing erroneous support for the hypotheses being tested (Field, 2015). For this reason, the value for London was corrected to $n=145$ in accordance with Zimmerman's recommendations (ibid.) The download values for all of the counties can be found in the righthand column on the table in BathSPAdata (Step 1: 4.3.1.2). A winsorising procedure was also used to correct the value of dissemination events for Greater London from 8 to 5 (the next value after $n=4$ for Devon, Dorset, Somerset, Wiltshire and Gloucestershire).

4.5 Results of statistical analysis of Step 1 download and dissemination event data

The results are reported below and summarised in Table 4.

Hypothesis 1: Number of downloads increases when dissemination events are held in a county

Total downloads in counties where events were held ($Mdn = 49.00$) were significantly higher than in counties where no events were held ($Mdn = 27.00$), $U = 403.00$, $z = 2.48$, $p = .013$, $r = .36$. This demonstrates that dissemination events positively influence downloads of the TAPS pyramid, resulting in higher downloads in the counties where they were held.

Hypothesis 2: Number of downloads is positively affected by the frequency of dissemination events held in a county

In counties where dissemination events were held, a significant positive relationship was found between the frequency of dissemination events, and the total number of downloads made $H(2) = 9.26$, $p = .010$. Pairwise comparison with adjusted p -values per Field (2015) showed there were no significant differences between event frequencies of 0 and 1-2 events

($p=.51$) and 1-2 events and 3-4 events ($p=.24$). Pairwise comparison showed a significant difference between event frequencies of 0 events and 3-4 events ($p=.009$).

Hypothesis 3: There is a significant difference between the number of downloads made between counties where small-medium sized and large sized events have been held

There was no significant difference in total downloads between counties where only small to medium sized events were held ($Mdn = 41.00$), compared to counties where large events were also held ($Mdn = 96.00$), $U = 59.5$, $z = 1.61$, $p = .10$, $r = .35$. This finding indicates that larger events are not more effective in stimulating download activity.

Hypotheses	Test statistic	p	ES	Notes
Number of downloads increases when dissemination events are held in a county	403.000	.013*	.36	
Number of downloads is positively affected the frequency of events in a county	9.266	.010*	.21, .51, .38	0 events and 1-2 events; 0 and 3or more events; 1-2 events and 3-4
There is a significant difference between the number of downloads made between counties where small-medium sized and large sized events have been held	59.500	.10	.35	

Footnotes:

N=2,764

* $p \leq .05$ (two-tailed)

ES: effect size. Small ES .1 - .29, Medium ES .3 - .49, Large .5 and above.

Table 4: summary of test results for statistical significance of Step 1 download and dissemination event data

4.6 Discussion of Step 1 results

The research question for this part of the study sought to understand the relative impact of the dissemination modes used by the research team and whether there was any evidence of one mode influencing another. The following section discusses the results in relation to each part of the research question, considering how the findings relate to the wider literature.

4.6.1.RQ1a: dissemination online provides dissemination for international and national awareness

The finding that the TAPS pyramid was downloaded 134 times in 45 non-UK countries demonstrates that online dissemination is a useful strategy for achieving dissemination for awareness (King, 2003) at an international level. These findings chime with Duffy's (2000)

view that the internet has democratised the availability of new ideas; anyone with a browser and search engine is free to find them. They also provide some challenge to the view that resources that are issued online can be lost amongst the endless proliferation of innovations and ideas being published (Siemens, 2005). It is worth noting, however, that the TAPS pyramid was hosted on the Primary Science Teaching Trust's website. This organisation is recognised for its advocacy and expertise in the curriculum area of primary science, so a potential user who found the TAPS pyramid in a list of search results might have been persuaded to pursue it by their trust in the dissemination channel (Kirst, 2000). Although it cannot be tested with this data, this raises the intriguing idea that online dissemination of the TAPS pyramid might have been shown to be less effective if it had been hosted on a website of a relatively unknown organisation or university faculty.

The internet also played a crucial role for dissemination for awareness within the UK, where 2764 copies were downloaded during the specified time period. In countries such as Scotland and Wales, with widely dispersed populations and no known dissemination event activity, online dissemination was the only dissemination mode used, and can therefore be assumed crucial to its penetration of those territories. Equally, in UK counties where there were no known dissemination events, there is evidence, through download activity, of the TAPS pyramid being found online nevertheless. This study therefore provides some evidence that online dissemination is a useful strategy for reaching a wide potential audience with research outputs aimed at in-service primary practitioners, at both the national and international level.

The lower overall download figures in areas where there were no dissemination events, however, confirm the view that dissemination online is not a complete dissemination strategy (Cooper, 2014) and that the effectiveness of such a passive strategy is enhanced by what Edelstein, Levin and Shah (2012) call active outreach. This finding is discussed in more detail below.

4.6.1 RQ1b: Dissemination events positively influence online dissemination

Dissemination by event has been shown in the literature to be a more effective but more costly mode of dissemination that reaches a smaller potential audience (Southwell et al., 2010), but these events are nevertheless considered a more effective means of dissemination if the aim is to encourage the use of the innovation being promulgated (Hutchinson and Huberman, 1994). Statistical analysis of these data showed a significant link between

dissemination events in a county and higher levels of downloads of the TAPS pyramid (see Table 4) which indicates that these events, while reaching a smaller total audience than online dissemination, can nevertheless play an important part in a dissemination strategy. It is argued that they do this by providing a forum for education professionals to learn about a research output in detail. This in turn lets them consider its value and potential application to their setting (Beacham et al., 2003).

The process of adaptation is a key concept in sociocultural theories of learning, and also considered a key part of the dissemination process for education research outputs (Hutchinson and Huberman, 1994; Gravestock, 2003; King 2003) that makes it more likely that the resource will be used to change practice in some way. These data provide some support for the notion that increased understanding of the TAPS pyramid, which was obtained by attending a dissemination event at which it was presented, resulted in a greater interest among the target audience in downloading a copy than in areas where no such events were held.

When the size of the audience at the dissemination event was taken into account, however, no significant difference was found between counties where large dissemination events had been held and those where only small to medium sized events had been held. To interpret this result, it is useful to consider Klein and Gwaltney's (1994) four levels of dissemination. They provided two levels for dissemination through events, based on the size of the audience and the assumed amount of interaction that was possible between the knowledge broker (Nordholm, 2016) and the target audience. Thus, a conference speech provides less opportunity for interaction with and between the audience members than a seminar or workshop. In their view, the smaller dissemination events provided more interaction between the speaker and the audience, enhanced the exchange of ideas and provided more opportunity for reflection (*ibid.*), leading to a better understanding of the resource being disseminated.

These data confirm Klein and Gwaltney's view that larger dissemination events are not as effective as smaller events, both through statistical testing for significance and from examples from the raw data. For example, a large dissemination event with an audience of 300 was hosted in May 2016 in the county of South Yorkshire. There was no significant peak in downloads in the month when the event was held, nor was there evidence of "overspill" of downloads into the following month (McKenzie and Özler 2011). The TAPS pyramid was downloaded 29 times in this county during the specified time period, or 0.09 copies for every person attending a dissemination event.

In the county of Devon, three small and one medium sized dissemination events were known to have been held during the same time period. The total estimated audience for these events was only 74, but the TAPS pyramid was downloaded 75 times in this county, or 1.01 times for every person attending.

As such, these findings provide some evidence for a qualitative difference between dissemination events of different sizes, whereby those attending events have more opportunity to learn about and discuss the resource being presented, engaging in authentic learning and drawing examples from their everyday practice (Van der Linden and van Braak, 2010). In so doing, those attending smaller events are more likely to be engaging in the sociocultural processes of internalisation and adaptation, as they consider how to apply this new resource to the specific demands of their work setting. It is argued that this, in turn, provides more motivation to use the resource following their introduction to it.

4.7 Limitations to this step of the research

It has been suggested that small to medium sized events are more useful to a dissemination strategy because they facilitate interaction between the presenter and the target audience. This hypothesis cannot be tested with these data and would benefit from further scholarly inquiry to define the types of interaction possible within bounded audience sizes.

It has not been possible, from these data, to test the idea that download figures for the resource being studied would have been different if it had not been hosted on a well-known website that advocates excellence in primary science teaching. Future research into the effect of hosting the resource on the website of a university faculty, in comparison to a known and trusted specialist subject organisation, could further clarify the importance of online dissemination through a trusted channel (Kirst, 2000) and would make a welcome addition to the literature.

4.8 Step 1 chapter summary

This chapter has outlined the first part of a three-part study into the dissemination, interpretation and enactment of the TAPS pyramid.

By using download and dissemination event data to produce the first maps of TAPS pyramid downloads and dissemination events by UK county, it has been possible to demonstrate an

interaction between both modes of dissemination, the significance of which has been established through statistical analysis. The presence of higher downloads in counties where dissemination events were held strongly suggests that the dissemination events stimulate greater download activity and it is concluded that this demonstrates the relative effectiveness of a bimodal dissemination strategy, whereby face-to-face presentation and explication of a resource to its target audience stimulates more downloads through better understanding of its possible application to an individual's setting. It is also concluded that the increased interactivity and opportunity to ask questions at small to medium sized dissemination events may increase the potential user's understanding of the resource and may facilitate the adaptation process as the potential user reflects upon how they might best use the innovation within their school.

This study has also demonstrated the crucial role played by the internet in dissemination for awareness, both nationally and internationally. It is therefore concluded that both the dissemination modes were valuable to the dissemination strategy for the TAPS pyramid, but that there was a clear and demonstrable interaction between the two. These findings in turn suggest that dissemination activities which entail dissemination for *understanding* (King, 2003), such as dissemination by event, are more likely to result in downloads of the TAPS pyramid than dissemination activity which could be classified as dissemination for *awareness* (ibid.), such as passive online availability.

4.9 Directions for Step 2 of the study

What cannot be known from these data is whether a person's interpretation of the resource being disseminated - and the subsequent use(s) that they put it to - are influenced by the dissemination mode through which they discovered it. What also cannot be known from these data is how the TAPS pyramid was interpreted and used by those who downloaded it, nor the impact that it might have had on their practice. These data from Step 1 also tell us nothing about the factors within schools which might inhibit or enable the implementation of a research output at a schoolwide level to address some aspect of pedagogical practice among teaching staff.

These gaps in the knowledge will be explored by addressing RQ2 and RQ3 in the next step of this three-part study:

RQ2: How might a disseminated research output be interpreted and enacted by its users?

RQ3: In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

4.10 Outline of the next chapter

The following chapter in this thesis will address RQ2 and RQ3 and will be structured as follows. A brief introduction will contextualise the second step of the study with reference to relevant parts of the literature review and conceptual frameworks that will be applied. The methods, results and a discussion of the Step 2 analyses will follow.

5 Step 2 of the study

5.1 Introduction to Step 2

In the previous chapter, the first step of this three-stage mixed methods study was outlined, and the outcomes discussed. What could not be ascertained from this initial analysis was how the TAPS pyramid had subsequently been used by those obtaining a copy, and what impact this use might have had upon their assessment practice in primary science. The literature review has already highlighted the lack of empirical data currently available to address this gap in the knowledge, as well as the lack of knowledge regarding how meeting (see section 2.5.4) or workplace characteristics (see section 2.5.5) might influence the TAP pyramid's adoption at a school level.

This chapter describes the second step of this three-stage mixed methods study, in which the following two research questions and their associated sub-questions will be addressed:

RQ2: How might a disseminated research output be interpreted and enacted by its users?

2a) How has the TAPS pyramid been interpreted?

2b) Does dissemination mode make a difference to interpretation?

2c) What impact has the TAPS pyramid had upon the assessment practice of those using it?

2d) What evidence is there in the data for the practice of different user groups being influenced differently?

RQ3: In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

3a) Do specific meeting characteristics play a role in school-wide implementation of the TAPS pyramid, and if so, what are they?

3b) Do specific workplace characteristics play a role in the schoolwide implementation of the TAPS pyramid, and if so, what are they?

3c) What other factors, if any, are significantly linked to reports of the TAPS pyramid being implemented at an individual or schoolwide level?

The rest of this chapter outlines the methods, data collection and analysis, results and discussion for Step 2 of this three-part research study into the dissemination and enactment of

the TAPS pyramid. As described in chapter 3, this study has been conducted within an Explanatory Sequential Mixed Methods design (Creswell 2013). The data collected in this second step is therefore quantitative, and the objectives for its collection have been partially informed by the outcomes of the first step.

The Appendices for Step 2 can be found at <https://doi.org/10.17870/bathspa.8066321.v1>.

5.1.1 Conceptual frameworks for Step 2

Two conceptual frameworks which were judged relevant to the school-wide adoption of a new assessment framework in primary science will be applied to the analysis of data in Step 2 (see section 3.4.2).

In order to probe whether the structure and characteristics of staff meetings might be significantly linked to reports of whole school use of the TAPS pyramid, the five characteristics of an effective PLC meeting (Vescio, Ross and Adams, 2007) will be used to establish which meeting characteristics, if any, of staff meetings held to support participants' use of the TAPS pyramid are significantly linked to reports of changes to practice at a school level.

If “knowledge becomes a collective activity which takes place within work practices and is enacted by a community of professionals who possess and develop the knowledge necessary to work, organise and innovate” (Brown and Duguid, 1991, p.218), it follows that the workplace itself, where this knowledge is being created and enacted, might influence what knowledge creation, transfer and enactment is possible (Gherardi, 2012). In order to examine the possible link between wider workplace characteristics enabling changes to practice at a school level, five of Hodkinson and Hodkinson's (2005) expansive workplace characteristics for teachers in schools will also be used as a conceptual lens.

5.2 Step 2 Methods

The data for this step of the research were collected via SurveyMonkey, a third-party online survey website between 15th December 2016 and 27th February 2017. The rest of this Methods section will outline: the design and piloting of the online survey; the data collected by the survey; the rationale for the sampling strategy and dissemination strategy that were used;

ethical considerations; and the analyses of the data.

5.2.1 Design of online survey for TAPS pyramid users: research aims

As explained at the beginning of this chapter, the second step of the research was conceived to answer the second and third research questions.

Because this is an exploratory sequential mixed methods design, they were also informed by the outcomes of the previous step of research. Specifically, the apparent influence of dissemination events, where the TAPS pyramid had been presented and explained to its target audience, seemed to have a positive influence on the number of downloads in a region. This could suggest that the TAPS pyramid might be understood differently by members of the target audience, depending on the dissemination mode through which they discovered it. This interpretation might also influence the use(s) to which it was reportedly put. This aspect of the dissemination process, highlighted by the analysis of Step 1, was therefore investigated in Step 2.

The aims of the online survey were therefore to find out the following:

- How participants had interpreted the TAPS pyramid
- Whether interpretation was influenced by the dissemination mode through which they had discovered it
- Whether the participant's execution of the assessment practices described on the TAPS pyramid had changed as a result of them engaging with it, and if so, which ones
- What learning opportunities the participant felt that they had had to learn about using the TAPS pyramid
- Whether its users were using it to inform their own assessment practice, or whether they had attempted to use it to inform assessment practice at a whole school level
- How participants rated the characteristics of any staff meetings held to support their use of the TAPS pyramid
- How participants rated their schools as workplaces
- Find schools where the TAPS pyramid had changed practice at a school level and who might be interested in participating in the final step of research

An easy criticism of this list is that it is rather lengthy, and as such would generate a number of hypotheses to be tested (with the exception of the final point, which relates to finding participants for Step 3 case studies). This is indeed the case, but the length of the list also reflects the lack of existing knowledge about the TAPS pyramid at the time that this study was conducted. It also reflects the researcher's intent to cast the exploratory net wide, in order to investigate not only the impact of the TAPS pyramid upon assessment practice but also the possible factors influencing its implementation in schools, thereby collecting data which, through analysis, could contribute to the knowledge on what dissemination for action entails within a primary school setting.

5.2.2 Development of the online survey to address RQ2 and RQ3

5.2.2.1 *Rationale for a survey*

The aim of this step of the research was to reach as many potential participants as possible who had used the TAPS pyramid to inform their use of assessment in primary science. In this way, a more meaningful general picture of use might be compiled than would be possible through qualitative approaches, such as interviewing. It was also the intention of the researcher to subject the data from the survey to descriptive and statistical analyses, providing a snapshot of use which could then be interrogated in more depth in the final qualitative step of this three-part research study (Creswell 2013). For this reason, an online survey format was chosen, allowing the collection of unlimited data from users located around the UK (Bryman 2015), who could complete the survey at a time of their choosing (Wulf, 1996).

5.2.2.2 *Page layout*

A plain background and minimal imagery were used to enhance the readability of the text on different devices, such as tablets, smartphones and desktop computers. Lists of question responses were kept to eight to avoid the primacy effect (Newby, 2014). Research has demonstrated that, for optimum concentration upon the part of the respondent, and online survey should last for no more than ten minutes (Adams and Wieman, 2010). As a result, this survey was designed to be completed within this timeframe.

5.2.2.3 *Question types*

A range of closed question types were used to provide interest and variation to the participant (Ellis, 2014). Closed questions were used to facilitate the aggregation and statistical analysis

of responses, but where a list of statements relating to perceptions or feelings were given, participants could select an option called “Other” which then provided them with a free text box to type their response. In this way, all possible responses could be collected.

Where appropriate, Likert-scale questions were used to measure the participant’s strength of feeling towards particular statements about their workplace or the characteristics of staff meetings. This type of question offers a wider range of possible answers than a simple yes/no question, but it can also induce satisficing behaviour when respondents simply select the middle alternative – often worded as “neither agree nor disagree” - instead of engaging fully with the statement (Krosnick et al., 2002). For this reason, a four-point Likert question format was used of *strongly agree; agree; disagree; strongly disagree*, with the middle alternative removed. This was done to encourage participants to engage with the statements and offer a more meaningful response.

5.2.2.4 Question design

For reasons of space, a full specification of the variable type, question text, possible answers, rationale for inclusion and links to the appropriate literature for each question can be found in BathSPAdata (Step 2: 5.2.2.4a). A summary table of each question and how each question addresses the sub questions can also be found in BathSPAdata (Step 2: 5.2.2.4b). However, the derivations of statements used to measure meeting characteristics (Vescio, Ross and Adams, 2007) and workplace characteristics (Hodkinson and Hodkinson, 2005) will be outlined below, as will the use of an “other” option to collect all possible responses.

5.2.2.4.1 Derivation of Likert Scale statements for workplace characteristics and staff meeting characteristics

In accordance with the conceptual frameworks for Step 2 (see section 3.4.2), some of the online survey questions were designed to probe the extent to which the characteristics of meetings held to support the use of the resource might influence reports of its use at a school-wide level. The characteristics of effective staff meetings which can lead to changes in practice, as defined originally by Newman et al. (1996) and reviewed and verified by Vescio, Ross and Adams (2007), were used as the basis for these statements. The five characteristics were reworded in non-academic language, and shortened to fit on the online survey page. The five statements used to evaluate the extent to which expansive workplace characteristics might influence reports of school-wide changes to practice were derived from Hodkinson and Hodkinson’s (2005) ten criteria for schools as workplaces. The wording for both sets of

statements can be seen in Table 5. The five that were judged most pertinent to the uptake of the TAPS pyramid were chosen and reworded as brief statements in non-academic language. The text for all of these statements was included in the five-step piloting and validation process (Radhakrishna, 2007) described in section 5.2.2.6.

Vescio et al. (2007)	Statements for online survey
Shared values and norms	The meeting(s) had a clear purpose
Clear and consistent focus on learning	The link between primary science assessment practice and pupil learning was made clear
Reflective dialogue	Teachers were able to reflect upon their practice and discuss it with colleagues
Deprivatising practice / teacher authority	Teachers were able to raise concerns and suggest ideas
Collaboration	Teachers had the opportunity to work collaboratively
Hodkinson and Hodkinson (2005)	Statements for online survey
Close collaborative working / isolated, individualist working	There are opportunities to work collaboratively
Colleagues mutually supportive in enhancing teacher learning / colleagues obstruct or do not support teacher learning	Ongoing professional development is encouraged
Out of school educational opportunities / few out of school educational opportunities	Teaching staff go on training courses
Opportunities for boundary crossing into other departments / opportunities for boundary crossing only come with job change	There are opportunities to work with colleagues from different key stages / classes
Support for local variation in ways of working and learning / standardised approaches to teacher learning are prescribed and imposed	Innovation is encouraged

Table 5: derivation of statements for online survey from conceptual frameworks

5.2.2.4.2 Collecting all possible responses

As described earlier, when a participant selected “Other”, a free text box appeared for them to enter their preferred answer. In this way, participants were not restricted to only choosing the responses included by the researcher, and the researcher collected the full range of possible answers in the survey population (Newby, 2014). It is also important to note that, due to the skip logic employed in the survey’s design (see section 5.3.2.5) which fed the participant through the survey based on the responses they gave, none of the participants had to respond to all of the questions.

A definition was also given, in the text for Question 21, of using the TAPS pyramid to inform practice at a whole school level as meaning “most or all of the teachers in your school”. A

free text box at the end of the survey, where participants were invited to “add any additional feedback that you wish about using the TAPS pyramid”. This gave the participants a final chance to express any views which they held and felt that they had not had the opportunity to share through their responses to the questions.

5.2.2.5 Site layout and skip logic

Skip logic was used in the survey’s design to move the respondent onto relevant questions, based on their previous answer. For example, when asked if the TAPS pyramid had been used at a school level, if the respondent said “yes” they were taken to questions about how it had been used. If they said “no” they were taken to a question which asked them why it had not been possible to use the TAPS pyramid at a school level. Skip logic also filtered potential respondents who did not work in primary schools to a page which thanked them for their interest while explaining that this survey was only for in-service primary practitioners. It was also used to identify participants who had previously completed the survey, so that they could not complete it twice in error. A user flow diagram of the survey, showing how the skip logic operated, can be found in BathSPAdata (Step 2: 5.2.2.5).

5.2.2.6 The field testing and piloting process

Development of the online survey drew upon a five-stage process for developing questionnaires (Radhakrishna, 2007). This included a field test of proposed questions, revisions following feedback, expert panel review of revised question text, a pilot test and readability testing for the final text.

Science Subject Leads from the project schools completed a field test of proposed questions for the online survey, giving their feedback upon specific issues of comprehension, such as: *were any questions confusing? If so, which? And Did any questions seem irrelevant? If so, which?* This helped to counter what Briggs (1986) calls the problem of meaning, whereby the researcher’s intended meaning is not similarly interpreted by the respondent. For example, one SSL commented on Question 13: “who is ‘they’? The children?” which resulted in the researcher clarifying this in the final question text.

The SSLs from the project schools were also asked to suggest additional responses to some questions by using the “Other” button and free text field, as explained earlier. The feedback from field tests was then collated and used by the researcher to improve the perceived

relevance of the questions and the readability of the question text. The log of compiled comments and researcher actions can be found in BathSPAdata (Step 2: 5.2.2.6).

5.2.2.7 Validity

All variable types were nominal or ordinal and no scale was developed or used. This meant that there was no requirement for scale validation to establish internal validity (Bryman, 2015). It was desirable, however, to check the validity of the questions, and the extent to which their deployment would enable the researcher to answer the research questions. An expert panel, comprised of a senior academic and the academic director of the charity funding this research, was therefore asked for their feedback upon the face, construct, ecological and content validity (Newby, 2014) of the questions, as well as for general comments about the usability of the survey. They were given access to a revised online version of the survey, and a verbal review technique (Walonick, 2013) was used to capture their comments. Their judgement upon the validity of the different questions was used to further refine and improve the survey's relevance to the research aims and the readability of the text. For example, changing the wording on Question 5 to ensure that participants who hold more than one job role, for example a Deputy Head who also has class teaching responsibilities, selects their most senior role.

An example of a completed feedback form from the expert panel can be found in BathSPAdata (Step 2: 5.2.2.7). Once these comments had been incorporated into the design, a final pilot test was completed by two teachers from the project schools who had used the TAPS pyramid before but had not seen earlier versions of the online survey.

5.2.2.8 Readability scores

Once the pilot test was completed, the survey was tested for readability. It scored 62.5 on the Flesch Reading Ease Test and the 8.9 Flesch-Kincaid Grade Level Test, which is based on the expected reading ability of children in the US school system. A score of 8.9 indicates that the survey text had a required reading age of fifteen years. These scores confirmed that the text had a high level of readability for its target audience of adult primary school teachers.

5.2.3 Sampling strategy for the online survey of TAPS pyramid users

While the population for this study was primary teachers, the sampling frame was a purposive

and non-probability one, in that there was no intent to include primary teachers from across the entire workforce. Rather, the intention was to sample only those who were familiar with the TAPS pyramid and able to answer questions about the extent to which they had used it. For this reason, a dissemination strategy that facilitated purposive and non-probability sampling (Etikan, 2016) by exploiting existing subject interest networks for primary science was devised, as explained below.

5.2.4 Dissemination strategy for the online survey

The sampling frame for the online survey was defined as primary practitioners who had heard of the TAPS pyramid and could answer questions about their interpretation of and engagement with it. For this reason, the sample was reached by contacting teachers in the following ways:

- Using email contact details, for which permission for use had been given, during dissemination events where the TAPS pyramid had been presented
- A link to the survey on the Primary Science Teaching Trust website, Facebook page and Twitter feed
- A link to the survey via the TAPS project lead's Twitter feed
- An emailed link, sent by the Primary Science Quality Mark, to schools who were working towards their award
- An emailed link, sent by the Primary Science Teaching Trust, to their College Fellows

All of these dissemination channels ensured that the link was sent to primary practitioners with a particular interest in primary science. And given that the TAPS pyramid had been promoted by the Primary Science Teaching Trust (who funded the TAPS project) among its College Fellows network, and also promoted by the Primary Science Quality Mark as a useful resource, there was a higher chance of this sample having heard of the TAPS pyramid or having tried to use it.

Equally, due to contacting the required sample through subject interest groups, it was possible that there would be some overlap, whereby a potential participant received a link to the survey from both of the organisations that they belonged to. This in turn raised the possibility of them attempting to complete the survey twice, and contaminating the data. For this reason, a

setting was used to detect the participant's IP address. Someone who had already completed the survey was instead directed to a page which confirmed that they had already completed the survey and thanked them for their previous participation.

5.2.4.1 Rationale for mono-modal dissemination strategy

It should be noted that Dillman, Smith and Christian (2014) recommend the use of mixed mode surveys, whereby the survey is also disseminated by post and telephone, to collect data from the widest possible sample of respondents. While it is probable that such multi-modal dissemination would encourage those who did not wish to complete the survey online (Oppenheim, 1999), the relevant contact details for all the potential users of the TAPS pyramid, wherever they might have been residing, simply could not have been known by the researcher.

Online dissemination of the survey link, via trusted channels (Kirst, 2000), made the survey as visible as possible to as many potential respondents with internet access as possible, while keeping the costs of administration to a minimum (Watt et al., 2002). The anonymity of web surveys also gave the advantage that respondents were more likely to be honest in their responses, especially those which they feel might arouse dislike or disappointment in a face-to-face situation (Tourangeau and Yan, 2007).

Due to its proven influence upon web survey response rates (Cobanoglu and Cobanoglu, 2003) and the desire to encourage as many responses as possible, a small incentive to complete the survey was offered in the form of a £50 Amazon voucher to spend on class resources. The ethics of this were discussed with the supervisory team and a representative of the organisation funding the research. It was decided that, as long as participation was entirely voluntary, this was a reasonable way to encourage the submission of response data.

5.3 Participation and ethical considerations

In line with ethical guidelines for educational research (British Educational Research Association, 2011), the purpose of the survey was made clear to participants on the first page, as well as how their data would be used. Participation was voluntary and initiated by the participant clicking on the "Begin" button. The participant could leave the survey at any stage by closing the browser. On the final "Thank you" page the contact name and email of the researcher were clearly displayed, with a message to explain that the participant could contact

her to discuss the use of their data or to request to withdraw from the research. No requests for withdrawal were received, nor questions regarding the survey.

There were two opportunities, both optional, for the participant to provide personal details which would identify them. The first was when they were asked if they were interested in participating in the final step of the research, the aim of which was to visit schools where the TAPS pyramid had been used to inform assessment practice at a whole school level. Interested participants were asked for their contact name and contact email address. The second section was the prize draw upon completing the survey. Once again, interested participants were asked to provide a contact name and email contact address, but there was no obligation to participate or submit contact data.

The contact details were downloaded by the researcher at the end of the survey period and stored in a separate spreadsheet on her computer. The sheet was deleted in June 2017, once the case study schools had been finalised and there was no more need to have access to the contact data.

5.4 Data analysis for the Step 2 online survey

This analysis is structured as follows. First, a descriptive analysis of the data pertaining to interpretation and impact upon practice is presented to address RQ2. A statistical analysis for significant relationships between other variables and the use of the TAPS pyramid then follows to address RQ3. At the end of each section the key findings will be summarised. They will be considered in more detail in the Discussion section of this chapter.

5.4.1 Descriptive analysis of the data relating to interpretation and impact upon practice

The descriptive analysis addressed RQ2 and its associated sub-questions:

- 2a) How has the TAPS pyramid been interpreted?
- 2b) Does dissemination mode make a difference to interpretation?
- 2c) What impact has the TAPS pyramid had upon the assessment practice of those using it?
- 2d) What evidence is there in the data for the practice of different user groups being influenced differently?

5.4.1.1 Sample size

Once incomplete data sets were removed, the data contained 96 complete sets of responses. The data set contained four less than the data set used for statistical analysis because of a problem with the page validation that was corrected within twenty-four hours of the survey going live. In the interim four of the one hundred data sets had incomplete “impact upon practice” data. For this reason, they were excluded from the analysis.

Descriptive statistics of responses were generated using third party survey analysis tools from SurveyMonkey. All percentages and counts have been rounded to the nearest whole number.

5.4.1.2 Participant characteristics

84%, or 81 of the survey participants worked in state-maintained primary schools, and 77%, or 74 of these schools had more than 200 pupils. Participants tended to be quite experienced teachers, with 89%, or 85 of the sample having taught in primary schools for four years or more. Three quarters of the participants were Science Subject Leads, with the remainder split equally between Class Teachers and Leadership roles. 96% of the sample, or 92 participants rated their confidence to teach science as high or very high.

5.4.2 RQ2a) How has the TAPS pyramid been interpreted?

Participants indicated what they considered to be the main purpose of the TAPS pyramid from the following statements: *A tool for evaluating existing primary science assessment practice; A ‘post levels’ assessment framework for primary science; A database for work examples; A guide for using formative assessment strategies in primary science; A model for using teacher assessment instead of written testing for summative judgments; Other (please specify).*

The most common interpretation of the TAPS pyramid’s purpose, shared by 44% or 42 of the sample, was as *A tool for evaluating existing practice in primary science assessment*. Next, 23% or 22 participants interpreted it as *A guide for using formative assessment strategies in primary science*. Just under one fifth thought its main use was as *A model for using teacher judgment instead of written testing for summative assessment* (19%, or 18 participants). 10%, or 10 participants understood its key purpose to be *A “post-levels” assessment framework*.

5.4.3 RQ2b) Does dissemination mode make a difference to interpretation?

When grouped by dissemination mode, 20% or 19 participants discovered the TAPS pyramid online. The most frequent interpretations of the TAPS pyramid for this group were *A guide to using AfL strategies in primary science* (33%, or 6 participants) or *A model for using teacher judgment to assess pupil progress* (33%, or 6 participants). Only 13% or 2 participants thought that it was *A tool for evaluating existing primary science assessment practice*.

80% or 77 participants discovered the TAPS pyramid at a dissemination event. They were far more likely to interpret the TAPS pyramid as *A tool for evaluating existing primary science assessment practice* (50% or 39 participants, compared to 13% for online discovery). This difference in interpretation may have arisen through this group having the purpose of the TAPS pyramid explained to them by a linking agent at the dissemination event, rather than interpreting its purpose on their own.

5.4.4 RQ2c) What impact has the resource had upon the assessment practice of those using it?

5.4.4.1 *Impact upon practice at an individual level*

The activities from the blue layers of the TAPS pyramid were presented as statements. A list of these statements is provided in BathSPAdata (Step 2: 5.4.4.1). Respondents were asked to rate each statement as: I do this as a result of TAPS / I am doing this already / I don't do this yet.

The graph in Figure 7 shows that overall, using the TAPS pyramid has resulted in reports of engagement with all of the specified activities. Assessment activity G, *I give the children time to reflect upon their science work*, is now being used by 45% or 43 participants. Forty-two percent also report that they now *judge pupil progress in science by looking at a range of formative data* (H), a finding triangulated by the 37% or 36 participants reporting that they now *gather evidence from a wide range of different science activities for assessment* (D).

Overall, the TAPS pyramid has had the least reported influence upon *I discuss learning objectives and success criteria for science lessons with my class* (B) and *I give children written or oral feedback on how to improve* (F). Eighty percent, or 77 of all respondents indicate that they already engage in these assessment activities, however, possibly because they are already firmly embedded in lesson planning templates and school marking policies in

participants' schools.

The activity which seems hardest overall for individual teachers to implement is I: *I have a manageable system for keeping and using formative data*, with twenty-eight percent or 27 participants saying that they have not yet engaged with this assessment activity. The challenge of implementing this activity is triangulated by the low figures of participants saying that they already do this.

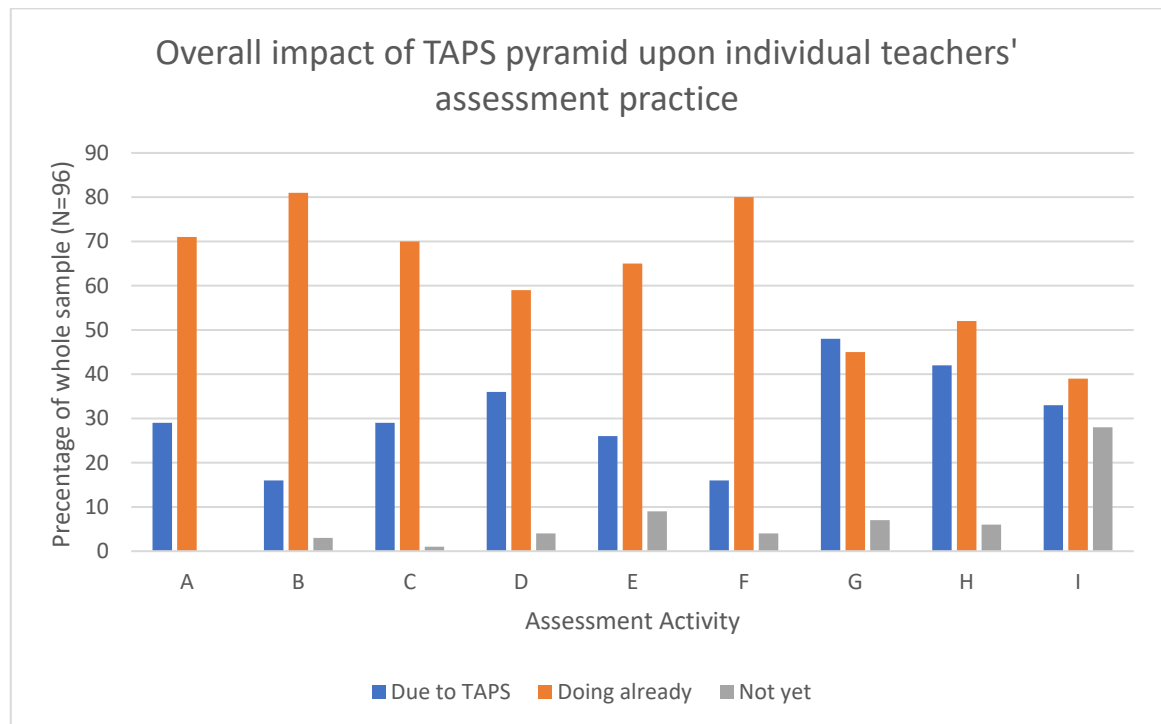


Fig. 7: overall impact of using the TAPS pyramid upon teacher assessment practice

Activities are as follows: A: Plan opportunities for eliciting children's knowledge; B: Discuss LO and success criteria with class; C: Gather formative assessment (FA) data from observations, questioning and discussion; D: Gather evidence from range of activities for assessment; E: Use formative assessment data to adapt pace and challenge of lessons; F: Give written and oral feedback on how to improve; G: Give children time to reflect upon science work; H: Judge pupil progress by looking at a range of FA data; I: Have manageable system for keeping and using FA data.

5.4.4.2 *Impact upon practice at a whole school level*

42% of the total sample, or 40 participants reported that they had been able to use the TAPS pyramid at a whole school level.

Of these 40 participants, 40% or 16 participants now *Plan for eliciting knowledge and ideas*; 55% or 22 participants *Gather a range of evidence for pupil progress*; 43% or 17 participants *Use formative assessment to adapt the pace and challenge of a lesson*; and 31% or 12 participants *Give children feedback about how to improve*.

At the level of moderation of judgments and reporting, the TAPS pyramid has had a considerable impact upon how pupil progress is judged and understood. 50%, or 20 participants report that they now *Judge pupil progress by looking at a range of data (H)*; 52% or 21 participants state that they now *Have a shared understanding of what progress in primary science looks like (J)*; 31% or 12 participants say that they now *Use teacher judgments for end-of-term reporting (K)*. Just under one quarter of respondents say that they now *Use teacher judgment for end-of-year reporting (L)*; this is triangulated to an extent by the finding that only 29%, or 12 participants reported that their schools *Hold moderation meetings to align teacher judgments (M)*. Alongside setting up *A manageable system for collecting and using formative assessment data (I)*, moderation between teachers has proved the most challenging assessment activity for schools to execute.

5.4.4.3 *Comparing impact upon practice for individual use and whole school use*

When the impact upon practice is compared by whole school use and individual use, these data show that whole school engagement with the TAPS pyramid results in greater reported impact upon assessment practice. When laid out in a table (see Table 6), it can be seen that reported impact upon assessment activity was greater across seven of the nine specified activities when participants reported whole school use.

The greatest difference was for D: *I gather evidence from a range of different science activities for assessment* (where reports of impact were 10% higher when it had been used at a school level); E: *I use formative assessment to adapt the pace and challenge of science lessons* (where reports of impact were 9% higher when it had been used at a school level) and I: *I have a manageable system for keeping and using formative data* (where reports of impact were 10% higher when it had been used at a school level). Activity E involves the skilful use of formative assessment data to adapt the lesson content to the children's needs as it is being

taught; this skill might be better developed through a school-wide initiative to support teachers' practice in this area. Activities D and I are both concerned with the collection and use of formative assessment data, and would be supported by a decision on the part of the school leadership to encourage teachers to use teacher judgment based on a range of sources.

TAPS pyramid assessment activity	Individual	School
A I plan opportunities for eliciting children's science knowledge and skills	30%	35%
B I discuss the learning objectives and success criteria for science lessons with my class	17%	16%
C I gather formative assessment data from observations, questioning and / or discussion	30%	30%
D I gather evidence from a range of different science activities for assessment	36%	46%
E I use formative assessment to adapt the pace and challenge of science lessons	26%	35%
F I give children written or oral feedback on how to improve	17%	19%
G I give the children time to reflect upon their science work	49%	51%
H I judge pupil progress in science by looking at a range of formative data	42%	49%
I I have a manageable system for keeping and using formative data	33%	43%

Table 6: "I now do this as a result of TAPS" responses by individual and whole school reports of use

5.4.5 RQ2d) What evidence is there for the practice of different user groups being influenced differently?

5.4.5.1 *Impact upon practice by job role*

The graph in Figure 8 shows that engagement with the TAPS pyramid had the biggest impact upon the assessment practice of Class Teachers. For example, 60% or 7 participants indicate that they now *plan opportunities for eliciting children's science knowledge and skills (A)*, and that they now *give children time to reflect upon their work*. Fifty percent or 6 participants report that they now *gather formative assessment data from observations, questioning and / or discussion (C)*. In comparison, Science Subject Leads are more likely to report that they now *gather evidence from a range of different science activities for assessment (D)* and *use formative assessment to adapt the pace and challenge of science lessons (E)* as a result of using the TAPS pyramid.

Among participants holding Leadership roles, the TAPS pyramid has had most impact upon *giving the children time to reflect upon their work (G)*. Where it had no impact upon practice (activities F and I) it was due to respondents stating that they already engaged in those activities. The modest impact upon assessment activities such as *using formative assessment*

to adapt the pace and challenge of lessons (E) may be due to these participants having limited or no class teaching responsibilities.

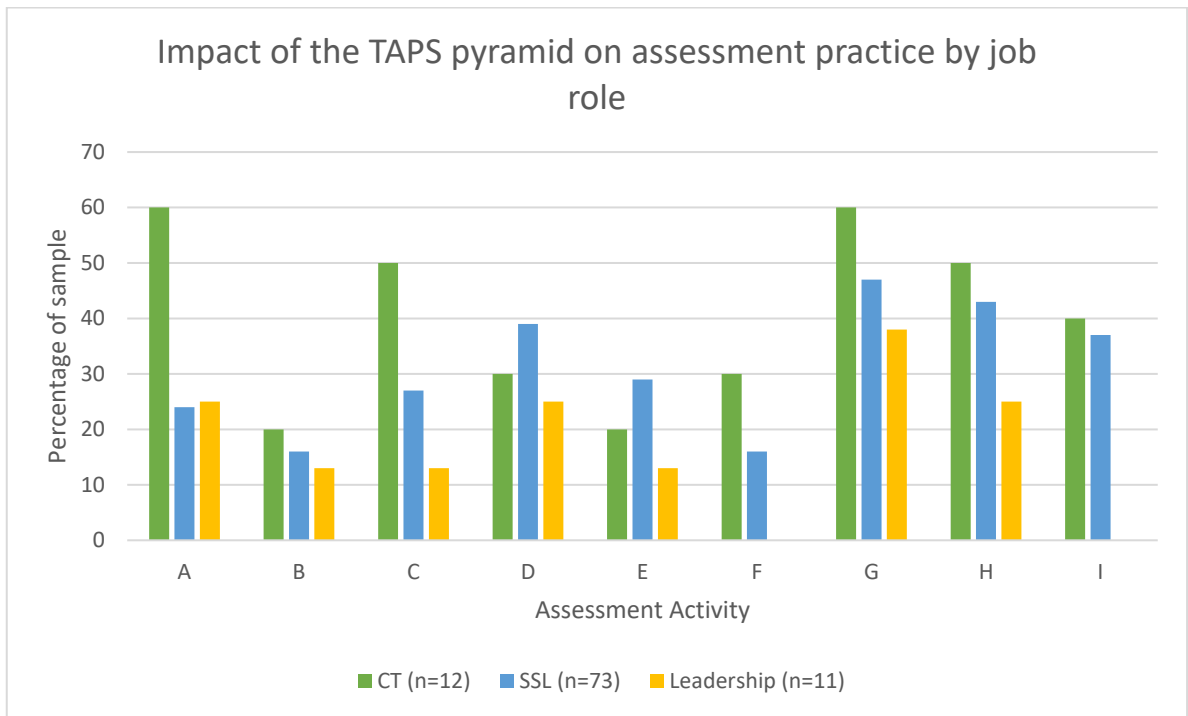


Fig. 8: the impact of the TAPS pyramid upon assessment practice, by job role. Measured in “I now do this as a result of TAPS” responses to assessment activities A to I.

5.4.5.2 Impact upon individual practice by years worked in teaching

The line graph in Figure 9 shows the impact of each of the assessment activities across the respondents’ years in primary teaching. A striking feature of this graph is the peak in impact among teachers who have been teaching for three years or less. Up to eighty percent of this group report that they now use some of the assessment activities listed on the TAPS pyramid, as result of having engaged with it. There is a further spike in the impact upon assessment practice for participants who have taught in primary schools for twenty years or more, but the impact upon practice is more modest for teachers who have worked between four to nineteen years.

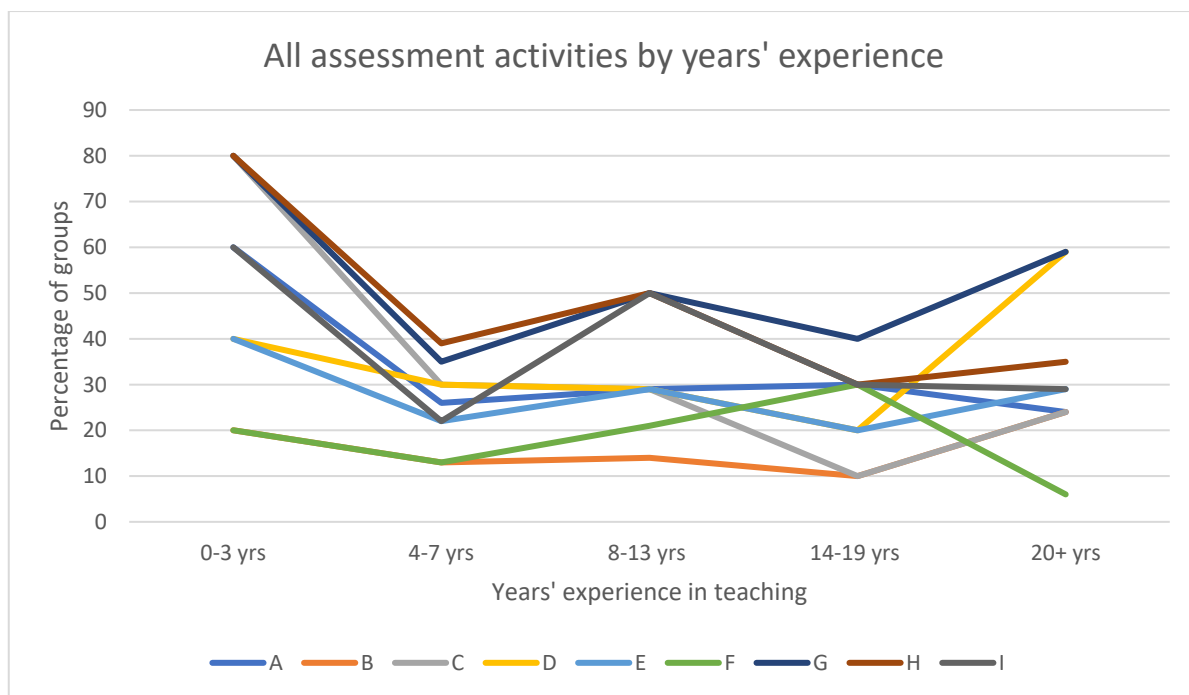


Fig. 9: impact of TAPS pyramid across years in teaching, as measured in “I now do this as a result of TAPS” response against each assessment activity (A-I)

5.4.5.3 Satisfaction with use: reasons given for individual and whole school use

97% or 93 respondents reported being satisfied or very satisfied with how they had been able to use the TAPS pyramid to inform their individual assessment practice. When asked to explain why, 67% or 64 participants said that they now *Use a wider range of AfL strategies in primary science*, and 60% or 58 participants were *More confident about assessing progress in primary science*.

Of those participants reporting use of the TAPS pyramid at a whole school level, 95% or 38 respondents were satisfied or very satisfied with how they had been able to use it. The most commonly cited reason was *More opportunities to discuss teaching and assessment in science* (80% of the sample, or 32 participants). This suggests that participants value the opportunity to discuss their practice with colleagues and the TAPS pyramid presented a context for this. Another frequently cited reason for satisfaction was *Teaching staff are interested in developing their assessment practice in primary science* (65%, or 26 participants).

These reasons for satisfaction are centred on the opportunity to discuss practice and work with colleagues. As such they contrast with those given for individual use, which centred upon the improvement of assessment practice.

5.5 Summary of the descriptive analysis of the online survey

The descriptive analysis addressed RQ2: *How might a disseminated research output be interpreted and enacted by its users?*

Overall, the TAPS pyramid was interpreted as a tool for evaluating assessment practice or for outlining appropriate assessment strategies to use when teaching primary science. This interpretation varied depending on whether the participant had discovered it through online channels or at a dissemination event, however. This suggests that the participant's interpretation was influenced by whether or not they had its possible use explained to them.

The TAPS pyramid has had a demonstrable impact upon the assessment practice of those who have used it, with participants reporting increased use of the specified formative assessment activities. The hardest activities to implement were those which involved some changes to existing assessment or reporting systems, such as having a manageable system for storing formative assessment data. At a whole school level, holding moderation meetings to align judgments was also challenging to implement, which once again might entail changes to existing systems for assessment and are highly likely to also require the involvement and agreement of the school leadership.

When the results are grouped by job role, class teachers report using the TAPS pyramid to develop their use of formative assessment strategies when teaching science. The Science Subject Leads tend to report that they are already using those strategies, and instead indicate that their engagement with the TAPS pyramid has resulted in them using the formative data that they were already collecting for a wider range of purposes, such as reporting and evaluating progress. When the results are grouped by years in teaching, the TAPS pyramid had a demonstrably higher impact upon the assessment practice of newly and recently qualified teachers, followed by those who have worked in primary teaching for twenty years or more and whose initial assessment training and workplace practice is likely to have been based upon training in the previous framework of levelling and best-fit statements of progress.

Response data for whole school use demonstrated that school level engagement with the TAPS pyramid tended to result in participants reporting that they now used a wider range of formative assessment activities as a result of interacting with the TAPS pyramid, than if the participant reported individual use. This suggests that there is something about a school wide approach to evaluating and improving assessment practice which stimulates or increases the

range of strategies attempted by the participants.

The implications of these results, along with the outcomes of the statistical analysis, will be explored in more detail in the Discussion section of this chapter.

5.5.1 Statistical analysis of the Step 2 online survey of TAPS pyramid users

The statistical analysis addressed RQ3 and its associated sub-questions:

RQ3: In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

3a) Do specific meeting characteristics play a role in school-wide implementation of the TAPS pyramid, and if so, what are they?

3b) Do specific workplace characteristics play a role in the schoolwide implementation of the TAPS pyramid, and if so, what are they?

3c) What other factors, if any, are significantly linked to reports of the TAPS pyramid being implemented at an individual or schoolwide level?

5.5.2 Hypotheses

It is acknowledged that a large number of hypotheses were generated for this part of the study. This was a deliberate choice on the part of the researcher, who was seeking to provide new knowledge about factors influencing the TAPS pyramid's use. Given that such factors were unknown at the time of the study, questions were generated to provide data which could be used to test the influence of several possible factors, rather than impoverishing the analysis by collecting only one or two.

A full list of the hypotheses generated for factors linked to reports of individual use and whole school use can be found in Table 7. All test results are presented in summary in this thesis (see Tables 8 and 9) but only the significant results are reported in full.

5.5.3 Sample size for the statistical analysis

There were one hundred complete data sets for statistical testing. This figure is slightly different to the number of data sets available for descriptive analysis for two reasons. Firstly, the statistical testing involved a sub-set of the data which was not used for the descriptive analysis, and secondly, this sub-set of the data was not affected by the technical fault which

had resulted in four sets of data for the descriptive analysis remaining uncollected.

Individual Use	Whole School Use
Hypothesis 1: reports of individual use will be significantly linked to discovery by dissemination event	Hypothesis 1b: school level use will be significantly linked to discovery by dissemination event
Hypothesis 2: reading online comments from other users will be significantly linked to reports of use	Hypothesis 2b: reading online comments from other users will be significantly linked to reports of use
Hypothesis 3: engaging in online discussion with other users will be significantly linked to reports of use	Hypothesis 3b: engaging in online discussion with other users will be significantly linked to reports of use
Hypothesis 4: being able to discuss the TAPS pyramid with a colleague is significantly linked to reports of use	Hypothesis 4b: being able to discuss the TAPS pyramid with a colleague is significantly linked to reports of use
Hypothesis 5: being able to discuss the TAPS pyramid with a group of colleagues is significantly linked to reports of use	Hypothesis 5b: being able to discuss the TAPS pyramid with a group of colleagues is significantly linked to reports of use
Hypothesis 6: opportunities to work collaboratively are significantly linked with individual use*	Hypothesis 6b: opportunities to work collaboratively are significantly linked with whole school use*
Hypothesis 7: the encouragement of ongoing professional development is significantly linked with individual use*	Hypothesis 7b: the encouragement of ongoing professional development is significantly linked with whole school use
Hypothesis 8: attending external training courses is significantly linked to individual use*	Hypothesis 8b: attending external training courses is significantly linked to whole school use*
Hypothesis 9: opportunities to work with colleagues from different classes and year groups is significantly linked to individual use*	Hypothesis 9b: opportunities to work with colleagues from different classes and year groups is significantly linked to whole school use*
Hypothesis 10: the encouragement of innovation is significantly linked to individual use*	Hypothesis 10b: the encouragement of innovation is significantly linked to whole school use*
	Hypothesis 11: school use of the TAPS pyramid is more likely in smaller schools
	Hypothesis 12: school level use will be significantly linked to schools applying for or holding the Primary Science Quality Mark
	Hypothesis 13: holding staff meetings about primary science assessment is significantly linked to reports of whole school use
	Hypothesis 14: Staff meetings about primary science assessment with a clear purpose are significantly linked to reports of whole school use**
	Hypothesis 15: staff meetings about primary science assessment where the link between assessment and pupil learning was made clear are significantly linked to whole school use**
	Hypothesis 16: staff meetings about primary science assessment where participants reflect upon and discuss practice with colleagues were significantly linked to whole school use**
	Hypothesis 17: staff meetings about primary science assessment where the participant could raise problems and suggest ideas were significantly linked to whole school use**
*Derived from Hodkinson and Hodkinson (2005) **Derived from Vescio et al. (2008)	Hypothesis 18: staff meetings about primary science assessment where there were opportunities to work collaboratively were significantly linked to whole school use**

Table 7: hypotheses generated for testing with Step 2 statistical analyses

5.5.4 Testing rationale

The chi square test for significance between groups was used throughout because the data set contained 100 complete response sets. This would be split between four or six cells during analysis of expected and observed counts, however, resulting in some cells containing less than thirty and breaking the assumptions required for parametric tests (Bryman, 2015).

Due to a large number of the calculations being flagged in SPSS as having expected cell counts of below five, a decision was made to report the Fisher's Exact Test result for all 2x2 contingency tables. This is considered a more accurate and cautious calculation of significance when one or more cells contain less than the expected count (Freeman and Campbell, 2007). Fisher's Exact Test was selected instead of Yate's Continuity Correction because it takes into account both the unexpectedly low cell counts and corrects for possible Type 1 errors due to binomial categories, such as Yes / No, being treated as continuous (ibid.).

Pearson's Chi Square was reported for 2x3 contingency tables because Fisher's Exact Test is not available for these. In all cases, the two-tailed significance was reported as an additional caution against committing a Type 1 error through overstating the significance of the relationship between variables. As such, these tests do not indicate causality but provide an indication of significance which, when taken with the effect size and odds ratio, can be used to speculate upon causality (Field, 2015).

5.5.4.1 Interpretation of significance

A *p* value of less than .05 has been interpreted as significant. Odds ratios were calculated according to Field (2015) to indicate the direction of any observed effects. An odds ratio of 4.25 or greater has been interpreted as significant. Where value distribution made it impossible to calculate an odds ratio, percentages have been used instead. Effect sizes, while considered an arbitrary and controversial measure of significance on their own (Glass, McGaw and Smith, 1981) were calculated in accordance with Cohen (1988), whereby an effect size of .1-.29 is a small effect size, of .30-.49 is a medium effect size, and of .5 or greater is a large effect size. Taken together, these calculations give an indication of the significance, size and direction of any relationships found in the data during analysis.

5.5.5 Statistical test results for the Step 2 online survey

The results of all tests for statistical significance are presented in Tables 8 and 9. Significant or borderline significant test results are reported in full. Results for relationships between individual use and variables are presented first, followed by the results for tests for significance between variables and use at a school level. A sample of the commented SPSS test files can be found in BathSPAdata (Step 2: 5.5.5).

5.5.5.1 *Factors influencing individual use of the TAPS pyramid*

Two hypotheses were supported by statistical analysis of the data.

Hypothesis 4: being able to discuss the TAPS pyramid with a colleague is significantly linked to reports of use

There was a significant relationship between use of the TAPS pyramid by teachers to inform their individual assessment practice and being able to discuss it with a colleague at work, $p = .005$, $r = .29$. Based on the odds ratio, the odds of a respondent reporting individual use of the TAPS pyramid were 3.8 times more likely if they had been able to discuss it with a colleague at work.

Hypothesis 5: being able to discuss the TAPS pyramid with a group of colleagues is significantly linked to reports of use

There was also a significant relationship between use of the TAPS pyramid by teachers to inform their individual assessment practice and being able to discuss it with a group of colleagues at work, $p < .001$, $r = .47$. Based on the odds ratio, the odds of a respondent reporting school level use of the TAPS pyramid were 9.4 times more likely if they had been able to discuss it with a group of colleagues at work.

5.5.5.2 *Summary of results for factors linked to individual use*

These results show that, for individual use, the only factors from the survey which are significantly linked to reports of use are being able to discuss the TAPS pyramid with a colleague or group of colleagues. This interaction between peers is not offered by the other learning opportunities that were tested – reading the comments of others and guidance about the TAPS pyramid online – and these were also not found to be significantly linked to reports

of individual use.

The dissemination mode by which the TAPS pyramid was discovered was not found to significantly affect whether it was used or not, although the descriptive analysis earlier in this chapter indicated that the participant's understanding of its possible use might be more limited than if they had discovered it through a dissemination event. None of the expansive workplace characteristics were found to be significantly linked to participants' reports of using the TAP pyramid to inform their individual assessment practice.

Variables	χ^2	<i>p</i>	ES	OR
Discovery mode	FET	.40	.09	1.6
Learning opportunities since discovery: reading online comments	FET	.15	.15	1.9
Learning opportunities since discovery: engaging in online discussion	FET	.75	.07	1.6
Learning opportunities since discovery: discussion with colleague at work	FET	.005*	.29	3.8
Learning opportunities since discovery: discussion with group of colleagues at work	FET	<.001*	.47	9.4*
E-R workplace: collaborative working opportunities	FET	.24	.12	2.4
E-R workplace: ongoing professional development encouraged	FET	.44	.07	1.7
E-R workplace: teaching staff attend training courses	FET	.75	-0.05	0.7
E-R workplace: opportunities to work with colleagues from diff classes and year groups	FET	1.00	<.01	1
E-R workplace: Innovation is encouraged	FET	.51	.08	1.6

Footnotes:

N=100

Fisher's Exact Test reported for 2x2 tables.

FET: Fisher's Exact Test has been used, thus no chi square value is reported.

* $p \leq .05$ (two-tailed)

ES: effect size. *Phi* used for 2x2 tables and Cramér's *V* for 2x3 tables. Small ES .1 - .29, Medium ES .3 - .49, Large .5 and above. Large effect size marked with an asterisk.

OR: odds ratio, calculated according to Field (2015) and rounded to one decimal place. ORs greater than 4.25 are marked with an asterisk.

Table 8: variables influencing use of TAPS pyramid at an individual level

5.5.5.3 Factors influencing the use of the TAPS pyramid at a whole school level

The following hypotheses were supported by statistical analysis of the data. As stated earlier, only significant results are written in full, but all results are given in Tables 8 and 9.

Hypothesis 11: school use of the TAPS pyramid is more likely in smaller schools

There is a significant link between school size and school level use of the TAPS pyramid, $\chi^2(2)=10.43, p=.005, r=.32$. Calculated as odds ratios, the likelihood of a respondent reporting school level use is 3.2 times more likely if they worked in a small school than in a medium school, and 6.3 times more likely if they worked in a small school than those working in large schools.

Hypothesis 4b: being able to discuss the TAPS pyramid with a colleague is significantly linked to reports of use

There was a significant link between school level use of the TAPS pyramid, and being able to discuss it with a colleague at work, $p=.001, r=.32$. Based on the odds ratio, the odds of a

respondent reporting school level use of the TAPS pyramid were 4.3 times more likely if they had been able to discuss it with a colleague at work.

Hypothesis 5b: being able to discuss the TAPS pyramid with a group of colleagues is significantly linked to reports of use

There was a significant link between school level use of the TAPS pyramid and being able to discuss it with a group of colleagues at work, $p < .001$, $r = .46$. Based on the odds ratio, the odds of a respondent reporting school level use of the TAPS pyramid were 10.1 times more likely if they had been able to discuss it with a group of colleagues at work.

Hypothesis 13: staff meetings about primary science assessment are significantly linked to reports of whole school use

There was a significant link between the number of staff meetings held about primary science, and school level use of the TAPS pyramid, $\chi^2(2) = 9.94$, $p = .007$, $r = .32$. The odds ratios for respondents saying that the pyramid had been used at a school level were 6.3 times more likely if 1-2 meetings had been held than if 0 had been held. The odds for respondents reporting school level use were 12.4 times more likely if 3 or more staff meetings had been held than for those who reported no staff meetings.

Hypothesis 15: staff meetings about primary science assessment where the link between assessment and pupil learning was made clear are significantly linked to whole school use

There is a borderline significant link in the data between staff meetings where the link between assessment practice and pupil learning was made clear and school level use, $p = .057$, $r = .24$. The odds ratio for a respondent who felt the link between practice and learning was made clear during meetings also reporting school level use were 8.1 times more likely than if they disagreed with the statement.

Hypothesis 17: staff meetings about primary science assessment where the participant could raise problems and suggest ideas were significantly linked to whole school use

There was a significant link between staff meetings where staff could raise concerns about primary science assessment and suggest ideas, and school level use, $p = .012$, $r = .30$.

Expressed as a percentage, 53% of respondents who agreed that they were able to raise concerns and suggest ideas also reported school level use, compared to 0% of respondents who disagreed that they could raise concerns and suggest ideas during staff meetings.

Hypothesis 18: staff meetings about primary science assessment where there were opportunities to work collaboratively were significantly linked to whole school use

There was a significant link between staff meetings where teachers could work collaboratively and school level use of the TAPS pyramid, $p = .029$, $r = .27$. Based on the odds ratio, the odds of a respondent reporting school level use of the TAPS pyramid were 9.8 times more likely if they also reported attending staff meetings about primary science assessment where they were able to work collaboratively.

Hypothesis 6b: opportunities to work collaboratively are significantly linked with whole school use

There was a significant link between being able to work collaboratively at work, and school level use, $p = .009$, $r = .27$. Expressed as a percentage, 47% of respondents who agreed that they could work collaboratively during staff meeting about primary science assessment also reported school level use of the TAPS pyramid, compared to 0% of respondents who disagreed that they were able to work collaboratively during staff meetings.

Hypothesis 7b: the encouragement of ongoing professional development is significantly linked with whole school use

There was a significant link between the encouragement of ongoing professional development in the workplace and school level use, $p = .01$, $r = .26$. Expressed as a percentage, 46% of respondents who agreed that professional development was encouraged at their workplace also reported school level use of the TAPS pyramid. This is compared to 0% of respondents who disagreed.

Hypothesis 9b: opportunities to work with colleagues from different classes and year groups is significantly linked to whole school use

There was a significant link between being able to work with colleagues from other classes and key stages at work, and school level use, $p = .017$, $r = .25$. Based on the odds ratio, the odds of a respondent reporting school level use of the TAPS pyramid were 4.8 times more

likely if they also agreed that they had opportunities in their workplace to work with colleagues from different key stages or classes.

Hypothesis 10b: the encouragement of innovation is significantly linked to whole school use

There was a significant link between a workplace where innovation is encouraged and school level use of the TAPS pyramid, $p = .021$, $r = .23$. Based on the odds ratio, the odds of a respondent reporting school level use of the TAPS pyramid were 5.7 times more likely if they agreed with the statement that innovation is encouraged in their place of work.

Variables	χ^2	<i>p</i>	ES	OR	%
School size	10.43	.005*	.32	3.2, 6.3	
School applying for or holds Pri Sci Quality Mark	FET	.14	.17	2.4	
Discovery mode	FET	.08	.18	2.7	
Learning opportunities since discovery: reading online comments	FET	.20	.14	1.9	
Learning opportunities since discovery: engaging in online discussion	FET	1.00	-0.03	0.9	
Learning opportunities since discovery: discussion with colleague at work	FET	.001*	.32	4.3*	
Learning opportunities since discovery: discussion with group of colleagues at work	FET	<.001*	.46	10.1*	
Number of staff meetings about primary science assessment	9.94	.007*	.32	6.3, 12.4	
PLC characteristics of staff meetings: meetings had clear purpose‡	FET	.67‡	.09‡	2.0	
PLC characteristics of staff meetings: link btwn primary science assessment and pupil learning made clear‡	FET	.056‡	.24‡	8.1*	
PLC characteristics of staff meetings: able to reflect upon and discuss practice with colleagues‡	FET	.20‡	.18‡	5.4*	
PLC characteristics of staff meetings: able to raise concerns and suggest ideas‡	FET	.012*‡	.30‡		53%, 0%
PLC characteristics of staff meetings: opportunity to work collaboratively‡	FET	.029*‡	.27‡	9.8*	
E-R workplace: collaborative working opportunities	FET	.009*	.27		47%, 0%
E-R workplace: ongoing professional development encouraged	FET	.010*	.26		46%, 0%
E-R workplace: teaching staff attend training courses	FET	.38	.12	2.1	
E-R workplace: opportunities to work with colleagues from diff classes and year groups	FET	.017*	.25	4.8*	
E-R workplace: Innovation is encouraged	FET	.021*	.23	5.7*	

Footnotes:

N=100

‡n=83

χ^2 : Pearson's Chi Square for 2x3 contingency tables. Fisher's Exact Test used for 2x2 tables.

FET: Fisher's Exact Test has been used, thus no chi square value is reported.

* *p* ≤ .05 (two-tailed)

ES: effect size. *Phi* used for 2x2 tables and Cramér's *V* for 2x3 tables. Small ES .1 - .29, Medium ES .3 - .49, Large .5 and above. Large effect sizes marked with an asterisk.

OR: odds ratio, calculated according to Field (2015) and rounded to one decimal place. ORs greater than 4.25 are marked with an asterisk.

%: percentage calculation, where odds ratio calculation not possible.

Table 9: variables influencing use of TAPS pyramid at a school level.

5.5.5.4 *Summary of results for factors linked to whole school use*

School level use of the TAPS pyramid is significantly linked to variables including the size of the school and the provision of staff meetings, and the significance of this relationship increased as the frequency of those meetings increased. Where staff meetings to support teachers' use had been offered, it was found that two of the five characteristics of effective meetings were significantly linked.

On the other hand, four of the five expansive workplace characteristics were found to be significantly linked. This suggests that the nature of a teacher's workplace plays a role in school-wide attempts to change assessment practice, in addition to the provision of staff meetings to support these efforts.

The common thread between individual use and whole school use in these results is the opportunity to discuss the TAPS pyramid with a colleague or group of colleagues; in both cases the relationship between these variables and reports of use is significant or highly significant.

These results will be explored in more detail in the Discussion section that follows.

5.6 Discussion of Step 2 results

The second step of the research was devised to address RQ2 and RQ3. The discussion will be structured according to the associated sub-questions.

5.6.1 RQ2a) and b) Interpretation of the TAPS pyramid by its users

A variety of interpretations for the TAPS pyramid were given by the survey participants. While each is validated by the fact that the TAPS pyramid can be used to those ends (Hopwood-Stephens, 2018b), these results make it clear that there is no consensus interpretation of the TAPS pyramid's use amongst participants.

When the interpretation data were grouped by the dissemination mode, those who had discovered it through a dissemination event were far more likely to interpret it according to the TAPS project team's intended use, a finding which is somewhat at odds with Ansari, Fiss and Zajac's (2010) suggestion that the interpretation of an innovation becomes distorted as it travels through intermediaries on the way to its target audience. This finding therefore permits the assumption that those presenting the TAPS pyramid generally did so in terms which could be understood well by the survey participants, but it also highlights the important role played by the presenter, also known as the linking agent (Louis, 1980) or knowledge broker (Nordholm, 2016), in the dissemination process.

Conversely, the participants who discovered the resource via the internet, with no recourse to intermediaries, were less likely to interpret its purpose according to the stated aims. This finding might reflect the view that adaptation is a part of the dissemination process (see King, 2003; Gravestock, 2003) and it is not dependent on the face-to-face presentation of the resource to the target audience member; in these data, it could be argued that it starts when the member of the target audience has discovered a resource online.

Brindley et al. (2009) concluded that internet dissemination provides limited scope for the explication of research outputs made available online, but this finding also indicates that any explication that is provided may not be noted by the target audience. The TAPS pyramid download is accompanied by explanatory text which describes it as a framework for "identifying strengths and areas for development in school assessment systems" (Earle et al., 2016, p.2) but this definition was rarely reflected in the interpretations of those who found it

online.

These results therefore indicate that the dissemination mode can make a difference to how the target audience interprets a resource's purpose, but also that project teams can control the interpretation of their innovation more closely if they choose to disseminate it by event than by online availability. These results also indicate that if online dissemination is the only option available, project teams should have a reasonable expectation of the extent to which the target audience will pay attention to any accompanying explanatory text.

Discovery mode was not found to be significantly linked to reports of whole school use of the TAPS pyramid, meaning that the target audience's initial interpretation of the resource's purpose did not seem to affect their attempts to implement it at a schoolwide level. This is heartening news for an academic research team who can only disseminate their resource online, but they should remember that the target audience might interpret and appropriate the resource in a way which is at variance with the stated aims.

5.6.2 RQ2c) Impact upon users' assessment practice

This analysis has demonstrated that the target audience for the TAPS pyramid has used it to change aspects of assessment practice in primary science. In overall terms, the activities in the blue layers of the TAPS pyramid (see Figure 1) have proved easier to implement, possibly because they entail the expansion of a participant's existing repertoire of formative assessment strategies to use during the teaching of primary science. As such, these changes can be made by an individual teacher without needing the input or co-operation of others. This analysis is supported by the observation that the two assessment activities which proved most challenging overall for participants to implement involved changes to existing administrative systems and the co-operation of others. This supports Smith's (2011) view that the development of formative assessment practice at a schoolwide level requires changes at the strategic level to set up the systems to support the changes, which in turn involves the school leadership. These results therefore indicate that the TAPS pyramid can have an impact upon the assessment practice of individual teachers acting alone, but there is a limit to what they can achieve.

There were greater reports of change across all assessment activities when whole school use was also reported. A school-wide effort to improve assessment practice in primary science

using the TAPS pyramid might lead to more opportunities to discuss practice with colleagues (Hood, 1990) leading to greater understanding of what is required (Aalbers, Dolfsma and Koppius, 2014); a sense of a shared purpose (Ryder and Campbell, 1989); the visible support of the school leadership upon efforts to improve assessment practice (Smith, 2011); and tacit messages being received by the teaching staff that these aspects of teaching are important and worth developing (Rogoff, 1990). Any or all of these factors might increase: the engagement of participants with the TAPS pyramid; the extent to which they felt that they had used the resource to inform their assessment practice; or both. A conclusive answer to whether this was indeed the case this cannot be drawn from these data, but the work of Heitink et al. (2016) indicates that many factors combine in the successful implementation of initiatives to improve the use of formative assessment in Dutch schools. As such, participants' reports that they change more aspects of their assessment practice when they also report whole-school enactment of the TAPS pyramid can be taken as evidence that schoolwide attempts to change practice can entail processes or aspects which are not available or accessible to individual teachers attempting to change practice on their own.

5.6.3 RQ2d) The assessment practice of different groups is influenced differently

These data show a noticeably higher level of impact upon the assessment practice of class teachers, compared to science subject leads or leadership roles. This might be partly explained by limited opportunities for professional development in primary science for school teachers; reductions to school budgets for training and professional development (Teacher Development Trust, 2017); and the increased autonomy of schools to set their own curriculum leaving the curriculum area of primary science vulnerable to the preferences and priorities of school leaders (Ickowitz-Seidler, 2017). Class teachers working within this context may not be given access to the subject-specific training in aspects of primary science which are offered to their science subject-leading peers (Wellcome Trust, 2014); they may also be unaware of subject-specific support which is available through organisations which advise on the effective teaching of primary science.

These results also indicate that Science Subject Leads are operating at a higher level of assessment literacy than their class teacher peers; where the TAPS pyramid influenced this group's practice was in showing them how to put formative assessment data to a wider range of evaluative and reporting purposes, such as adapting the content of their lessons as they

teach (Serret et al., 2017).

The finding that newly and recently qualified teachers reported the highest levels of impact upon assessment practice, however, indicates that their use of the specified assessment activities was due to using the TAPS pyramid (Hopwood-Stephens, 2018b). This suggests that these participants had not learned these skills, or realised their applicability to primary science, during Initial Teacher Education, the shortcomings of which have been noted with regard to training in formative assessment theory and practice (Carter Review, 2015). At the other end of the spectrum, the TAPS pyramid has had a noticeable impact upon the assessment activities for participants with twenty years' or more teaching experience, who entered the profession in the era of levelling and best-fit judgments (TGAT, 1988) and may use it to brush up on the formative assessment strategies most appropriate to teaching science, now that assessment policy has been changed (Department for Education, 2014).

These findings therefore indicate that different groups in the participant sample engage with the TAPS pyramid differently, based upon their work experience in teaching and job role. Two linked conclusions can be drawn from this: firstly, that the TAPS pyramid is a flexible resource with a fundamentally open character (Nordholm, 2016) which users of different levels of experience and assessment literacy can engage with, and secondly, that engagement with the TAPS pyramid has enabled participants to develop their assessment practice, irrespective of their teaching experience or assessment literacy.

However, these findings also highlight the wider issue of diversity in assessment literacy among teachers in school workforces (Cristoforidou et al., 2014). It is possible that this diversity in assessment literacy might impact upon teachers' ability to reach a reliable teacher judgment of progress in primary science if teachers are not given adequate support to develop their assessment skills (Murphy et al., 2013). It is therefore argued that school leaders and project teams alike need to consider this when devising an intervention or innovation to improve assessment practice; a resource designed to accommodate this range of ability and experience might be more widely used than a resource which assumes a fixed level of ability or understanding.

5.6.4 RQ3a) Staff meeting characteristics: reflective discussion in staff meetings is not significantly linked to schoolwide changes to practice

In this study, two of the five characteristics identified by Vescio et al. (2008) for effective meetings – *being able to raise concerns and suggest ideas* and *opportunities to work collaboratively* – were significantly linked with reports of schoolwide engagement with the TAPS pyramid. However, *being able to reflect upon and discuss practice with colleagues* was not significantly linked. Given what is known about teachers' preferences for learning socially, and from each other (Hood, 1990; Desimone, 2009; van Veen, Zwart and Meirink, 2012) the finding that collaborative working and discursive activity can be significantly linked with schoolwide engagement with new ideas about assessment practice is not surprising. What *is* surprising is that these data did not indicate that engaging in reflective discussion during the staff meetings about the TAPS pyramid was significantly linked to schoolwide use. This could be due to the participants recalling staff meetings which were typically administrative in purpose, with the aim of passing large amounts of information to the teachers in a linear communication style (Harris and Nelson 2008).

Another possible interpretation is that the participants were still engaging in reflective discussion as part of their engagement with this new resource, but they were doing so outside of the mandated learning opportunity (Adler and Borys, 1996) of the staff meeting. This supposition is lent more weight by the responses to a question about learning opportunities provided (see Table 9). Being able to discuss the resource with a colleague or group of colleagues was highly significantly linked to reports of schoolwide implementation. This indicates that the participants were discussing their practice with each other; just not necessarily within the staff meetings held to support their use of the new resource. Thus, the limited reflective activity which might be possible during a formal staff meeting could be less important to teachers changing their practice than the ongoing reflective activity – both intra- and interpersonally - that they engage in as part of their daily work.

This finding is a positive one, because there is evidence in the literature that running an effective staff meeting with the focus on discussing and improving practice is challenging. The process can be fraught with interpersonal conflict and reluctance to collaborate (Dooner, Mandzuk and Rodney 2008) and incompetent facilitation of the meeting itself can inhibit the opportunities for professional growth (Wood 2007). Furthermore, we have already seen how the crowded agenda for staff meetings provide limited opportunity to cover pedagogical

matters (Keeble, 2016). Evidence, therefore, that teachers' learning opportunities are not limited to the potentially sub-optimal learning experience of the staff meeting is heartening.

5.6.5 RQ3b) Workplace characteristics: an expansive workplace can facilitate school-wide changes to assessment practice

The analysis also shows that expansive workplace characteristics are more frequently linked with the schoolwide reports of implementing the TAPS pyramid. Four out of the five characteristics were significantly linked: *opportunities to work collaboratively; ongoing professional development encouraged; opportunities to work with colleagues from different classes and year groups; and innovation is encouraged*. It should be noted that two of these are inherently discussion-based activities, further strengthening the notion that discussion outside of the staff meeting is a key part of schoolwide adoption of a new assessment framework.

This finding might be interpreted as evidence that the social learning and boundary-crossing opportunities (Engeström 2001) implicit in an expansive workplace give rise to opportunities for reflective discussion between colleagues, but on an *ad hoc* basis within the fabric of daily work, rather than as part of a mandated learning opportunity. Recent scholarship in the field of intra-organisational knowledge transfer demonstrates the importance of informal contacts between colleagues, such as spontaneous conversations and temporary alliances based on shared interests, in addition to the formal contacts such as meetings and briefings, in the successful transfer of innovative knowledge between colleagues (Aalbers, Dolfsma and Koppius, 2013; 2014). It is possible that an expansive workplace which encourages collaboration, working with colleagues from other departments and innovation is also one in which employees make regular informal contacts with each other as part of their working day. This, in turn, facilitates the spread of innovative practice.

Another reason why an expansive workplace might be influential to the adoption of a new assessment framework relates to the pre-requisites identified by Heitink et al. (2016) in their study of schoolwide changes to formative assessment practice. The support of the school leadership has been shown to be a crucial factor, and working within a school where innovation, collaboration and cross-boundary working is possible might deliver tacit, distal messages that professional development is valued (Scott and Palincsar 2013), resulting in more extensive and involved interaction between employees.

It is therefore argued that, while staff meetings play an important role in the dissemination of research outputs such as the TAPS pyramid amongst practitioners within a primary school setting, the expansive characteristics of the wider workplace play a more significant part, in terms of the extent to which they facilitate the discussion of practice between practitioners as they engage in collaborative working, boundary crossing and ongoing professional development.

5.6.6 RQ3c) Discussion with a colleague or group of colleagues is significantly linked to both individual and schoolwide use

For both individual use and schoolwide use, being able to discuss the TAPS pyramid with a colleague or a group of colleagues is highly significantly linked in the data. This gives clear support to the sociocultural theory of learning as an inherently social activity (Brown and Duguid, 1991) and indicates that, as well as there being an intersubjective learning benefit to having a shared goal (Littleton and Mercer, 2013), there might be an inherent value in simply being able to talk to someone else about what you're trying to achieve. This social interaction between two teachers might represent a form of guided participation, in that the individual attempting to engage with the TAPS pyramid receives the approbation of her colleague through discussion, which encourages her to continue. In confirming Hood's (1990) view that a teacher's preferred learning resource is another teacher, it also indicates the central role that discussion with peers takes in teachers' workplace learning (Gassenheimer, 2013).

These results indicate that discussion of practice is a part of attempting to change it, and, as Hattie (2016) has previously argued, a hallmark of a supportive working environment where mistakes are welcomed as a source of professional growth. It also supports the argument that reflective discussion is a social learning process which can – and should – be facilitated within and without of the staff meeting to enhance workplace knowledge-sharing and professional learning (Littleton and Mercer, 2013). It is further argued here that discussion is more than a signifier of an effective staff meeting, because the extent to which it is enabled within the wider workplace could impact upon the depth and extent of professional learning that is possible. As such, it could be considered as a further measure of Hodkinson and Hodkinson's (2005) expansive or restrictive characteristics of schools as workplaces.

These findings do not give school leaders the green light to cancel all weekly staff meetings as unnecessary, nor do they justify the provision of a limited forum for reflective discussion

between practitioner colleagues. Teachers' preference for learning from and with each other is well evidenced in the literature (Korthagen 2017) and school leaders would be foolish to ignore it. Instead, these results highlight the importance of school leaders attending to the characteristics of the workplace as well, and the extent to which colleagues feel enabled to work collaboratively, to pursue innovative approaches, or to work with people from different departments.

It is already known that changes to teachers' practice can result from situated, relevant and reflective learning experiences (Winch, Oancea and Orchard, 2015; Desforges, 1995), wherein knowledge *of* practice is developed by the application of this new knowledge, resulting in knowledge gained *in* practice (Cochran-Smith and Lytle, 1999). To put it bluntly, a workplace which enables the ongoing opportunity for reflective social learning activity between practitioners might compensate for the limited reflective learning opportunity within staff meetings that are characterised by a more linear communication style (Harris and Nelson 2008). As such, the role of the workplace in the schoolwide implementation of research outputs should be considered influential.

5.7 Limitations to this step of the study

The purposive sample for this survey was self-selecting and participation was voluntary, meaning that only those who wished to share their experiences of using the TAPS pyramid took part. It is possible that those who had had a positive experience – and felt that they had something to say about how the TAPS pyramid had helped them – were more willing to participate than those who had had a negative experience, such as finding it hard to understand. This may have led to a slight over-representation of positive views in the data.

Equally, the survey was disseminated to a target audience of teachers with a special interest in primary science through social media pages, Twitter feeds and subject advocacy websites which all focus on primary science teaching. This was to ensure that it was seen by as many potential participants as possible who may have heard of the TAPS pyramid in the first place. However, this dissemination strategy may have been a factor in Science Subject Leads being over-represented in the survey data when compared to other job roles.

The five expansive workplace criteria (Hodkinson and Hodkinson, 2005) used in this study were selected for their relevance to the research questions, but their selection meant the

exclusion of others. This represents a trade-off between collecting all possible data about the participant's workplace and collecting sufficient data to answer the research question. As such, further enquiry is needed to explore the relevance of the other criteria to whole school changes in assessment practice following the adoption of a new assessment resource. While a conclusion has been drawn that expansive workplace characteristics enable professional learning, it is also possible that these same characteristics might enable more reflective discussion during mandated learning opportunities such as staff meetings. This cannot be known from these data, however, and more research is needed to probe the existence or causality of such a relationship.

The size of the sample is both a strength, in that data was collected from one hundred schools, but also a weakness, in that only one viewpoint from each school was obtained. These results should therefore be viewed as indicative.

5.8 Directions for Step 3 of the research

The experience of class teachers was relatively under-represented in the sample for this study, but class teachers will be affected by the decision of their school's leadership to adopt and apply a resource at a school level, such as the TAPS pyramid. The final step of the research will address this gap in the knowledge gained so far by seeking to understand the experiences of class teachers.

Discussion between the participant and either a colleague or group of colleagues was found to be significantly linked to reports of changing assessment practice as a result of interacting with the resource, and this was the case whether the participant reported using it only to inform their individual practice or at a whole school level. What cannot be known from the Step 2 data is the format or nature of discussion between a colleague or group of colleagues, and how is it valued by teachers in a school where the TAPS pyramid has been used to implement changes. This will be investigated in the final step of this study.

The disproportionate representation of Science Subject Leads in the survey data might indicate that this group has easier access to innovative ideas about science teaching than their class teacher colleagues. An exploration of how new ideas about primary science assessment practice would illuminate who has access to this information and the role played by the Science Subject Lead in bringing this to their colleagues. The question of which source(s)

teachers, SSLs and head teachers go to for innovative ideas about primary science assessment will be explored in Step 3 of this study.

The fourth research question for this study will therefore address these points as follows:

RQ4: How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?

5.9 Summary of Chapter 5

A gap in the existing knowledge as to how the TAPS pyramid has been interpreted and enacted has been identified, and a quantitative study of online survey data has been used to demonstrate its impact upon practice, as well as various factors which influenced reports of its use. A highly significant factor in reports of both individual use and whole school use was being able to discuss it with a colleague or group of colleagues. Expansive workplace characteristics were found to be significantly linked with reports of whole school use, leading to the conclusion that the workplace within which teachers operate plays a role in them changing their assessment practice, by facilitating the collaborative working, discussion and innovative approaches to practice which are entailed in learning to change assessment practice; these data indicate that such a workplace environment is more significantly linked to whole school changes in practice than the staff meetings provided to support teachers' learning.

5.10 Outline of the next chapter

The following two chapters in this thesis will address RQ4 and will be structured as follows. A brief introduction will contextualise the third and final step of the study with reference to relevant parts of the literature review, and reference will be made to the conceptual frameworks applied. The methods for Step 3 will be outlined. In the next chapter, the thematic analyses of both cases and a brief discussion of the themes found in the Step 3 data will follow. The results from all three steps will be discussed, in relation to a more detailed specification of dissemination for action amongst teaching colleagues within primary schools, in the General Discussion in Chapter 8.

6 Step 3 of the study

6.1 Introduction to Step 3

Amongst other findings, the Step 2 quantitative analysis of online survey data revealed that the characteristics of staff meetings (Vescio, Ross and Adams, 2007) held to support participants' use of the TAPS pyramid were not as significantly linked to reports of whole school use as workplace characteristics (Hodkinson and Hodkinson 2005). The one factor which was significantly linked to reports of use, at both an individual level and a whole school level, was the opportunity to engage in discussion about the TAPS pyramid with either a colleague or group of colleagues. What could not be ascertained from this analysis was the nature, format or perceived value of these opportunities to discuss assessment practice, nor the relative levels of access that colleagues in a school have to external and expert sources of knowledge about primary science assessment.

This final step of the study will attempt to clarify the following issues raised by the Step 2 analysis by addressing RQ4 and its associated sub-questions:

RQ4: How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?

- 4a) What opportunities to learn about assessment practice with a colleague or group of colleagues are identified by participants in the case study schools?
- 4b) How do participants value these learning opportunities, and to what extent are these perceptions common within and between cases, and within and between job roles?
- 4c) What is the nature of communication between colleagues during these learning opportunities?
- 4d) What sources of information and guidance are named by the participants in the case study schools for innovative approaches to assessment in primary science? Do they differ between roles?

6.1.1 Conceptual frameworks for Step 3

This final stage of the research applies ideas from the related fields of organisational learning, communication theory and knowledge transfer (see section 2.6) to address RQ4. Two

conceptual frameworks, outlined in section 3.4.3, will be applied to this final step of the research: the concept of informal and formal contacts playing an equally important role in the transfer of innovative knowledge within an organisation (Aalbers, Dolfsma and Koppius, 2014) and a three-level model of communication (Harris and Nelson 2008) between colleagues during opportunities to discuss their assessment practice with regard to the TAPS pyramid. These opportunities for discussion will be referred to as social learning opportunities.

6.1.2 Structure of Step 3 in the thesis

The final step of this three-part study is the final stage of this ESMM study. It entailed the collection and thematic analysis of qualitative interview data from two case study schools. This final step of the research is presented in two chapters; this chapter will cover the methods for the collection and analysis the Step 3 data. Chapter 7 will present the thematic analysis and discussion of themes found in the Step 3 data. A general discussion chapter, which draws together the findings of all three steps of this study and considers their implications, will comprise Chapter 8.

The Appendices for Step 3 can be found at <https://doi.org/10.17870/bathspa.8066321.v1>.

6.2 Methods for Step 3

This final step of a three-part ESMM research study entails the collection and analysis of qualitative interview data collected from two case study schools. The rationale for selecting a case study design, as well as the selection criteria for the case study schools, are explained and the data collection methods and planned analyses will be outlined.

6.2.1 A rationale for case study design

The intention of the final step of this three-part mixed methods study is to investigate the issues raised by the step 2 analysis in more detail. A case study design will therefore facilitate the collection of rich, situated qualitative data containing the reasons behind people's actions, decisions and perspectives (Watts, 2014).

These cases will collect data about the use of the TAPS pyramid and its impact upon practice,

providing access to a hitherto unexamined area of study. In this regard, these cases are revelatory. However, the intention is also to “capture the circumstances and conditions of an everyday of commonplace situation” (Yin, 2009, p.48) which in this case is the teachers’ experiences of using assessment and participating in learning opportunities to develop their assessment knowledge, as part of their regular jobs. In this regard, these cases are therefore also representative (ibid.).

This study uses a collective case study design, insofar as it entails the comparative study of data from more than one case to provide insight into an issue or phenomenon (Stake, 2005). There are good reasons for this: schools are unique settings for work and learning, with different catchments, teachers, administrations, norms and pupils (Hargreaves, 1999). While the generalisability of qualitative findings is recognised to be more limited than that for quantitative data (Larsson, 2009; Williams, 2000) the conclusions that can be drawn from the data will nevertheless be more broadly applicable if more than one case is studied.

6.2.2 Selection of the case study schools

Participants in the online survey in Step 2 of this study were able to express an interest in participating in Step 3. Four survey participants registered an interest, and two schools were chosen to study from this sample.

In total, there were twelve participants, two of whom were head teachers, two of whom were Science Subject Leads and eight of whom were class teachers. Of those class teachers, three had been working at their current school for less than six months, although all of these newly arrived teachers were experienced and had worked in teaching for at least three years before arriving at their current post.

The two case study schools were selected using a strategy of intentional similarity (Bryman, 2015), whereby the cases have been selected for sharing key contextual features (Benson and Jackson, 2013). These are explored in more detail below. A summary of the key features of each case study school is provided in Table 10.

	School 1	School 2
Catchment type	Rural	Rural
Size	Small (less than 200 pupils)	Small (less than 200 pupils)
Ofsted Grading	Outstanding	Good
Total number of staff	Seven (five teachers, one head, one SSL)	Five (three teachers, one head, one SSL)
Science Subject Lead	Deputy Head as well as SSL. Confident and authoritative within her school.	Former head teacher. Now SSL. Confident and authoritative within her school.
Affiliations	Is a PSTT College Fellow. School holds PSQM.	School holds PSQM. Is not a College Fellow.
Discovery of TAPS pyramid	Via PSQM hub leader	Conference workshop / seminar.
Region	Essex	Devon
Known dissemination activity in region	Low	High
SSL's dissemination activity	Has shared with her staff and also within a cluster group of local primary schools.	Has shared with both schools in their primary federation.
Whole school use reported?	Yes	Yes

Table 10: key features of case study schools selected for Step 3

6.2.2.1 *Strengths and weaknesses of the selection*

A strategy of sampling for intentional similarity (Benson and Jackson, 2013) has conferred the following similar features on each case: school size; number of class teachers; rural catchment; and the seniority of the SSL. Given that the nature and format of communication is of key interest, similar size is helpful in ensuring that there is a similar number of teaching staff between whom communication needs to take place. Furthermore, having two experienced SSLs either holding or having previously held leadership roles helps to control for any between-case disparity in their authority within their school.

By choosing two schools of similar size, no analysis of larger schools is included in this study. A comparison of the nature and format of communication between teachers in smaller and larger schools would be of interest, but the selection of two cases of different sizes for this study would not allow for a potential generalisation of findings based upon size. Another consideration is the validity of any claims made from the collection and analysis of data from only two case studies. Such claims would doubtless be enhanced by the collection of data from more cases, but this was not possible due to the time restrictions imposed by the structure of the study.

6.3 Data collection methods

The following data collections were planned for this step of the research:

- **Documentary analysis** of references to assessment, teacher development and primary science, using publicly available documents on the school websites
- **Qualitative interview data from the SSL** about their background in teaching and their discovery and use of the TAPS pyramid so far
- **Qualitative interview data from teachers, SSLs and head teachers** about how they understood the TAPS pyramid, how its use had influenced their practice and the learning opportunities that they had had to develop their assessment practice

The collection and analysis for each data type is explained below.

6.3.1 Documentary analysis

The aim of the documentary analysis was to provide valuable contextual information about the ways in which primary science and assessment of pupil progress were presented within publicly available documents at each case study school. This analysis provided an indication of the extent to which these concepts were prioritised within the curriculum and policies of each school.

In order to ensure a systematic and replicable approach, a simple comparative content analysis approach (Bauer, 2000) was followed to ensure that all documents were analysed according to the same criteria. These were derived from the aims of the analysis above, and were:

- References to the subject: how it is described and what status it seems to have within the school's curriculum
- References to the assessment of pupil progress: what are the purposes and aims of assessment in this subject? What strategies for assessment are described?
- References to teacher development: what reference(s) are made to teacher development, either in primary science or more generally, in terms of skills development and assessment?

Any excerpts in the review documents which matched the criteria were logged by page and quote on a spreadsheet, which can be found in BathSPAdata (Step 3: 6.3.1). A summary of the findings of each documentary analysis is given at the start of each case study report. Table

11 indicates which publicly available documents were collected and analysed for each case.

Document Type	Case Study School 1	Case Study School 2
Ofsted Report	Y	Y
Inspection Data Summary Report	N	Y
School Prospectus	Y	Y
School Evaluation Framework (SEF)	Y	Y
School Website	Y	Y
Learning and Teaching Policy	Y	Y
Mastery in Science document	N	Y
Statement on Assessment	N	Y
Planning, Assessment and Reporting Policy	Y	N
School Improvement Plan (SIP) Priorities	Y	N
Curriculum Policy	Y	N
Governors' Reports	N	N

Table 11: documents collected for documentary analysis of the case study schools

6.3.2 Qualitative interviews

6.3.2.1 Formulation of interview questions

The interview questions were formulated with reference to the following sources:

- RQ4 and its related sub-questions
- The outcomes of the previous two steps of the study
- The literature on social learning opportunities for teachers seeking to improve their assessment practice, both in the subject area of primary science (e.g.: Hondrich et al., 2015; Serret et al., 2017), and in more general terms (Smith, 2011)
- Relevant literature from the related areas of knowledge transfer mechanisms (e.g.: Aalbers et al., 2014; Carlile, 2004), communication models (Harris and Nelson, 2008) and the collaborative climate in organisations (e.g.: Sveiby and Simons, 2002; Tschannen-Moran, 2000)
- Analysis of the preliminary SSL interviews and the pilot class teacher interview

The derivation of the interview questions is specified in the rationale document which can be found in BathSPAdata (Step 3: 6.3.2.1).

6.3.2.2 Derivation of 'communication styles' question

As part of the interview, participants were asked to classify communication styles during the learning opportunities that they had had with regard to the TAPS pyramid. They were given typed definitions of linear, interactive and transactional styles of communication to refer to, as derived from Harris and Nelson (2008) and asked to choose the communication style which most closely characterised each learning opportunity that they had identified. The typed definitions that were used can be found in BathSPAdata (Step 3: 6.3.2.2).

6.3.2.3 Refinement process

A gradual refining process was used to finalise the text of the question, based upon Bryman (2015). The process is summarised below:

- Formulate draft questions
- Review with supervisory panel
- Revise questions based on supervisory panel feedback
- Conduct pilot interview
- Identify problems with understanding / novel areas for data collection raised by pilot participants
- Revise interview questions
- Second pilot interview
- Final review by director of studies
- Finalise interview schedule

6.3.3 Schedule design

A schedule was created with factual questions at the start (Kvale, 1996) to establish the participant's role and demonstrate interest in understanding more about their experiences.

Next, there were open-ended biographical questions (Charmaz, 2002) to build trust and shared understanding before questions which addressed specific topics about changing practice, learning opportunities and the value they placed upon them. These questions required an evaluative, comparative or explicatory response (Grbich, 1999), to better understand the specifics of the participant's experiences.

This sequencing of question types was intentional, and done to capitalise on the trust and reciprocity built up at the beginning of the interview, so that participants were more willing to share their feelings and emotional experiences of learning, as well as possibly reveal their problems or disappointments with what had been made available to them. Pre-written probes were included on the interview schedules, so that the researcher could clarify questions or explore the responses further.

6.4 A thematic analysis

A theoretical thematic analysis of the data was conducted, on the assumption that there was a straightforward relationship between the words in the interview transcripts and the motivations, reasoning and experience of the participants (Potter and Wetherell, 1987).

A key advantage of thematic analysis is that it is not tied to a particular theoretical or epistemological perspective (Braun and Clarke, 2006). A noted disadvantage of thematic analysis, however, is the variable quality of the analyses generated by it (Watts, 2014). When the themes are understood by the researcher to be the interview questions themselves, a summary report grouped by the questions is produced instead of an analysis of the themes (Maguire and Delahunt, 2017). To avoid this pitfall, Braun and Clarke (2006) recommend: generating and familiarising yourself with the codes; searching for themes; reviewing themes; defining and naming themes; and producing the report (p.87). This procedure will be followed in this final step of the study.

Another criticism of thematic analysis, however, is the lack of methodological rigour which is sometimes applied to the coding of transcripts (Watts, 2014), leading to partial and unnecessarily subjective accounts. A decision was therefore taken to utilise a dual approach to handling the qualitative interview data (Gagnon and Roberge, 2012), whereby the six phases of thematic analysis identified by Braun and Clarke (2006) were used to structure the analytical process, and the two-step approach to coding the data (Watts, 2014) was used as the

interpretive framework for the data.

The two-step approach to coding the data focuses on *what* is being talked about first, and then *how* the topic is being discussed by the participant (Larkin, Watts and Clifton, 2006). It permits the researcher to code in a systematic way, while also facilitating the systematic updating of the coding categories and codes themselves. An extract from a coded transcript is included in BathSPAdata (Step 3: 6.4).

Specifying the coding and analysis process demonstrates that the researcher views the analysis of qualitative data as an active process of making choices, finding links in the data, reporting and exemplifying them (Taylor and Ussher, 2001). This is in contrast to a more passive view of the coding process, the very description of which “can be misinterpreted to mean that themes ‘reside’ in the data, and if we just look hard enough they will ‘emerge’ If themes ‘reside’ anywhere, they reside in our heads from our thinking about our data and creating links as we understand them”. (Ely et al., 1997, 205-6). It is therefore an active, reflexive and recursive process of identifying items in the data which has been pursued in this thematic analysis.

6.5 Data coding

A deductive, theory-driven approach to creating a provisional coding frame was taken, using the themes that were generated from the following analyses and artefacts from this research project:

- Themes emerging from the first two steps of this research
- Themes emerging from the literature review for Step 3
- Themes emerging from the preliminary SSL interviews
- Pilot interview with a class teacher

These themes and ideas were turned into provisional codes within a coding frame. The coding frame was reviewed with a senior academic colleague with extensive experience of analysing interview data. It was then revised and issued to another member of the supervisory team, along with a transcript, for review against the transcript for any missing categories or codes. These validated *a priori* codes were then be used as the basis for analysing the rest of the

transcripts (Bryman, 2015) and were added to, edited or collapsed as the coding process proceeded. The final version of the provisional coding frame can be found in BathSPAdata (Step 3: 6.5).

6.5.1 Strengths and weaknesses of a deductive approach to data analysis

A deductive approach to data analysis facilitates a systematic and replicable analysis process within the subjective activity of qualitative data analysis (Braun and Clarke, 2006). It also imposes an initial categorisation upon the data, providing a starting point for the analysis. A flexible approach to identifying themes, sub-themes and super-ordinate themes, however, also means that the provisional codes can be expanded, collapsed and re-grouped as appropriate as the analysis proceeds (Maguire and Delahunt, 2017). This captures over-arching themes which might not have been conceived of by the researcher when drafting the provisional coding frame.

Using *a priori* codes might lead the researcher to focus only upon those themes, however, to the detriment of others which remain unidentified in the data. This can be mitigated by using the coding frame as a live document which is provisional in nature and updated as required during the analysis process (Bree and Gallagher, 2016). The researcher also kept a reflective journal of changes made to the coding frame, the themes which were found and her reasons for amending them (Ortlipp, 2008). This helped to minimise the variation in how the transcripts were treated and analysed, by facilitating a recursive yet systematic approach to revisiting analysed transcripts in the light of changes to the coding frame (Braun and Clarke, 2006).

Taking a deductive, theory driven approach may also influence the design of the interview questions themselves, insofar as the only questions posed were ones which would answer the research questions. For this reason, the schedule was designed to end with an open question, giving participants the opportunity to speak about any other aspect of their experience that they wish to (Watts, 2014).

The coding and analysis procedure is as follows:

- Check transcript against recording for accuracy (Braun and Clark, 2006)
- Read transcript twice and make notes of initial impressions

- Code what is being talked about first in the lefthand margin (Watts, 2014) – make a note of anything else needed
- Update record sheet for any changes made to coding frame
- Code how it being talked about next in the righthand margin (Watts, 2014) – make a note of any changes required to coding frame
- Update record sheet and coding frame as appropriate
- Update reflective log with notes on the outcomes of the analysis:
 - What have you noticed about this participant’s responses?
 - How do they compare to the responses of others?
 - Other thoughts about the data
- If the coding frame has been updated, re-check all previously coded transcripts for the new code(s) (Maguire and Delahunt, 2017)
- Once all the transcripts have been coded, collate the codes by themes using a spreadsheet (Bree and Gallagher, 2016)
- Assign the relevant text extract to each code, along with a unique numerical identifier and the job role of the participant
- Once all extracts have been collated and grouped by theme, filter the data in the spreadsheet by school or by job role to make the intra- and inter-case comparisons required
- Check the themes for duplication and edit as required before defining and mapping the themes (Braun and Clarke, 2006)
- Report findings and link to the wider literature

6.5.2 Interview procedure

The framework for a semi-structured interview provides a structure for the interaction while also allowing the researcher to steer the conversation to cover all required topics (Kvale, 1996). It also standardises, to the extent that conversational encounters can be standardised, the discussion to provide better comparability across interviews conducted with various individuals (Newby, 2014).

For this reason, a brief introduction to explain the purpose of the interview was read out loud to all participants; the researcher had an interview schedule to ensure that the same questions were asked to all participants; probes or alternative explanations were prepared to help the participant answer the question; and there was a clearly specified debriefing procedure which allowed the participant to ask clarifying questions at the end. A copy of the schedule can be found in BathSPAdata (Step 3: 6.5.2).

An audio recording was made of the interviews to compensate for the researcher's necessarily partial recall of the conversation afterwards, to allow the production of a transcript. An intent to reflexivity was made, both during the interview so that the researcher did not ask questions that had already been covered by the participant's previous answers (Kanuha, 2000), but also between interviews, with the researcher making notes on each schedule of how the interview had gone, the demeanour of the participant and any misunderstandings that had arisen (Moore, 2012).

6.5.3 Ethics and the validation process

All participants were given a research information sheet to read and a consent form to sign before the interview commenced (Step 3: 6.5.3a and Step 3: 6.5.3b in BathSPAdata). The interviewer outlined the process verbally and they were asked if they had any questions. Once the interview had concluded, a scripted debrief procedure was followed to ensure that the transcript validation process was outlined and the researcher's contact details were passed on. The participants were also advised that they could withdraw their data if they wished by contacting the researcher.

Following interview, a transcript was produced. A copy of this was sent to the participant with instructions on how to annotate it, and a postage paid envelope to send it back to the researcher. Participants were encouraged, but not obliged, to read the transcript carefully and add any further comments that they felt were appropriate to clarify the contents of the transcript.

This process was deployed in an attempt to mitigate what van Heughten (2004) calls the "reliability of respondents' retrospective self-reports about the decision-making process" (p. 203). When a participant can review what they have said and notice inaccuracies in date or detail, they can pass these on to the researcher in their commentary, so that it can be taken

into account. The intention was to receive these comments and add them to the transcripts as secondary text, for consideration in the analysis (Segall, 2002). However, only one participant responded, indicating that she was happy with the transcript, so no secondary text was added.

6.5.4 Validity and trustworthiness of the findings

Much has been written over the years about ensuring the rigour and integrity of conclusions derived from the analysis of qualitative data, in terms of its integrity and trustworthiness when compared to the positivist paradigms (Lincoln and Guba, 1985). Indeed, guidance exists for qualitative data analysis in procedural terms for specific paradigms and approaches (Creswell and Miller, 2000) as well as over-arching criteria which might be applied to all qualitative research in an attempt to ensure its effectiveness (Tracy, 2010).

The qualitative data collected for this step of the study comprised subjective accounts from individuals attempting to change their practice with reference to the TAPS pyramid. These data were then coded and analysed by the researcher who imposed her understanding upon the corpus to find patterns and themes. For this reason, the analyses are necessarily subjective. However, the development of the a priori codes was reviewed by two senior researcher colleagues to ensure consistency between viewpoints and the dual approach to handling the qualitative interview data (Gagnon and Roberge, 2012) ensured analytical rigour.

6.5.5 Generalisation of qualitative research findings

The explanatory sequential mixed methods design (Creswell, 2013) of this study means that the findings of each step are illuminated by the findings of the next. It therefore follows that, once the third and final step of data analysis is complete, these findings can be used to better understand the outcomes of the first two steps and answer the research questions with depth and rigour.

Whilst qualitative analysis involves the subjective interpretation of data by the researcher, its findings can be generalised – with due regard to the design, aims and population studied - to similar contexts or populations (Larsson, 2009). Such a moderatum generalisation (Williams, 2000) will be made from the findings to similar populations; indeed, there would be little point in engaging in qualitative studies if the applicability of the findings to any realm of human experience were nil (Wolcott, 1994). As such, the results will be assumed to be most generalisable in terms of context similarity (Larsson, 2009).

6.6 Chapter summary

This chapter has outlined the methods for the third step of this three-part study. The conceptual frameworks of informal contacts (Aalbers et al., 2014) between teachers working to improve their assessment practice and also the communication style between them during learning opportunities (Harris and Nelson, 2008) have been identified.

A rationale for collecting and analysing qualitative data from two cases which purposefully share key similar features (Benson and Jackson, 2013) has been outlined, as well as the process for developing and refining the interview schedule. A thematic analysis has been identified as the method for analysing the data, within a dual approach of coding using a two-step process (Watts, 2014) within Braun and Clarke's (2006) framework for conducting a robust thematic analysis. The following chapter will present the thematic analysis for each case study before discussing the Step 3 findings.

6.7 Outline of the next chapter

The following chapter presents a thematic analysis of the qualitative data from each case study, which will be referred to as School 1 and School 2. A summary of cross-case and single-case themes will be presented in a table at the end of the analysis. The results will be discussed with specific reference to RQ4 and the limitations of Step 3 of this three-part study will be considered.

7 Step 3: thematic analysis of the two case studies

7.1 Introduction

Two case studies have been made of primary schools where the TAPS pyramid has been reported to have been used to evaluate and improve assessment practice at a whole school level.

For each case study, the following analyses have been made:

- Contextual data about the school
- Documentary analysis of publicly available information about primary science within the curriculum, assessment practice and teacher development in assessment
- Vignette of the SSL's background in science, responsibilities and discovery and use of the TAPS pyramid
- Definition of the themes found in the qualitative interview data
- Summary of findings

A summary of the documentary analysis for each School can be found in BathSPAdata (Step 3: 7.1a and Step 3: 7.1b).

The thematic analysis for each case study will be presented separately. In line with the two-stage approach to data analysis that has been adopted (Watts, 2014) and also the phases of thematic analysis defined by Braun and Clarke (2006), there will be no reference to the wider literature while the themes are being defined. All themes are summarised in Table 12.

Once both cases have been presented in this way, a discussion of the Step 3 analyses only will explore the similarities and differences between the themes. At this point, reference to the wider literature will be made to illuminate the findings and position them in the wider context of scholarly endeavour.

7.1.1 Labelling conventions

The participants are identified within the analysis by school setting and job role. For example, SSL001 is the Science Subject Lead from School 1, and SSL002 is the Science Subject Lead from School 2. "CT" is the abbreviation of Class Teacher and "HT" is the abbreviated form of

Head Teacher. Each teacher is differentiated in the analysis by a letter from the alphabet, so CT002a, CT002b and CT002c are the three class teacher participants from School 2.

Where extracts from the transcript are used to illustrate a point, a reference in square brackets, e.g.: [238], indicates the location of the extract on the coding spreadsheet. A sample of the coding spreadsheet is available to view on BathSPAdata (Step 3: 7.1.1).

Themes which pertain directly to RQ4 and its associated sub-questions are reported as themes. Themes which are found throughout the data corpus and are not directly related to the participants' responses to the interview questions are classified as overarching themes.

7.2 Contextual data for School 1

School 1 was a small rural school located in an agricultural part of Essex. There were 150 pupils on roll and five mixed age classes. The last Ofsted inspection was in 2013 and the school was rated as outstanding. The school was a Church of England school. Eight percent of pupils were eligible for Pupil Premium. There were seven participants at School 1: five class teachers, a Science Subject Lead (SSL), and the head teacher.

7.2.1 Vignette of the Science Subject Lead's career and use of the TAPS pyramid

The SSL at School 1 had a scientific degree and has held the role of SSL for eighteen years. In addition to this responsibility, she currently held the post of Deputy Head, PE Lead and Year 6 teacher. She saw her responsibilities as SSL as: organising the curriculum to ensure good topic coverage for a mixed year group school; organising resources and talks for staff; working with new teachers to ensure that they understand how science assessment and teaching is approached at the school (this was done through team teaching); and maintaining a high profile for science within the school through displays. She was regularly asked to help other schools with aspects of their science teaching and found her membership of the Primary Science Teaching Trust, of which she became a Teaching Fellow the previous year, highly valuable in terms of developing her own teaching ideas.

The SSL discovered the TAPS pyramid at a Primary Science Quality Mark hub meeting, where resources to support assessment were introduced to those attending. It was a relatively informal presentation but she had the opportunity to look at it and consider how her school

was doing in relation to the assessment activities suggested on the diagram. She understood it to primarily be an audit tool for evaluating whole school assessment processes and practice and thought it could be used to show areas where they were doing well and where they needed to improve. She took it straight to her staff meeting to discuss, noting that they work very collaboratively. They have continued to use it as a collective auditing tool since then, with periodic reviews with the whole staff.

She has also presented it at a consortium meeting of teachers, where there were around 60 attendees, with a brief presentation and discussion of how it could be used. She has also shared it at a smaller meeting for local SSLs, on a more informal basis.

7.3 Thematic analysis of School 1

7.3.1 RQ4a) Opportunities identified to learn about assessment practice in primary science

All the participants at School 1 reported participating in staff meetings as part of their learning about assessment practice in primary science. All of them also reported either providing or receiving peer support in the form of discussing specific issues with a colleague, and all reported receiving support from the SSL on an *ad hoc* basis. More generally, one of them had attended a conference in the last year and one had attended a cluster group meeting of SSLs, although this teacher did so as a non-specialist class teacher.

7.3.1.1 Frequent informal contacts between staff

References to informal contacts with colleagues were found across the data corpus. Some of these references implied that such contacts were simply part of the working culture at School 1.

The SSL's observation that she does "[327] a lot of corridor meetings", is triangulated by CT001d's reflection that "[298] because of how we work, and because we very much do have these *ad hoc* meetings all the time... It's very supportive like that, I think."

These comments indicate that these informal contacts arise between teachers as well as between the SSL and a teacher. The head teacher feels that these informal requests for support arise "[291] because of the quality of the relationships here; people trust each other and they don't feel intimidated". The new teachers had noted this openness between their colleagues

for requesting and offering support, with teacher CT001c observing that, “You’re always having to talk in a corridor, it’s one of the best places”, and that her colleagues’ doors were “always open” if she had a question.

The head teacher viewed these brief interactions as significant to teacher development: “[221] It’s the interaction between colleagues; it doesn’t matter whether it’s a flying conversation or a focussed lesson study. It all adds to what you’re doing.” The reason why these brief and informal interactions are so valued is exemplified in CT001d’s comment about approaching a colleague with a question in the corridor:

“[307] We might have a think [together], or someone might say, ‘I’ll give it some thought and come back to you later’... And then later on, someone’s like, ‘I’ve been thinking – try this’... or... ‘have a look at what I’ve done.’”

These brief, informal contacts between teachers are valuable sometimes for the support and reassurance that they offer, but sometimes because of the ongoing nature of the communication; a question that cannot be answered on the spot will be returned to later, after some consideration.

7.3.2 RQ4b) How teachers ascribe value to the learning opportunities identified

7.3.2.1 *Perceived value is influenced by time working in the school and participant’s job role*

All participants in School 1 showed a preference for learning from each other as opposed to solitary learning activities. When asked to choose the most valuable learning opportunity for changing their assessment practice in primary science, there was an interesting divide in the data, however. Responses were influenced by the length of time the participant had worked at School 1 and the participant’s job role.

Two class teachers had recently joined the teaching staff at School 1, and both valued peer support most highly. Teacher CT001c valued the “step-by-step” guidance and “really good tips” that she had been given by her predecessor, whereas teacher CT001e preferred approaching a colleague with a direct question because “[219] it’s more kind of relevant to what I want to know” when compared to the typical content of a staff meeting, adding that he got “a better answer quicker.” Both of these participants were experienced teachers, but had joined School 1 within the last six months. Guidance from a peer was the most highly valued for its specificity to their needs.

The other three teachers had taught for between five to fourteen years at School 1. In contrast to their newly arrived peers, they found staff meetings the most valuable learning opportunity for changing their assessment practice. Teacher CT001b valued staff meetings “[216] because we can talk things through and talk about what’s working, what’s not working, and just hav[e] the time [to] focus”. Teacher CT001a valued staff meetings most highly because “[208] staff meetings are the one time that we can all sit together and share ideas or concerns, or methods of assessing.” For these participants, staff meetings were highly valued because of the forum they provided to discuss and compare practice. These teachers did not raise the issue of specific advice to address specific needs.

The head teacher and SSL, however, both felt that watching another teacher was the best way to improve assessment practice. In the words of the SSL:

“[48] [watching another teacher] is reflective and ... you get excited about a new idea that you suddenly see how you can use it... You get loads of ideas and it’s like, ‘no, no, no, yes – that’ll make a difference in my room’. So yeah, I do think that seeing it helps it come alive; you can see what can be done and the opportunities.”

Thus, although all participants valued social learning opportunities, the value they placed upon the different formats – staff meeting, peer support, observation – seemed to be influenced by how recently they had joined the staff, as well as by job role.

7.3.3 RQ4c) The nature of communication within learning opportunities

7.3.3.1 *Communication tending towards the transactional*

Throughout the data corpus, the communication style during learning opportunities was described as transactional. The SSL described “the way we work in this school” as transactional and collaborative. She also added, “[286] I’m not sure that there’s a lot of, ‘Thou shalt do this’ going on here. I don’t think that happens; it’s not needed, it’s not necessary.” The teachers who had worked at the school for a long time confirmed this. Teacher CT001b described staff meetings about primary science as “[162] mainly transactional, because we’ve looked at the TAPS and then we’ve said you know, ‘how do you think we’re doing with it?’ And then we’ve all inputted and then that kind of sparks the conversation.”

CT001d reflected that, although a staff meeting might commence in a more interactive mode of communication, it would shift to a transactional mode as the teachers become involved:

“[165] Sometimes it will be more ... specific, you know, ‘this is what I want us to think about’, and then we would talk about [it], but it tends to end up as transactional.... If it’s something that we talk about to make us focus on a particular part of assessment, we would then - perhaps with our groups - might all sit and talk together and come up with how we’re going to make that work, and come up with ideas. And then we kind of end up being more discussion based about how we might do it.”

7.3.3.2 Communication preference influenced by the participant’s time at the school

As seen above, the communication style during staff meetings about science assessment was broadly characterised as transactional. A preference for linear communication was shared by the two new members of staff, however. Teacher CT001c stated a preference for linear communication while she was trying to settle in: “[166] I’m having to take over all the subjects so, for me, it sounds terrible but it was easier for me to start off those six weeks just doing as I was told.” Teacher CT001e implied a preference for more instructional communication as he settled into his new role:

“[265] I quite like having someone say, ‘you need to be doing this, are you doing it?’ All that kind of thing, and kind of popping in.”

These comments imply that the newer teachers sought reassurance that they were proceeding in accordance with the expectations of their new workplace. This concern to be fulfilling expectations might be reflected in their valuing of specific guidance from their peers over a discussion of practice, as seen above.

7.3.4 RQ4d) Sources of information and guidance for innovative approaches to assessment in primary science

7.3.4.1 The SSL as a source of new and expert knowledge about science assessment

All participants were asked to specify what resource they turned to – a person, group, website or object - for guidance on innovative approaches to assessment in primary science. Their responses are represented diagrammatically in Figure 10.

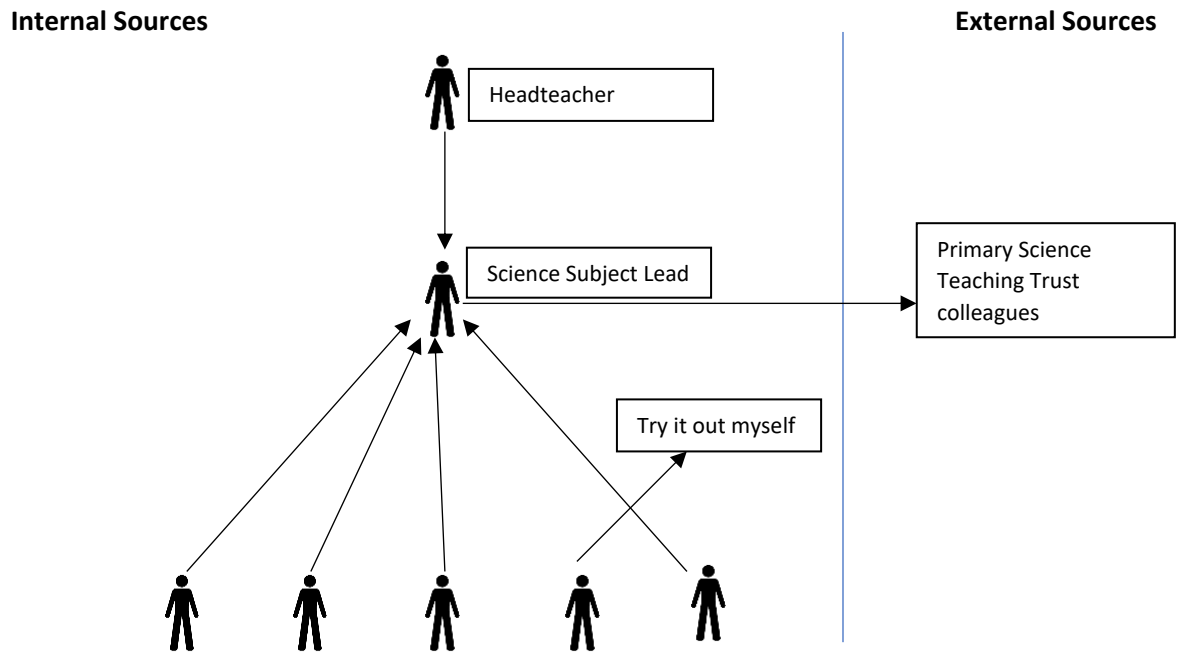


Fig.10: sources of information and guidance for innovative approaches to assessment in primary science at School 1 (Arrow indicates “would go to...”)

The only member of staff who named external sources of expertise was the SSL; she referred to her colleagues within the Primary Science Teaching Trust who are expert teachers of primary science. Overwhelmingly, the other members of staff relied upon the SSL for information and guidance on innovative approaches to assessment; none of them named websites, each other or other external organisations.

7.3.5 Overarching theme: the SSL as a teacher educator

Numerous comments within the data corpus pertained to the SSL, whether in terms of the views of the staff about her role and responsibilities within the school, or the SSL’s own comments relating to those areas. The theme of the SSL as a teacher educator emerged strongly, with the following sub-themes:

- Evaluating colleagues’ skills to provide support
- Approachable expert
- Source of new and expert knowledge about science pedagogy and assessment
- Developing subject leadership

7.3.5.1 *Evaluating colleagues' skills to provide support*

At School 1, the SSL developed other teachers' science practice through a tailored mentoring programme. This was a recognised approach in the school which was supported by the head. All three longer-serving members of staff recalled being mentored by the SSL, all reflecting positively upon the impact that the mentoring process had on their science teaching, such as CT001b's observation that: "[346] She was my mentor and she really supported me... That gave me the confidence to kind of, you know, go forth and teach science on my own."

Considering the needs of the two newly joined teachers, the SSL at School 1 explained: "[335] What I'm doing [right now] is leaving them alone for a little while and then I'll go and work with them a bit on science when they've got their feet under the desk." Acknowledging that she was some way ahead of her colleagues in her knowledge and assessment practice, she also demonstrated a reasonable expectation of what they might achieve:

"[336] I do know that some of the things that I do are not yet something that everybody does. That's something we've already talked about and been open about and they're going to work on it when they get a chance."

This open acknowledgement of diversity indicates that the SSL at School 1 views her colleagues as individuals who are operating at variance to her, and possibly each other. Her attempts to evaluate their teaching practice to provide timely and relevant support demonstrates her use of formative assessment, or evaluating the existing knowledge as compared to the new knowledge she would like to impart to them.

7.3.5.2 *Approachable expert*

In School 1, the SSL was the acknowledged expert within the school on primary science. Teacher CT001a indicated that the other staff frequently deferred to the SSL's knowledge: "[343] Often they say, 'I don't know, let's go and ask [SSL name].... [the others] don't always know the answer so the best person would be to ask [SSL name].'" The head teacher acknowledged that if the SSL left the school, there would be "an enormous void" in the school's knowledge and expertise in this subject. Comments relating to the SSL's approachability are found throughout the data corpus, with both newer and longer serving teachers commenting that they can approach the SSL with questions whenever necessary. This is triangulated by the SSL's observation that she is regularly stopped in the corridor with

questions from colleagues about science, saying that: “[327] I do a lot of corridor meetings.”

7.3.5.3 Source of new and expert knowledge about science pedagogy and assessment

As exemplified by the diagrammatic representation of sources of new knowledge in Figure 10, the SSL at School 1 was the source of new and expert external knowledge about teaching science for all of her colleagues.

7.3.5.4 Developing subject leadership

The SSL at School 1 had taken over the running of a cluster group for the local school consortium, where she had presented the TAPS pyramid as a useful tool for evaluating current assessment practice in primary science, among other things. She also made frequent visits to other schools at the request of other SSLs, to help them with a specific aspect of science teaching. The head teacher’s view on this external work was positive: “[347] She’s developing some really good science leadership with people.”

In summary, the theme of the SSL as a teacher educator includes her formative evaluation of her colleagues’ pedagogy in primary science as well as their assessment practice. She is viewed by her colleagues as a valuable source of information and guidance about all aspects of science teaching and has taken responsibility for sharing good practice beyond the walls of her own school, sharing it through the cluster group that she chairs as well as through her expert visits to other schools.

7.3.6 Overarching theme: transactional talk as a tool for working and learning

Participants were asked to identify the learning opportunities they had had regarding assessment in primary science, and in doing so were asked to characterise the communication style within those activities. As previously discussed, the communication style was described as transactional. Throughout the data corpus for School 1, however, were implicit or explicit references to a transactional style of communication between colleagues.

These references have been grouped into the following sub-themes, which pertain to the different outcomes of the transactional communication between colleagues:

- Staff meetings as a discussion forum
- A culture of questioning
- A tool for negotiation and agreement
- Enabling review and reflection
- Means of deprivatising practice

7.3.6.1 Staff meetings as a discussion forum

Teachers who had worked for a long time at the school referred to staff meetings as their opportunity to share ideas and “[216] talk things through and talk about what’s working, what’s not working.” Teacher CT001c, who had recently joined the school, triangulated this comment: “[300] at staff meetings we talk about the children, where we’re going, what we’re doing”.

Staff meetings were also viewed as an appropriate forum for raising problems, as illustrated by CT001a’s comment about issues that the teachers cannot solve alone: “[304] you’d bring it to a staff meeting... yeah, we’d bring it to a staff meeting and everybody would be into it.” This comment implies that teachers at School 1 are willing to share their problems in a public forum. It also suggests that Teacher CT001a would receive a positive response, benefiting from the engagement of her colleagues.

The purpose of the staff meeting as a forum for discussion was underscored by the SSL’s observations about some resources she had recently created. She approached her colleagues with an idea and took her lead from the staff meeting:

“[284] I’ve just started producing some stuff about writing scientifically to tie in with our writing objectives... We had a discussion and thought it would be a good idea to have something like this available for the children in science lessons... it’s come about collaboratively... I.. had the idea and suggested it to people and ... they’ve all gone, ‘Yeah, go do that, it’s a good idea.’”

7.3.6.2 A culture of questioning

Teacher CT001a comments that, during staff meetings, “[297] we don’t always sit quietly,

surprisingly. So we usually ask questions to clarify – ‘and how is this going to look? What else do we need to change?’”

The head teacher describes the sharing of good practice during staff meetings thus:

“[295] It’s not like a judging of what they’re doing, it’s an asking. It’s a, ‘how are you doing it in this year group? How does it look in this year group? Yes, but also what have you done that’s different and had a good impact?... Has it had a good enough impact that we should all be doing it?’”

These comments indicate that questioning to clarify or exemplify is explicitly encouraged. The two teachers who had recently joined the school felt able to ask questions of their colleagues. CT001d, who has worked at the school for five years, triangulates this viewpoint: “[298] I know that I could go and ask [SSL name] for help at any time, or any of the other teachers”. This implies that the culture of questioning at School 1 extends to a willingness to seek support from colleagues.

7.3.6.3 Talk as a tool for negotiation and agreement

The role of transactional talk in the negotiation and agreement of objectives came out strongly from the data for School 1. There was evidence of transactional talk being used to reach agreement, such as Teacher CT001d explaining what typically happens following a lesson observation:

“[164] It might have been following an observation, you know, ‘I noticed that, you know, this is something that we need to work on,’ but it would always end up in a conversation so, how I think I could do it. And I’d suggest things, or we’d come up with, you know, sensible steps to take things forward.”

This teacher’s use of “sensible” implies that she is comfortable with the decisions jointly reached about how to improve her practice.

When the head teacher reflected upon the positive impact that the TAPS pyramid had had upon the practice of her staff, she made it clear that negotiation through discussion, followed by a shared agreement of how to proceed, had been key:

“[290] All the staff were there and all the teaching assistants were there ... We know what we’re after in science but I think the fact that we did this as a whole teaching

team had a big impact. I don't think it would have the impact if just your science co-ordinator did it on their own and then came up with their action plan. But if you do it with your whole staff team, then you're agreeing what are your next steps."

Teacher CT001b triangulated the head teacher's account of how agreement was reached, summarising the same meeting thus: "[42] We've all got together as a team... We've decided where we are at this present moment in time. And then we've thought about what we need to do to improve."

Transactional discussion has been used in all of these examples, whether between two colleagues or the staffing team, to reach agreement of how to best proceed to solve the issues identified.

7.3.6.4 Enabling collective review and reflection

Talk as a means to reflect upon progress towards a shared goal can be found in the longer-serving teachers' descriptions of using the TAPS pyramid. Teacher CT001b commented that, "[59] It [the TAPS pyramid] is an ongoing tool, so we came back to it several times and thought, 'right, we looked at that last time, have we now improved our practice?'"

Teacher CT001d noted that:

"[57] It's something that comes up quite regularly really in the staff meetings. It's not like, 'oh we've done this once this year, we won't have to think about that for another year', or something.... We do sort of keep on our toes about it."

These teachers' use of "we" implies a collective effort has gone into evaluating and improving assessment practice in primary science at School 1. The reflective process had been noted by Teacher CT001c, who had recently joined the school: "[301] Even if we're doing really well in something... that doesn't mean to say you haven't got anything to work on. I think that's the thing I've got from here, that they're always evaluating what they need to do next."

7.3.6.5 Talk as a means of deprivatising practice

Talk is used in this school as a means of sharing good practice. The SSL says that she often

uses staff meetings “[280] to highlight what others people are doing... ‘Look, this is really good stuff’,” and Teacher CT001a suggested that she would bring problems to discuss at the staff meeting. The head teacher feels that “[291] the quality of the relationships here [mean that] people trust each other and they don’t feel intimidated”. In her view, this leads to a greater willingness to share problems as well as triumphs.

Teacher CT001c, who had recently joined the school, triangulated this observation with her reflection upon the willingness of her colleagues to be approached with questions: “[311] We’ve always got open doors, you can always come and ask each other if you’ve got an issue.” The SSL also noted the willingness of colleagues to ask for and offer support, observing that “[282] people are kind and generous with their time and work at this school.”

7.3.7 Overarching theme: working and learning as a team

There was a strong sense of a team identity in the responses from School 1, such as when CT001b described taking decisions during staff meetings “as a collective” or revisiting the TAPS pyramid to discuss “where we are now”. Sometimes it was implied in managerial decisions, such as the head teacher expressing the view that the teaching assistants should also be involved in decision-making. But the comments of CT001c, who had recently joined the school, were more explicit: “[311] I think we all work together as a team really. I am Class 3 but I’m [School Name]. I think that’s the main message I get from being here the last six weeks, that we’re all working together”.

All the teachers at School 1 described themselves as learners, but within a collective effort to improve their practice. Teacher CT001b summed this up in her comment that “[59] We came back to it [the TAPS pyramid] several times and thought, ‘Right, we looked at that last time, have we now improved our practice?’” These teachers see learning as an inherently social, collective endeavour.

7.3.8 Overarching theme: modelling innovation and agency

The Senior Leadership Team at School 1 model innovation and agency by actively seeking out new ideas and showcasing good practice within the school to the other staff. The head teacher actively encourages this, explaining that this “[296] honours their professionalism a

bit better” than she and the deputy telling them how to teach. The head teacher also expresses a determination to keep her school connected to new ideas and developments in teaching:

“[293] It’s very hard, in a little primary school in the middle of nowhere, to really stay at the cutting edge of what goes on, but that’s been [SSL name]’s and my determination for a long time; that we’re not going to be a school in the middle of nowhere”.

These comments demonstrate a commitment to improving practice and an openness to innovative practice among the senior leadership team at School 1.

7.3.9 Overarching theme: competent practitioners of assessment

Throughout the data corpus, a theme emerged of the participants at School 1 being confident and competent practitioners of formative assessment.

CT001a remarked upon the variation in age and ability between year groups and the need to select appropriate assessment strategies: “[386] Sometimes they can say it and they can’t write it, you know?” She also expressed a view that written testing was inadequate for evaluating practical scientific skills. CT001d described how she used formative assessment strategies to check the children’s recall of previous learning and build in opportunities to expand upon their thinking during the lesson. CT001c reflected upon how using a range of open and closed questions helped her establish who needed additional support and who could work independently: “[389] Some of them really rely on you telling them how to conduct a fair test, what you’ve got to include.... Whereas the others, I think, are quite capable of coming up with their own question of what they’re investigating, deciding on their method.”

The head teacher and SSL both triangulated these viewpoints when they said that engagement with the TAPS pyramid had helped to fine-tune and build upon existing assessment practice in the school, rather than using it to explain the basics of formative assessment practice. This finding is also triangulated by the documentary analysis which indicated that ongoing formative assessment of progress took place across all subjects.

7.3.10 Overarching theme: high priority given to science

There was a clear impression within these data that the subject of science mattered at School 1. CT001d observed that, “[403] Science is very important [here] and the school places a lot

of focus on it, so we've had lots of training opportunities... I know of colleagues in schools where they don't really talk about science at all." A similar comparison was made by CT001b, who said, "[402] as a school, we do a lot and we're probably a bit further on than most schools are.... For us, you know, science really is a core subject." The head teacher agreed that it was treated as a high priority in their school curriculum, describing science as being "[399] as essential as English and Maths". She also worked as an Ofsted inspector and described the science teaching she often saw in other schools as "[397] a catalogue of rubbish," but explained its lower priority in those schools as resulting from the abolition of SAT testing:

"[394] I think that the minute you say there's no science test, it gets relegated to Geography, History, Music.... I think the message people got was it's not important because it's not being tested."

Science was therefore a priority subject at School 1, but the participants expressed a view that this was not necessarily the case in other schools.

7.3.11 Summary of findings for School 1

In summary, the following themes have been identified in the qualitative interview data.

RQ4 sought to define the learning opportunities available in the case study schools for teachers to improve their assessment practice using the TAPS pyramid, as well as understanding the value placed on those learning opportunities by the teachers. These data showed that the value placed on learning opportunities varied with job role and time working at the school, with the senior leadership team valuing observing an expert peer teaching most highly, the longer serving teachers valuing staff meetings most highly, and the two newest teachers valuing peer support most highly. All participants expressed a view that they learned from interacting with their peers, however.

RQ4 also sought to specify the nature of the communication within those learning opportunities. Communication between participants at School 1 was found to tend towards the transactional, no matter what the context. The two newest teachers expressed a preference for more linear communication, however, which made the school's expectations and their responsibilities clearer to them.

The SSL was found to have the role of teacher educator in School 1, taking responsibility for defining the teachers' development needs and planning support. The SSL was also responsible for developing the leadership of other SSLs in the region. She was recognised within the school as an approachable expert in her field and was the main source of new and expert knowledge about science pedagogy for the rest of the staff.

An overarching theme of transactional communication as a tool for working and learning was also found in the data. A culture of questioning, alongside transactional talk being used as a tool for negotiation and agreement was found. Transactional talk was used to discuss practice, negotiate shared goals and enable collective reflection upon progress against them. This was often within the forum of the staff meeting, but transactional communication took place through other formal contacts too, however, such as feedback on a lesson observation, and through non-formal contexts too such as peer support and ad hoc support from the SSL.

A strong sense of team identity was found in the data, along with a collective learning ethos, which was reflected in the way that they had been involved in the decisions about how they would use the TAPS pyramid to improve their science teaching as well as reviewing and reflecting upon progress. The use of the TAPS pyramid may have hinged upon the fact that the teachers were competent practitioners of formative assessment and its was being used to improve existing skills, rather than inculcate them. The school also prioritised the subject of primary science within their curriculum.

7.4 Contextual data for School 2

This was a small rural school in Devon with four mixed age classes and 98 pupils on roll. The school was part of a Federation which links together several small schools with rural catchments in the region. The school is a Church of England school and was rated Outstanding during the last SIAMS inspection. Ofsted rated the school Good in 2017. Seven percent of pupils were eligible for Pupil Premium. A summary of the documentary analysis for School 2 can be found in BathSPAdata.

There were five participants at School 2: three class teachers, one Science Subject Lead (SSL) and one head teacher.

7.4.1 Vignette of the Science Subject Lead's career and use of the TAPS pyramid

The SSL's background in science extended to A levels. She initially went into teaching as a PE teacher, then changed to teaching maths. She became Deputy Head in a middle school, followed by headships at two schools before retiring. She took up the post of SSL at the case study school upon her retirement and has held it ever since. She described herself as self-taught.

She saw her core responsibilities as: ensuring that she has good subject knowledge to teach primary science; ensuring that the teachers have good subject knowledge; developing her colleagues' teaching skills and assessment repertoire; and extending their repertoire of practical activities to demonstrate scientific concepts. She also mentored the science subject lead at their sister school and led a cluster group of SSLs in the local area.

The SSL discovered the TAPS pyramid at a termly briefing meeting for Science Subject Leads. They had a half hour input from a presenter and were then given time to access it on the internet and think about how to use it in their settings. This was followed up at next term's briefing, when the same presenter encouraged them to bring examples of how they had used it. The SSL presented the TAPS pyramid to her colleagues at her next school staff meeting. Everyone was given a paper copy. They all agreed "across the board" that it fitted nicely with their existing aims for assessment. She initially understood it to be a tool for evaluating practice and raising awareness of appropriate formative assessment strategies to use in the teaching of primary science.

The SSL has also taken it to her cluster group (6 schools other than her own) and shared it there.

7.5 Thematic analysis of School 2

7.5.1 RQ4a) Opportunities identified to learn about assessment practice in primary science

All participants felt that they had participated in staff meetings and INSET or Twilight sessions to support their learning about assessment in primary science. All participants also reported receiving or providing peer support, and all reported referring to the SSL for support on an *ad hoc* basis. Some mentioned lesson observations as a source of learning about assessment practice, and some felt that they had benefited from specific mentoring from the SSL with regard to evaluating and improving their use of formative assessment strategies.

7.5.1.1 Frequent informal contacts between staff

All participants gave examples of frequent informal contacts as learning opportunities for improving their assessment practice, such as approaching a colleague with a question or *ad hoc* advice from the SSL.

When asked if she was approached by other staff in the corridor with questions about science, the SSL replied, “[326] Yes... that’s always happening.” She also added that they discussed issues during lunchtimes in the staff room. CT002b characterised their workplace as “chatty,” saying that it was easy to approach her colleagues for advice because “[310] we’re always chatting to each other anyway.”

The SSL considered aloud whether the size of the school made informal contacts easier, but decided that there was a conscious effort being made by all: “[328] You can’t afford to fall out with anybody. It’s not about being best friends, it’s about all getting along and it’s about all moving together.” This view is triangulated by CT002b, who observes that working in a small school “[324]can be very isolating, but it’s not [here]”, once again implying that it is not the size of the school *per se* that dictates the frequency and friendliness of communication between colleagues, but the conscious effort made by those working within it to establish and maintain informal communication networks.

7.5.2 RQ4b) How teachers ascribe value to the learning opportunities identified

The following themes were identified in relation to how teachers at School 2 valued the learning opportunities they participated in for changing their assessment practice in primary science:

- Relevance
- Learning with and from their peers

7.5.2.1 *Relevance*

All the class teachers at School 2 valued learning opportunities that seemed pertinent to their immediate concerns or teaching responsibilities. Teacher CT002c valued learning opportunities which provided ideas that she could apply to her teaching straight away. Teacher CT002a was particularly concerned with knowing what was expected of him in his role: “[237] the most valuable [learning opportunity] to me would be staff meetings at this school, because it’s how the school wants it, isn’t it?” He also felt, like CT002b, that being able to apply what he had learned made the learning more relevant and useful; he recalled some training which had been done at the end of the Summer term “[253] and by September I didn’t remember any of those warm-up activities, and I didn’t remember what we’d done. So, from that perspective, it was a waste of time.”

CT002c, who had been working at the school for less than six months, also valued learning opportunities with highly relevant content. She did not feel that staff meetings, where “[238] one person [is] leading a meeting and everyone else is listening to what they’ve got to say,” were the best format for learning, however. Instead, she valued peer support most highly, as the new teachers at School 1 did, finding that peer support offered her more relevant information to her needs because: “[240] it’s a bit more ‘real life’”.

7.5.2.2 *Learning with and from their peers*

All participants valued learning opportunities which involved discussion with their peers. Referring to a recent INSET day, during which she had worked with teachers from other schools as well as her own, CT002b said:

“[232] You’re actually going through doing what the children would be doing and then able to talk about it and discuss how it’s impacted. And us working out what’s good about it, what’s powerful, how you would employ it in the classroom, so it’s all very discussion-based”.

The head teacher triangulated this view of learning as a social process, but also collaborative, noting: “[243] you’re getting people to work together, to some extent have fun, but also, appreciate the opportunities for formative assessment and the value of doing that”.

7.5.3 RQ4c) The nature of communication within learning opportunities

7.5.3.1 *Communication style varies according to context and level of prior knowledge*

The teacher participants felt that the communication style during learning opportunities varied. Teacher CT002a expressed the view that:

“[191] for certain things, it would just be interactive in terms of ‘this needs to get done, any questions, any problems?’ whereas [for] some things it’s like, ‘okay, we want to improve our science practice, what ideas have people got?’ and then that makes it more transactional.”

This indicates that the communication style varied based on whether the senior leadership team was telling the staff to do something, or was asking for their input.

The SSL also felt that the communication style varied, but according to the level of knowledge and understanding among those with whom she was communicating:

“[189] When I was first introducing TAPS, it was very much linear, then they went away, but when they came back, that was the point where it became more interactive. We said, “right, six weeks, come back with an example of something you’ve done, let’s have a look and see how you’re finding it”. So then it became interactive”.

According to the SSL, as the level of understanding among the teachers changed, the teachers were able to bring examples from their developing practice to discuss. This led to a more interactive communication style between her and her colleagues.

7.5.4 RQ4d) Sources of information and guidance for innovative approaches to assessment in primary science

7.5.4.1 *The SSL as a source of new and expert knowledge about science assessment*

All participants were asked to specify what resource they turned to – a person, group, website or object - for guidance on innovative approaches to assessment in primary science. Their responses are represented diagrammatically in Figure 11.

One of the teachers referred only to the SSL for innovative approaches to science assessment, but the other two teachers also used teacher friends and websites as external sources of information. The head teacher referred to the SSL as well as websites, but the SSL was the only participant at School 2 with access to a range of external and expert sources of guidance, including secondary school science teachers, the members of the cluster group she chaired, the other teachers at the science subject lead briefing meetings, or an educational consultant specialising in primary science.

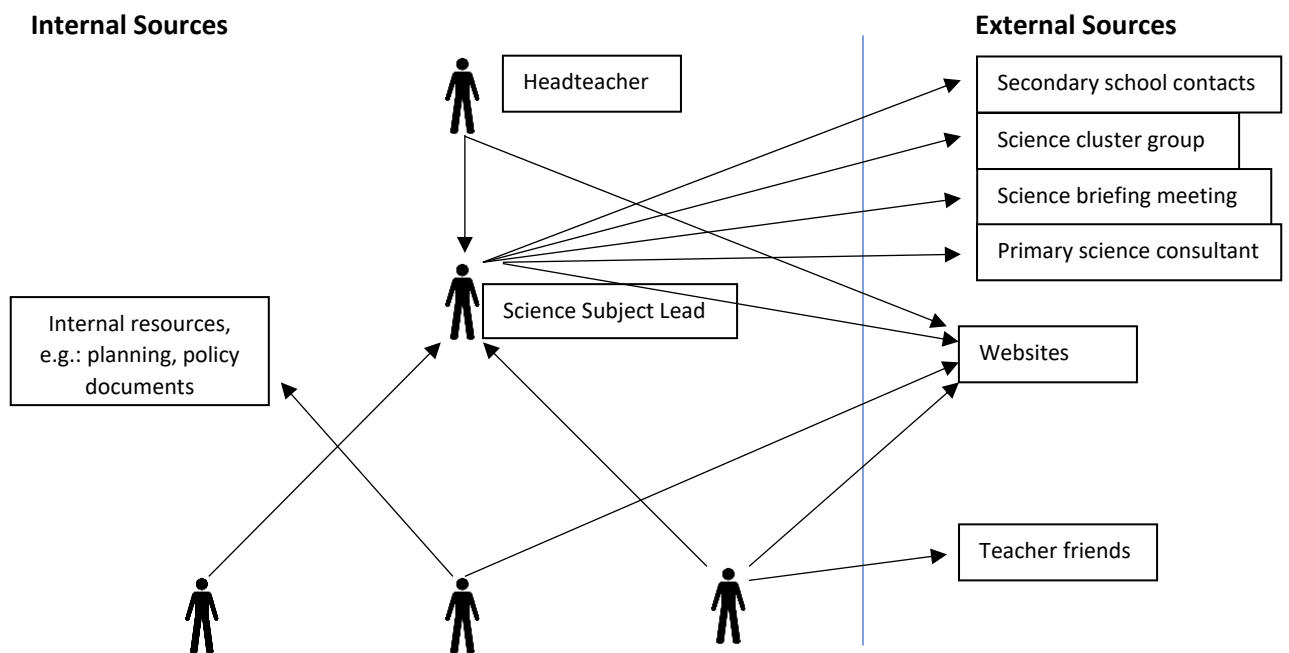


Fig. 11 sources of information and guidance for innovative approaches to assessment in primary science at School 2 (Arrow indicates “would go to...”)

7.5.5 Overarching theme: the SSL as a teacher educator

A considerable body of interview data pertained to the SSL, whether in terms of the views of the staff about her role and responsibilities within the school, or the SSL's own comments relating to those areas. What came across very strongly was the sense of the SSL as not being merely a source of information about her subject, but also a teacher educator.

The following sub-themes were found in the theme of the SSL as a teacher educator:

- Evaluating colleagues' skills to provide tailored support
- Approachable and authoritative
- Source of new and expert knowledge about science pedagogy and assessment
- Developing subject leadership

7.5.5.1 *Evaluating colleagues' skills to provide tailored support*

Throughout her accounts of working with the SSLs at her cluster group, her partner school or colleagues at the case study school at her own school, a theme emerges of the SSL evaluating the development needs of others to plan appropriate supports.

Discussing a teacher who had only recently started teaching science, she reflected: “[421] He has only just met science and has only just started with all this [the TAPS pyramid]”, adding; “[428] my expectation has to be right as well, I can't expect him to do [all] that.”

The comments above indicate that the SSL at School 2 views teacher development as a gradual process. She uses the TAPS pyramid to formatively assess their assessment practice before deciding how to support them, and in doing so she observes that whole-school teacher development is an ongoing, sometimes repetitive process:

“[422] Where we were, even a year ago, is actually quite different to where we are at the moment, because we've had changes in staff, we've had changes in roles of staff and some people who were teaching science now aren't, and some people are now teaching science who weren't before.”

She also evaluated the limits of her own expertise. When talking about developing topic planning with the Key Stage 1 teachers, she said:

“[331] I came back with the skeleton [topic plan] and they filled in the meat of it, so I would say it was definitely a two-way communication, because I am not an early years or Y1/2 specialist... [They] are the people who can actually say, “Well, I can see the science that needs to be got across in that, but [the children are] not going to be able to do that.”

These comments demonstrate an awareness of how her colleagues’ needs, experience and aptitudes vary, how teachers’ changes in circumstances can affect their professional development needs, and how her expertise can be limited in some areas.

7.5.5.2 Approachable expert

All participants viewed the SSL as approachable and helpful. In the words of CT002a: “[351] I say, ‘help me, help me [SSL name], what do I do for this? I’m teaching this, how do I do it?’ and she’s just full of great ideas.” He also felt that she listened to the issues he raised and responded to them. The head teacher also approached the SSL with questions, on the assumption that she would point him “in the right direction”. There was some deference among participants to the SSL’s perceived expertise, however; Teacher CT002c would discuss new ideas with the SSL before trying them out, so that the SSL could judge their merits, and Teacher CT002a noted that if he approached the head teacher with a question about science, “[333] he’ll just say, ‘go and see [SSL name].’”

7.5.5.3 Source of new and expert knowledge about science pedagogy and assessment

As we have already seen in 7.5.4.1, the other participants had far less access to external expert sources of knowledge about primary science than the SSL, and seemed to be dependent upon the SSL for new and innovative ideas about primary science. The head teacher of School 2 acknowledges the role that the SSL plays in bringing new and expert knowledge about teaching science into the school, describing her as “an information source” and a “conduit”.

7.5.5.4 Developing subject leadership

The SSL at School 2 was not only responsible for developing the assessment literacy of the teachers in her school. She also chaired a cluster group of SSLs from schools in the region, and had assumed the responsibility for evaluating their professional development needs and

planning appropriate supports: “[105] At the cluster group I use [the TAPS pyramid] for my agenda and working through, having done an analysis of what the other schools need and with them coming to me and saying, ‘I would really like some help on this,’ ...I come up with a visitor to talk to us.” She had also mentored the SSL at a nearby school.

7.5.6 Overarching theme: teachers learning from each other

All the participants in School 2 valued learning opportunities where they could interact with their peers. None extolled the virtues of studying or reading alone. When asked to describe a learning experience that they would *like* to have for developing their assessment practice, all the teachers suggested an activity that involved observing and discussion, such as Teacher CT002c’s view on learning walks:

“[196] I think it’s probably one of the most helpful things to do, is just to see what other people are doing in their classrooms. And then... the reflection after that and discussing it professionally in a staff meeting or whatever and talking about what you’ve seen.”

The other participants at School 2 shared CT002c’s view that one learning activity complemented the other; the value of observing another teacher’s practice was increased by being able to talk about it afterwards, clarifying and making sense of what they had seen.

7.5.7 Overarching theme: a reflective workplace

The word “reflective” was used to describe the workplace or methods of working by several participants at School 2. Teacher CT002b felt that the INSETs planned by their staff offered the opportunity to reflect upon teaching practice. She also felt that the small size of the staffing body meant that “[312] We have to be reflective and we won’t do something if we don’t see the value in doing [it].” This implies that a reflective discussion process helps the staff at School 2 to make better decisions about how to use their finite human and physical resources. The head teacher also felt that teachers learn “[55] by having an opportunity to reflect.”

7.5.8 Overarching theme: competent practitioners of assessment

A high level of assessment literacy was demonstrated by all participants, from the head teacher referring to research by the Education Endowment Foundation into formative assessment strategies, to teacher CT002c giving the following impromptu explanation of the TAPS pyramid:

[87] “Well, from what I see of it is that it’s how to use all of your formative assessments and how to actually make those formative assessments is at the bottom and how that builds up into the summative assessments that you make of the children and the final assessments, which doesn’t necessarily have to be at the end of the term or the year. It could be at the end of a unit or, I guess, even halfway through, to see where the gaps and misconceptions and things are, which, I guess, then, once you’ve made the summative assessments, feeds back down into the planning and start again with the formative assessment.”

The above quote illustrates a competent working knowledge on the part of this teacher of the rationale and outcomes for using formative assessment.

Teacher CT002a described using formative assessment as “[379] ‘standard teaching’ things; you do an elicitation, you find out what they know, you then take it the ways that’s interesting to them or what they need to know – I would say that would be natural in any lesson”. His use of the words “standard” and “natural” to describe the use of formative assessment in teaching imply that he views such activities as essential components of his routine teaching practice. The head teacher’s comments that the TAPS pyramid have “sharpened up” and “tightened up” assessment practice in his school triangulate this interpretation.

7.5.9 Overarching theme: science is important but under pressure

According to the participants at the second case study school, the subject of primary science was important and enjoyable to teach, but it was under pressure from other subjects in the curriculum. All the teachers referred to the fact that, although it was a core subject, it did not have the same status as the other core subjects which were tested. One teacher put it this way:

“[384] How can I do an analogy? You’ve got your Premier League – your Maths, your English – and you’ve got your Championship – your science and your RE and PE. And then, underneath, Topic, Art, and things like that. It is very much Championship and it always will be.”

CT002c reflected upon the pressure from national education policy to cover certain curriculum areas over others: “[208] I know science is a high priority, but at the end of the day, maths spelling, writing and reading are the ‘big four’ that the government wants us to focus on.”

The SSL also described having to “fight” for the time to discuss her subject within the limited confines of the time allocated for staff meetings, during which many other priorities must be discussed. She expressed frustration with having to wait for a slot to come up for discussing science, reporting an imaginary conversation between herself and the head teacher:

“[395] I’m still waiting for a staff meeting time when I can...’but you had one last term’. ‘Yes, I did have one last term but I was re-introducing things and now I want to do some practical and I want to show how useful it is.’”

This comment also triangulates the earlier interpretation of SSL’s view of teacher development as an ongoing process, requiring the revisiting of material that has been covered previously.

7.5.10 Summary of findings from School 2

In summary, the following themes have been identified in the interview data for School 2:

RQ4 sought to define the learning opportunities available in the case study school for teachers to improve their assessment practice using the TAPS pyramid and to understand the value placed on those learning opportunities by the teachers. A wide range of learning opportunities were identified, all of which involved interaction with others. The opportunity to learn alongside their peers was highly valued, as was the perceived relevance of the learning opportunity. However, the newest member of staff felt that the most relevant learning opportunity was when she discussed an issue with a colleague, one-to-one. As in School 1, the preference for the format of learning opportunity varies across the staffing body and seems influenced by how recently the participant started working at the school.

RQ4 also sought to define the nature of the communication within those learning opportunities. All participants felt that communication was occasionally linear but more frequently interactive or transactional. It was felt that the context of the learning opportunity defined the communication style, such as a linear mode for meetings where the teachers were told what to do, and interactive when their input was sought. The SSL felt that the factor

which affected the communication was the teachers' understanding of what was being discussed. As their knowledge increased, the communication became less linear or instructional and more interactive as they brought their ideas and experiences to bear upon the discussion.

RQ4 also looked at the sources of information and guidance available to participants in the case study school. Although some teachers cited websites or teacher friends as external sources of knowledge and ideas, the SSL was the only participant who had access to several external human expert sources of knowledge about science.

As in School 1, an overarching theme of the SSL as a teacher educator was found. This entailed evaluating the assessment literacy among her colleagues and devising appropriate interventions, while remaining mindful of the limits to her expertise and the knowledge held by her colleagues. The SSL was also portrayed as authoritative and approachable in the words of the other participants.

Participants' responses across the data corpus indicated that they felt that they learned primarily from each other, and this learning might have been aided by the easy and frequent informal contacts that participants described, in addition to formal contacts such as staff meetings and INSETs.

7.6 Summary table of cross-case and single-case themes in the data

A table to summarise the cross-case and single case themes relevant to RQ4 follows. This in turn will be followed by a full discussion of the results, how they relate to the existing literature, and the implications of these findings.

RQ4a): Opportunities identified to learn about assessment practice in primary science	
Cross-case theme:	
<ul style="list-style-type: none"> • Learning with and from colleagues • Frequent informal contacts between colleagues 	
RQ4b): How teachers value learning opportunities	
Cross-case themes:	
<ul style="list-style-type: none"> • Opportunity to learn with peers valued • Newest teachers value peer support most highly 	
Single case theme: CS1	Single case theme: CS2
<ul style="list-style-type: none"> • Value is influenced by job role 	<ul style="list-style-type: none"> • Relevance is highly valued
RQ4c): Communication style within learning opportunities	
Single case theme: CS1	Single case theme: CS2
<ul style="list-style-type: none"> • Tending towards transactional • Communication preference influenced by participant's time working at school 	<ul style="list-style-type: none"> • Communication style dependent on learning context (teacher participants) • Communication style dependent on level of existing knowledge (SSL)
RQ4d): Sources of information and guidance about primary science	
Cross-case:	
<ul style="list-style-type: none"> • The SSL as a source of new and expert knowledge about science pedagogy and assessment 	
Over-arching theme: across both cases	
<ul style="list-style-type: none"> • The SSL as teacher educator <ul style="list-style-type: none"> ○ Evaluating colleagues' skills to provide support ○ Approachable expert ○ Source of new and expert knowledge about science pedagogy and assessment ○ Developing subject leadership • Teachers learning from each other • Competent practitioners of formative assessment 	
Single case overarching theme: CS1	Single case overarching theme: CS2
<ul style="list-style-type: none"> • Primary science: prioritised • Transactional talk as a tool for working and learning <ul style="list-style-type: none"> ○ Staff meetings as a discussion forum ○ Dynamic and ongoing communication between colleagues ○ A culture of questioning ○ Talk as a tool for negotiation and agreement ○ Enabling collective review and reflection ○ Talk as a means of deprivatising practice 	<ul style="list-style-type: none"> • Primary science prioritised, but under pressure • A reflective workplace
Single case overarching theme: CS1	
<ul style="list-style-type: none"> • Working and learning as a team 	

Table 12: cross-case themes and single case themes, grouped by RQ4 sub-question or overarching theme

7.7 Discussion of Step 3 results

The cross-case findings of Step 3 will be discussed below with reference to the wider literature, as the following themes:

- Teachers prefer different communication and learning formats, based on time served at their school
- Formative evaluation of existing knowledge can influence the communication process
- Transactional communication underpins whole school changes to assessment practice
- Teachers value informal contacts as part of their learning process
- Primary science has a high priority in the local curriculum
- Competent practitioners of formative assessment

A general discussion of the findings from all three steps of the study will follow in Chapter 8.

7.7.1 Teachers prefer different communication and learning formats, based on time served at their school

Across both cases, the recently joined teachers valued peer support most highly for learning. One openly queried the value of staff meetings “when there’s one person talking and everyone else is listening”. Her critique implies a more linear communication style during staff meetings which prevents the other attendees from interacting, but it also contains an assumption on her part that a more interactive format is better for her learning. The longer-serving participants across both cases valued the staff meeting or INSET training most highly as the learning opportunity for changing their assessment practice, viewing it as an opportunity to compare their practice to others’ and learn from their peers.

These findings indicate that an open discussion of practice, as might be provided by the forum of the staff meeting, might not provide newly arrived teachers with the specific supports that they need; indeed, they might not feel secure enough in their new role to talk with sufficient openness about their practice to be able to benefit from the process. This interpretation is strengthened by the linked finding that two newly arrived teachers expressed a preference for linear communication (Harris and Nelson, 2008). These participants felt that it helped them to understand what was expected of them, and they sought this clarification through peer

support, such as one-to-one conversations with a colleague.

These findings about learning preferences support the view that teachers prefer to learn from and with each other (Hood, 1990; Desimone, 2009; Gassenheimer, 2013). But what they also highlight is the diversity within that preference, including a wish for more directive communication and more private supports for experienced teachers who are newly arrived at a school, than for their more established counterparts.

7.7.2 The formative evaluation of existing knowledge can influence the communication process

Both SSLs described how they had held meetings with their colleagues, firstly to present the TAPS pyramid and discuss its possible use with reference to improving assessment practice, but also to revisit and reflect upon progress over time. In School 1, this was done within an inherently transactional communication style that was identified by all participants. In School 2, however, the SSL described modifying the way in which she communicated with her colleagues from a more linear and instructive approach when she assessed her colleagues' understanding as limited, to a more interactive style as her colleagues' knowledge and experience increased. This finding suggests that, in assessing the novelty of the new knowledge she wished to transfer, she also modified her communication style.

This indicates that, when the difference between the knowledge held by the actor transferring and the audience she is transferring to is perceived to be high, the actor transferring the knowledge might not opt for the transformational process which Carlile (2002; 2004) would have specified as optimal. Instead, in adopting a linear communication style to transmit her knowledge, she omits the persuasive and negotiated elements of the transformational transfer process (ibid.). The opportunities, within the transfer process that she used, for the audience to ask clarifying questions or check details are clearly reduced, however, and this might impact upon the effectiveness (Cross, Borgatti and Parker, 2002) and ultimately, upon the extent to which dissemination for action (King, 2003) can be achieved through that knowledge transfer.

This finding does not invalidate Carlile's model, which was specified to help understand why the transfer of innovative knowledge sometimes fails. But in demonstrating that an accurate evaluation of novelty does not automatically lead to the actor selecting an optimal transfer process, it illuminates Hargreaves' (1999) observation that the same initiative can transform practice in one school, yet sink like a stone in another. Perhaps the reasons for Hargreaves'

observed phenomenon are not solely related to the specifics of the school setting and the complex interpersonal dynamics of the staffing body (Kemmis et al., 2014a) but also the extent to which the SSL (or other actor holding the new knowledge) accurately evaluates the diversity of existing knowledge among her colleagues and selects optimal transfer strategies to convey the new knowledge.

Considered alongside the noted diversity of learning and communication preferences within the participants in this final step of the study, these results show that the ability to formatively assess existing knowledge becomes imperative to the success of dissemination for action; this is because it allows for the provision of learning opportunities which not only contain content appropriate to the learners' needs, but are delivered in a format within which they like to learn. And by implication, it also demonstrates that a high level of skill is required on the part of the actor attempting to transfer new knowledge across a boundary (Akkerman and Bakker, 2011).

7.7.3 Transactional communication underpins whole school changes to assessment practice

Across both case studies, participants identified the style of communication during learning activities to help them develop their assessment practice as being transactional or interactive (Harris and Nelson, 2008), such as in School 1, where the various learning and decision-making processes described in their schoolwide efforts included: asking questions; collective negotiation and agreement of goals; and the regular review of progress by the whole staffing body, or in School 2, where the communication during peer support and *ad hoc* support was characterised as transactional.

It is, of course, no secret that teachers learn from collaboration, discussion and observation of others' practice (Hodkinson and Hodkinson, 2005; Vescio, Ross and Adams, 2007). Nor is it a shock that how teachers communicate is key to the learning that might be achieved; Littleton and Mercer (2013) and Popp and Goldman (2016) have used discourse analysis to clearly demonstrate that greater co-construction of knowledge and problem-solving can take place when certain types of discourse moves are used by the teachers working together.

Where this study contributes new knowledge is through its demonstration that the inherent communication style between colleagues, within and outside of mandated learning opportunities, might enable the learning processes necessary for a whole school change to a

pedagogical practice such as assessment of pupil progress in primary science. In doing so, it demonstrates how a “complex, dynamic, irreversible, ongoing, contextual and simultaneous” (Harris and Nelson, 2008, p.17) style of communication between colleagues in a school can facilitate professional learning, enabling the discussion, definition and negotiation processes which facilitate school-wide changes to assessment practice. In doing so, it exemplifies the enabling role of transactional communication within the transfer of new knowledge, and by implication the role played by transactional communication in enabling dissemination for action (King, 2003).

But while a transactional style has been shown in this study to underpin group learning and decision-making processes, there is plenty in the literature to suggest that communication within a group of teaching professionals is not inherently transactional (Wood, 2007; Graham, 2007). They may therefore need support in developing a mode of communication more conducive to the co-construction of knowledge and problem-solving (Littleton and Mercer, 2013). And, as demonstrated elsewhere in these findings, newly or recently arrived members of staff may not respond as positively to an open, discursive learning forum as their more established peers.

7.7.4 Teachers value informal contacts as part of their learning process

In its attempt to define the nature and format of the social learning opportunities entailed in the dissemination of new ideas about practice within a primary school, this analysis has demonstrated that informal contacts between colleagues were frequently reported and highly valued. All participants valued the informal contacts that they had with their colleagues, expressing the view that they were able to approach each other with a question at any time. The perception that this type of support was available whenever needed seemed more important than the depth of expertise received through the contact, suggesting that being able to seek support from a non-expert in primary science might fulfil another need, such as clarification of aims (Cross, Borgatti and Parker, 2002), checking their appropriation of the resource against a colleague’s (Szulanski Cappetta and Jensen, 2004), and in doing so, reinforcing the sense of collective endeavour or intersubjectivity (Ryder and Campbell, 1989).

In demonstrating the significance of informal contacts to teachers learning to change their practice, this finding supports the view that frequent informal contacts can improve clarity of intention between colleagues, thereby improving the spread of innovative knowledge

horizontally and vertically within an organisation (Cross, Borgatti and Parker, 2002). This analysis contributes to the knowledge by demonstrating that, in addition to the transfer of innovative knowledge in business organisations, such contacts are also a crucial part of the internal dissemination of knowledge between teachers in a primary school workplace. It also demonstrates that, in the case of the newly arrived teachers, the benefit of the informal contact was the specificity of the knowledge being transferred, which participants did not feel that they could obtain through the formal contact of the staff meeting (Aalbers et al., 2014).

The head teacher of School 1 opined that her teachers were willing to approach each other with questions because of the high level of trust between them. This is in accordance with Szulanski, Cappetta and Jensen's (2004) view that frequent informal contacts between colleagues working in the same business organisation can develop trust, but can also be linked to the school as a workplace with reference to Tschannen-Moran's (2000) finding that mutual trust between stakeholders in US schools leads to a greater willingness to work collaboratively. This analysis contributes the finding that the virtuous circle identified by Tschannen-Moran (2000) could also be applicable to education practitioners working in the same school, and therefore might be ripe for cultivation by the school leadership.

It is therefore argued that informal contacts between colleagues are a key part of the knowledge transfer process for research outputs aimed at changing practitioners' practice within an English primary school, and as such they can be considered an important part of achieving dissemination for action (King, 2003). There is plenty of research into how to structure the formal contacts mandated by job role and responsibility (Adler and Borys, 1996) for education practitioners, so that they might result in practitioner learning (see Dooner, Mandzuk and Clifton, 2008; Kools and Stoll, 2016), but there is little that acknowledges the role of informal social contacts. This may well be due to their spontaneous nature, rooted as they are in temporary alliances and mutual interests (Gulati and Puranam, 2009). But further scholarly endeavour might recognise these informal contacts as a key part of the learning process among teachers attempting to change their practice at a schoolwide level, and explore the wider workplace conditions which might encourage or enable them (Fuller and Unwin, 2004; Hodkinson and Hodkinson, 2005).

7.7.5 Primary science has a high priority within the school curriculum

Another finding across both cases was the relatively high priority afforded to the subject of primary science, in spite of participants also alluding to its diminished status following the abolition of SAT tests in 2009. A view was expressed across both cases that this prioritising of the subject was at odds with what happened in other schools, a view confirmed by the Wellcome Trust (2017) and the schools inspectorate (Ofsted, 2018). Across both cases, the SSLs expressed the view that science was a crucial part of a child's education, confirming the notion that the priority given to primary science tends to be driven more by the enthusiasm and drive of the subject leader than its status as a non-assessed core subject (SCORE, 2013).

When this finding is considered in the wider context of achieving dissemination for action, it underscores Valente and Davis' (1999) view that the advocacy, articulacy and persuasive skills of the target audience for a resource should be considered carefully by the project team disseminating their findings; if the target audience members will ultimately be responsible for disseminating the knowledge within the resource, as was the case with the TAPS pyramid, then an audience which possesses the requisite skills should be selected. This will be considered in more detail below.

7.7.6 The role of the SSL in knowledge transfer and teacher learning

The SSLs in the case studies not only had access to more external expert sources of information about primary science teaching than their class teacher or head teacher counterparts; they were also the only people in their schools with access to such knowledge. This led to a dependence, expressed across both cases, of the other staff upon the SSL for innovative ideas and practice in primary science teaching. As such, the SSLs in these case studies played a crucial role in bringing new knowledge about the TAPS pyramid to their schools. In finding and bringing the resource to their colleagues, they were also responsible for articulating its potential value and leading the efforts to implement it.

When it comes to the generalisability of this finding, it should be treated with caution, however. Both SSLs were either serving or had served in a senior leadership role; one had previously been a head teacher and the other was currently the deputy head of her school. They were also involved in mentoring and developing the leadership skills of other SSLs in their region. As such, they were likely to have developed some or all of the interpersonal and

managerial skills which would help them to articulate new ideas, lead initiatives and provide support, thereby advocating for their subject (Wellcome Trust, 2010).

This is in marked contrast to the situation in most primary schools, where science is led by non-specialist class teachers (Mackintosh, White and Dickerson, 2016), only 52% of whom might have received training in subject leadership or subject knowledge in the previous twelve months (Wellcome Trust, 2017). There is no mandated national training programme to develop subject leadership among SSLs, and we have already seen how in-service professional development for primary teachers in the state sector is increasingly restricted by budget cuts (Richardson, 2017). This finding therefore begs the wider question of whether the target audience members for our research-derived outputs have the ability to digest the key messages, repackage them in a palatable format for the school leadership, accurately assess the support needed by their colleagues in enacting them, and then provide that.

If we are asking more from our SSLs than the skills laid out in the Subject Leader guidance (for example, Department for Education and Skills, 2001; Ofsted, 2013) we might need to provide some form of professional development which helps them to achieve these goals on our behalf, alongside an explanation of how the research output might be used.

Put bluntly, the more work we ask the target audience to do, the harder we make it for them to disseminate our ideas successfully (Moore, 2006), and the less likely it is that dissemination for action (as opposed to dissemination for understanding) will be achieved. Most schools do not have a former head teacher or deputy head in the role of SSL, and consideration needs to be given to the assumptions we might make about the communicative, advocative and organisational skills of the target audience for our research innovation.

7.7.7 Competent practitioners of formative assessment

Across both cases, participants felt that interaction with the TAPS pyramid had improved their existing skills in formative assessment. Class teachers gave examples of augmenting and extending existing practice and the head teachers referred to the previous formative assessment practice being ‘sharpened’ or ‘tightened’. As previously discussed, this is a resource with a fundamentally open character (Nordholm, 2016) which has been variously used to improve assessment practice, depending on the experience or job role of the user (Hopwood-Stephens 2018b). This finding therefore indicates that it could be useful to those

who already have a sound working knowledge of formative assessment practice; it cannot be known from these data whether that would still be the case if the baseline level of assessment literacy among the staff in a school was lower, such as amongst the schools in Hodgson, Pyle and Shamsan's (2009) study which demonstrated that formative assessment strategies were used inconsistently in primary science teaching and less than in the other core subjects.

In summary, the findings for Step 3 show that social learning opportunities were characterised by an interactive or transactional communication style, and that preferences for communication style and learning fora varied depending upon the time participants had worked within a school. While a transactional communication style has been found to facilitate the transfer of new knowledge during the social learning opportunities available to participants in the case study schools, their learning was also assisted by the informal contacts that they shared with each other. The role of the SSL in bringing new ideas into the school has been highlighted, as well as the relatively high level of seniority, managerial, evaluative and communicational skill that they showed when compared to the national picture (Wellcome Trust, 2011; 2017). The case has been made for research teams to carefully consider the role that they expect their target audience to play in the dissemination of their resource.

7.8 Limitations to this step of the study

Two schools were selected for case study, but more schools would have provided a wider range of data and a greater generalisability of findings. As such, this limitation is a feature of one researcher working alone. The schools were deliberately selected for their similarity in some key features, such as school size and catchment type. This permitted easier comparison, but meant that larger sized schools were not included in the sample. It therefore cannot be known from these data whether the mechanisms for knowledge transfer would be similar in larger schools, and more research is needed in this area.

Much could also be learned from studying two schools, of similar size and catchment, where the TAPS pyramid had not been implemented effectively, and changes to assessment practice had been minimal or zero. This was not possible within the constraints of this study, but the application of the same conceptual frameworks of knowledge transfer and communication style to schools where reported impact was minimal could yield valuable comparative data.

7.9 Chapter summary

This chapter has presented the analysis and discussion of Step 3, the final step of this three-step mixed methods study of the dissemination, interpretation and enactment of the TAPS pyramid. Qualitative data were collected and analysed from two case study schools where the TAPS pyramid had been used to change assessment practice at a school level. A thematic analysis demonstrated the role that the SSL plays in bringing innovative ideas to her school, as well as the lack of access to external expert sources for the other participants. The SSLs in the case studies were shown to be experienced leaders of their subject but also of school leadership, and a comparison was made to the relative lack of leadership experience among the wider school population of SSLs.

Transactional communication between participants was widely reported and was shown in one case to underpin the learning and decision-making processes involved in making changes to assessment practice in science at a school level. In both cases, informal contacts were shown to be an important part of knowledge transfer between colleagues, with participants expressing divergent preferences for the type of communication and the format of learning opportunities, based primarily on the amount of time that they had worked at their school.

7.10 Outline of the next chapter

The next chapter will bring together the findings of all three steps of the research. An introduction to the chapter will be followed by a reminder of the research questions for this study and a summary of the key findings from each step of this three-step mixed methods research project. The next section will elucidate the findings drawn from the study as a whole. The next section will articulate, in fuller detail than has been previously made available in the literature, the activities, enablers and inhibitors involved in achieving dissemination for action within the walls of a primary school. Finally, the limitations to the study as a whole will be considered.

8 General discussion

8.1 Introduction

“[Dissemination] goes well beyond simply making research available through the traditional vehicles of journal publication and academic conference presentations. It involves a process of extracting the main messages or key implications derived from research results and communicating them to targeted groups of decision makers, and other stakeholders, in a way that encourages them to factor the research implications into their work.”

(Canadian Foundation for Healthcare Improvement, 2016, p.2).

This study had as its focus the successful dissemination of a research innovation for in-service primary school teachers. With reference to the CFHI’s concept of dissemination as being the extraction of the main messages of research, it could be argued that the Nuffield Foundation (2012) did that with their original study of assessment policy and principles. The innovative output they derived from their synthesis of existing expertise about assessment was the data flow pyramid, a visual representation of rich and varied sources of formative assessment generating formative data which could be used towards more specific summative assessment and reporting.

This idea was disseminated and reached the TAPS project team, who extracted what *they* judged to be the key idea – the generation of formative data and its use for summative reports of pupil progress – and, through specifying the assessment activities entailed at each level of the Nuffield Foundation’s data-flow pyramid they created a representation of this process for a target audience of teachers, Science Subject Leads and school leaders (Earle et al., 2016). Some people in the target audience for the TAPS pyramid then took the resource into their schools, extracted what *they* considered to be the main messages and attempted to transfer this new knowledge to and among their colleagues, who in turn may have adapted these messages to fit the precise requirements of their class, and, through verbal interaction, supported each other in their efforts to adapt their practice using this new knowledge. As such, the CFHI’s definition of dissemination summarises the interactions at each stage of this dissemination process.

However, the theoretical framework for this study was King’s three levels of dissemination for research innovations derived from educational research and aimed at in-service

practitioners (King, 2003). This postulated three levels of dissemination activity – awareness, understanding and action - but as discussed in section 2.3.2, the only level which was likely to result in changes to practice was dissemination for action, and the processes of this level were under-specified in the literature.

In its attempt to explore the successful dissemination of the TAPS pyramid, this study therefore set out to answer the research questions specified in section 2.7. In doing so, it also sought to address our wider questions about the dissemination of research outputs to in-service practitioners by providing a fuller specification of dissemination for action: what social learning activities might be involved and what factors enable or inhibit these processes?

8.2 Structure of this chapter

The previous chapters of this thesis have presented the rationale, procedure and findings for three interlinked steps of research. In this chapter, the findings of this three part study will be considered as a whole and their implications explored.

This chapter is divided into the following sections. In the first section, the key findings of each step will be summarised. In the second section, the overall findings will be discussed in relation to the wider literature. In the third section, the empirical findings of this study will be used to more fully specify the activities, enablers and inhibitors of the third level of dissemination of educational research outputs, dissemination for action (King, 2003). The final section of this chapter will consider the limitations to this study as a whole.

8.3 A summary of the findings for each step of this three-part study

8.3.1 Step 1 summary

Step 1 of this three-part, mixed methods study addressed the first research question:

RQ1: What was the relative impact of online and face-to-face dissemination modes?

A quantitative analysis of download data and event data, plotted against each other by region and over time, compared the relative effectiveness of both dissemination modes. While online dissemination was found to be very useful for reaching an international audience (Duffy, 2000) statistical analysis demonstrated an interaction between modes which led to more

downloads taking place in regions where dissemination events had also been held (see section 4.6.2 and also Hopwood-Stephens and McMahon, 2019). It was concluded that these events helped to stimulate download activity for the TAPS pyramid by providing the target audience with an explanation of the TAPS pyramid's purpose and possible use (Louis, 1980), while also providing the opportunity for the audience to ask clarifying questions (Hutchinson and Huberman, 1994) and reflect upon its possible application to their setting (Beacham et al., 2003). The lower download counts in regions where no events were held (see 4.6.2) were interpreted as confirmation of the view that online availability does not result in the target audience automatically finding the resource (Cooper, 2014) and that active outreach, through face-to-face events, alongside online availability, is advisable (Edelstein, Levin and Shah, 2012), because face-to-face presentation of the resource stimulates the process of adaptation, which is considered a key stage in the dissemination and enactment of new ideas (Gravestock, 2003). This in turn results in the achievement of dissemination for understanding, and a greater likelihood that the target audience will choose to implement the research output in some way.

In terms of King's three levels of dissemination (2003), it was argued that the TAPS pyramid dissemination strategy had achieved dissemination for awareness and understanding, but it was not possible from these data to establish whether dissemination for action had been achieved.

8.3.2 Step 2 summary

Step 2 of this three-part, mixed methods study addressed the second and third research questions, which were:

RQ2: How might a disseminated research output be interpreted and enacted by its users?

RQ3: In what ways might a school's workplace and staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

Quantitative analysis of responses to an online survey showed that dissemination for action had been achieved amongst these users, but their interpretation of purpose tended to be closer to the project team's stated aims if they had discovered the TAPS pyramid at a dissemination event, where its possible use had been explained to them (see section 5.4.2). The reported impact upon assessment practice varied according to the number of years that the participant

had worked in teaching, and also by job role (see section 5.4.5), demonstrating an ongoing diversity in assessment literacy for primary science (Hodgson, Pyle and Shamsan, 2009) and the need for school leaders and SSLs to consider this carefully when devising interventions to improve the use of formative assessment strategies in this subject (Hopwood-Stephens, 2018b).

In response to the third research question, quantitative analysis of the data revealed that the only factors significantly linked to reports of individual and whole school use were opportunities to discuss the TAPS pyramid with a colleague or group of colleagues (see section 5.6.6). This supports the view that learning is an inherently social activity (Mercer and Howe, 2012), which is further underlined by findings that showed a link between the expansive workplace conditions (Hodkinson and Hodkinson, 2005) which facilitate collaborative working and reports of whole school use. The finding that the workplace seemed to be more significant than the characteristics of the meetings held to support learning was interpreted in section 5.6.4 as evidence that teachers were learning how to improve their assessment practice outside of the mandated learning opportunities provided (Adler and Borys, 1996) through an ongoing, situated, reflective and discursive process (Little, 2003; Winch, Oancea and Orchard, 2015) and that the expansive or restrictive characteristics of the workplace could influence the extent to which the social interactions required between teachers could be supported. As such, these workplace characteristics were concluded to play a key part in influencing the implementation of research outputs aimed at in-service practitioners and, alongside the opportunity to discuss practice, played a key role in enabling dissemination for action within the setting of a primary school.

8.3.3 Step 3 summary

The final step of this three-part mixed methods study addressed the final research question:

RQ4: How is the transfer of new knowledge about assessment practice within a primary school affected by the nature of the communication within the social learning opportunities identified?

Through qualitative analysis of interview data, the importance of interactive and transactional communication between colleagues attempting to change their practice was demonstrated (see section 7.3.6 and 7.5.3). This final step of the research also demonstrated the importance of

informal contacts (Aalbers, Dolfsma and Koppius, 2014) in the transfer of innovative knowledge resulting in changes to practice in a primary school setting, as the transfer of new knowledge relating to the research output was enabled by frequent informal contacts between participants, improving the spread of innovative knowledge (Cross, Borgatti and Parker, 2002) and developing interpersonal trust (Szulanski, Cappetta and Jensen, 2004). A willingness to work collaboratively, based on this trust, (Tschannen-Moran, 2000) was also noted.

A preference for learning from and with each other was found (Desimone, 2009; Gassenheimer, 2013) but recently arrived members of staff were found to prefer more private support and more directive communication to their more established peers (see section 7.7.1). The SSLs in both cases were demonstrated to have access to a wider range of external and expert sources of knowledge about primary science assessment practice than the other participants (see section 7.7.6), and their role in assessing the knowledge of their peers, and disseminating the ideas of the TAPS pyramid, was demonstrated as critical to the achievement of dissemination for action (King, 2003) within the case study schools.

8.4 Themes emerging from the overall findings about the dissemination process

As explained in section 3.2.1, this study was conducted within an explanatory sequential mixed methods (ESMM) design (Creswell, 2013), which permitted a macro-to-micro approach (Layder, 1993) to the collection and analysis of data. It also allowed the researcher to use the outcomes of each step of the study to inform the aims and questions of the next, which in turn provided the opportunity for deeper analysis of the issues raised during the study. This meant that each of the three steps in this study were interlinked, and as such, the findings are also linked. The insights into the dissemination process which are afforded by considering the findings are summarised as bullet points and then expanded below:

- Successful dissemination of research outputs entails interactive learning
- The interactivity of verbal communication during dissemination improves its effectiveness
- Successful dissemination involves the formative assessment of knowledge at each stage of the process
- The target audience is also the knowledge broker for the research output

- An expansive workplace enables the social learning activities involved in schoolwide changes to practice

8.4.1 The successful dissemination of research outputs entails interactive learning

In Step 1, dissemination of the TAPS pyramid was more successful in counties where dissemination events had been held, during which the TAPS pyramid was explained to its target audience, then counties where it was only available online. In Step 2, participants who had discovered the TAPS pyramid at a dissemination event gave an interpretation that was more closely aligned to the stated aims of the project team, even though those online could read the guidance notes which accompanied the download. Discussion of the resource with a colleague or group of colleagues was also linked to reports of use, as were staff meetings to support teachers' learning, whereas reading others' comments online or participating in online discussion about it was not. In Step 3, knowledge transfer processes within the cases study schools were shown to be enabled by staff discussion, peer support, informal contacts and a transactional communication style. This in turn developed a sense of intersubjectivity, whereby the participants in one case study expressed a clear view that they were working towards a shared goal.

These findings indicate that successful dissemination of research outputs to in-service primary teachers is not a mechanical process of physical resource provision, but one of interactive verbal communication. This is in accordance with King's (2003) assertion that "effective dissemination can only be achieved through effective communication" (p.97), but these findings have elaborated upon this statement by showing that successful dissemination is enabled by interactive talk: the knowledge broker (Nordholm, 2016) or linking agent (Louis, 1980) to the target audience; the target audience member to their staff team (Valente and Davis, 1999); the staff team to each other (Hood, 1990; Gassenheimer, 2013). Talk, throughout each of these stages of dissemination and knowledge transfer, is the mediating tool through which the actors establish existing knowledge, articulate the purpose and value of the innovative practice, question and clarify how they might proceed, and internalise and adapt the new knowledge to serve their specific needs.

The implication of this study finding is that optimal dissemination strategies would include active outreach (Edelstein, Levin and Shah, 2012) in the form of presenting the innovation,

verbally, to its target audience; but that the discussion would need to continue, once the resource has been taken by the target audience into their school, as the new knowledge is transferred amongst colleagues and changes to practice are attempted (Stevens, 2004).

8.4.2 The interactivity of the verbal communication during dissemination improves its effectiveness

In Step 1, it was shown that larger dissemination events did not lead to greater downloads as a result of presenting the TAPS pyramid to a larger target audience (Hopwood-Stephens and McMahan, 2019). This is in keeping with Klein and Gwaltney's (1994) postulation that there is a qualitative difference in the interactivity of communication between the target audience and presenter at smaller events, which makes smaller dissemination events more effective for transferring new knowledge about the resource being disseminated. Through enabling more, and more interactive, communication between the presenter and audience, smaller events are thought to promote the processes of adaptation and appropriation (Fincher, 2000; Gravestock, 2003), which are considered key to achieving dissemination for action (King, 2003).

In Step 2, it was shown that staff meetings which featured discussion, during which participants could raise concerns and suggest ideas were also significantly linked, demonstrating the importance of being able to discuss practice through mandated as well as informal contacts (Vescio et al., 2007; Aalbers et al., 2014). The centrality of interactive communication to the successful dissemination of the TAPS pyramid is also implied by the finding that expansive workplaces (Hodkinson and Hodkinson, 2005) which enabled interaction between colleagues through activities such as collaborative and cross-boundary working were also linked to reports of whole school use.

Participants in the Step 3 case studies valued the specificity and immediacy of approaching each other for advice, as well as the ongoing, transactional nature of communication between colleagues working together to solve a problem. In identifying the communication in one of the cases as inherently transactional, the Step 3 analysis also demonstrated that this type of dynamic and continuous communication (Harris and Nelson, 2008) comprised shared learning and decision-making activities such as discussion, questioning, negotiation of goals, review of progress, and the deprivatisation of practice.

These study findings support the view that the interactivity of the communication at each stage of the dissemination process – from the detail and interaction provided during dissemination events, to the presentation of the TAPS pyramid at staff meetings, to the discussion between teaching colleagues - seemed to enhance the transfer of innovative knowledge through increasing the receiver’s understanding (Cross, Borgatti and Parker, 2002) and providing a means of checking meaning or interpretation (Aalbers, Dolfma and Koppius, 2013). A more interactive communication also provided a means for the receivers of the new knowledge to share their feedback with the actor transmitting it, who could supplement the initial information with more detail or responses to clarifying questions (Hutchinson and Huberman, 1994).

There are two implications here. Firstly, the discussion fora within a dissemination strategy must facilitate, through size and format, verbal interaction between the knowledge broker and the target audience members. These fora must also be led in such a way to facilitate the interactive or transactional communication required for the professional discussion of, and learning about, practice (Wood, 2007; Graham, 2007). After all, if the relationship between thinking and social activity “is a vital, distinctive characteristic of human cognition... which underpins cognitive development” (Mercer and Howe, 2012: p. 12), these findings have shown that it is in our interests, as research teams or school leaders, to understand knowledge creation as a social process (Eraut, 2007) and facilitate that.

The second implication of this finding is that the more interactive the communication between those holding the new knowledge and the target audience for that knowledge, the better the chance of establishing intersubjectivity through a shared understanding of its content and purpose (Littleton and Mercer, 2013). If we are interested in stimulating dissemination for action therefore, where our ideas are enacted in a way that leads to modified practice, interactive and ongoing communication is key, to ensure that not only the initial knowledge has been transferred (Carlile, 2004) but that clarity of purpose remains over time, as the innovative knowledge is appropriated and adapted to serve the needs of its users (King, 2003). Thus, the dominant mode of communication between colleagues in a school is instrumental in enabling dissemination for action, and as such should be viewed as an enabler or an inhibitor of this process.

8.4.3 Successful dissemination involves the formative assessment of knowledge at each stage of the process

It should be noted that formative assessment is generally characterised as the process by which a teacher evaluates the existing knowledge and understanding among her students before planning how and what to teach next.

However, it is argued that the actors in the dissemination process for the TAPS pyramid have formatively assessed the level of knowledge and understanding present in their audience: the TAPS project team when modifying and specifying the Nuffield Foundation's ideas; the knowledge broker at the dissemination event who is explaining the research output to an audience and taking their questions; the SSL who plans to introduce it to her colleagues and explain its purpose; the teacher who has just been asked a question by another colleague about assessment and is considering how to respond.

In each instance, in order to fulfil their role adequately, the actor has to evaluate the level of knowledge or understanding in their audience, so that they can communicate their knowledge in a comprehensible format. This is what organisation theory would call evaluating the boundary type (Carlile, 2004), whereas primary school teachers might liken it to the formative assessment strategy of elicitation (Ollerenshaw and Ritchie, 1997). But the point is this: however we name this process, the successful dissemination of innovative ideas relies upon each actor in the chain being able to articulate them in terms that the audience can understand and enact.

Throughout the Step 2 and Step 3 analyses, variations between participants in terms of assessment literacy, job role, learning preferences, communication preferences, engagement with the TAPS pyramid and reported impact upon practice were found (Hopwood-Stephens, 2018b). This demonstrates the need for knowledge brokers at each stage of the dissemination process to formatively assess existing knowledge amongst their audience, so that they can articulate the value of the new knowledge in terms which they understand (Carlile, 2004).

This study finding is unlikely to be limited solely to schools where an attempt was being made to use the resource being studied; variation in teacher formation (Carter Review, 2015), assessment literacy (Cristoforidou et al., 2014) and learning dispositions (Hodkinson and Hodkinson, 2003) within the wider teaching population have previously been identified and are likely to be present in any teaching workforce. The range of learning preferences and

assessment literacy found in the Step 2 and Step 3 analyses therefore indicates the diversity that exists within the teaching workforce, and can be interpreted as evidence that the competent formative assessment of ability and understanding, by the target audience member who is bringing the resource into their school, is a prerequisite for the successful transfer of new knowledge.

It is not possible, however, to generalise the study findings about the SSLs, who, when compared to the national picture (Wellcome Trust, 2017) were highly experienced practitioners and skilled evaluators of their colleagues' professional development needs. Their role in bringing innovative practice about assessment in primary science to their colleagues, as well as their competent evaluation of their colleagues' assessment literacy, was key in the successful dissemination of the TAPS pyramid within their schools. As such, the role – and skill – of the target audience member in achieving dissemination for action for a research output is key and will be explored in more detail below.

8.4.4 The target audience is also the knowledge broker for the research output

As we have seen, dissemination for action is often the end-goal of a research team, and yet this level of dissemination is beyond the research team's control (Southwell et al., 2010; Gannaway et al., 2013). As demonstrated in Step 2 of this study of the dissemination of the TAPS pyramid, that target audience member was most frequently the Science Subject Lead.

There are advocates within the literature for the ongoing support of those whom we would like to implement our ideas (Shoenberg, 2000), but budgetary or logistical constraints often make this level of support impossible. In the case of the TAPS pyramid, therefore, the role that the SSLs played in bringing the resource into their schools and articulating its purpose and potential value was shown to be a key part of a project team's dissemination strategy. In Step 3, the SSLs in the case study schools were shown to have a high level of assessment literacy and to be skilled evaluators of their colleagues' aptitudes and experience (Carlile, 2004), a skillset derived at least in part from their relative seniority and experience. They also had a clear vision of how the TAPS pyramid might be used to improve the assessment of science in their school, and were effective communicators and trusted colleagues (Valente and Davis, 1999).

The implication of this study finding is that research teams need to consider the role that their

target audience might play in achieving dissemination for action on their behalf, and the supports which this audience might require to do so. The Step 2 findings showed that, when participants reported that they had not been able to use the TAPS pyramid at a whole school level, it was often because there was little interest among their teaching colleagues, or no support among the leadership team. This could indicate a failure to persuade, and a consequent need for academic research teams to consider whether the target audience has the requisite skills to advocate their resource. If not, part of the content delivered to the target audience might need to be a component which helps them to understand how to articulate and promote the resource, or to evaluate the existing knowledge among their colleagues, as well as information on how to interpret and use the resource itself.

8.4.5 An expansive workplace enables the social learning activities involved in schoolwide changes to practice

The analyses from Step 2 showed that expansive workplace characteristics such as opportunities to collaborate, work with colleagues from different year groups, and the encouragement of innovation and professional development (Hodkinson and Hodkinson, 2005), were significantly linked to reports of whole school use of the TAPS pyramid. These workplace characteristics seemed to play a greater role than the characteristics of the staff meetings held to support teachers' learning, implying that a workplace where these activities were enabled or facilitated was also one where changes to practice could be enacted at a school level.

The Step 3 analysis indicated that participants felt that they learned best through their interactions with each other, whether through formal staff meetings or informal contacts with their peers (Aalbers, Dolfmsma and Koppius, 2014), triangulating the finding that collaboration and cross-boundary working are enabling of whole school changes to practice. The Step 2 and Step 3 analyses therefore show that it is not just the affordances for workplace learning (Billett, 2001) which make whole school changes to practice possible, but the wider context of "taken-for-granted routines, rituals and institutionalised regularities" (Hager, 2012; p.19) within which they are situated. The implication of this finding is that expansive workplaces that encourage collaborative, cross-boundary and innovative working can enable the activities involved in teachers learning to change their practice and the achievement of dissemination for action. As such, the workplace should be viewed as an enabler or inhibitor of whole

school change and consideration should be given to evaluating its dominant characteristics.

8.5 Towards a fuller understanding of dissemination for action: an elaboration of King's model

In the original specification of King's three levels of dissemination activity for educational research outputs (King, 2003) the activities associated with dissemination for action were under-specified. There was also no link to their theoretical underpinning, nor the factors which might enable or inhibit them.

The findings of this three-part empirical study have been used to elaborate upon King's original model. Specifically, the findings from this study have been used to specify the activities and enablers, and to speculate upon the inhibitors for achieving dissemination for action within a primary school setting. Where it is possible to specify further activities or speculate upon inhibiting factors for King's other levels of dissemination – dissemination for awareness and dissemination for understanding – these have been added. The contributions summarised in Table 13 are explored in more detail below, alongside the theoretical underpinning for their efficacy, as related to sociocultural theories of learning.

Activities	Enablers	Inhibitors
AWARENESS Online dissemination	Online availability Disseminated through trusted channel	Limited opportunity for explication or exemplification of resource online
UNDERSTANDING Dissemination events	Smaller events enable more interaction between knowledge broker and target audience Interaction between audience and knowledge broker allows for clarification of resource's purpose and reflection upon possible application	Larger events inhibit interactivity of presentation, providing dissemination for information instead of dissemination for exchange.
ACTION Formal contacts: Staff meetings, mentoring Informal contacts: Peer support <i>Ad hoc</i> subject specialist support Discussion-based social learning activities such as: negotiation of goals, review of progress, deprivatisation of practice.	Transactional communication style Opportunities to discuss practice, within a range of group sizes from 1:1 to entire staffing body Frequent formal and informal contacts Interpersonal trust between colleagues Expansive workplace where innovation, collaborative working and professional development is encouraged Subject specialist with access to external, expert ideas about assessment in primary science Subject specialist with the skills to evaluate existing knowledge among colleagues and transfer new knowledge Subject specialist able to support the professional development of colleagues' assessment practice through provision of appropriate support High status of subject area in school curriculum Teachers who are competent practitioners of formative assessment A research output with a fundamentally open character Accurate assessment of diversity of assessment literacy among staff and range of supports provided	Linear communication style between colleagues, or between school leadership team and teachers Few or no opportunities to discuss practice with colleagues, within limited formats which are restricted to entire staffing body / staff meetings. Restrictive workplace which discourages innovation, collaborative working or professional development Discouragement and / or undervaluing of informal contacts as learning opportunities Subject specialist with limited access to external and expert ideas about assessment in primary science Subject specialist with limited skills of evaluation and articulation Low status of subject area in school curriculum A research output designed with one possible use and according to a fixed assumption of assessment literacy Limited or no assessment of diversity of assessment literacy. Limited or only one type of support provided.

Table 13: elaboration of King's (2003) levels of dissemination with activities, enablers and speculative inhibitors

8.5.1 Specifying the social learning activities of dissemination for action in King's (2003) model

8.5.1.1 *Dissemination for awareness*

Based upon the empirical evidence derived from this study, dissemination for awareness has been shown to be achieved through the online availability of the resource (see section 4.6.1), which was disseminated through the trusted channel of the Primary Science Teaching Trust website. Dissemination for awareness is the least likely to result in changes to practice, due in part to the limited opportunities for explication; a factor inhibiting the successful dissemination of the TAPS pyramid at this level was the limited opportunities for explication and exemplification for resources promoted online (Brindley, Walti and Blaschke, 2009). Guided participation might also adversely influence a potential user's use of a research output at this level of dissemination as they form assumptions about how it will fit with workplace norms and routines (Hager, 2012; Rogoff, 1990).

8.5.1.2 *Dissemination for understanding*

Dissemination for understanding was achieved through the presentation of the TAPS pyramid to its target audience, through dissemination events. These events ranged in size and format but each of these dissemination events provided the target audience with an explanation of the resource and the opportunity, through its explication, to reflect upon its possible application to their school setting (see section 4.6.2). The effectiveness of these dissemination events was underpinned by sociocultural theories of learning, such as: language being a mediating tool for explaining and demonstrating the TAPS pyramid's purpose (Littleton and Mercer, 2013); learning through the socio-cognitive conflict (Doise and Mugny, 1984) of hearing someone else's interpretation of the tool and the possibility of being able to discuss or query it; reflection upon the usefulness of the resource (Seashore Louis, 2010) and the appropriation and adaptation of the ideas therein to fit the needs of the audience member's setting (King, 2003). Smaller events were assumed to facilitate greater interaction between the presenter and the audience (see section 4.6.2), enabling the clarification of the resource's purpose and possible uses, thereby allowing for what Klein and Gwaltney (1994) call dissemination for exchange. Larger dissemination events, due to the limited opportunities for interaction between the audience and presenter (Hutchinson and Huberman, 1994) provided a greater audience, but a more limited scope for target audience to gain a detailed understanding the resource through verbal interaction with its presenter or other audience members.

8.5.1.3 Dissemination for action: elaborating King's model

Within the walls of a primary school, dissemination for action has been shown by this three-part empirical study to entail formal contacts and their associated learning activities, such as staff meetings and INSET days, within which discussion-based group learning activities such as negotiation of goals, reviews of progress and the sharing of good assessment practice took place (see section 7.7.3). These formal learning opportunities were shown to be augmented by informal contacts and their associated learning activities, such as peer support and *ad hoc* support (see section 7.7.4).

With regard to the sociocultural theories of learning which underpin the effectiveness of these activities, language is shown to be a mediating tool throughout the verbal interactions which occur between colleagues attempting to change their practice with reference to the TAPS pyramid. These include discussion (see section 7.3.6.1), questioning (see section 7.3.6.2), collective reflection (see sections 7.3.6.4 and 7.5.8) and approaching each other for guidance (see section 7.5.6). Intersubjectivity, which is reached through the discussion and negotiation of shared goals, can also be demonstrated (see section 7.3.6). These activities are underpinned by transactional communication, either as the inherent communication mode within the school (see section 7.3.3.1) or as an evolved communication mode over time (see section 7.5.3.1).

Several of the enabling factors for dissemination for action that were found in this empirical study relate to verbal communication. As already mentioned, a transactional communication style was widely identified as a means of clarifying and agreeing aims, and this was identified within the more formal learning opportunities such as staff meetings and performance review feedback (see section 7.3.6.3) as well as informal opportunities, such as asking the SSL a question about a specific aspect of practice (see section 7.5.5.2).

Frequent informal contacts between colleagues were found to enable dissemination for action, by enabling the checking for understanding and reinforcing a sense of intersubjectivity about shared goals and aims (see section 7.3.7). Informal contacts were also valued for the reassurance that they provided as well as for the expert advice, as these were regularly sought from both non-specialist teacher peers and the SSL. Interpersonal trust was also shown to be an enabling factor for teachers feeling that they could approach each other with questions (see section 7.3.6.5).

Opportunities to discuss practice in a forum which suited the needs and preferences of the

teacher was also an enabler of dissemination for action, as some teachers preferred specific and more directive guidance and others preferred a more public group discussion (see section 7.5.2.1). In terms of the wider workplace, an atmosphere which encouraged communication between colleagues through collaborative working, innovation and professional development was shown to enable dissemination for action, perhaps by facilitating the frequent contacts required for this as well as providing the tacit message that these workplace behaviours are valued and encouraged (see section 5.6.5).

The role played by the SSL or subject specialist was shown to be instrumental in enabling dissemination for action within this empirical study. A subject specialist with access to external and expert sources of knowledge and who is able to articulate the benefits of assimilating this new knowledge into practice could obtain the innovative knowledge in the first instance (see sections 7.3.4 and 7.5.4), and enable the successful transfer of knowledge to her colleagues in the second instance through her skilful evaluation of existing knowledge and appropriation of the resource to fit the local need (see sections 7.5.5.1 and 7.3.5.1).

The SSLs in this study were also competent practitioners of formative assessment, as were their class teacher colleagues (see sections 7.3.9 and 7.5.8), but they were also competent evaluators of the range and extent of knowledge about assessment in their colleagues (see 7.3.5 and 7.5.5). Their ability to explain the purpose and potential value of the TAPS pyramid, and to support their colleagues' learning at a level appropriate to their abilities (see section 7.5.5.1), enabled the spread of the knowledge of good practice contained within it.

With reference to the TAPS pyramid itself, its design facilitated dissemination for action because it had been designed for education professionals to access at their own level. This meant that in-service teachers, with the diversity of assessment literacy and teaching experience that were found in this study (see section 5.6.2), could access its content in a way that they felt informed their assessment practice in primary science. A further factor which enabled dissemination for action in the case study schools was the prioritisation of primary science within the school curriculum (see sections 7.3.10 and 7.5.9).

8.6 Limitations to the study

In Step 1 of this three-part study, it was suggested that small to medium sized events are more

useful to a dissemination strategy because they facilitate interaction between the presenter and the target audience. This hypothesis cannot be tested with these data and would benefit from further scholarly inquiry to test this idea with more rigour.

It has also not been possible, from these data, to test the idea that download figures for the TAPS pyramid would have been different if the resource had not been hosted on a trusted and well-known website that advocates excellence in primary science teaching. Future research into the relative efficacy of hosting the resource on the website of a university faculty, in comparison to a known and trusted specialist subject organisation, could further clarify the importance of online dissemination through a trusted channel (Kirst, 2000) and would make a welcome addition to the literature.

In Step 2 of this study, the sampling was purposive and self-selecting. Participation was also voluntary, meaning that only those who wished to share their experiences of using the TAPS pyramid took part. It is possible that those who had had a positive experience – and felt that they had something to say about how the TAPS pyramid had helped them – were more willing to participate than those who had had a negative experience, such as finding the TAPS pyramid hard to understand. It cannot be known from these data if this led to a slight over-representation of positive views in the data.

Equally, the survey was disseminated to a target audience of teachers with a special interest in primary science, through social media pages, Twitter feeds and subject advocacy websites which all focus on primary science teaching. This was to ensure that it was seen by as many potential participants as possible who had heard of the TAPS pyramid in the first place. However, this dissemination strategy may have been a factor in SSLs being over-represented in the survey data when compared to class teachers. The size of the sample for the online survey is both a strength, in that data was collected from one hundred schools, but also a weakness, in that only one viewpoint from each school was obtained. These results should therefore be viewed as indicative.

The five expansive workplace criteria used in this study were selected for their relevance to the research questions, but their selection meant the exclusion of others. This represents a trade-off between collecting all possible data about the participant's workplace and collecting sufficient data to answer the research question. As such, further enquiry is needed to explore the relevance of the other criteria to whole school changes in assessment practice following

the adoption of a new assessment resource.

In Step 3, two schools were selected for case study, but more schools would have provided a wider range of data and a greater generalisability of findings. This limitation is perhaps an inevitable feature of one researcher working alone, instead of in a team. These findings could perhaps be viewed as the outcomes of a pilot study which could be expanded, either in terms of more case studies over more time, or more researchers working within the same timeframe to collect more data than is possible with one researcher.

The schools were deliberately selected for their similarity in some key features, such as school size and catchment type. This permitted easier comparison, but meant that larger sized schools were not included in the sample. It therefore cannot be known from these data whether the mechanisms for dissemination for action would be similar or distinct in medium-sized larger schools, and more research is needed in this area.

Much could also be learned from studying two schools, of similar size and catchment, where the TAPS pyramid had not been implemented effectively, and changes to assessment practice had been minimal or zero. This was not possible within the constraints of this study, but the application of the same conceptual frameworks of knowledge transfer and communication style to schools where reported impact was minimal could have yielded valuable comparative data.

8.7 Summary of this chapter

A brief summary of the findings from each step of the study was presented at the start of this chapter, before the findings – as derived from the data as a whole – were articulated, and situated within the wider literature. The third level of dissemination for educational research outputs, as defined by King (2003), has been more fully specified, with reference to the empirical findings of this study, in terms of activities, theoretical underpinning, enablers and inhibitors. As such, a fuller specification of the mechanisms and factors influencing dissemination for action within the walls of a primary school has been achieved.

8.8 Outline of the next chapter

In the final chapter that follows, the contributions to knowledge for this study will be articulated and recommendations will be made, derived from these analyses, for achieving the successful dissemination of research outputs to in-service teachers, as well as for the enabling of school-wide adoption of new practice through the internal dissemination of innovative ideas. Possible avenues for future study will also be considered.

9 Contributions to knowledge and recommendations

9.1 Introduction to this chapter

In this final chapter, the claim that the successful dissemination of research outputs to in-service teachers is an inherently sociocultural learning process will be explained, with reference to the empirical findings of this study. The contributions made to knowledge with regard to the research questions will also be stated. Recommendations which are derived from this study will be made for academic research teams wishing to devise a successful dissemination strategy. Recommendations to school leaders who wish to enable school-wide changes to practice among their staff will also be made, and once again these will be derived from the findings of this empirical study. A concluding section will be followed by some ideas for future study.

9.2 Contributions to knowledge

9.2.1 Dissemination as a sociocultural learning process

At the beginning of this thesis, the study was positioned within a sociocultural perspective upon learning, with dissemination recognised as a process of communication (King, 2003) through which professional practice might be influenced (Primary Health Care Research and Information Service, 2017). At the conclusion of this study, it is argued that the effective and successful dissemination of research outputs to in-service primary teachers and the subsequent sharing of the new knowledge derived from them is an inherently sociocultural process, involving the interaction between the disseminator and the receiving audience at each stage.

At the outset of the TAPS project, the project team internalised and appropriated (Leontiev, 1986) the content of the Nuffield Foundation's recommendations about the use of formative assessment in the teaching of primary science, producing an output which was specifically tailored to the needs of primary science subject leaders and practitioners (Davies et al., 2014). This resource was designed through the iterative presentation and discussion of the resource with teachers and subject leaders in the project schools (Earle et al., 2017), with talk being used as a mediating tool to explain its purpose and possible use to these representatives of its target audience, and the project schools appropriating its content to serve their setting's needs.

When the final version of the TAPS pyramid was disseminated for public use online and through dissemination events, the presentation and explication of the resource in a forum

which permitted clarification and detailed explanation provided the target audience with the opportunity to reflect upon its possible use (Hutchinson and Huberman, 1994) and adapt its content to suit the needs of their setting (Gravestock, 2003). The appropriation of the resource to meet the needs of the users (King, 2003) was evident in the varied reports of impact upon different aspects of assessment practice. Talk, once again, was shown to be a mediating tool for engaging with the resource, whether it was used by an individual teacher or at a whole school level, and intersubjectivity (Littleton and Mercer, 2013) was fostered through ongoing discussion between colleagues of how they were applying the resource to their assessment practice, and in some cases seeking a shared view on how to proceed. The participation of these practitioners was also guided (Rogoff, 1990), insofar as they were encouraged to proceed with their efforts to change their practice through the visible support of the school leadership (Smith, 2011). The setting within which this attempt at schoolwide learning took place also influenced the behaviours of the participants (Wertsch, 1994), but at each stage, a knowledge boundary had to be negotiated and crossed (Carlile, 2004; Akkerman and Bakker, 2011) as the knowledge broker evaluated the existing knowledge and understanding amongst the audience to whom they were disseminating the new ideas.

In conclusion, this study has demonstrated that a successful dissemination process for research outputs to in-service teachers is underpinned by sociocultural processes and predicated upon the interactive verbal communication and clarification of new knowledge between the sender and the receiver.

9.2.2 RQ1: What was the relative impact of face-to-face and online dissemination modes?

As elucidated in section 2.3.6 of the literature review for this study, the use of a bimodal dissemination strategy of online availability and face-to-face presentation is widely recommended (World Health Organisation, 2014; EU Horizon 2020, 2014) and yet no studies in the existing literature have examined the relative impact of each mode in a real-life dissemination strategy, nor investigated a possible interaction between them. Similarly, there was a gap in the knowledge regarding how successful these two dissemination modes were in reaching a target audience of in-service primary practitioners with an interest in primary science assessment.

This study has contributed to knowledge by demonstrating the importance of online dissemination for international reach, but has also shown that there is a statistically significant

interaction between online dissemination and dissemination by event (Hopwood-Stephens and McMahon, 2019). In doing so, it has built upon the advice offered by organisations such as the World Health Organisation and the European Union by providing empirical proof of the benefit of running a bimodal strategy. This was done through the innovative plotting of spatial and temporal data for downloads of the TAPS pyramid against spatial and temporal data for dissemination events, which in turn has built upon the work of Plume and Kamalski (2014) and Ball and Duke (2015) by further exemplifying how downloads of a resource can be used as a reliable measure of its reach, and in mapping the downloads to geographical regions, how the overall aggregated download total can be split to explore regional differences.

In response to RQ1, this study has also developed the hypothesis of Klein and Gwaltney (1994) by providing evidence to substantiate their suggestion that larger dissemination events are not more effective than smaller ones, due to the relative lack of interactivity between the audience and presenter. These results provide empirical support for their suggestion that dissemination events could be split into two categories of dissemination, *choice* and *exchange* (ibid.), based upon the interaction between the audience and presenter, although further enquiry would be required to define the nature of the boundary between these different sized events.

9.2.3 RQ2: How might a disseminated research output be interpreted and enacted by its users?

As section 2.4.3 of the literature review made clear, there were no empirical data available regarding the interpretation and use of the TAPS pyramid, nor its impact upon practice, among its wider users. The participant accounts that did exist were derived from the project schools which had been involved in its design, and had been supported by members of the TAPS project team in their interpretation and enactment of the resource.

This study has contributed to knowledge by collecting and analysing data from one hundred users of the TAPS pyramid based in schools up and down the country. In doing so, it has provided empirical evidence of how it has been interpreted outside of the project group and builds upon the accounts derived from the project schools. The analysis to answer RQ2 has also shown that there is a link between interpretation of purpose and the dissemination mode through which the TAPS pyramid was discovered, in that the end user's interpretation coheres

more closely with the research team's aims when the resource has been presented and explained in a face-to-face setting. This is an important consideration for research teams disseminating research and one which, at the time of writing, does not seem to appear in the institutional guidance referred to earlier for research teams disseminating their research (World Health Organisation, 2014; EUHorizon2020, 2014).

The systematic analysis of the impact data also revealed that participants reported adjusting different aspects of their assessment practice as a result of using the TAPS pyramid, based upon their job role and time in teaching. This demonstration of the diversity in assessment literacy within the primary teaching population builds upon the work of Murphy et al. (2013) by exemplifying the variability that they found among Irish teachers using formative assessment data towards a summative judgment of progress. In demonstrating the variability in assessment literacy and learning preferences for professional development in primary science practice among English primary teachers, this analysis indicates that school leaders will have to take this diversity into account when planning interventions to develop formative assessment skills among their staff (Hopwood-Stephens, 2018b). In showing where assessment practice has shifted as a result of interaction with the TAPS pyramid, it provides an indicative update to Hodgson, Pyle and Shamsan's (2009) report on the use of formative assessment in the teaching of primary science, and provides pointers for a further study to examine the extent to which the use of formative assessment strategies in primary science has changed in recent years.

9.2.4 RQ3: how might workplace or staff meeting characteristics influence the implementation of academic research outputs at a schoolwide level?

As section 2.5 of the literature review explained, there was a gap in the knowledge regarding the relative importance and role of staff meetings and workplace characteristics in the adoption of new assessment practice at a school-wide level. This study built upon the work of Vescio, Ross and Adams (2007) and their classification of the five characteristics of effective staff meetings that result in professional learning by applying them to the learning experiences of the survey participants. In doing so, this study contributed the finding that the characteristics of staff meetings held to support participants' learning about the TAPS pyramid were not as important as the expansive characteristics of the school within which they worked.

Through ascertaining the importance of discussion between colleagues as part of learning how to use the TAPS pyramid, this study has built upon previous scholarship indicating that teachers like to learn from and with each other (Hood, 1990; Desimone, 2009; Gassenheimer, 2013). It has done this by positing that this discussion was taking place within the wider context of the working day, rather than during a formal contact mandated by their job role and responsibilities (Adler and Borys, 1996).

This builds on previous research that has advocated the creation of time within the teaching timetable for staff meetings to discuss practice (DuFour, 2004) by showing that it might actually be the wider workplace which enables the learning processes required in changing practice. A conclusion was drawn that the workplace was the enabler of these discursive activities, rather than the mandated learning opportunities of staff meetings. This finding built upon Hodkinson and Hodkinson (2005) by providing a real-life example of how workplace characteristics can contribute to whole school adoption of new assessment practice, as well as Fuller and Unwin (2004) by confirming the applicability of a specific sub-set of the original expansive-restrictive criteria to schools as workplaces. A suggestion has been made that the school as a workplace is the silent partner in a teacher's professional learning, acting either as an enabler or inhibitor, extends the work of Billett (2001) to show that the learning affordances made and the employee's response to these might also be influenced by the workplace characteristics, and these should therefore be taken into account when studying employees' responses to the affordances made, and possibly the nature of the affordances themselves.

9.2.5 RQ4: How is the transfer of new knowledge about assessment practice affected by the nature of the communication within social learning opportunities?

This study has revealed the importance of discussion amongst colleagues attempting to change their assessment practice using the TAPS pyramid, while indicating that it might take place outside of mandated contacts (Aalbers, Dolfsma and Koppius, 2014) such as the staff meeting or INSET training. In identifying the formal and informal contacts through which case study participants learned to change their practice, these findings not only broadened the methodological palette available to educational researchers by proving the applicability of concepts from the study of knowledge transfer (Aalbers et al., 2013; 2014) to the setting of primary schools, but it also confirmed the views expressed elsewhere in the literature that discussion of practice underpins professional learning (Stoll et al., 2006; Hattie, 2016), while

expanding our understanding of this process by demonstrating the importance to the participants of informal contacts in their attempts to change practice. This study also contributed new knowledge, through the application of Harris and Nelson's (2008) model for communication to teachers' learning opportunities, by showing that learning opportunities that were characterised by interactive or transactional communication were most valued by the participants.

Popp and Goldman (2016) have previously shown that the type of discourse moves and nature of the utterances during staff meetings can contribute to learning taking place amongst the teachers attending a meeting, but this analysis offered the additional insight that the style of the communication itself can enable the group learning processes required in whole school attempts to change assessment practice in primary science. Furthermore, transactional analysis was shown to underpin the activities involved in achieving dissemination for action within the case study schools, such as: negotiation and agreement of shared aims; reflection and review of progress; asking questions to clarify intent; and the sharing of good practice. These findings have been used to specify the mechanisms of dissemination for action in the context of in-service teachers learning within primary schools, providing a starting point in the literature for further investigation and building upon related scholarship in the field of higher education (Southwell et al., 2010; Gannaway e al., 2013).

As explained in section 2.3.2, dissemination for action (King, 2003) is the ultimate aim of many research teams intent on changing teacher practice, but it is out of their control (Southwell et al., 2010). Furthermore, the activities of dissemination for action among in-service primary teachers remains an unexplored area of scholarly enquiry.

This study has addressed this gap in knowledge by providing an empirically derived specification of the activities entailed and the analytical focus upon the theoretical underpinning for those activities, as related to sociocultural theories of learning, has enabled a further contribution to understanding this particular level of dissemination. By identifying the specific enabling and inhibiting factors to the whole school enactment of new knowledge about assessment practice in primary science, this study has also increased the general knowledge available regarding recommendations to school leaders intent upon enabling professional learning amongst their staff.

Similarly, it has highlighted to academic research teams that their target audience might also

become responsible for achieving dissemination for action on their behalf, and through careful analysis of the data has argued that there is a need for research teams to consider the communication and leadership skills of their target audience, and the extent to which they can articulate and implement their ideas without further support. This study therefore exemplifies the calls for professional development for Science Subject Leads, as frequently made in the literature (CaSE, 2014; SCORE, 2013; Wellcome Trust, 2017), by demonstrating that subject leadership and advocacy might also need developing alongside subject knowledge and pedagogy. It has also validated the TAPS team's strategy of targeting Science Subject Leaders for their resource, by showing that SSLs can have access to more external and expert sources of information about primary science, and as such they might be considered the gatekeepers to the rest of the teachers at their school.

And finally, in showing, through careful analysis, the variations in learning preferences and beliefs about the activities which were most beneficial to developing their assessment practice, this study has confirmed the views expressed elsewhere in the workplace learning literature (Hodkinson and Hodkinson, 2003; Billett, 2001) that individuals respond differently to the same opportunities for professional development, but by furnishing new insights into the diversity within primary teaching populations, it has shown the need for school leaders to take this range of abilities and attitudes into account when planning interventions to develop assessment practice.

9.2.6 Methodological contributions

In applying models and theories from hitherto unlinked fields of research, this study has shown that the concept of the workplace enabling or inhibiting professional development (Fuller and Unwin, 2004; Hodkinson and Hodkinson, 2005) can be used to understand which workplace characteristics enable the schoolwide adoption of a new resource to improve assessment practice. Through the application of models from organisational learning, it has also been shown that both informal and formal contacts play an important role in the transfer of innovative knowledge (Aalbers, Dolfsma and Koppius, 2014) between work colleagues learning to change their assessment practice in a primary school setting, and that the nature of the communication itself can enable the transfer of new ideas between school colleagues (Harris and Nelson, 2008). Through the innovative application of these concepts to the study

of the dissemination of this resource, this study has shown that these frameworks might explain workplace learning among teachers in a school and has provided a methodological base upon which others can build.

9.3 Recommendations for achieving the successful dissemination of research outputs to in-service primary teachers

The recommendations will be presented as follows. Firstly, in narrative form, according to the Step of the study from which they were derived. Secondly, they will be presented in bullet point form, according to the audience to whom they apply.

9.3.1 Recommendations derived from Step 1 of this study

Based on the results of Step 1 of this research, the following recommendations are made to research teams considering how to disseminate their research outputs. Firstly, a bimodal strategy of online availability and dissemination by event is recommended, on the assumption that one will influence the other, but also because online availability will enable the target audience to find the research output, irrespective of whether they can attend a dissemination event. Secondly, when planning a dissemination event, small to medium sized events are recommended, with a suggested maximum audience size of fifty. This is because smaller sized events seem to offer more opportunity for the audience to ask clarifying questions and interact with the presenter, thereby gaining a greater understanding of the resource and its possible application to their setting. And thirdly, it is recommended that these events include the opportunity for the audience to ask questions and are somewhat interactive in format, providing the opportunity for the target audience to reflect on how they might apply the research output to their setting.

9.3.2 Recommendations derived from Step 2 of this study

Based on the evidence from the second part of this three-part study, the following recommendations are made to project teams disseminating innovations based upon educational research to in-service primary teachers.

The interpretation of a research innovation's purpose can be more closely controlled by the

research team if it is explained to the target audience; dissemination online may result in the innovation's purpose being more diversely interpreted than via a dissemination event, or in a more limited interpretation of the intended purpose. However, adaptation of the resource to fit the needs of the target audience's school setting is part of the dissemination process (King, 2003), and in-service teachers may appropriate the innovation to address their specific needs, rather than apply it to the purpose for which it was originally conceived. A versatile resource which can be accessed according to the level of experience or competency of the end-user might be more widely useful and widely used than a resource which assumes a fixed baseline ability.

From these data, dissemination for action seems to be dependent upon teachers being able to learn with and from each other, though opportunities for discussion of practice. The school leadership can support its staff by providing a regular forum for this discussion. When planning an intervention to develop teachers' assessment literacy, consideration should be made for the likely diversity in assessment literacy among the staffing body. It is also possible that school level changes to assessment practice which require changes to existing recording and reporting systems are likely to be harder to achieve than those requiring changes to an individual teacher's practice; these changes could require additional planning and engagement at a leadership level. Teachers' learning is also facilitated by the characteristics of the workplace; in particular, school leaders should consider the extent to which their workplace facilitates collaborative working and encouraging innovative approaches.

9.3.3 Recommendations derived from Step 3 of this study

The following recommendations have been derived from the Step 3 analyses. For school leaders, it is important to be aware that preferences for learning opportunities among teachers might vary according to the number of years that they have worked at the school in question. A range of supports should therefore be provided, such as whole staff discussion and discussion between pairs of colleagues, or mentoring for teachers who need more reassurance about how they are proceeding against expectations.

A workplace which encourages formal and informal contacts might enable the successful transfer of innovative ideas and practice. One way of encouraging this would be to foster a transactional communication style, both within and without of staff meetings, to facilitate the development of interpersonal trust and a collaborative climate between colleagues. This will

help to make the transfer of new knowledge more efficient and can increase the trust between professionals.

Teaching is an isolated profession (Little, 2003) and teachers have few opportunities to discuss practice with their peers during the school day or working week. School leaders may need to build these opportunities into the timetable, or provide working and learning spaces where teachers can gather to share their thoughts and work collaboratively. Care should be taken to establish a style of communication during these contacts which enables participation and is conducive to professional learning, however. And finally, if a decision has been made to task the relevant subject specialist with the delivery of an intervention to improve assessment practice, they may not have the requisite leadership skills required to articulate, plan and implement changes to practice at a school. As such, they may require mentoring or another form of support to help them deliver these changes to practice.

For research teams wishing to disseminate resources relating to primary science, the SSL may turn out to be the conduit for new and innovative ideas. It may therefore be sensible to target the SSL as a means of getting your innovation noticed and taken into a school, but the need to develop the SSL's ability to articulate the value and purpose of the innovation should also be considered. For this reason, consider providing a means for the SSL to evaluate the existing knowledge for the innovation among her colleagues; this might help her to prepare for planning appropriate supports to her colleagues, and lead to a more successful internal dissemination of innovative practice at her school.

9.3.4 Recommendations for academic research teams

This section contains recommendations, derived from these analyses, for the successful dissemination of academic research outputs to in-service teachers. The first set is general principles and the second set of recommendations pertains to resources designed to improve teacher practice within primary science:

- Use a bimodal strategy of online dissemination and dissemination by event, on the assumption that one will stimulate the other
- When planning dissemination by event, provide small to medium-sized dissemination events which provide opportunities for the audience to ask clarifying questions of the presenters and reflect upon the possible application of the resource to their setting

- Disseminate resources internationally by making them available online
- Interpretation of the innovation's purpose can be more closely controlled by explaining it to the target audience; dissemination by event is recommended for this purpose
- Dissemination online may result in the innovation's purpose being more diversely interpreted than via dissemination event, or in a more limited interpretation of the intended purpose
- Adaptation is part of the dissemination process and in-service teachers may appropriate the innovation to address their specific needs, rather than apply it to the purpose for which it was originally conceived. A versatile resource which can be accessed according to the level of experience or competency of the end-user might be more widely useful and widely used than a resource which assumes a fixed baseline ability

The recommendations in the section below pertain specifically to the dissemination of resources for use within the subject of primary science:

- The SSL is a conduit for new and innovative ideas and may have superior access to external and expert sources of knowledge. It may be sensible to target the SSL as a means of getting your innovation noticed and taken into a school
- You might need to develop the SSL's ability to articulate the value of your innovation as well as her understanding of its purpose and possible application to her setting
- Consider providing a means for the SSL to evaluate the existing knowledge for your innovation among her colleagues; this might help her to prepare for planning appropriate supports to her colleagues, and lead to a more successful internal dissemination of your ideas at her school
- SSLs do not necessarily receive training in subject knowledge or subject leadership. You may need to consider a parallel course or innovation to support them in their interpretation of your innovation and their attempts to bring the idea to their school and persuade the leadership to use it.

9.3.5 Recommendations for primary school leaders

The following recommendations, as derived from this three-part empirical study, are aimed at school leaders who would like to enable the school-wide adoption of new initiatives through facilitating the internal dissemination of innovative practice:

- Dissemination for action is dependent upon teachers being able to learn with and from

each other, though opportunities for discussion of practice. The school leadership can support its staff by providing a regular forum for this discussion

- Teachers' learning is also facilitated by the characteristics of the workplace; school leaders should consider the extent to which their workplace facilitates collaborative working and encouraging innovative approaches
- When planning an intervention to develop teachers' assessment literacy, consideration should be made for the likely diversity in assessment literacy among the staffing body
- School level changes to assessment practice which require changes to existing recording and reporting systems are likely to be harder to achieve than those requiring changes to an individual teacher's practice, and may require additional planning and engagement at a leadership level.
- Be aware that preferences for learning opportunities among teachers might vary according to how recently they have joined the staffing body, with more recent arrivals maybe preferring more private supports.
- Provide a range of supports, such as whole staff discussion and discussion between pairs of colleagues, or mentoring for teachers who need more reassurance about how they are proceeding against expectations
- A workplace which encourages formal and informal contacts might enable the successful transfer of innovative ideas and practice
- Fostering a transactional communication style, both within and without of staff meetings, might facilitate the development of interpersonal trust and a collaborative climate between colleagues. This in turn will aid the effective transfer of new knowledge
- Teaching is an isolated profession and teachers have few opportunities to discuss practice with their peers during the school day or working week. School leaders may need to build these opportunities into the timetable, or provide working and learning spaces where teachers can gather to share their thoughts and work collaboratively

This recommendation pertains specifically to the subject area of primary science:

- The SSL in your school might not have the leadership skills required to articulate, plan and implement changes to practice at a school; you may need to mentor them or arrange appropriate support to develop these abilities

9.4 Conclusion

This study has changed the state of knowledge about dissemination of educational research outputs to in-service teachers and the mediating factors within schools which affect the uptake of new ideas to change assessment practice. It has done this through the lens of evaluating the reach and impact of the TAPS pyramid. In doing so, it has: demonstrated the value of a bimodal dissemination strategy to project teams who intend to reach in-service teachers with their research outputs; defined the workplace factors within schools that can enable the schoolwide adoption of new ideas about assessment practice; and shown the value of informal and interactive communication between teachers as part of the internal dissemination process.

Throughout the study, the dissemination of research outputs to in-service teachers has been demonstrated to be an inherently social and communicative process which can be explained with reference to sociocultural theories of learning. As a result of this study, the state of knowledge about dissemination for action and how it might be achieved has also been increased, through the specification of the activities which it entails and their associated enablers and inhibitors.

9.5 Areas for future research

This study has indicated that transactional communication between teaching staff in a primary school can underpin whole school changes to assessment practice in primary science. It has also provided some evidence for the idea that an expansive workplace facilitates these efforts. However, it is reasonable to point out that not all school workplaces are expansive, nor all communication between colleagues transactional. It would therefore be of interest to examine the mechanisms and processes involved in creating an expansive workplace or a transactional communication style in the first place.

A mixed methods longitudinal study which measures expansive workplace characteristics and participants' judgments of communication style over time would allow the plotting of one measurement against the other to see if there was evidence of them being linked phenomena. Another possible research route would be to test the assumption that a transactional communication style between colleagues improves innovative knowledge transfer and professional learning. This could be done by identifying schools where communication acknowledged as problematic. In collaboration with the school leadership, baseline data could

be collected regarding teachers' views on communication, and the formal and informal learning opportunities that they feel they have. Support could be given to the school leadership on transactional communication and how they could model it, and then regular measurements could be taken of staff attitudes alongside the structured roll-out of a new initiative which is intended to change an aspect of teacher assessment practice.

A further study of the dissemination of the same resource in larger sized schools with more teaching staff would also contribute useful knowledge, through the comparative investigation of communication format(s) and style(s) within a larger staff body.

Alternatively, a study could be made of how the TAPS pyramid is received and disseminated in schools where the SSL is not as highly experienced as those in this research. This would help to identify skills that might need to be developed in SSLs to advocate for and provide effective leadership for their subject, and in doing so provide useful pointers for how the project team might support the use of the resource outside of a teaching population comprised largely of Science Subject Leads and class teachers with a special interest in the curriculum area of primary science.

9.6 Summary of this chapter

Contributions to knowledge were summarised and recommendations to achieve successful dissemination of research outputs, which have been derived from the findings for academic research teams and school leaders were given. Possible directions for future study were outlined.

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