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PRIMARY TEACHERS' PROFESSIONAL LEARNING PREFERENCES IN SCIENCE AND TECHNOLOGY

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Abstract:

It has long been established that there are particular challenges to the teaching of primary science and technology. Teacher professional development is almost universally regarded as critical to the provision of high quality school education and to the provision of effective science and technology teaching. This study surveyed 173 primary school teachers in Australia to determine the current state of teacher professional learning in order to understand what professional learning might be attractive to primary school teachers of science and technology. The survey was conducted during the roll out of a new national curriculum and obtained information on: personal and demographic details, professional learning preferences, and school science and technology capability. The findings suggest that these teachers' preferred professional development that included: expert input, sequences of workshops delivered during school time, the trial of practical activities in their own class with collaborative reflection, sharing and discussion of classroom experiences facilitated by a team based strategy such as co-planning and teaching common lessons or lessons with similar activities.

Keywords:

Science, technology, primary teaching, elementary teaching, professional learning, teacher education

JEL Classification: I20, I21, I23

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1 Introduction

This article briefly considers the current state of teacher professional learning and asks: what professional learning might be attractive to primary school teachers of science and technology? The study was conducted during a period of major change, during the roll out of a new national curriculum. The research was conducted in one Australian State. In this state, there is a syllabus specifying the curriculum for primary science. The syllabus covers both science and technology learning outcomes that primary school children are expected to achieve.

Research of teacher professional development and learning is a young field and while there are many examples of arguably successful teacher professional learning, it remains an under-researched field provides a 'full agenda' for future investigation (Borko 2004). In Australia, "The current episodic and disjointed nature of professional learning offered to Australia's teachers means that much more research is needed, particularly from the viewpoint of the teachers" (Yates 2007, p.220).

It has long been established that there are particular challenges to the teaching of primary science and technology both internationally and in Australia (Goodrum, Hackling & Rennie 2001, Tytler, 2003). These include modest levels of teacher expertise and confidence; perceptions of inadequate resourcing; and priorities in primary school programming that often devalue the significance of science in taught curriculum (Lewthwaite 2005). If science and technology are to be taught and learnt effectively then these obstacles to effective science and technology education need to be addressed in well targeted professional learning programs for teachers.

Teacher professional development is almost universally regarded as critical to the provision of high quality school education (Department of Education, Training and Youth Affairs [DETYA] 2000; Ingvarson, Meiers & Beavis 2005; Organization for Economic Cooperation and Development [OECD] 2004) and to the provision of effective science and technology teaching (Loucks-Horsley, Stiles, Mundry, Love, & Hewson 2009; Rodrigues 2005). Yet, it remains a perennial problem for many education systems (Darling-Hammond, Wei, Andree, Richardson & Orphanos 2009). Career-long professional learning is essential for teachers operating in today's complex world due to the rapid pace of change in knowledge (Clarke & Hollingsworth 2002; Guskey 2002; Grundy & Robison 2004). There is abundant evidence that collaboration is critical for effective professional learning and that the processes of collaborative engagement among teachers promote critical reflection on practice and acknowledge teachers as active learners and producers of knowledge (Aubusson, Brady & Dinham. 2006; Burbank & Kauchak 2003; Clement & Vandenberghe 2000). Furlong (2009, p. ix) summarised his concern regarding the gap between what is considered productive in teacher professional learning and what teachers experience:

> While we may know what an effective professional development programme looks like, we also know that the reality is often very different. A recent 'state of the nation' survey … of teachers' experiences of professional development programmes offered to teachers in England demonstrated, yet again, that most of the programmes offered to teachers remain 'top down', short events; they are nearly always disconnected from teachers' own school contexts, and most offer no opportunities for collaboration. As a result, it is not surprising that the study found

that the majority of teachers do not rate their professional development experiences particularly highly.

Traditional forms of teacher professional development delivery have been unproductive and, with few exceptions, have failed to achieve educational reform and, despite its importance, the professional development that is currently available to teachers remains inadequate (Borko 2004; Sykes 1996). According to Darling-Hammond et al. (2009), there is a need for sustained engagement in a professional learning endeavour, with a minimum of about 50 hours required to promote significant change and enhanced student learning. Yet the dominant form has been brief encounters in short conferences and workshops. While it is inappropriate simply to generalise to other contexts, a comprehensive review of teacher professional development, with a focus on implications for the USA, has provided an extensive set of relevant findings (Darling-Hammond et al. 2009). These include that:

- collaborative approaches to professional learning promote productive educational change
- professional learning should be: intensive; ongoing; connected to practice; focus on the teaching and learning of specific academic content; connected to other school initiatives; and build strong working relationships among teachers
- teachers report little professional collaboration in designing curriculum and sharing practices; and that the collaboration that occurs tends to be weak
- teachers report that much of the professional development available to them is not useful and
- teachers have limited influence in school decision-making including decision making regarding professional development.

Literature from Australian studies and reviews on school teacher professional learning indicates general types of professional learning that teachers prefer, as well as the types of professional learning that might be considered effective (e.g. McRae, Ainsworth, Groves, Rowland & Zbar 2001; King, Hill, & Retallick 1997; DETYA,2000). In general primary teachers prefer professional learning that is embedded in classroom practice; where the teachers rather, than the employer, determine the content and mode of learning; that is school based; and that is sequential. Recommended professional learning is typically characterised by collaboration and reflection on actual classroom experiences. Recommended types of professional learning include: action learning, study groups, lesson study, case discussion and peer observation (The Department of Education and Training [DET] 2005).

In a study of Australian teachers professional learning preferences, Yates (2007) found that their preferences were consistent with the professional learning features described above. Specifically, the findings indicated that the teachers' preferences were consistent with the features of professional learning identified by the OECD's Centre for Educational Research and Innovation] (cited in Yates 2007). That is:

- experiential, engaging teachers in concrete tasks that elucidate learning & development

- participant driven. Grounded in inquiry, reflection & experimentation
- collaborative, interactional, involving sharing knowledge
- connected to and derived from teachers' work with students
- supported by modelling, coaching & collective problem solving around specific problems of practice
- connected to & integrated with comprehensive school change
- sustained, ongoing and intensive

Little is known about primary school teachers' preferences about how to address the specific needs of science teaching and the professional learning they consider to be beneficial in what is to them a challenging field. This study sets out to inform this current gap in our knowledge. The study is conducted at an opportune time with a new national science curriculum which will generate extensive demands for school curriculum development and educational change in a variety of fields including science (Atweh & Sing 2011; Aubusson 2011).

2 Methodology

The research used an online survey to explore primary teachers' perceptions of professional learning in science.

2.1 Sampling

The sample consisted of 173 primary school teachers in one Australian state, NSW. Teachers were invited to participate by email. The email included a link to the online questionnaire. The teachers who were sent emails were listed on a Government employer database. The teachers on the database had expressed or demonstrated some previous interest or involvement in science and technology. The email invited the recipient to forward the invitation to participate in the survey to other primary teachers. It is therefore not possible to determine a response rate.

The participants were asked to complete and submit the questionnaire. The surveying process was supported by *Survey Manager* and hosted on a website. Responses were anonymous. A response to all items was not required in order to submit the survey. The number of responses on items ranged from 149 to 173. The items recording the lowest level of responses were personal and demographic items. The lowest number of responses were recorded for gender and school type being a range from very small to very large schools). The sample included teachers with diverse levels of experience (ranging from less than 1 year to more than 10 years teaching experience) rom all primary school types, sizes and regions. Unsurprisingly, in a primary context, there were many more females (80%) than males (20%) and more participants from city (38%) than other school settings (27% rural and 34% regional).

2.2 Instrumentation

The questionnaire was devised based on a review of relevant literature with an emphasis on the Australian context (see Aubusson, Relich & Wotherspoon 1991; King, Hill, & Retallick 1997; McRae et al. 2001, DET 2005; Parliament of Victoria Education and

Training Committee 2009), a review of websites providing teacher professional learning in science to identify the characteristics of professional learning opportunities on offer with particular reference to NSW Department of Education and Training websites; and the advice of a panel of experts. A draft questionnaire was developed and its construct validity examined by a group of university academics with extensive experience in professional learning; staff from the employer with responsibility for professional learning programs in science and technology; and a group of primary school teachers. A revised draft was trialed with a small sample of teachers. This resulted in minor clarifications to instructions and items prior to the questionnaire being disseminated.

The questionnaire was developed to obtain information in three major areas;

1. Personal and demographic details, specifically gender and teaching experience as well as school type, region and setting.
2. Professional learning preferences. Items on professional learning preferences were organised into four sub categories:
    - Broad nature of the professional learning, e.g. collaborative, syllabus focused
    - Type of professional learning specifying specific forms of professional learning e.g. study groups, case discussion, peer observation, co-teaching etc.
    - Modes of professional learning seeking detailed information about 'design' including: timing, location and who determines content and process and delivery e.g. face-to-face workshops or online.
3. School science and technology capability. This consisted of a subset of items selected from the Science Curriculum Implementation Questionnaire (Lewthwaite 2005). This included perceptions of understanding of, importance of, and support for science and technology in the teachers' schools as well as perceptions of the adequacy of school science and technology facilities and resources.

2.3 Data Analysis

The survey included a series of items identifying characteristics of professional learning. Respondents could indicate their preference by choosing one of the following responses: strongly disagree, agree, neutral, agree or strongly agree. These data are reported as frequency data. Cross tabulations were used to analyse the relationships among selected categorical dependent and independent variables. Independent variables included: teaching experience, region of school where the teacher taught; size of school; where the teacher taught; and location (rural, regional, city). A measure of school capability was determined by calculating the average score on all survey items that sought information on perceptions of school capability. All other variables related to perceptions of dimensions of professional learning preferences.

Generally, only relationships with significant Chi-Square ($\aleph^2$) scores are reported here. The level adopted for statistical significance in this study was $p<.05$. To optimise the cross tabulation cell sizes for valid statistical analysis the categories were collapsed from five to three. Strongly disagree and disagree formed a single category of disagree;

undecided/neutral remained as a single category; and agree/strongly agree were combined into a single agree category. However, for some categorical variables, such as school type, the sample resulted in cross tabulations with small cell numbers making the calculation of some Chi-square scores impractical. This outcome is a function of the nature of the sample. Some sub-groups, notably respondent teachers from very small schools, have very small numbers.

Where analysis yielded Chi-Square scores with a probability very close to a significant result, these may be reported with a recommendation for further investigation. This could be achieved by using larger sample sizes. Qualitative methods, as proposed for a future stage in this research, also could be productive. This would necessitate, for example, interviewing teachers from very small schools to determine their specific professional learning needs and preferences.

3 Results

3.1 Professional Learning Preferences Frequency data

Results of the Professional Learning survey suggest teachers would like to engage in professional learning that promotes collaboration between teachers, and offers some structural framework by which to do so. When given the options of either working with teachers in school and sharing real classroom experiences, or working mainly with syllabus support documents and the collection of evidence of Student Learning, 92-93% of participants agreed/strongly agreed that the former method would be beneficial compared to 71-78% approval for the latter.

While collaboration between teachers seems to be more favourable than working mainly with support documents and research, participants expressed a preference for working with teachers in their own school (92% agreed/strongly agreed) as opposed to inter-school collaboration (72% agreed/strongly agreed). These results are interesting in light of the response from teachers when asked about their own school. Only 42% agree/strongly agree that teachers at their school have a good background knowledge for teaching science and technology and only 46% agree/strongly agree that teachers at their school do good science and technology activities. This suggests that participants feel their professional learning needs are best addressed in their own school, that conducting professional learning collaboration with teachers within a school, could encourage professional dialogue to improve practice and support teachers when and where they need it. It could also contribute to professional community formation.

When defining collaboration between teachers for the purpose of professional learning, it is helpful to categorise methods of collaboration as follows:

1. Lesson Planning (preparation)
2. In-class collaboration (execution)
3. Reflection on own experiences (reflection)

3.2 Lesson Planning

Lesson preparation and science and technology unit co-planning yielded favourable responses. Survey results revealed teachers would like to participate in professional learning that provides collaborative unit planning where a group of teachers work together to develop a science and technology unit as well as co-plan selected lessons. 87-88% of participants agreed/strongly agreed with this course of professional learning. The popularity of this option seems to be more favourable if, once planning is complete, classes are taught independently. On the other hand, other studies (e.g. Aubusson, Ewing & Hoban 2009) have indicated that collaboration can gradually break down barriers to teacher isolation and in time encourage teachers to open up their classes for professional learning opportunities with others.

3.3 In-class collaboration

Co-teaching, where two or more teachers teach some science and technology lessons together proved considerably less popular (with a 68% agree/strongly agree) than independent teaching following collaborative lesson planning. The presence of another teacher or teachers in the classroom seems to be viewed as unhelpful or daunting to participants. Only 47-54% of participants agreed/strongly agreed that they would like to be involved with Peer Observation, where teachers observe each other's classroom as a stimulus to conversations and reflections about teaching and learning as well as Lesson Study, where teachers co-plan, observe the lesson taught by one of the team and discuss strengths, weaknesses and improvements. Perhaps teachers suspect such scrutiny may be in some way detrimental to their own teacher learning. There seems little doubt that peer observation is viewed by a significant number of teachers as threatening and associated with supervision and assessment of the quality of their teaching rather than professional learning. As noted above, this obstacle is not insurmountable but its significance as an obstacle to some forms of recommended professional learning should not be ignored.

3.4 Reflection on Own Experiences

This method proved highly favourable when reflection was based on the teachers' own experiences. Broadly speaking, professional learning that facilitates teachers sharing and discussing real classroom experiences proved to be an area of professional learning that a large majority, 93% of survey participants, would like to be a part of. Such professional learning was regarded as attractive where managed as Study Groups, where teachers meet to analyse, reflect on and discuss classroom experiences and practice or simply when teachers meet to reflecting on co-planning efforts, discuss experiences and class results. For discussions based on Case Studies or documents on primary science and technology, results were less favourable with a 51-57% approval rating.

When asked the type of professional learning the teacher would like to participate in, one option encompasses what seem to be all three preferred methods of preparation, execution and reflection. With an agreed/strongly agreed rating of 86%, Shared Common Lessons would have teachers co-plan lessons, teach them independently and then come together to collaborate and reflect on the experiences.

Survey results suggest science and technology reading, syllabus support and analysis of case studies is not something teachers chiefly seek in their professional learning. 28% believe teachers at their school want professional learning to provide reading in science and technology, a focus on syllabus support documents (as mentioned above) is not seen as important as teacher collaboration, and case discussions is the lowest ranking collaborative technique. However, 65% agree/strongly agree that teachers at their school want science and technology to provide an explanation of the syllabus while only 42% agree/strongly agree that teachers at their school have a good understanding of the K-6 syllabus. Such feedback implies that while gaining a better understanding of the syllabus may not be the main focus of professional learning, it is a necessary part of the program.

Furthermore, it seems teachers want science and technology professional learning to cover a wide range of methods, skill sets as well as science, technology, curriculum and pedagogical knowledge. There were marginal negative responses to all options under "Teachers at my school want science and technology professional learning that provides:" with the exception of Professional reading with teachers (only 28% agree/strongly agree, as discussed above). This section covered content and concepts, pedagogical ideas, resource management, teaching approaches, practical activities, information on science and technology equipment and materials, explanation of syllabus and confidence in teaching science and technology.

An explanation for the absence of negative responses and the need for professional learning to encompass many diverse needs could possibly be found in the next question set. Positive feedback from questions asking whether teachers at the participant's school have sound knowledge of the syllabus, strategies known to be effective for teaching science and technology; a good background knowledge for teaching science and technology; and do good science and technology activities, ranged between 31 - 42%. This data also supports results that suggest a desire for expert input, where an expert provides advice and practical strategies to try in class. 88% of participants supported this professional learning option. 84% agree/strongly agree that the mode of professional learning they value most is that provided by an external expert.

The need for professional learning to provide expert input in the form of presenting science and technology practical activities is a trend we see throughout the survey results. 100% of participants agree/strongly agree that teachers at their school want science and technology activities to be provided by professional learning. 96% of participants agree/strongly agree (66% strongly agree) that they would benefit from professional learning offering practical activities where the teacher can try science and technology activities for use in class. This preference for practical activities is evident when we remember only 30% agree their school has a sound knowledge of strategies known to be effective for the teaching of science and technology.

There seems to be a call to improve the support offered to science and technology teachers within their respective school. 45% agree/strongly agree the facilities and resources in their school promote the teaching of science and technology while 53% agree/strongly agree science and technology is an important subject in their school's curriculum. Some attention to the support structures within the schools is needed. There is room for improvement where 56% agree/strongly agree collegial support is important in fostering capabilities in teachers who find science and technology difficult to teach.

In terms of modes of professional learning, participants seemed keen to participate in workshops provided by an external expert (1% negative response) with the view of trying out learned strategies in class. When given the option of attending workshops within or out of school time, participants preferred the former. With regards to workshop location, attending at school seems more agreeable than away from school (67% and 56% respectively agree/strongly agree). Participants responded positively to workshops offered at a variety of times and places. Responses to online availability as a mode of professional learning varied, with moderate feedback of 22% disagreeing and 35% agreeing. Responses to the workshop time period also varied. A whole day workshop is most popular, more than a one day block seems to be too long while 1-2 hours is not enough time. The precise timing and logistics for workshops and professional learning in general is unclear from the data. However, the demand for sustained professional learning support is unequivocal.

4 Relationships Among Variables

4.1 Teaching experience and professional Learning Preferences

The sample did not yield sufficient numbers of respondents with less than five years of teaching experience to permit valid analysis. The experience variable was reduced to two categories: those with ten or less years teaching experience and those with more than ten years' experience.

There was a statistically significant difference in the professional learning preferences of teachers with different levels of experience, $\aleph^2 = 6.758$, DF = 2, p = .034, in relation to reflection. All teachers expressed strong preferences for professional learning that involves reflection. However, this preference appears to be even stronger among experienced teachers (>10 years) than less experienced teachers (< 10years).

A majority of all respondent teachers expressed a preference for professional learning that includes the collection of evidence of student learning. Teachers with more than ten years' experience were more likely to express this preference than were less experienced teachers, ($\aleph^2 = 9.436$, DF = 2, P p = 0.009).

Sequences of workshops were favoured features of professional learning opportunities for most teachers. An investigation of a relationship between teaching experience and level of preference for sequenced workshops yielded near statistically significant results, $\aleph^2 = 5.799$, DF = 2, p = .055. The difference lies not in the percentage agreeing that workshop sequences are desirable with 85% of teachers in both levels of experience agreeing that this is a desirable feature. Rather, the difference lies in those who are undecided or disagree. Specifically, teachers with ten or less years of teaching experience were twice as likely to disagree with this statement while teachers with ten years' experience or more were twice as likely to be undecided. This requires further investigation if this data is to be understood. It should be remembered that the numbers of teachers disagreeing or being undecided, overall, is relatively small at only 17% if both categories are combined.

Teachers with different levels of experience varied in their views on the value of professional learning determined by the school, $\aleph^2 = 10.542$, DF = 2, p = .005. The more experienced teachers (50%) were about twice as likely to value school determined professional learning than less experienced teachers (24%). Both groups were equally

represented in the undecided response. Less experienced teachers (38%) were about twice as likely to not value professional learning determined by the school compared to 16% of more experienced teachers. A similar pattern was exhibited with reference to professional learning determined by the employer, $\aleph^2 = 5.895$, DF = 2, p = .05. Although only a minority of teachers of all levels of experience agreed with the value of employer determined professional learning, teachers with less experience (40%) were almost twice as likely to disagree with the statement that employer determined professional learning was most valued. Interestingly a high proportion of both groups were undecided (44 - 48%). Experienced teachers were more likely than inexperienced teachers to value employer determined professional learning (34% and 14% respectively).

There were also significant differences between experienced and inexperienced teachers on perceptions of aspects of their school's capability in Science and Technology education. Less experienced teachers were inclined to regard their school's capability less highly than experienced teachers. The items of difference included the collegial support evident $\aleph^2 = 6.992$, DF = 2, p = 0.03 and perceptions of whether teachers do good Science and Technology activities in the school, $\aleph^2 = 6.390$, DF = 2, p = 0.04. There was also a near statistical difference in perceptions of the quality of the science and technology facilities and resources suggesting that more experienced teachers are more likely than less experienced teachers to view the resources available as satisfactory, $\aleph^2 = 5.743$, DF = 2, p = 0.057. Further exploration is needed to investigate this near statistically significant difference.

The differences between professional learning preferences of more (> 10 years) and less experienced teachers (< 10 years) are interesting but should not be overstated because the differences between groups are quite small particularly with regard to the nature of professional learning. The differences are not entirely unexpected in that experienced teachers may be more likely to be involved in the executive or more influential within their schools. If so, it is unsurprising that they would find school determined professional learning more favourable than less experienced teachers. It is worth repeating however, that overall a majority of teachers favour teacher determined professional learning over school or employer determined professional learning. It is also possible that more experienced teachers are likely to have higher levels of responsibility and accountability. If so they may be more likely to need data that provides evidence of student outcomes and more likely to favour professional learning that includes such evidence.

Different perceptions of school capability are difficult to explain because they may be genuine expressions of differences in capability or perhaps related to higher or lower expectations. Furthermore, it may be that teachers of different levels of experience are clustered together in schools, with some schools having far more experienced teachers than others. This is likely to influence real and perceived school capabilities. If we take the data at face value, then it seems that less experienced teachers perceive their school to be less collegial with regard to science and technology education. The sample of early career teachers in the study was small but early career teachers and other teachers new to schools often feel socially and professionally excluded. This may explain the variation in perception of collegiality. Difference in perceptions of the quality of science and technology are interesting. Many explanations are possible. Less experienced teachers may have higher expectations regarding what is appropriate in science and technology and hence

consider the nature of activities in their school to be less satisfactory. Alternatively experienced teachers may simply be in schools where the quality of science and technology activities is higher. Similarly, less experienced teachers may have higher expectations regarding school facilities than experienced teachers or experienced teachers may simply be located in schools with better facilities and resources. Here only speculation is possible but as there is greater dissatisfaction with both the nature of activities and the quality of resources and facilities among less experienced teachers it may be that the science and technology activities they would like to see and do in their school are not as widespread as they would like. Furthermore, this expression of dissatisfaction among less experienced teachers does not bode well for future participation in, and commitment to, science and technology among primary school teachers.

4.2 School capability and professional learning preferences

There were no significant differences in professional learning preferences associated with perceptions of school capability. It is noteworthy in one third of the tests, the size of cells were too small to calculate $\aleph^2$ scores that met the levels set for reasonable validity. Hence, it would be inappropriate to claim that there were no differences. Rather, it suggests a need to refine and expand the capability scale (note the scale was reduced from a much larger instrument for the purposes of this study). Alternatively, a larger sample may provide greater insights into potential relationships.

School Type

Preferences and capability by school size

Teachers were asked to identify their school size at which they taught by selecting the standard code used in the local education system. To provide cell sizes large enough for reasonable analysis the categories were collapsed into two groups with the smallest schools in one group and all larger schools in the other group. In about one third of statistical tests (14) the cells were too small for valid cross tabulation analysis. As noted above, it is unsurprising that small schools would be represented by small numbers in the sample.

School size was related to teachers' preferences for sequences of workshops in professional learning ($\aleph^2$ = 6.419, DF = 2, p = 0.040. All (100%) of teachers from small schools indicated that sequences of workshops were desirable. Such professional learning was also attractive to teachers in larger schools (79%) but 16% were undecided. Responses by teachers in small schools to some items related to collaboration indicated that they may be more likely to value collaboration with teachers from other schools but the data is too scant to have confidence in any interpretation.

There were differences in perceptions of school capability associated with school size. In particular, teachers from very small schools scored higher on their perceptions of their understanding of the science and technology syllabus, than those in larger schools ($\aleph^2$ = 6.512, DF = 2, p = 0.039. They also appeared to have more opportunities to engage in professional learning related to science and technology than their counter parts in larger schools ($\aleph^2$ = 9.365, DF = 2, p = 0.009. Specifically, 84% and 54% respectively agreed with the statement that "Teachers at this school have the opportunity to undertake professional development in science and technology". As well, teachers in small schools

($\aleph^2 = 10.894$, DF = 2, p = 0.004 were also more likely to agree that teachers at their schools had a sound knowledge of strategies known to be effective for the teaching of science and technology. Because school size, location (rural, regional or city) and region are linked data on regional differences, it is now reported before discussing patterns related to school size.

Preferences and capability by location (rural, regional, city).

There were no significant differences between school setting and any dimensions of professional learning preferences. Differences were only evident with regard to perceptions of capability. The differences were on perceptions of teachers' understanding of the science and technology K-6 Syllabus ($\aleph^2 = 9.686$, DF = 4, p = 0.046; and school facilities and resources $\aleph^2 = 12.080$, DF = 4, p = 0.017. Teachers in city schools were more polarised on their view of the understanding of the syllabus than those in regional or rural settings. They were both more likely to agree and to disagree on this item than would be expected from a null hypothesis. Thus a lower percentage of teachers in city schools responded as undecided on this item than their counter parts in other school types. This suggests considerable variability regarding knowledge of the syllabus in city schools or at least greater awareness of this variability among teachers. Only 44% of teachers surveyed agreed that the facilities and resources at their school promoted the teaching of science and technology. This concern was stronger among teachers from 'regional' schools where only 27% agreed. This suggests that while there is an overall dissatisfaction with resourcing, some may be better (or worse) off than others.

Preferences and capability by location (rural, regional, city).

There were no statistically significant differences between regions on the survey dimensions. This suggests that differences are more associated with factors that operate across rather than within regions.

In summary, there is little doubt that statistically significant differences exist in teachers' professional learning preferences but these differences are few, small and probably educationally insignificant for professional planning purposes. Differences in teachers' perceptions of school capability are difficult to explain but probably need to be taken into account when planning professional learning. These perceptions of capability may give an indication of perceived needs of teachers rather than simply what type of professional learning they like. Unfortunately the patterns revealed are not consistent enough to provide a guide to how one might address these needs differently according to school type (location, region or size). It does suggest however, that in designing a school-based professional learning program it would be advantageous to first assess school specific science and technology characteristics. This requires more than merely asking teachers what they want. It calls for an instrument to assess school science and technology capability (e.g. Lewthwaite 2005) or an instrument to audit and promote conditions for change (e.g. a Schools Innovation in Science [SIS] audit)

5 Limitations

This study was conducted in a single state in Australia. The context and sample size limit the extent to which the findings can be generalised. The reader is best placed to determine the relevance of the findings of this study to contexts in which they operate. The

implications outlined here pertain specifically to the population of primary teachers under study.

6 Implications

The professional learning preferences of teachers of science and technology in primary schools are consistent with research-based designs for productive professional learning.

There is a marked inherent similarity in the population sampled in terms of their responses to the items on the questionnaire. Given this similarity, the data provides a sound basis for designing professional learning experiences that are likely to be attractive to the vast majority of primary school teachers interested in improving their science and technology education capabilities.

In broad terms teachers express high preference for professional learning that is collaborative, sustained, practical and closely linked to the actual teaching for learning of science and technology in their school. They want to have choice and control over the content and type of professional learning in which they engage. They appreciate input from experts and sequences of workshops as part of their professional learning experience.

An ideal professional learning scenario could consist of:

A sequence of workshops with expert 'input' delivered during school time, the trial of practical activities in their own class with collaborative reflection, sharing and discussion of classroom experiences facilitated by a team based strategy such as co-planning and teaching common lessons or with similar activities. Many would also value the opportunity to extend the process to working with teachers from other schools.

There is little doubt that statistically significant differences exist in teachers' professional learning preferences but these differences are few, small and probably too educationally insignificant to influence broadly targeted professional learning planning.

Differences in teachers' perceptions of school capability are difficult to explain but probably need to be taken into account when planning professional learning. The differences are not strongly related to school type or region suggesting that the variations need to be considered, but at individual school level rather than on the basis of school type, setting or its region. It is difficult to assess whether the perceptions of school capability reflect a fundamentally good or bad state of readiness or capacity for science and technology education in primary schools. There is no denying that it would be desirable to enhance primary school science and technology capability. Many key capability needs could be readily addressed through effective teacher professional learning. Indeed, even seemingly unrelated matters such as facilities and resources may also be addressed if the professional learning activities take into account the particular science and technology equipment and materials available in typical primary schools and ensure strategies and activities work within these available means.

In adapting a school-based professional learning program it would be advantageous to first assess school specific science and technology capability. This requires an instrument to assess or audit school science and technology capability, create interest and awareness, and to identify specific conditions to promote engagement in the process.

7 Conclusions

The design of professional learning in primary science should take into account the professional learning preferences of teachers. There is a need for further research to explore patterns of school capabilities and to devise ways to adapt broad 'preferred' professional learning designs to meet the specific needs of individual teachers and schools.

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