Professional development and junior secondary mathematics teachers: Can out-of-field teachers benefit too?

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To foster effective teaching and quality education, professional development (PD) is imperative. This paper explores the perspectives of junior secondary mathematics teachers in two Queensland schools as part of a broader case study that investigated the perspectives of junior secondary mathematics teachers on the transition of Year 7 to secondary schooling in Queensland. The study explored existing PD practices and sought to identify perspectives of how PD can be better utilised to improve teacher quality. The theoretical lens of teacher identity was adopted, and the key findings indicated a lack of existing PD practices; the need for further PD; and a process for implementing mathematically focused PD in the future.

Professional development (PD), in any field of study, focuses upon changing and improving teacher quality and student achievement of those teachers already in the teaching profession; where individuals can update, revise, and reflect upon their current practices (Roland et al., 2014). Usdan et al. (2001) suggest that no singular facet of school reform is more impactful than the idea that student learning depends almost exclusively on the quality of teachers. Foster et al. (2013) identified PD as one of the few approaches by which teacher quality can be improved. This view is further supported by Kimmel et al. (1999) who state that "PD has become a key component for reform in teaching, learning and curriculum change" (p. 241); thus, in most educational jurisdictions PD must be undertaken on an ongoing basis. As the demand for quality education and the need to foster effective teachers is as crucial as ever, the challenge to incorporate timely and appropriate mathematics PD into schools is becoming increasingly apparent (Curtis, 2013). Not only will PD achieve this improvement of knowledge and broaden the scope of strategies utilised to teach mathematics effectively, it is also useful for supporting out-of-field teachers.

In recent times a shortage of teachers qualified to teach mathematics in secondary schools has occurred with a subsequent misfit between appointment, qualifications, and experience (Australian Mathematica Sciences Institute [AMSI], 2014). This shortage has led to secondary teachers teaching subjects that they are not qualified to teach, a practice known as teaching *out-of-field* (Hobbs, 2012b). Data from AMSI (2014) identified that teaching positions in mathematics are harder to fill than any other teaching positions and suggest that nearly 40% of mathematics teachers in junior secondary schools in Australia are currently underqualified to teach mathematics. Sharplin (2014) found that the experience of teachers and the degree of fit or misfit between teachers and their teaching load is a key consideration for successful student outcomes. Steyn and Du Plessis (2007) state that "out-of-field teachers struggle to teach effectively, which influences their perceptions on their professionalism, quality teaching and the extent of the success of their development in teaching as a profession" (p. 149). The literature reveals two predominant schools of thought in relation to out-of-field teachers. First is a proactive standpoint, whereby the focus remains on the improvement of the qualifications and content knowledge of out-of-field teachers to combat their lack of knowledge. Second, from a reactive standpoint, where schools are forced to remedy staff shortages by employing out-of-field teachers as the only viable option with little plan for PD. The underlying issue with the reactive approach is that utilising any registered teacher to teach mathematics classes does not work to eradicate the use of out-of-

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field teachers nor improve their knowledge (Lederer, 2004). As out-of-field teaching is complicated and prevalent in mathematics education in Australia, it is an important consideration when investigating PD.

Theoretical Framework

The theoretical framework underpinning this research is *teacher identity*, also known as "professional identity" that incorporates a range of teacher characteristics and considers their knowledge, ideals, principles and beliefs as educators and their pedagogical approach to teaching (Bennison, 2014). Teacher identity is an effective lens to examine the perspectives of teachers as it provides a robust foundation to successfully investigate qualitative data. This theoretical lens is particularly beneficial for this research as the information that is being sought from mathematics teachers and key stakeholders derives from their perspective and sentiments of themselves as educational professionals. Hobbs (2012a) suggests that teacher identity can work in conjunction with self-efficacy to reflect an individual's belief in their capacity to influence their environment in relation to motivation, behaviour, and particular performance accomplishments. Furthermore, a teacher's awareness of their own teacher identity affects their PD requirements, their ability and inclination to manage educational change, and how they innovate in their teaching practice (Beijaard et al., 2000). Therefore, to explore existing PD opportunities and to ascertain whether further PD is warranted and sought by the participants, the research question addressed in this paper herewith is: *Are current PD practices appropriate to support junior secondary mathematics teachers and out-of-field teachers of mathematics?*

Method

Data was collected from ten teachers and key stakeholders in two secondary schools in Queensland via a case study approach. Case studies offer opportunities to observe the emergent patterns and characteristics of a phenomenon with a view to establish generalisations regarding the wider population (Bassey, 1999). Although initially each school was to be considered as a separate case, the two schools have instead been considered together to form one case study. This change of approach occurred after the participants had been interviewed, in the analysis stage of research, since most of the responses were similar.

Participants

The qualitative data was gathered from ten participants comprising classroom teachers, the mathematics Heads of Department, and other key school stakeholders such as school leaders. The sample size consists of six participants from School 1; and four participants from School 2 to provide a suitable and practical data set (Kumar, 2014). Table 1 outlines the background of each de-identified participant. The participants were recruited by each school and the background of each participant was not known prior to each interview, thus the researcher had no influence over the selection of participants. Each participant was asked questions pertaining to the same issues, with the aim of encapsulating an emergent pattern to maintain quality interview data (Diefenbach, 2009).

Table 1
Demographics and Qualifications of Participants

Participant	Age Range (years)	Time at School Site	Current Teaching Position	Qualifications
School 1				
Peter	40-50	6 years	Mathematics HOD	B.Ed. Grad Dip Ed (Math)
James	20-30	2 years	Y8 Maths Co-Ord	B.Eng (Civil). Grad Dip Ed (Math/Phys)
Rose	30-40	11 years	Y9 Maths Co-Ord	B.Sc. Grad Dip Ed
Violet	50-60	22 years	Y8-12 Maths Teacher	Dip Teach, then upgraded to B. Ed
Leigh	50-60	2 years	Y7 Maths Co-Ord	B. Ed (Primary P-10). Flying Start.
Dylan	30-40	2 years	Y7 Maths Teacher	B. Ed (Primary). Flying Start.
School 2				
Mary	40-50	9 years	Y7 Echo Facilitator	Dip Teach, then upgraded to B. Ed
Caroline	20-30	4 years	Y7-9 Maths Teacher	BPsySc. Grad Dip Ed. Masters Candidate
Dougal	40-50	3 weeks	Y11/12 Maths Teacher Dir of Academic Perf	B.Ed (Math/Science)
Carly	50-60	1 year	Y7-9 Maths Teacher	B.Sc / B.IT. Grad Dip Ed.

Note. Flying Start denotes a teacher who is primary trained brought in from state primary schools to teach Year 7 students in the secondary setting; Echo denotes a special program which aims to enhance gifted students.

The participants in this study were interviewed and were required to critically reflect and analyse their own identity as a teacher. The interviews conducted were semi-structured and lasted approximately thirty minutes. The participants were invited to provide their perspective about existing PD available to them and to ponder PD opportunities sought in the future. While there were set questions of focus supported by the literature, at times, further questioning was required in response to participant remarks, thus fostering an adaptable interview structure tailored to each participant (Wiersma & Jurs, 2005). In addition, interviewees were given the opportunity to discuss topics not suggested by the researcher.

Methods of Data Analysis

Interviews were transcribed by the researcher and data was analysed methodically via the six phases of analysis approach developed by Braun & Clarke (2006) where the researcher: 1) becomes familiar with the data; 2) generates initial codes; 3) searches for themes; 4) reviews the themes; 5) defines and names the themes; and 6) produces the report. Key themes were identified throughout the transcription process via the thematic coding approach. Once the data was coded, the procedure of repeat reading was completed to validate or challenge previous observed patterns.

Findings and Results

PD is a vital approach to improving the knowledge and pedagogical methods of mathematics teachers and this is a continuous process (Linder, 2011). As such, PD forms the main premise for pedagogical improvement. One of the participants, Dougal, was involved with PD at both school sites and had conducted PD for other schools in the past, and as such, his approach to PD is a core consideration. Dougal professes the importance of PD and stated that teachers should be trying to improve themselves by attending PD or investigate other ways to enhance their pedagogy. However, it seems that mathematics PD was undertaken sporadically in both schools and this is consistent with the view of Curtis (2013) who outlines the difficulty in implementing timely and appropriate mathematics PD into schools. See Table 2 depicting details on the context of the last PD undertaken by participants.

Table 2
Topic of Last Professional Development Attended

Participant	Topic Area
School 1	
Peter	General PD focused upon the Australian Curriculum (ACARA).
James	PD on Leadership held with Teacher Education Centre of Excellence (TECE).
Rose	No PD completed recently. Requested PD in external assessment marking for Year 11.
Violet	PD attended with Dougal (in house 3 weeks ago). Last year requested PD on mathematics aimed at developing students – however not approved.
Leigh	PD on ACARA and alignment with the school textbook (generic).
Dylan	PD on Behaviour Management.
School 2	
Mary	PD on mathematics games (Concrete games in all topic areas).
Caroline	PD undertaken recently with Dougal.
Dougal	No formal PD undertaken recently.
Carly	Last attended mathematics PD at previous school and it was run by Dougal. This was school separate to both schools partaking in the study.

Dougal confirmed that he develops and presents PD for his staff incorporating an optional 15 to 20 minutes PD every week, or often larger sessions of PD in prescribed staff meetings. Since Dougal had only commenced at School 2 three weeks prior to being interviewed, it is likely that the PD he mentioned is only in its infancy. In his PD sessions, Dougal outlines that he always incorporates the use of technology. Technology can prove beneficial when utilised effectively in the classroom to teach mathematics and Peter supports this notion and suggests that if it is used properly it can be advantageous, although proper training in such technology is crucial. However, two participants (Dylan and Rose) suggested that they were unaware of how effective technology could be and felt that further training would be beneficial. While many teachers had admitted to undertaking some PD recently whether it is in other disciplines, it is concerning that eight respondents of the ten had not completed any mathematics PD in the past year meaning they had not worked to improve their mathematical content and pedagogical knowledge.

Desired Professional Development

The participating teachers were asked about the type of PD they would like to undertake, a variety of responses emerged. Table 3 outlines the participants desired mathematical PD. Peter felt that teachers would benefit from further PD on practicing mathematical problems. As the HOD of School 1, Peter stated that he goes "to some of my faculty meetings and say, 'do this problem', because I know that half of the teachers can't do it because they're not senior teachers". Peter believed that teachers must practice their mathematical skills and utilise a variety of ways to reach an answer, to ensure they are completely proficient.

Dougal agreed with Peter and further mentioned that he wanted to have more opportunities of teaching mathematics to the younger year levels to improve his pedagogic methods and ways to engage the younger students. Dougal felt that it is important to be "able to walk into any level of student and know the curriculum well enough to just jump in and teacher it really", and to achieve this, further exposure and access to junior secondary mathematics classes, and PD focused upon more simplified pedagogic methods would be useful. Furthermore, Dougal and Peter were also in alignment and believed in the benefits of the coaching model, where teachers can discuss processes and methods of teaching mathematics, and consequently are able to learn from each other.

Table 3
Desired Professional Development

Participant	Desired Professional Development
School 1	
Peter	Practising mathematical problems.
James	N/A.
Rose	Senior mathematics, essence of ACARA, STEM: the expectations from school administration.
Violet	Microsoft Excel and use with graphing.
Leigh	Apps in mathematics.
Dylan	Further exploration of tips and tricks in mathematics.
School 2	
Mary	Time management, better utilisation of time to ensure that all of the ACARA is covered.
Caroline	Senior mathematics, specifically the topic of algebra.
Dougal	Improvement of timetabling to have access and teach mathematics to younger year levels.
Carly	More difficult mathematics including Maths B.

Three participants (Rose, Caroline, and Carly) showed a strong desire to improve their mathematical content abilities in relation to senior mathematics. Rose wanted to expand her mathematical thinking to incorporate the senior mathematics curriculum "in terms of seniors, I feel like I'm in a really dark room and am just feeling my way around". Rose wanted to learn "everything about senior maths, because when it comes to senior maths, the topics are very topic driven" and currently all there is to rely on is "one or two books and one or two teachers that we can toss ideas around with". Caroline specifically identified that she would like PD on "harder algebra topics from a senior teachers' perspective, so that I can see where they need to get to". Carly's viewpoint coincided with this stance and additionally mentioned that "I don't have a clear idea of what they do in Maths B higher up the school, so because of that I don't know where the kids need to go".

Hindrances to Professional Development

Whilst it is evident that further PD is desired by the participants of this study, there are some hindrances that have emerged that inhibited staff members from actively undertaking further PD. These difficulties seem to stem from top tier school administration as well as the HOD for mathematics (Peter), and the Director of Academic Performance and Innovation (Dougal), who have control over PD opportunities. The first problem is the apparent lack of mathematics PD as most teachers reported limited opportunity. Dylan noted, "not so much, it's usually like there's a PD, but not really ones of (mathematical) interest". Dylan reported that PD must go through administration and/or the Head of Department for mathematics before reaching the teachers, "Peter sometimes says 'there's a PD of this coming up would you be interested in doing it'? So usually, they must sift through it from up here and then they pass it through". If this is the case, perhaps some opportunities are missed by departmental leaders simply because they are not aware of all PD opportunities. Also, if the school administration sifts through all PD opportunities, perhaps some are being withheld intentionally due to the cost of attendance to the school.

A further reason that could explain the reduced opportunity for PD is that School 2 prefers to undertake PD in house. Caroline reported, "since the new principal, there seems to be a shift in the way that PD is considered. They don't really want us to go out to PD, they want us to have internal PD instead of us going out to PD's it's more internal". Caroline further stated that only senior staff members attend external PD's "so it's only if you're like the Head of maths or Head of Echo. Only those type of people that do it, more the senior staff. So, everyone just teaches each other, which seems to be the way that it is". While

internal PD is an excellent method to increase the knowledge and pedagogical approaches to mathematics; perhaps this format in conjunction with external PD would be useful to broaden the horizon of the teachers.

Another issue hindering the opportunity to attend PD is the quantity of paperwork involved and the slow application response rate, an issue for School 1. Violet noted "the paperwork here is insane. So, if you find a PD that you want, you have to fill out the paperwork, take it to admin, then it's about a two-week turnaround before it's a yes or a no to go". Sonya also suggested that favouritism occurs where some teachers are more favoured and approved to undertake the PD more so than others. Violet also supported this claim "I did apply to go last year, but I got knocked back from admin. That was about teaching maths to lower-level kids. And it seems that some people are favoured more towards PD's than others in the school".

Professional Development for Out-of-field Teachers

The existence of out-of-field teaching has been identified in both participating schools with 50% of the respondents acknowledging this. Rose, Leigh, Mary, Caroline, and Dougal highlighted this issue and its occurrence. Rose mentioned that is has "been a huge problem for us, because we don't have enough maths teachers, the actual maths trained teachers are taken to teach senior maths because of the content knowledge, expertise and the amount of people qualified to teach certain subjects". Furthermore, Rose, Caroline and Leigh specifically mentioned that the mathematically untrained teachers are teaching mathematics to students in the lower year levels. Rose indicated "all the junior classes were given to teachers that are out of this department or out of this field". Caroline believed that these untrained mathematics teachers typically were from "Physical Education (PE), Science, and English backgrounds". While it is a common practice to combine the Mathematics and Science disciplines so that they are often taught by the same teachers, PE and English has limited to no relevance.

Rose felt this is particularly disadvantageous to students as she believed that Year 7 and Year 8 are the most important years of schooling, "they are teaching Year 7 and 8 (I've said this to my principal as well) they are the most important years". Furthermore, Leigh outlined the inconsistency of utilising out-of-field teachers, in that "they get that maths class for a year, and then next year they won't get another maths class – almost guaranteed. It's just their timetable and how it all fits in and gels". As out-of-field teaching is a common occurrence at these schools, PD is needed for all teaching staff no matter the discipline in case they are required to teach mathematics the following year. Leigh noted that PD is vital for out-of-field teachers but is problematic as workload changes occur each year.

Both schools are aware of the need to reduce the use of out-of-field teachers and have taken steps to combat the shortage of specialist teachers such as implementing changes to timetabling to match the mathematics trained teachers with the mathematics classes. While this is a positive step in the right direction in terms of diminishing the use of out-of-field and untrained teachers, this does not completely correct the issue as it still relies on having enough specialist mathematics teachers to meet the timetabling requirements.

A tactic that School 2 is opting for is a differentiated approach so that in conjunction to ensuring its teachers are mathematically trained, they are actively training and up-skilling the untrained mathematics teachers. Dougal explained this in house training to involve team teaching where Dougal does the teaching, and the staff member observes by watching and learning. With one new staff member specifically, in conjunction to the coaching model, "I am sitting down one-on-one and doing a lot of work with her at the moment to up-skill her".

Overall, it seemed that while some PD relating to mathematics has been undertaken, much further incorporation in both schools is warranted considering that PD is one of the few approaches to improve teacher quality (Foster et al., 2013). This is particularly important to this study as the Junior Secondary teachers interviewed are perhaps not completely confident in their abilities along with the use of out-of-field teachers in mathematics.

Conclusion

In summary, the findings indicated that eight of the teachers have not undertaken mathematics PD in the past year. Although School 2 is in the process of improving this, the focus is the incorporation of digital technology. Whilst a step in the right direction, the findings suggest that little emphasis has been placed upon other pedagogical strategies to improve mathematical content knowledge and teaching. The findings also suggested that School 2 favoured in house PD which again limits the scope of the PD available. This is contrary to the findings by Roland et al. (2014) who suggests that PD which incorporates a variety of teaching professionals such as teacher candidates, current teachers from the discipline and internationally educated teachers, allow professionals to collaborate as members of the broader educational community providing a more robust and enriching learning experience. School 1 was not of this belief and had recently employed Dougal for external PD specifically, however, it was unclear as to how long this had been occurring and again if technology is of focus.

The findings indicated that the deficiency of PD is attributed to several factors including: the lack of opportunities provided by school administrators; lack of time to attend PD; and tedious paperwork involved in the application process. Perhaps if a more streamlined, automated administrative process were adopted, mathematics teachers would be able to attend more PD. It is evident that there is a need for future teacher learning, and the findings indicated specific topic areas that the teachers would like to explore such as problem solving and extending their understanding to explore the senior mathematics curriculum. Several teachers also felt that the tactic of pairing teachers with their more senior counterparts to learn from each other and practice their existing mathematical skills would be beneficial.

The use of out-of-field teachers occurred in both schools; however, proactive steps are in action to reduce this and thus improve the quality of teaching. School 1 is working to improve timetabling, whilst School 2 has incorporated a different approach by up-skilling its existing teachers. Perhaps by multiskilling junior secondary mathematics teachers to teach mathematics to senior students, there would be more availability of staff to fill teaching roles, and this will be beneficial for timetabling which is an issue identified at both schools. This would also reduce the likelihood of employing out-of-field teachers to teach mathematics. However, the shortage of qualified mathematics teachers in Queensland remains a significant problem. Overall, it appears that teachers want to develop and extend their existing mathematical knowledge and pedagogical practices; however, there is limited scope for this development.

Implications and Limitations

It was found that although PD is a requirement to sustain teacher registration, very little PD is undertaken in mathematics education and rectifying this will aid to not only improve the content knowledge of teaching but will also expose teachers to a variety of methods and strategies to improve their pedagogic approaches to teaching mathematics. PD will also help to expand the skill level of existing mathematics teachers, for instance, if Junior Secondary

teachers are trained in senior mathematics teaching there will be more teachers available to fulfil the mathematics teaching jobs and the use of out-of-field teachers would be less likely.

This paper was part of a wider study that explored the self-reported perspectives of Junior Secondary mathematics teachers considering the Year 7 transition to secondary schooling in two Queensland schools. As such, only one facet of this research focused upon PD specifically. Therefore, this research was limited, in that further exploration of PD is required to provide a wider consensus to existing PD practices in schools. It is evident that PD is crucial to foster high quality mathematics teachers, and as such, further exploration and research into effective mathematical PD practices would be beneficial to all stakeholders.

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