AMSI CHOOSEMATHS RESEARCH

[No1 - 2017]

Teacher Confidence, Education & Experience:

CHOOSEMATHS
TEACHERS SURVEY 2016

Inge Koch & Ning Li

Teacher Confidence, Education and Experience: CHOOSE**MATHS** Teacher Survey 2016

Inge Koch and Ning Li

Australian Mathematical Sciences Institute

April 2017

Executive Summary

The 2016 CHOOSE**MATHS** survey of teachers provides information about educational background, training and experience of teachers, their level of confidence and competence regarding mathematics content and teaching of the mathematics curriculum, as well as their competence in curriculum documentation. CHOOSE**MATHS** of the Australian Mathematical Sciences Institute (AMSI) worked with 85 Australian government, independent and catholic schools at the time of the data collection in 2016. A total of 620 teachers from these primary, secondary and combined primary/secondary schools completed the survey and the data collected represent their self-assessments.

Of the 492 primary teachers 87% are female, and 97% of primary teachers are trained to teach mathematics at primary level. The primary teachers are confident regarding mathematics content, but their level of competence in curriculum documentation is considerably lower. The largest difference in confidence and competence was seen between teachers with little or no previous teaching experience and those with 5 – 10 years of teaching experience. Most teachers welcome the opportunity of professional development, with less experienced teachers feeling in need of professional development in almost all aspects of mathematics content, teaching and curriculum documentation.

Of the 128 secondary teachers nearly 65% are female. More than 75% of teachers are trained to teach mathematics at secondary level, yet 32.5% of teachers regard themselves as out-of-area. Relatively more female teachers and more than half of the less experienced teachers are among the out-of-area teachers. Our analysis shows that the out-of-area teachers are considerably less confident and competent than their counterpart in almost all aspect relating to mathematics content, teaching and curriculum documentation.

The 2016 survey represents the first in a series of annual surveys. One aim of the surveys is to assess the efficacy of CHOOSE**MATHS** over time. In the concluding paragraphs of this report we discuss the findings, present hypotheses and explanations and outline future directions.

Contents

1 Introduction

Women are severely underrepresented in science, technology, engineering and mathematics (STEM) in schools, university and the workforce, with mathematics, physics and engineering being most affected by this inequality.

The CHOOSE**MATHS** program of the Australian Mathematical Sciences Institute (AMSI) addresses this underrepresentation of women by aiming to increase participation of girls and young women in mathematics and disciplines requiring mathematics throughout the school and university education and into the workforce. The program is funded by the BHP Billiton Foundation from 2015 to 2019 and has a staff of 18 including eight experienced primary and secondary teachers, referred to as Schools Outreach Officers. The program's multilevel approach includes working actively with 120 schools across Australia, affecting a change in attitude and behaviour towards mathematics through career awareness, supporting girls and young women with a strong mentoring network and celebrating the achievements of mathematics teachers and students in annual awards ceremonies.

Recruitment of schools started in the second half of 2015. The CHOOSE**MATHS** schools are organised into clusters consisting on average of one secondary school and three feeder primary schools in regions agreed with the BHP Billiton Foundation. The cluster structure enables tracking students from their primary to their secondary school experience and allows us networking within clusters.

Each CHOOSE**MATHS** Schools Outreach Officers is responsible for a number of school clusters. Since Term 1, 2016 the CHOOSE**MATHS** Schools Outreach Officers have been visiting their schools twice each school term. These visits include professional development, conducting model lessons, advising on lesson planning and curriculum documentation as well as responding to specific requirements of the local teachers involved in teaching mathematics. Schools that joined the program chose to participate in order to improve teacher quality, teachers' confidence and skills in mathematics and mathematics teaching, and as a consequence of improved teaching they hope to achieve better student outcomes and promote mathematics to girls more effectively.

We monitor the effectiveness of the program in part through annual surveys of teachers and students in the CHOOSE**MATHS** schools. The CHOOSE**MATHS** team is responsible for the study design, questionnaire development, data collection and analysis of the student surveys, and the Australian Centre for Educational Research (ACER) conducts annual surveys of teachers and principals in the CHOOSE**MATHS** schools. The schools were selected in regions nominated by the BHP Billiton Foundation. We expect that the results will be representative of Australian schools, since we are working with public, independent and catholic schools in cities, regional and remote areas of Australia.

This report complements the evaluation of ACER on CHOOSE**MATHS** – see Underwood (2016). The current report describes insights we obtained from our analysis of the teacher survey in 2016, with emphasis on out-of-area teachers in secondary schools and on length of teaching experience in primary teachers. A companion report will focus on gender aspects in the teacher survey and our 2016 student surveys – see Li and Koch (2017).

2 Teacher Survey

The first teacher survey took place in the middle of 2016. ACER designed the survey instruments in collaboration with the CHOOSE**MATHS** team, and was responsible for the data collection and evaluation. For ACER's evaluation and their findings, see Underwood (2016). The survey was completely anonymous.

At the time of the first CHOOSE**MATHS** teacher survey 85 schools in NSW, QLD, SA, VIC and WA had been recruited to the CHOOSE**MATHS** program. This sample of schools consisted of 52 primary schools, 19 secondary schools and 14 combined schools in urban, regional and remote areas. The schools include single-sex girls as well as co-educational public, independent and catholic schools. By the end of 2016 we had reached our goal of 120 schools which will form the sample in the 2017 survey.

In Term 2, 2016 ACER conducted the teacher survey in the CHOOSE**MATHS** schools. ACER received 620 survey responses from teachers in primary, secondary and combined primary/secondary schools. The overall teacher response rate for these surveys was 49.5%. This rate calculation is based on all teachers in primary schools and all teachers engaged in teaching mathematics in secondary schools. In the last section of this report we explain how we intend to improve the response rate in future surveys.

We received the survey data from ACER and carried out our own analyses of the data. Maths anxiety of primary teachers and out-of-area teaching of secondary teachers are of interest in our analyses. We examine the evidence (or lack thereof) in our data and attempt to gain better insight into relationships between confidence, experience, education and training of teachers. At the same time the data provide a baseline for future teacher surveys which will allow assessment of the efficacy of CHOOSE**MATHS**.

We present separate analyses for the data from the primary teacher survey and the secondary teacher survey; these analyses complement the evaluation described in Underwood (2016) which includes responses from 39 primary and secondary principals who completed the survey. We did not analyse the principals' data, primarily because of the small sample size; but refer the interested reader to Underwood's account and summary of their opinions and responses.

In combination ACER's evaluation, this report and the companion report of Li and Koch (2017) will provide a more complete picture of mathematics teaching in the CHOOSE**MATHS** schools. As our schools include urban, regional and remote schools, we hope that our results and insights will be representative for Australian schools.

We begin with an analysis and assessment of the primary teacher survey in Section 3, and describe our analysis of the secondary teacher survey in Section 4. In the last section of this report we present comparisons and insights which lead to hypotheses and directions for future work.

3 Analysis of Primary Teacher Survey

One of the key concerns in primary mathematics teaching is maths anxiety which has known effects as well as implications on students' subsequent interest in and engagement with mathematics. Female teachers' attitudes to and opinions of mathematics and, in particular, their apparent or latent anxiety influence young girls more than young boys, see Beilock et al (2010). Since the majority of primary teachers in Australian schools are female, it is important to gain a better understanding of the existence and prevalence of this effect in order to redress the lack of engagement and the lower participation rate of girls in advanced mathematics subjects in secondary schools and careers involving mathematics.

Insufficient knowledge of mathematics and the resulting lack of confidence in teaching mathematics appear to be common among primary teachers. Our experienced CHOOSE**MATHS** teachers, the Schools Outreach Officers, observe these phenomena, and school principals raise them independently in the hope to see an improvement in the quality of mathematics teaching over the duration of CHOOSE**MATHS**. We had expected to find evidence of a lack in mathematical skills, confidence or competence in the survey data. This is mostly not the case in the current survey data; there are plausible reasons for this lack of maths anxiety in these data which we consider in Section 5.

3.1 The Primary Teacher Survey

The survey for primary teachers included classroom teachers, mathematics coordinators, teachers' aides, numeracy coaches and (deputy) principals involved in teaching. About two-thirds of the combined primary/secondary schools completed the primary teacher survey and their responses are analysed as part of the primary data. The remaining third is subsumed into the secondary survey data.

The primary teacher survey consists of 22 questions including teacher education and experience, their 2016 teaching, questions relating to their confidence in and competence of mathematics content, mathematics teaching and curriculum documentation and their confidence and competence in promoting mathematics to girls.

The sample of 492 teachers comprised 426 female teachers (86.6%), 57 male teachers (11.6%) and 9 teachers who ticked other/prefer not to say as their gender status. The percentage of female teachers is a little higher than the 80% quoted in Weldon (2015), but could be a result of the sampling design.

Of the completed primary surveys, 444 were obtained from primary teachers and 48 from combined primary/secondary schools; the response rate for primary teachers is 53.2%, and that of teachers from combined primary/secondary schools is 35.1%. Throughout this report we will not distinguish between teachers in primary schools and those in combined primary/secondary schools who completed the primary teacher survey, but refer to all as primary teachers.

3.2 Participation in CHOOSE**MATHS**

School principals in the CHOOSE**MATHS** schools selected teachers who participated in the CHOOSE**MATHS** program throughout 2016, and these teachers took part in the activities the CHOOSE**MATHS** Schools Outreach Officers in their schools. The ACER survey was

distributed to all classroom teachers – irrespective of their participation status. As we shall see in the results described in this section, the participating and non-participating groups of teachers have very similar responses in terms of their education, experience and confidence/competence in mathematics teaching. As the CHOOSE**MATHS** program had only just started at the time of the 2016 surveys, the non-participating teachers can therefore be treated as a control group when measuring effectiveness of the program over time.

Of the 492 teachers who completed the primary survey, 141 -- almost 29% -- had not been selected to participate in the CHOOSE**MATHS** program in 2016, and two did not respond to the question relating to their participation status. The proportions of participating/non-participating are very similar for the female and male teachers in the sample.

Figure 1 shows the percentages of teachers in the survey who participated in the CHOOSE**MATHS** program -- separately for each school year. As primary teachers are primarily classroom teachers, they typically teach one year level in any given year.

Year levels 2 and 5 have the highest participation, but the difference is not big between years. Year 7 is only taught in South Australia (SA) as part of primary school. There are only 8 teachers in the survey teaching year 7, so this percentage is not representative because of the small sample size. Overall the difference over the years is less than 10% -- not counting the year 7 group which only applies in SA.

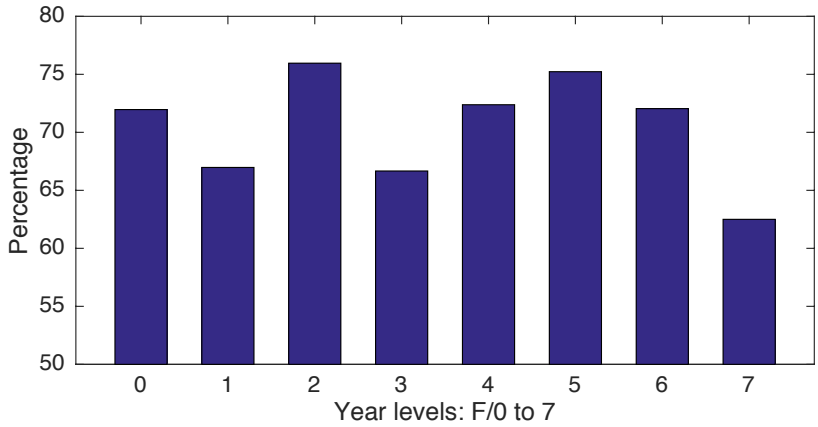

Figure 1: Percentages of participating teachers on the vertical axis against year level they teach on the horizontal axis: 0 corresponds to F/K, 1 to year 1, 2 to year 2, etc.

3.3 Teachers' Training, Education and Experience

Just over 97% of teachers are trained to teach mathematics at primary level or primary and secondary level, and 2.3% are not trained to teach at either primary or secondary level. Of those trained to teach at primary level, almost 88% have a B.Ed. which includes primary mathematics teaching or a Dip.Ed. which includes primary mathematics. Most of the remaining 12% have other teaching qualifications including Masters degrees.

A small number of teachers, 0.7%, have a B.Ed. or Dip.Ed. which includes primary mathematics content, but state that they are not primary trained. It is possible that these teachers feel that their training did not include an adequate component in mathematics teaching as distinct from mathematics content, or the other way around.

Overall the survey responses on training and degrees indicate that most primary teachers in the sample are trained to teach mathematics at primary school level.

The number of years of teaching experience differs wide in the sample. For the 482 teachers who responded to this question, Table 1 shows the number and percentage of teachers in the different groups which range from just started to more than 10 years of teaching experience.

Table 1: Number of years of teaching experience

	Just started	1	2 - 5	5 - 10	More than 10
Number of teachers	36	48	95	82	221
Percentage	7.5%	10.0%	19.7%	17.0%	45.6%

Figure 2 returns to the teachers participating in the CHOOSE**MATHS** program and shows the percentage of these teachers by number of years of teaching experience. The five groups of Table 1 are shown on the horizontal axis of Figure 2, so the value 1 corresponds to the just started group, 2 corresponds to the group 1 year of teaching experience, etc. The bar at the horizontal value 2, which refers to 1 year of teaching experience, has height 75%. Using the information in Table 1, this tells us that 36 teachers – so 75% of 48 -- with 1 year teaching experience participated in the CHOOSE**MATHS** program in 2016.

The first value of 61% for just started is lower than the rest; this could be a small sample size effect. Overall the percentages hover around 70%, suggesting that participation in CHOOSE**MATHS** is largely independent of the number of years of teaching experience. In contrast, teachers who taught mathematics more than the median number of hours a week, were less likely to participate than those who taught fewer than the median number of hours. Table 2 shows these percentages. We do not have any information whether principals took the number of hours of teaching mathematics into account when they assigned teachers to the CHOOSE**MATHS** program.

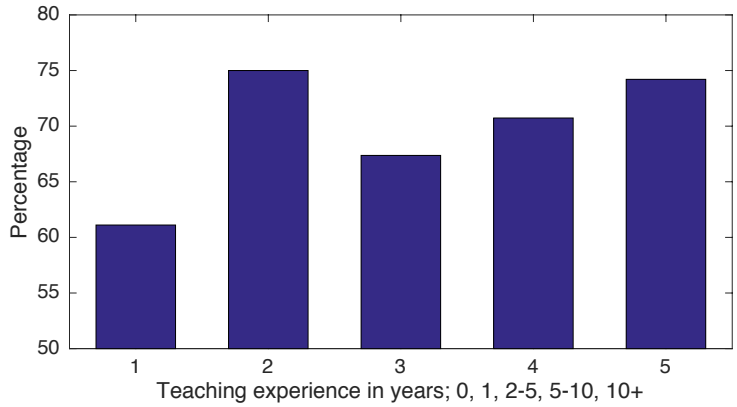

Figure 2: Percentages of participating teachers on the vertical axis against number of years of teaching experience on the horizontal axis: 1 corresponds to just started; 2 to 1 year; 3 to 2-5 years; 4 to 5-10 years; 5 to more than 10 years of teaching experience.

Table 2: Participation rates by number of hours teaching mathematics

Teach more than median # of hours	Participate yes	Participate no
yes	64%	36%
no	77%	23%

3.4 Confidence and Competence in Mathematics Teaching

To assess the level of confidence and competence in mathematics teaching we used the following eight criteria in 2016.

1. I enjoy teaching MATHS
2. I do not feel tense when teaching MATHS
3. I feel knowledgeable
4. I feel confident
5. I do not rely on textbooks as the primary source
6. I include practical examples
7. I relate mathematics to real life
8. I do not put off difficult maths topics.

In the figures below we often use the criterion number only, so 4 refers to I feel confident. Respondents chose between four answers: rarely (1), not often (2), often (3), mostly (4). The means for each of the eight criteria are shown in the top panel of Figure 3. These means are surprisingly high, that is, teachers indicate that these criteria apply to them often or mostly. There are a number of reasons why the means of the mathematics teaching criteria are higher than expected. We will discuss these reasons in Section 5 and indicate how we intend to obtain more information on this issue in future surveys.

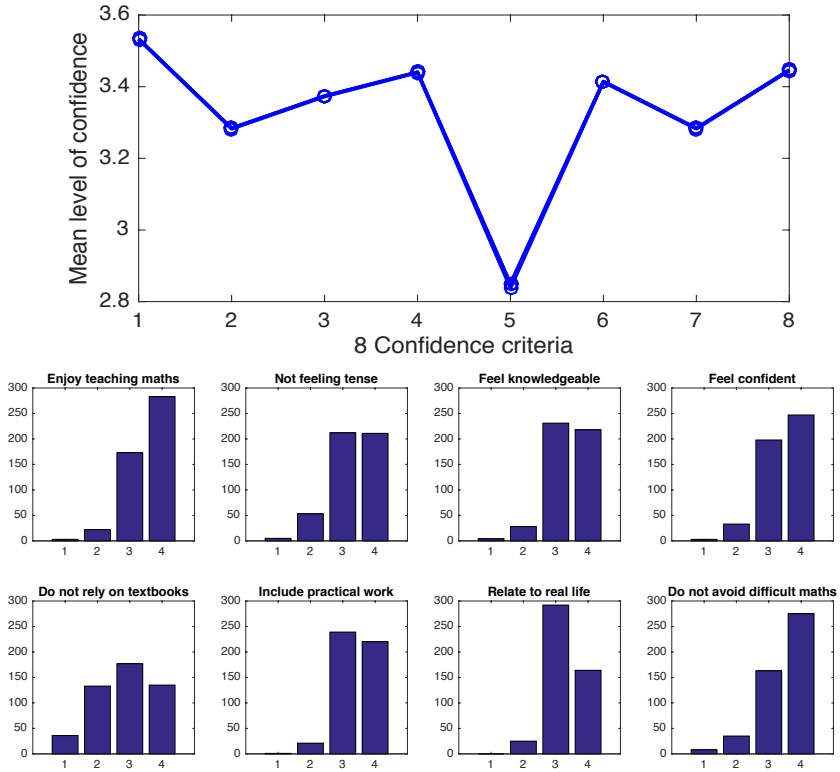

Figure 3: Means (top graph) and counts of teachers in the 8 criteria related to mathematics teaching and listed at the beginning of Section 3.4. In the top graph the horizontal axis shows the criterion number, the vertical axis shows the means. In the bar plots frequencies of each of the 4 possible response values are shown separately for each criterion.

The only exception to the high means is criterion 5, the reliance on textbooks. The reason why the textbook mean could be much lower than the other means is most likely that school policy informs teachers' behaviour with respect to the use of textbooks. The response to the textbook question is therefore less indicative of teacher confidence or competence in teaching mathematics.

The lower panel in Figure 3 shows the distribution of responses in bar plots separately for each criterion. The four bars in the top left subplot, which refers to I enjoy teaching maths, for example, show that a very small number of teachers, here 3, chose the answer rarely which corresponds to the value 1 on the horizontal axis, 25 chose not often which corresponds to 2, 175 chose often which corresponds to 3, and nearly 300 chose mostly. The very large proportion of often and mostly in seven of the eight bar plots is a strong indication that the teachers assess themselves very highly in these criteria.

When we consider classes of teachers grouped by the number of years of teaching experience, we obtain better insight. The top panel of Figure 4 shows three curves corresponding to the groups just started in blue, 5-10 years of teaching experience in green and, in black, overall means as in Figure 3. On the vertical axis the means of the three groups are given and the criterion numbers 1 to 8 are shown on the horizontal axis. In the lower panel of Figure 4 we include all five groups from Table 1 in the form of bar plots which show the means, in groups of six, for criterion 1 to 8 on the horizontal axis. The colours in the bar plots correspond to the different groups ranging from just started (dark blue) to more than 10 years (orange) and to all teachers (yellow).

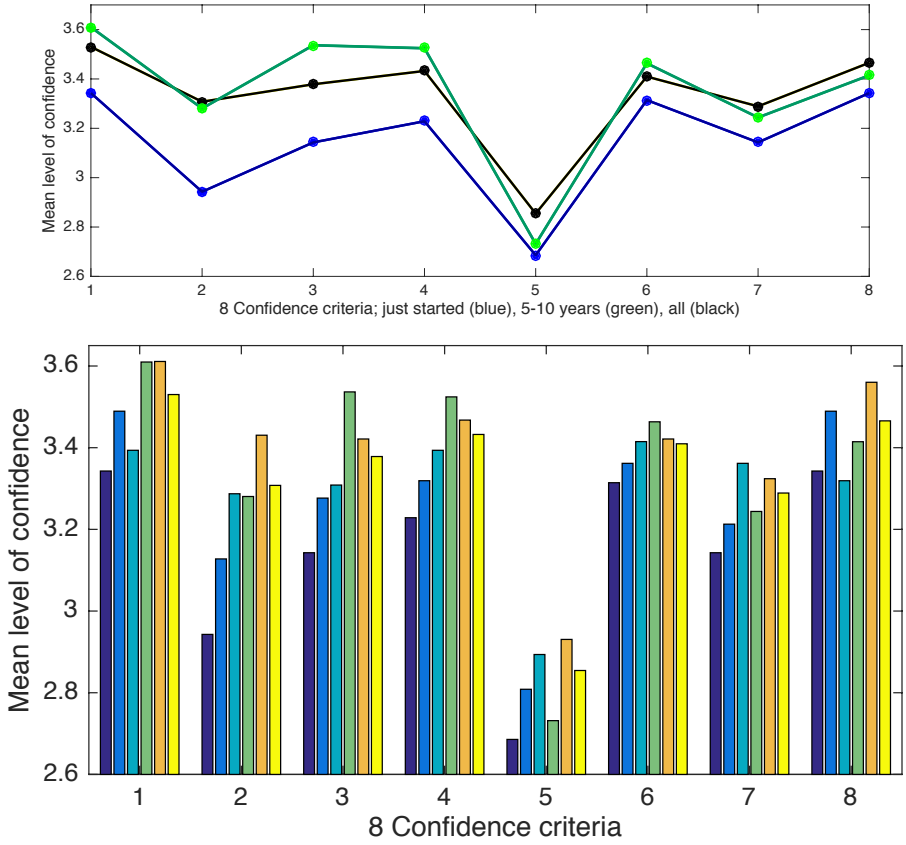

Figure 4: Means for all eight criteria related to mathematics teaching by number of years of teaching experience with the criterion number 1 to 8 shown on the horizontal axis. Top panel: the blue graph shows the just started group, the green graph shows the group with 5-10 years of teaching experience,

and the black graph refers to all teachers. In the lower panel, the sequence of bars in each group is arranged by increasing number of years of teaching experience, with the last bar (in yellow) showing the overall mean.

The difference between the just started group and the 5-10 years of teaching experience group is very clear in the graphs shown in the top panel of Figure 4, especially for the first four criteria which are more directly related to skills, knowledge and the teaching of this knowledge. The numbers for the blue graph (just started group) in the top panel are the same as those of the dark blue bars for the corresponding criterion in the bar graph, and similarly for the green graph and the green bars, and the black mean graph which is shown as the yellow bars in the lower panel. The two figures offer a different view of the data, for this reason we have shown both visualisations.

Although not directly comparable, Willet et al (p57, 2014) report that 23.7% of teachers have been with their current employer less than 4 years, 19.7% stayed between 5-9 years, and the remaining 56.5% have been with the current employer for 10 or more years. These numbers are similar to those given in Table 1.

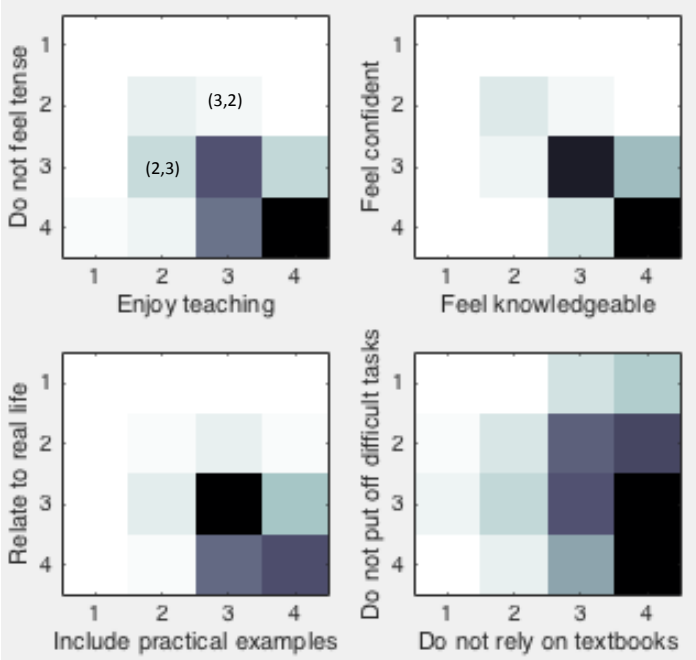

Figure 5: Counts of teachers for pairs of the eight criteria related to mathematics teaching. The darker the colour, the higher the count in the field. The numbers on the axes range from 1 for rarely to 4 for mostly. The panels show the following pairs, with the criterion on the horizontal axis listed first: top left panel I enjoy teaching and I do not feel tense; top right panel I feel knowledgeable and I feel confident, bottom left panel I include practical examples and I relate maths to real life and the bottom right panel I do not rely on textbooks and I do not put off difficult maths tasks.

We expect teachers who chose often (3) or mostly (4) in response to I feel knowledgeable to have a high score in their response to the criterion I feel confident, and similarly we expect a strong relationship between I enjoy teaching and I do not feel tense, and between I include practical examples and I relate maths to real life. To study whether this response pattern holds, we examine the responses of teachers to pairs of questions. The plots in Figure 5 show the responses of teachers for pairs of criteria, with the pairs chosen here to reflect an assumed strong relationship.

The image plots in Figure 5 display counts expressed by colour, with darker colours corresponding to higher counts. In the top left panel the light grey in the field marked (3,2), that is, three across from the left and two down from the top, shows the number of teachers, here 7, who chose often (3) for I enjoy teaching and not often (2) for I do not feel tense. The field (2,3) in the same panel is shown in a darker colour: 29 teachers chose not often (2) for I enjoy teaching and often (3) for I do not feel tense. A much higher number of teacher, namely 111, chose often (3) for both I enjoy teaching and I do not feel tense, and 178 teachers -- almost 37% -- chose mostly (4) for both I enjoy teaching and I do not feel tense. The other three image plots are interpreted in a similar way.

In all image plots other than the bottom right plot, the largest number of teachers (darkest colour) either chose often (3) or mostly (4) for pairs of related criteria with the least consistency in the bottom right panel which tells us that teachers who chose mostly for I do not rely on textbooks are divided almost equally between the responses often (3) and mostly (4) for the question I do not put off difficult tasks.

Figure 6 displays the responses from participating and non-participating teachers. The figure shows -- in different colours -- the percentages of teachers who chose rarely, not often, often, mostly, starting with the percentages for rarely in blue at the bottom of each bar. The percentages in the two groups are very similar in each of the eight criteria, and it will therefore be appropriate to use the non-participating teachers as a control group in later years.

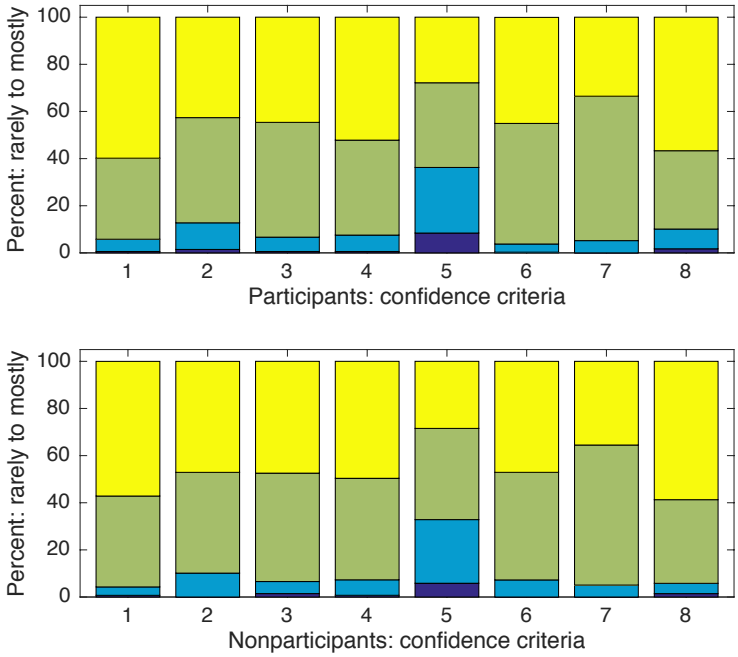

Figure 6: Percentages of participants' (top) and non-participants' (bottom) responses to the eight teaching-related criteria.

3.5 Confidence and Competence in Mathematics Content and Curriculum Documentation

We look at three areas of mathematics content and four criteria relating to planning of programs, developing resource and assessment material and mentoring which we refer to as curriculum documentation in this report. The seven criteria are

1. Number and algebra
2. Measurement and geometry
3. Statistics and probability
4. Planning mathematics programs appropriate to the year levels taught
5. Building a bank of mathematics teaching resources and rich tasks
6. Mentoring new graduates or teachers
7. Developing mathematics assessment tasks.

For the first three criteria, respondents chose between the four answers: not confident (1), would benefit from help (2), feel okay (3), feel confident (4). For the four criteria listed as numbers 4 to 7 the respondents chose between the four answers: not competent (1), somewhat competent (2), competent (3), very competent (4). Although the scales are not the same in the two sets of criteria, we combine the two sets of criteria here. The means over all teachers for the seven individual criteria are shown in Figure 7.

The graph of means in the top panel of Figure 7 has a gap between the horizontal values 3 and 4. This is done to separate the two set of criteria visually.

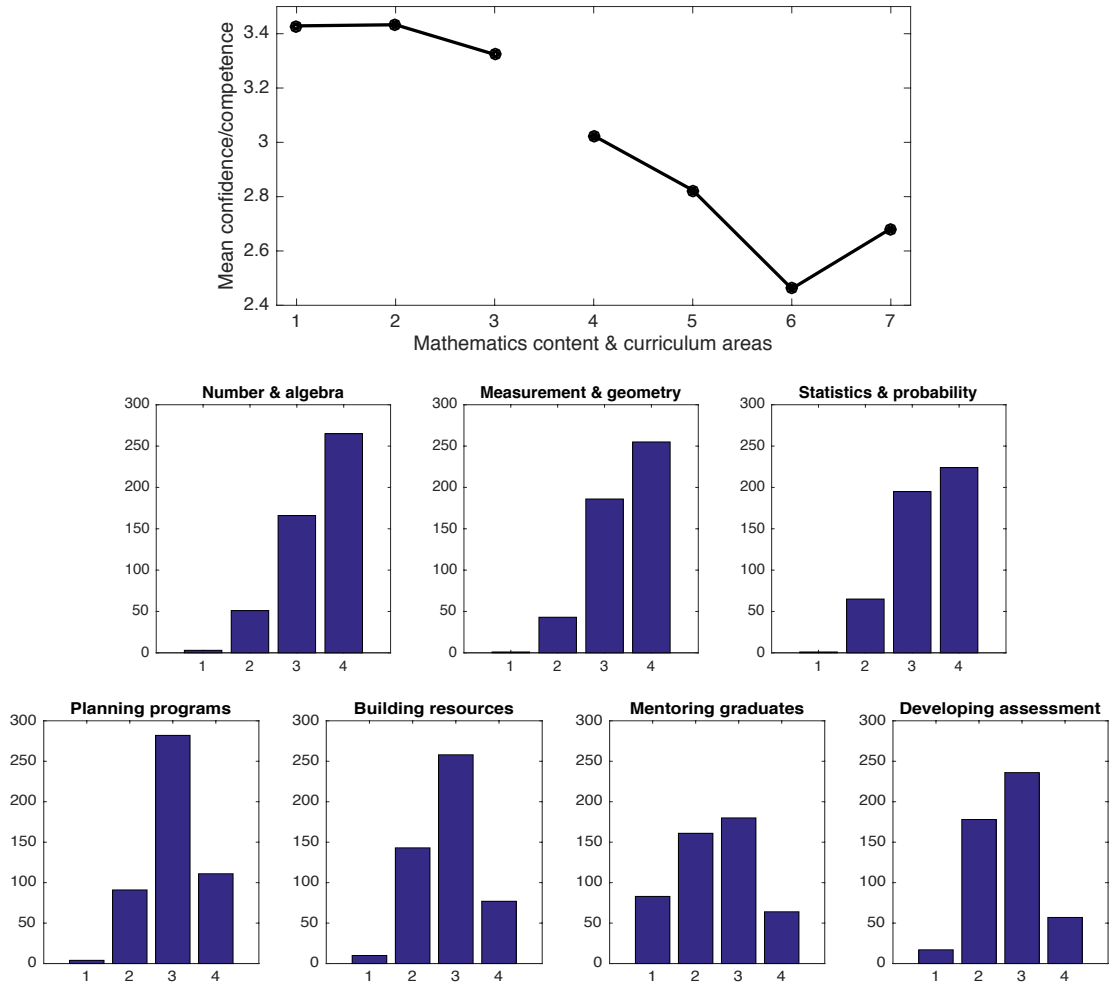

Figure 7: Means (top graph) and counts of teachers in the seven criteria relating to competence in curriculum documentation. In the top graph the horizontal axis shows the criterion number, the vertical axis shows the means. In the two rows of bar plots frequencies for the four response values are shown separately for each criterion.

Figure 7 shows a clear difference in the means between the first three and the last four criteria. There are two reasons for this difference; the two sets of criteria measure different quantities; teachers may feel confident regarding the mathematics content, but this does not imply that they are competent in curriculum documentation or mentoring aspects. The other reason is that although there are four possible responses for each criterion, the highest level in the three mathematics content criteria is feel confident, while the highest level for the four curriculum documentation criteria is very competent. In the 2017 teacher survey the values for the different criteria will be adjusted so they will be on more comparable scales.

The mentoring criterion – third bar plot in the bottom row of Figure 7 -- has a low mean and a relatively high number, namely 83, of responses for not competent (1). This suggests that more effort needs to be directed towards improving these skills.

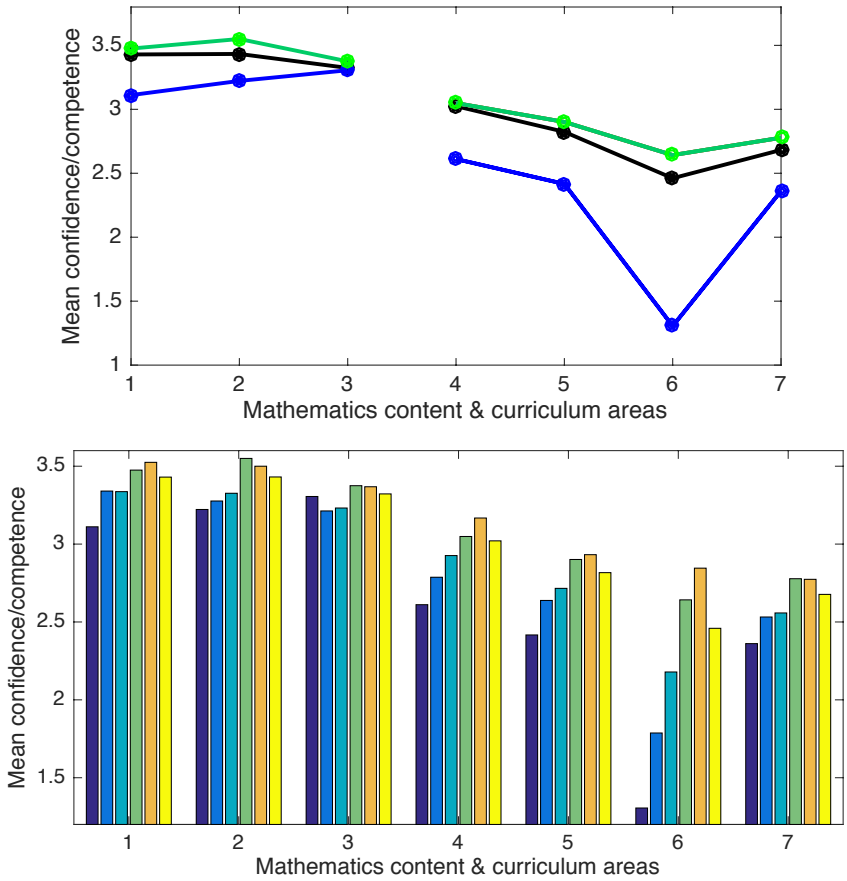

Figure 8: Means for all seven criteria related to mathematics content and curriculum documentation by number of years of teaching experience with the criterion number 1 to 7 shown on the horizontal axis. Top panel: the blue graph shows just started, the green graph shows the 5-10 years of teaching experience, and the black graph shows the overall means. In the lower panel, the sequence of bars in each group is ordered by increasing number of years of teaching experience, with the last bar (in yellow) showing the overall mean for each criterion.

In Section 3.4 we considered teachers grouped by the number of years of teaching experience and found that there is a noticeable difference between the just started group and the group 5-10 years of teaching experience. We will look at the means for these two groups in the context of the seven criteria considered in this section, and show a bar plot

corresponding to that in Figure 4 which looks at the means across the five groups differing in the number of years of teaching experience.

As in Figure 7, the mean graphs in the top row of Figure 8 have a gap between the horizontal values 3 and 4 which highlights that we combine two sets of criteria in one graph.

The lower panel of Figure 8 shows that the means increase with increasing number of years of teaching experience. Unlike the corresponding bar graphs in Figure 4, the means do not peak at 5-10 years of teaching experience but continue to grow except for criterion 2 --- content knowledge in measurement and geometry -- where the mean for the group more than 10 years of teaching experience has decreased compared to the cohort 5-10 years of teaching experience.

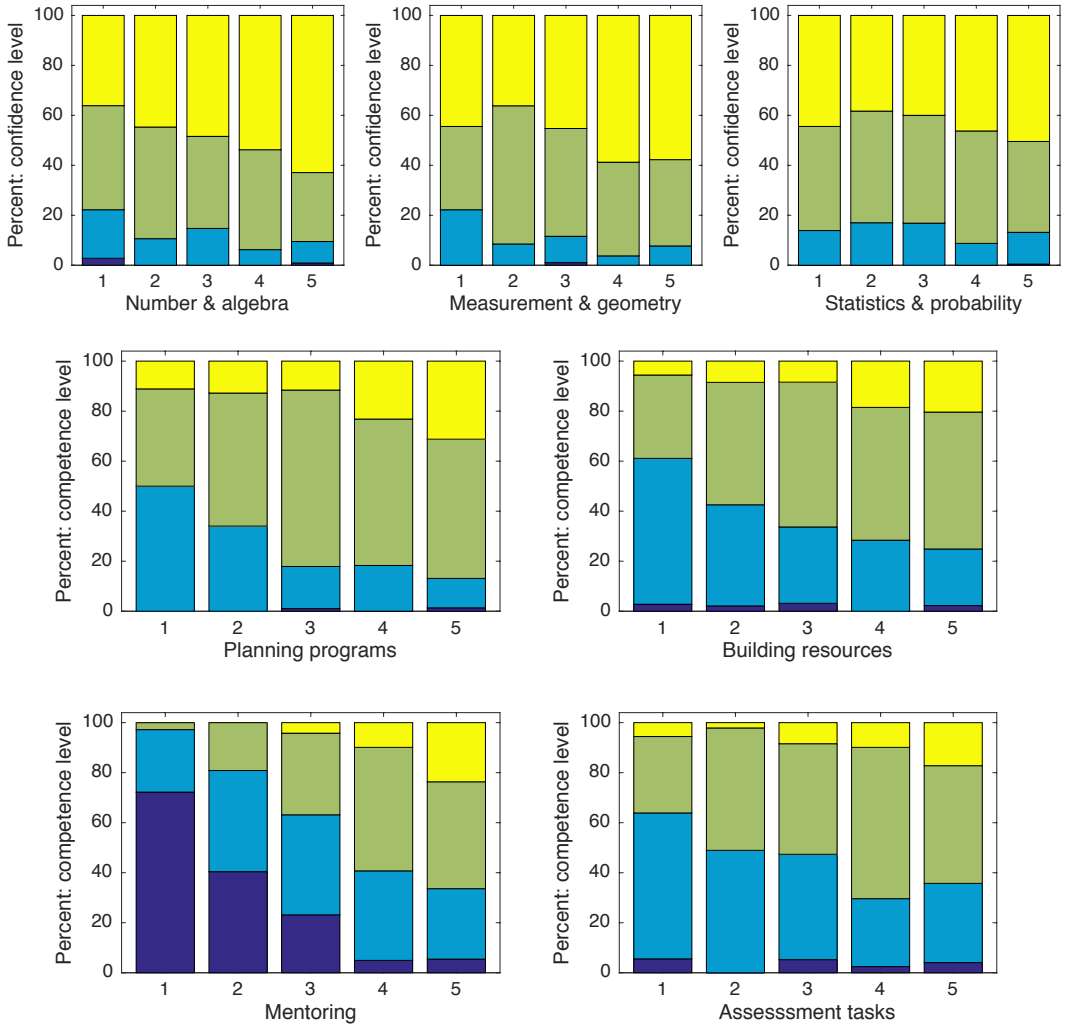

Figure 9: Percentages of responses to the four choices not confident/would benefit from help/feel okay/feel confident of the criteria 1-3 (top row) and to the four responses not competent/somewhat competent/competent/very competent of the criteria 4 – 7 (middle and bottom row). Dark blue refers to the first value (least proficient), light blue to the second, green to the third, and yellow to value confident, respectively very competent.

It is interesting to see that the just started group has a relatively high mean for criterion 3, content knowledge in statistics and probability. The explanation here could simply be that the teachers in the just started group finished their training more recently than the other

groups and therefore have had more exposure to content knowledge in statistics and probability.

It is worth mentioning that criterion 6, mentoring, has a much wider spread of means than the other criteria, and the means over each group are much lower than in the other criteria. Mentoring new graduates or teachers requires greater knowledge of mathematics content and pedagogy than any of the other criteria.

Another view of confidence and competence in mathematics content and curriculum documentation is given in the next series of bar plots which show, again for the five sets of teachers grouped by number of years of teaching experience, the percentages that each of the responses 1 to 4 was selected for each of the seven mathematics content and curriculum documentation criteria.

The percentage views allow us to see and compare the distributions over the four possible values across all five cohorts differing in the number of years of teaching experience. In the plots relating to mathematics content (top row), we mostly only see three colours. The reason is that even among the just started group hardly any teacher selected not confident in any of the areas number and algebra, measurement and geometry, or statistics and probability.

3.6 Professional Development in Mathematics

Professional development (PD) plays an important role in the CHOOSE**MATHS** program. The CHOOSE**MATHS** Schools Outreach Officers are experienced primary or secondary teachers who prepare and present PDs on teaching, learning, curriculum documentation etc. as well as providing the local teachers with resource material and model lessons.

The opportunity to receive professional development is one of the main reasons for schools to join the program, as evidenced by statements of the school principals. As mentioned in Section 1, the participating schools expect to improve mathematics knowledge and teaching with a flow-on effect on achieving better student outcomes and promoting mathematics to girls more effectively. Principals indicated that they regard professional development provided by the CHOOSE**MATHS** Schools Outreach Officers as a cost-effective way towards achieving these goals.

In the initial phase of the CHOOSE**MATHS** program -- throughout 2016 – the Schools Outreach Officers delivered professional development and provided material on teaching and curriculum documentation that specifically addressed the requirements of the different schools. This aspect is important and will be continued throughout the program. From late 2016 onwards we included more generic modules and professional development which can be used for different schools. Unifying our outreach has two advantages: we can measure the success of particular initiatives, as we compare like with like, and we can export and make available these modules and materials to other schools. The latter aspect will become particularly relevant in terms of the sustainability of the program.

The 2016 teacher survey has the following list of PD options

1) Assistance in planning of the mathematics curriculum
2) Assistance in planning at the year levels you teach
3) Mentoring of staff, particularly new graduates
4) Mentoring of girls to encourage them to develop an interest in mathematics

5) Development of assessment tasks
6) Consolidating mathematical pedagogy and content knowledge
7) Assisting with research and building a bank of teaching resources
8) Lesson observations and targeted feedback
9) Team teaching/modelled lessons with targeted planning and evaluation
10) Open access to a wide variety of resources for teachers and students
11) Networking opportunities with other teachers
12) Materials and information on careers in mathematics and mathematics in careers
13) Tools and information for teachers, parents and students to increase awareness of mathematics and mathematics related fields as careers for girls.

For each PD option respondents chose between very important, somewhat useful and not needed.

Figure 10 shows the survey responses starting with the just started group in red in the top row. The top left panel of bar graphs shows the percentage of just started teachers who regard the topic as very important. The right panel of bar graphs includes, as the second bar in each group of three bars, the percentage of teachers who regard the topic as somewhat useful, and the third bar refers to the percentage of teachers who responded with not needed. The numbers on the horizontal axis of left and right panels are those of the PD options 1 to 13 in the list above. The second row of bar graphs refers to teachers with 1 year of teaching experience and is interpreted in the same way.

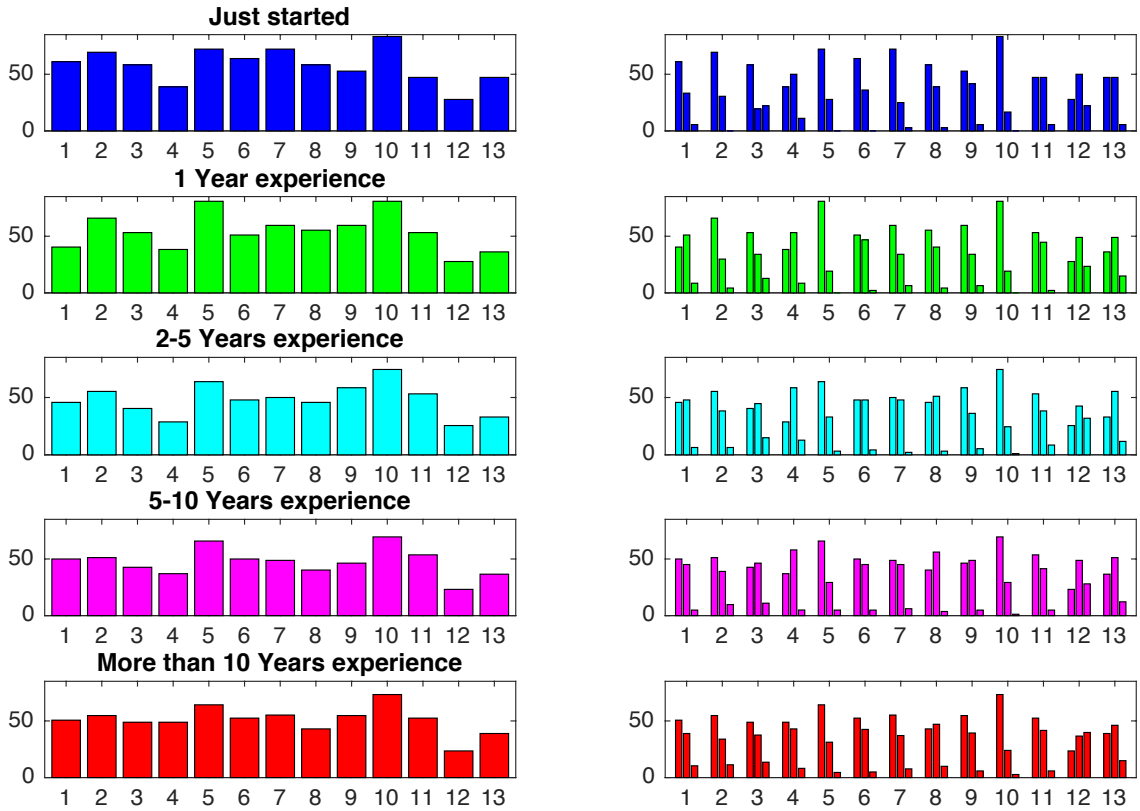

Figure 10: Percentages of teachers regarding PD options 1 to 13 as very important – left panels and first bars in each group of three bars in the right panels. In the right panels percentages for somewhat useful are shown as the second bar in each group of three bars, and not needed refers to the third bar in each group. The numbers on the horizontal axis correspond to the 13 PD options.

A summary view of all five groups of teachers is shown in Figure 11. This bar graph focuses on percentages of teachers regarding the PD as very important. The numbers on the horizontal axis are those of the PD options. The sequence of bars shows dark blue for just started, lighter blue for 1 year of teaching experience, green for 2-5 years, orange for 5-10 years and yellow for more than 10 years. We omitted the combined percentages; they are very similar to those of the group more than 10 years of teaching experience which constitutes more than 45% of all teachers.

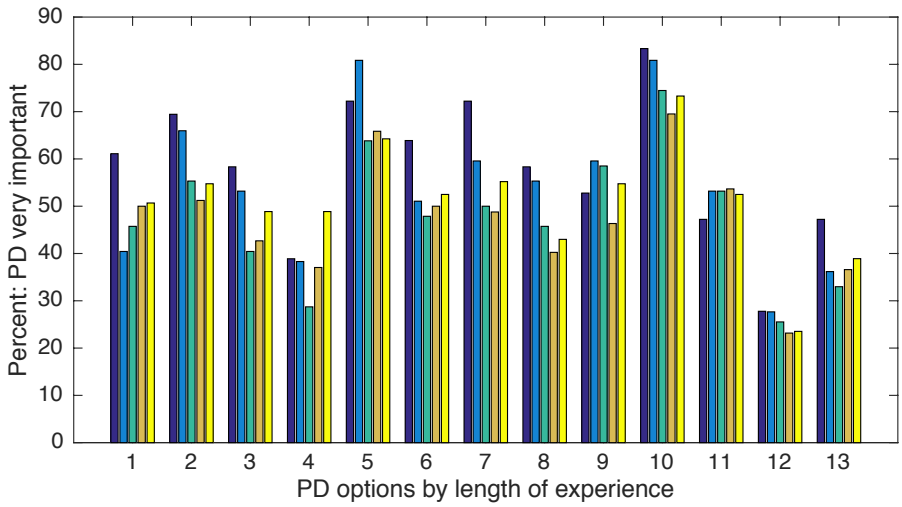

Figure 11: Percentages of teachers regarding PD options 1 to 13 as very important. The numbers on the horizontal axis correspond to the 13 PD options in the list. Each group of bars consists of the percentage from the just started in dark blue, to the more than 10 years of teaching experience teachers in yellow.

The two PD options regarded as very important by the largest percentage of teachers are in decreasing order

- Open access to a wide variety of resources for teachers and students (10), and
- Development of assessment tasks (5).

The first PD choice correspond closely to criterion 5 in Section 3.5: building a bank of mathematics teaching resources and rich tasks, and the second in the list above is the same as criterion 7 in Section 3.5. The means for both these two criteria are low, but particularly so for the just started teachers.

Apart from these two PD options, there is no clear ranking, however, there is a more than 50% overall agreement among teachers that the following PD options are very important.

- Assistance in planning at the year levels you teach (2)
- Assisting with research and building a bank of teaching resources (7)
- Team teaching/modelled lessons with targeted planning and evaluation (9)
- Networking opportunities with other teachers (11)
- Consolidating mathematical pedagogy and content knowledge (6).

Figure 11 shows that the just started group has higher percentages for most PD options than the other groups which could hint at a certain amount of maths anxiety and clearly indicates a greater need for extra support in the early years of a teaching career. The just started group

ranks the PD assisting with research and building a bank of teaching resources (7) third highest. This is yet another PD that focusses on provision of resource material.

The only PDs that received low percentages from the just started group are mentoring of girls to encourage them to develop an interest in mathematics (4) and materials and information on careers in mathematics and mathematics in careers (12). A possible interpretation is that the just started group requires assistance with tangible resources with little time left for less immediate aspects of teaching.

Figures 10 and 11 suggest that the interest in PDs decreases with increasing number of years of teaching experience, but then interest rises again for teachers with more than 5 years of teaching experience (orange bars in Figure 11). A potential interpretation is that after some time in the job teachers realise that there is still more to learn, and they become more receptive again to learning and improving. Overall at the primary level, there is less interest on career and gender equity topics than on the tangible teaching-related resources.

3.7 Summary

Most primary teachers are trained to teach mathematics at primary level and overall these teachers feel confident and competent with the required mathematics content and teaching mathematics. They feel less competent with curriculum documentation and creating new resources and strongly welcome PD sessions supporting these topics.

Dividing the teachers by their number of years of teaching experience shows that the just started group differs strongly from the more than 5 years of experience group in terms of confidence and competence in all aspects of teaching, pedagogy, creating material and curriculum documentation. In line with the lower levels of confidence is their greater responsiveness to or need of a wide range of PD options.

It would be of interest to examine whether maths anxiety increases with the year level taught. Since the grouping into the number of years of teaching experience affects confidence and competence much more than any other spit, we have not presented results relating to year level taught, as the numbers in each subgroup (year level and teaching experience) would become too small to allow us to draw meaningful conclusions.

4 Analysis of Secondary Teacher Survey

A key concern in secondary mathematics teaching is out-of-area teaching -- especially in the early and middle years of secondary education and among teachers with less experience. Out-of-area teaching is also referred to as out-of-field teaching, and the definition of this concept has changed over the years.

Weldon (2016) defines out-of-field teachers as 'secondary teachers teaching a subject for which they have not studied above first year at university, and for which they have not studied teaching methodology.' He applied this definition to the 2013 Staff in Australia's Schools (SiAS) surveys from which we quote in this report. In 2007 the steering committee of SiAS adopted the following as in-field teaching: a teacher who 'either studied the subject at second year tertiary level or trained in teaching methodology for that subject at tertiary level' (see p4 of Weldon (2016)). It is worth noting that this definition reduces the percentage of out-of-field teachers compared to previous definitions, since only those teachers are counted as out-of-field who have **neither** subject content at second year university **nor** teaching methodology at tertiary level. For mathematics teaching this implies that teachers who have trained in methodology but not content may exhibit or experience a lack of confidence and may struggle with some mathematics content. Similarly teachers without university study in the teaching methodology of mathematics may not feel adequately trained to teach the mathematics content well. Yet both these groups of teachers are regarded as in-field teachers.

In this report the term out-of-field refers to the definition adopted by SiAS and used in Weldon (2016); we will use the terms out-of-field/in-field when we refer to or quote from Weldon. In contrast we use the term out-of-area when we refer to the ACER teacher survey 2016. The ACER teacher survey does not define the term out-of-area teaching, but merely asks teachers to state whether they regard themselves as teaching out-of-area. Analogously we will use the term in-area when describing or discussing teachers who did not tick out-of-area in the ACER teacher survey.

4.1 The Secondary Teacher Survey

The survey for secondary teachers included classroom teachers and heads of mathematics departments or mathematics coordinators, numeracy coaches and deputy principals who are teaching mathematics.

A total of 128 teachers completed the secondary teacher survey. Of these, 24 teachers are from combined primary/secondary schools. The response rate for secondary only teachers was 49%, and that of teachers from combined primary/secondary schools was 35.1%. We will not distinguish between secondary teachers and those in combined primary/secondary schools who completed the secondary teacher survey, but refer to all of these as secondary teachers – similarly to primary teachers in the previous part.

The 128 completed survey responses were obtained from 83 female teachers (64.8%), 43 male teachers (33.6%) and two teachers who selected other/prefer not to say as their gender status. Often secondary teachers teach across a number of year levels. Our data show that 27 taught only one year level, 31 taught three year levels, and nine teachers taught across levels 7 – 12 in 2016.

Regarding participation in CHOOSE**MATHS** in 2016, of the 125 teachers who responded to this question, 100 (or 80%) teachers participated and 25 did not. The secondary participation rate is higher than the participation rate in primary schools (71%). As in the primary schools, the participating teachers were selected by the school without input from CHOOSE**MATHS**.

The secondary teacher survey consists of 23 questions including teacher education and experience, their 2016 teaching, questions relating to their confidence in and competence of mathematics content and mathematics teaching and their confidence and competence in promoting mathematics to girls.

In this report we focus on out-of-area teaching. The companion paper by Li and Koch (2017) examines the gender effect in the survey data in more detail. The sample of male teachers in particular is too small to divide it further into out-of-area and in-area and still be able to draw meaningful conclusions.

4.2 Out-of-Area Teaching

The survey contains the question: Are you teaching mathematics out-of-area? The question was answered positively by 32.5%: 34 female teachers and 7 male teachers. These numbers indicate that a higher percentage of female teachers regard themselves as out-of-area teachers. One teacher did not respond to this question. As mentioned at the beginning of Section 4, the ACER survey did not provide any kind of definition for out-of-area, but simply asked teachers for their own assessment.

Weldon (2016) quotes 21% out-of-field teachers for mathematics, and counts the 17% who have exactly one of methods training or tertiary mathematics content beyond first year as in-field. Figure 19 in Section 5 shows a schematic diagram of components of degrees relating to mathematics content and teaching or methodology.

We consider educational background and training, gender and teaching experience, and we examine potential differences between the out-of-area and the in-area teachers. We start with the teachers' assessment regarding the appropriateness of their training to teach secondary mathematics.

Relationship with Trained to Teach at Secondary Level

We intentionally did not qualify our survey question regarding out-of-area teaching, but merely asked for teachers' self-assessment. As a consequence teachers who have either successfully completed teaching methodology for secondary mathematics teaching at university level or tertiary mathematics content beyond first year but not both may consider themselves as out-of-area teachers. Asked if they are trained to teach mathematics at primary, secondary, both, or neither level, we found that 75.6% of teachers are trained at secondary or both primary/secondary level. The left panel of Figure 12 shows the distribution of teachers trained to teach mathematics at primary (P), secondary (S), both primary and secondary (B) and neither at primary nor secondary (N) levels for the in-area teachers (left bar) and the out-of-area teachers (right bar).

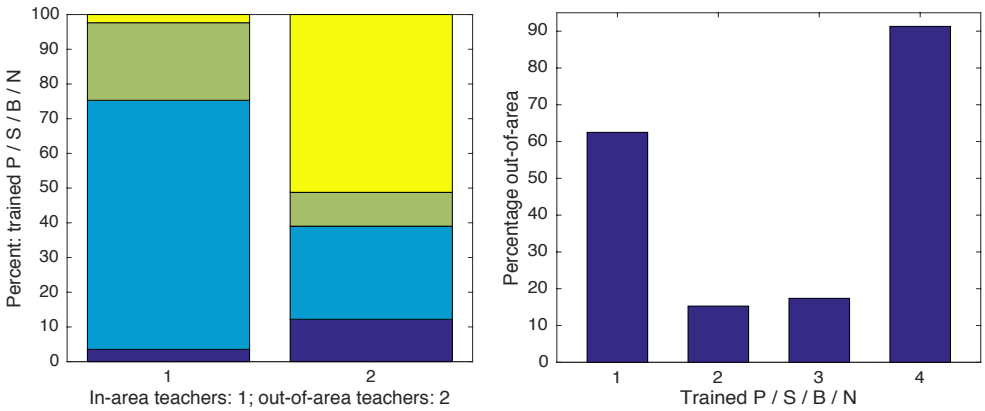

Figure 12: Percentages of teachers trained to teach primary/secondary or neither by in-area, bar 1, and out-of-area teachers, bar 2. Dark blue refers to trained to teach mathematics at primary level, light blue refers to secondary level, green refers to both primary and secondary level, and yellow refers to neither primary nor secondary level.

The right bar, which represents out-of-area teachers, includes 15 teachers shown in light blue (36.6% of the out-of-area cohort) who are secondary trained but state they are out-of-area. This assessment supports the statement made at the beginning of Section 4 that mathematics teachers who are trained to teach mathematics at secondary level may not be sufficiently confident with the mathematics syllabus or the teaching methods. It is worth noting that these 15 teachers would not be classified as out-of-field using Weldon's definition, they nevertheless regard themselves as such.

The right panel of Figure 12 show the percentage of teachers who state they are out-of-area separately for each level of 'training to teach'. Starting from the left, the four bars correspond to trained to teach at primary (P), secondary (S), both primary and secondary (B) and at neither primary nor secondary (N) level. We note that for the teachers trained to teach at secondary or both levels more than 15% of teachers stated that they are out-of-area. The number of teachers trained at both primary and secondary is small and therefore only indicative. However, the fact that teachers who are trained S or B feel that they are teaching out-of-area is of concern.

In Section 5 we indicate how we have refined these trained to/out-of-area questions in the 2017 survey.

Relationship with Teachers' Degrees

We remain with the out-of-area teachers and look at the degrees they completed. Table 3 shows details. Some teachers have multiple degrees so the numbers in each row may be bigger than the number of teachers in each cohort.

Table 3: Degrees of Out-of-Area Teachers

Degree/ trained to teach	B.Ed. Primary	B.Ed. Secondary	Dip.Ed. Primary	B.Sc. Major in Maths	B.Sc. no Maths	Other degree	Total in cohort
Primary	4	0	1	0	0	0	5
Secondary	0	3	1	1	4	4	11
Both	2	1	0	0	0	2	4
Neither	0	2	0	0	7	12	21

Table 3 shows that six out-of-area teachers have a B.Ed. degree with secondary mathematics, and one has a B.Sc. degree majoring in mathematics. The pattern is indicative only, since we are dealing with small sample sizes and it is not likely that larger samples follow exactly the same pattern. The seven teachers with a B.Ed. degree with secondary mathematics or a B.Sc. degree majoring in mathematics describe themselves as out-of-area. This assessment could express a lack of confidence in their own knowledge or skills of what is required from a secondary mathematics teacher. We will return to this point in Section 5 and look at ways of addressing the issues raised through the information provided in the table.

Relationship with Gender Distribution

In terms of a gender distribution the 41 out-of-area teachers split into 7 male and 34 female teachers, corresponding to 16.3% and 41% of the male and female teachers respectively who completed the survey. The gap between the genders could be concerning if it persisted in larger samples.

Relationship with Number of Years of Teaching Experience

Weldon (2016) found that early career teachers are more likely to be teaching out-of-field than more experienced teachers. From the 125 teachers who responded to the question about the number of years of teaching experience, 65% have been teaching more than five years, see Table 4. Yet the number of out-of-area teachers with less than five years of teaching experience exceeds that of the more experienced group, and the percentage of out-of-area teachers in this less experienced group is about 50%. The percentage for the group with 5-10 years of teaching experience is lowest with a mere 20% but then the percentage rises again to 26.3% for the group with 10plus years of teaching experience. The numbers in the third row of the table are small and should only be regarded as indicative.

Although not directly comparable, since Weldon's categories split into the year levels taught and consider years 7 to 10, our proportions of out-of-area teachers in the less experienced group are considerably higher than those reported in Weldon (2016) for out-of-field teachers; the percentage of teachers with more than five years of teaching experience is about the same.

Table 4: Number of years teaching experience

	Just started	1	2 - 5	5 - 10	More than 10
Number of teachers	12	11	20	25	57
Percentage of teachers	9.5%	8.7%	15.9%	19.8%	45.2%
Number out-of-area	5	6	10	5	15
Percentage in cohort	41.7%	54.5%	50%	20%	26.3%

4.3 Confidence and Competence in Mathematics Teaching

The secondary teacher survey had the same question on confidence and competence in mathematics teaching as the primary teacher surveys. The eight criteria are listed at the beginning of Section 3.4. Respondents chose between four answers: rarely (1), not often (2), often (3), mostly (4). The top panel of Figure 13 shows the means for each of the eight criteria

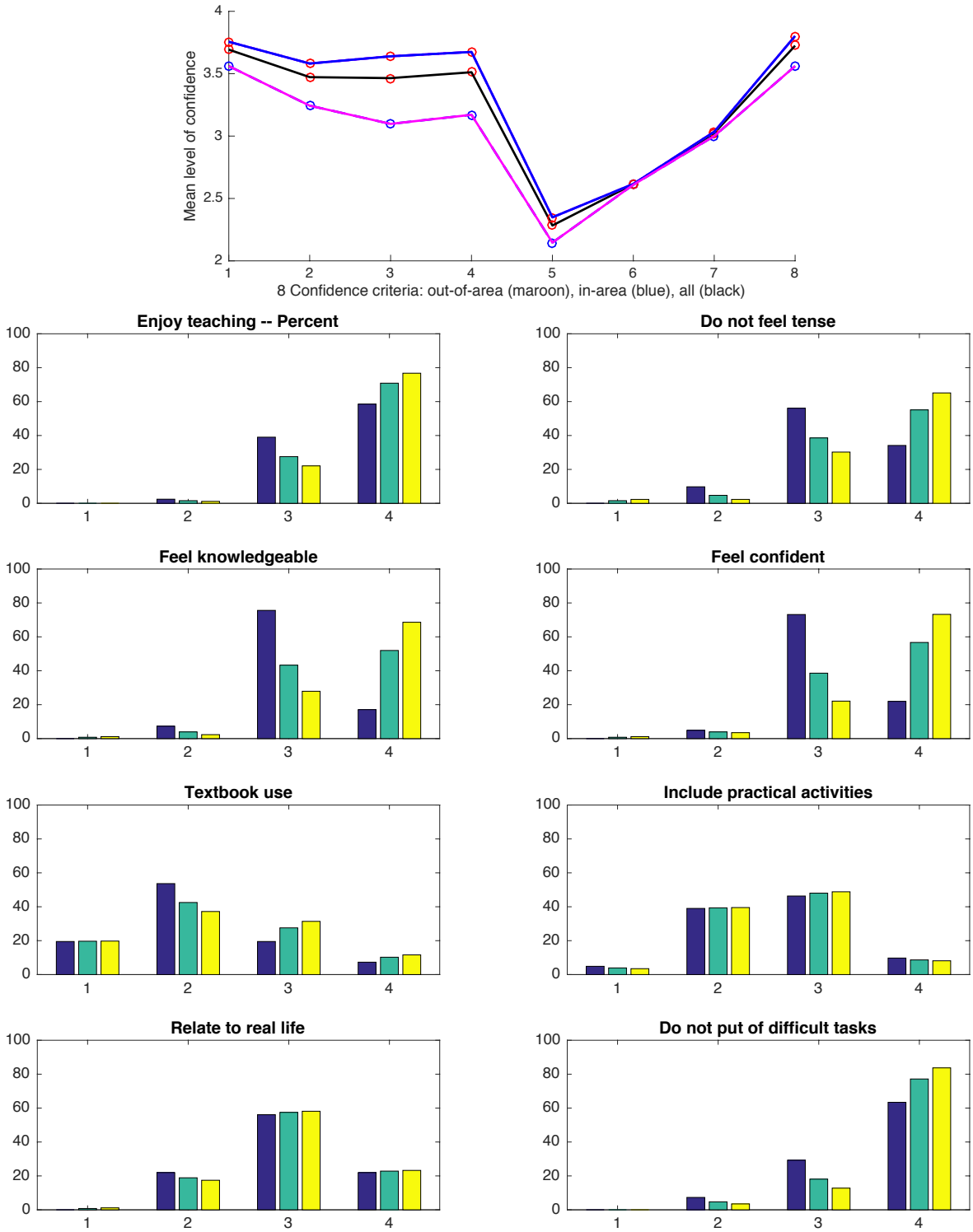

Figure 13: Means and percentage of counts for all eight criteria related to mathematics teaching – listed in Section 3.4. In the top panel the criterion numbers 1 to 8 are shown on the horizontal axis. The black graph shows the mean for all teachers, the maroon graph that of out-of-area teachers and the blue graph shows that of in-area teachers. The eight bar plots show the distribution for each criterion with percentages given on the vertical axis for the possible values 1 to 4, shown on the horizontal axis. The percentages for out-of-area teachers are shown in blue, for all teachers in green, and for in-area teachers in yellow.

with the criterion number shown on the horizontal axis. The eight bar plots in the lower part of Figure 13 show percentages of counts across the response values 1 to 4, that is, a separate distribution for each criterion. We use the following colours in Figure 13: all teachers (black graph and green bars), out-of-area teachers (maroon graph and blue bars), in-area teachers (blue graph and yellow bars).

The third and fourth criteria exhibit the biggest mean difference between the out-of-area and the in-area teachers, the criteria most directly related to knowledge and confidence. The bar graphs clearly show that the out-of-area teachers predominantly chose the response often (3) in criteria 2, 3 and 4 (second to fourth bar plots), while the in-area teachers had modes at mostly (4). The difference between out-of-area and in-area teachers is much smaller for criterion 6, include practical activities, and 7, relate to real life. This is expected, as these criteria are influenced by factors other than content knowledge and skills.

In the corresponding analysis of primary teachers in Section 3.4, we considered results by number of years of teaching experience. For the secondary teachers we do not present the corresponding graphs or bar plots because of the very small sample size in some groups. Table 4 shows details. Suffice it to say that the means across all eight criteria show similar patterns to those of the primary data. The less experienced teachers have lower means especially in the criteria I feel knowledgeable and I feel confident. The teachers with 5-10 years of teaching experience typically have the highest means across most criteria.

It is worth noting that over half of the out-of-area teachers in our sample are in the up to five years of teaching experience group, although less than 35% of mathematics teachers who completed the survey belong to this group. For the small samples sizes of the less experienced and out-of-area teachers, it is not possible to separate the effects due to being out-of-area from those due to being less experienced in terms of years of teaching. However we expect that the larger sample sizes in the 2017 teacher survey will allow us to examine the less experienced out-of-area teacher group in more detail.

4.4 Confidence and Competence in Teaching Specific Year Levels

The survey for secondary teachers includes a question on teachers' confidence and competence in teaching the mathematics curriculum for different years and levels within years. Most states have two levels of mathematics in the year 10 and 11 curriculum and three levels in the year 12 curriculum. NSW has an additional level for year 12. We will not differentiate between the various levels within years, but only distinguish between lower level and all levels for the years where this distinction applies.

For each year and level – lower or all -- teachers chose one of the following options: not confident (1), would benefit from help (2), feel okay (3), feel confident (4). Figure 14 shows the means and distribution for each year and level of all teachers, the out-of-area teachers and the in-area teachers. In the top panel of Figure 14 the numbers on the horizontal axis correspond to the years and levels in the order they are shown in the bar plots of Figure 14, so 1 refers to year 7, 2 and 3 refer to years 8 and 9 respectively, 4 and 5 refer to lower level only and all levels of year 10, and similarly 6 and 7 refer to the levels of year 11, and 8 and 9 refer to the levels of year 12. In the bar graphs, the numbers 1 to 4 on the horizontal axis refer to the four possible values listed at the beginning of this paragraph.

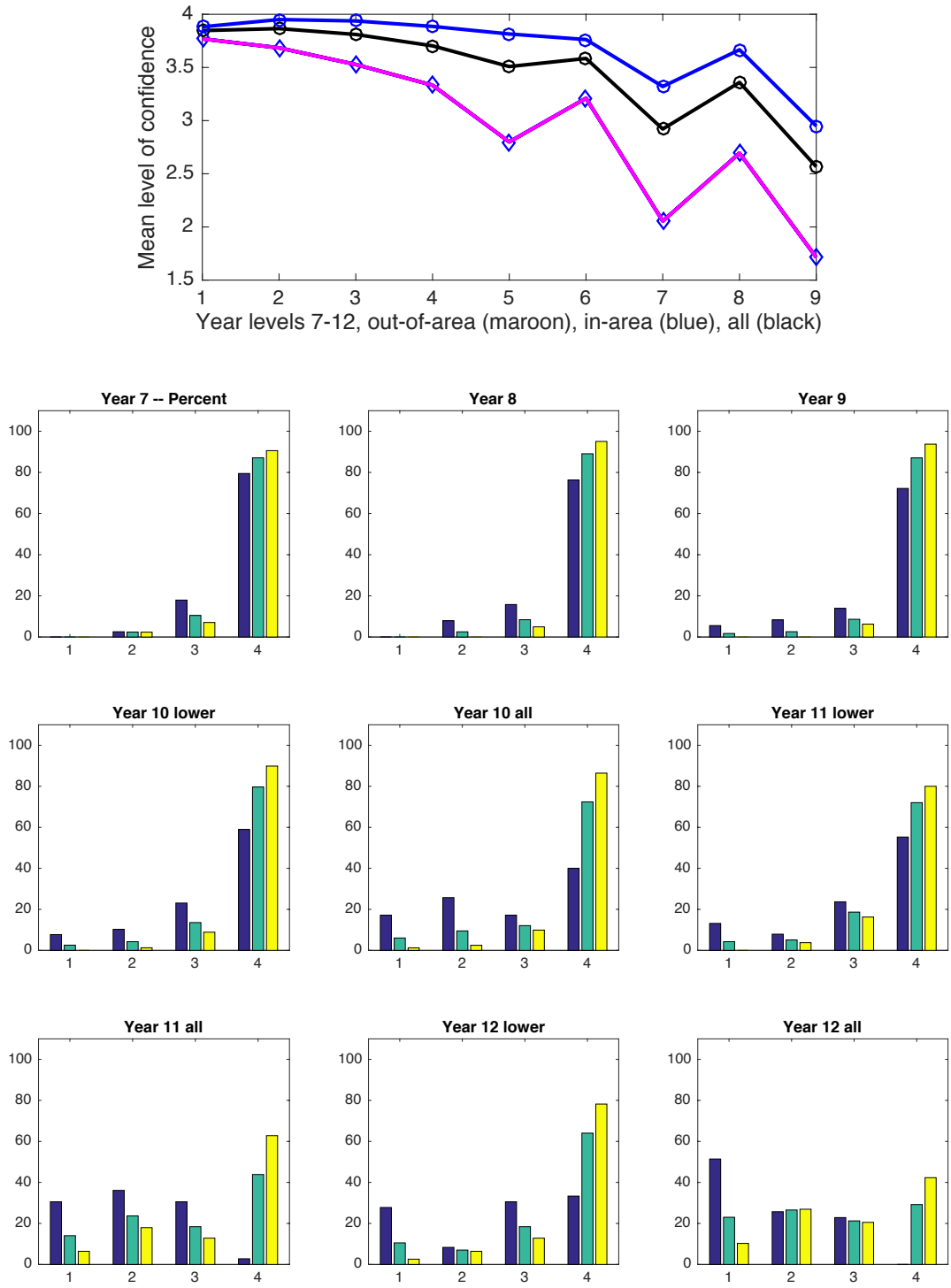

Figure 14: Means and percentage of counts related to confidence in teaching the curriculum at different years and levels. Top panel: the numbers 1 to 9 on the horizontal axis correspond to the years and levels in the order they are shown in the bar graphs below. The black line shows the means for all teachers, the maroon line that of out-of-area teachers and the blue line shows that of the in-area teachers. The nine bar plots show the distribution separately for each year and level with percentages given on the vertical axis for the response values 1 to 4. The response values are shown on the horizontal axis. The out-of-area teachers are shown in blue, all teachers in green, and the in-area teachers in yellow.

As in Section 4.3, we focus on the out-of-area teachers and the in-area teachers. The black graph in in the top panel of Figure 14 refers to all teachers, maroon refers to out-of-area teachers and blue to in-area teachers. In the bar graphs, blue refers to out-of-area teachers, green to all teachers and yellow to in-area teachers. The vertical axes in the bar graphs show percentage of counts in each of the three groups.

The graph in the top panel shows that the gap in competence and confidence is relatively small in Year 7 between the in-area and out-of-area teachers, but widens for later years and becomes increasingly large for the higher levels in years 10 to 12 which correspond to the values 5, 7 and 9 on the horizontal axis. There is a decrease in confidence/competence for the higher levels in years 10 to 12, however, for the in-area teachers this decrease is small compared to that of the out-of-area teachers.

The shape or distribution of the bar graphs changes for all teacher groups as we move to higher years and levels: in years 7 to 9 there are very high percentages for feel confident (4) which disappear quickly for the out-of-area teachers and more slowly for the in-area teachers as we move up the years and levels. This progression indicates a decreasing confidence for teaching higher years and levels of mathematics. In the last bar plot the out-of-area teachers have a mode at the response not confident (1), while the mode of the in-area teachers remains at feel confident (4), though the size of the mode is much reduced.

4.5 Confidence and Competence in Curriculum Documentation

For the secondary teacher survey we combine the planning, development and mentoring tasks, that is, curriculum documentation, with a question relating to preparing female students for tertiary study in mathematics. Since the questions for the secondary teachers differ from those of the primary teacher survey, we list the questions from the secondary teacher survey.

1. Planning mathematics programs appropriate to the year levels taught
2. Building a bank of mathematics teaching resources and rich tasks
3. Mentoring new graduates or teachers
4. Developing mathematics assessment tasks
5. Preparing students and in particular girls for further tertiary studies in mathematics.

For each question, the respondents chose between the four answers: not competent (1), somewhat competent (2), competent (3), very competent (4). Figure 15 shows the distribution of responses by question, and the means of the three groups: all teachers, in-area and out-of-area teachers.

The shapes of the distributions displayed in the first three bar plots are very similar, with the out-of-area teachers showing increasingly less competence as we go from top left to top right and then from bottom left to the right. In the last bar plot, preparing students for tertiary study, only 40% of out-of-area teachers feel very competent compared to 86.5% of in-area teachers. It will be informative to examine the difference in competence between the less experienced and the more experienced teachers in more detail, but the numbers in this sample are too small to draw any inferences from such comparisons. We therefore postpone this examination to the 2017 teacher survey.

The mean graphs in the bottom right panel show the steady decrease in mean competence of all teachers, but in particular the out-of-area teachers with question number.

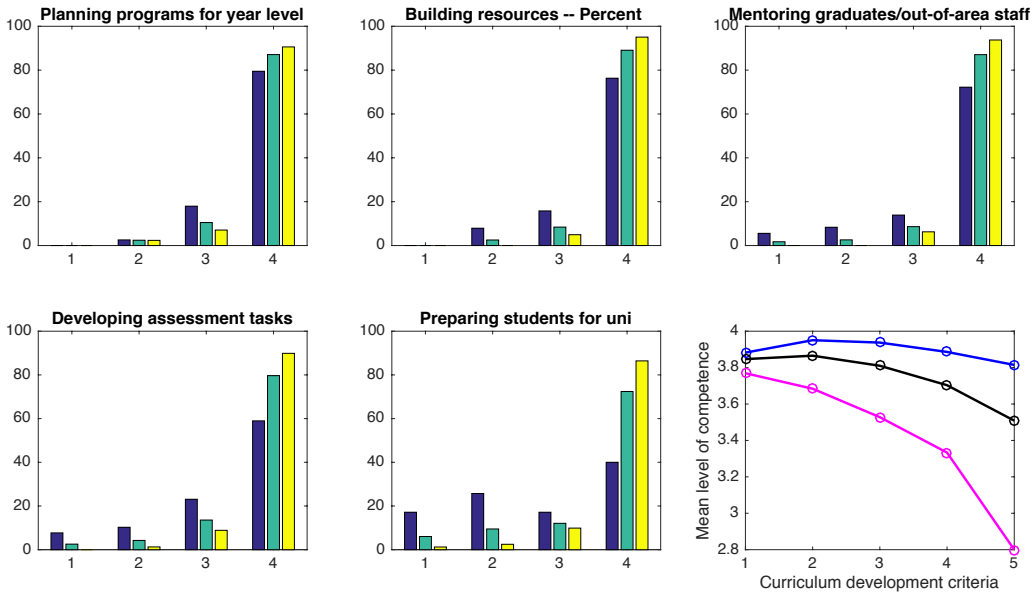

Figure 15: Percentage of counts and means for the five criteria related to competence in curriculum documentation. The bar plots show the distribution separately for each criterion with percentages given on the vertical axis for the possible response values 1 to 4, shown on the horizontal axis. The out-of-area teachers are shown in blue, all teachers in green, and in-area teachers in yellow. The graphs in the bottom right panel show the means over the 4 possible responses on the vertical axis and the question numbers 1 to 5 on the horizontal axis. Black corresponds to all teachers, blue to in-area, and maroon to out-of-area teachers.

In Section 5 we will compare the findings for secondary teachers with the corresponding results for primary teachers which are given in Section 3.5 and summarised in Figure 8.

4.6 Motivating Female Secondary Students

In years 9-11 of secondary school students make choices regarding the level of mathematics they want to study. To increase the participation of female secondary students in mathematics and STEM disciplines, constructive engagement is required from teachers, parents and the community. We examine teachers' engagement in this area through the following questions:

1. Have you been involved in motivating girls' interest in mathematics as part of your mathematics teaching?
2. Have you developed any material that may help in motivating girls' interest in mathematics?
3. Have you developed teaching approaches of teaching modules for encouraging and motivating girls in the study of mathematics?
4. Have you been involved in encouraging female students to consider careers involving mathematics in any formal way?

Figure 16 shows the percentage of teachers who answered positively to each of these four questions with the first four bars corresponding to in-area teachers, and the last four bars corresponding to the out-of-area teachers.

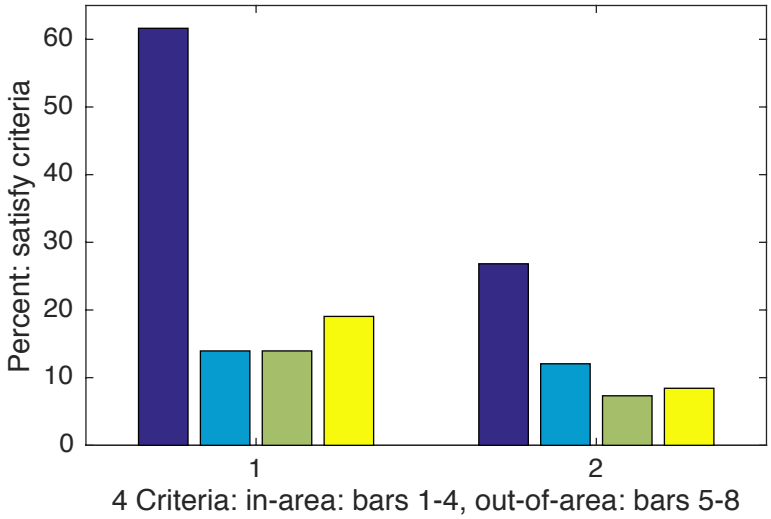

Figure 16: Percentage of teachers engaged in motivating girls' interest in mathematics. The first four bars show the percentages for in-area teachers, the second group of four bars refers to out-of-area teachers with colours dark blue for question 1, light blue for question 2, green for question 3 and yellow for question 4.

Figure 16 shows a much higher percent of in-area teachers involved in motivating girls as part of their teaching (question 1) than out-of-area teachers. The reason for this could be that in-area teachers have a better insight into mathematics and are therefore better able to 'sell' mathematics to students. All other questions have very low positive responses from both teacher groups, indicating that more effort needs to be invested in this aspect of mathematics teaching if we want to increase the participation of students, and especially female students, in mathematics and STEM disciplines at school and university. Some teachers responded with examples of involvement which range from STEM activities and guest speakers to information about career options and career paths.

In response to whether teachers thought they were a good mentor for female students, about 90% responded positively, with almost equal percentage contributions from the out-of-area and in-area teachers. This assessment is a little surprising in view of the relatively low engagement shown in Figure 16. It will be interesting to compare the 2017 responses with the 2016 responses described here.

4.7 Professional Development in Mathematics

The questions regarding professional development are the same for primary and secondary teachers. For the reader's convenience we list the 13 PD options below.

1. Assistance in planning of the mathematics curriculum
2. Assistance in planning at the year levels you teach
3. Mentoring of staff, particularly new graduates
4. Mentoring of girls to encourage them to develop an interest in mathematics
5. Development of assessment tasks
6. Consolidating mathematical pedagogy and content knowledge
7. Assisting with research and building a bank of teaching resources
8. Lesson observations and targeted feedback
9. Team teaching/modelled lessons with targeted planning and evaluation
10. Open access to a wide variety of resources for teachers and students

11. Networking opportunities with other teachers
12. Materials and information on careers in mathematics and mathematics in careers
13. Tools and information for teachers, parents and students to increase awareness of mathematics and mathematics related fields as careers for girls.

Figures 17 shows the percentage of teachers who regard the 13 PD options as very important. The dark blue bars refer to the out-of-area teachers, and the yellow bars to the in-area teachers.

Higher and sometimes much higher percentages of the out-of-area teachers regard PD options 1 to 11 as very important. Interestingly, PD options 12 and 13, which relate to careers and motivating girls, are regarded as very important by a larger proportion of in-area teachers than out-of-area teachers. More than two-thirds of the out-of-area teachers listed the following PD options as very important, given here in decrease percentage order with the PD number in brackets.

- Open access to a wide variety of resources for teachers and students (10)
- Assisting with research and building a bank of teaching resources (7)
- Team teaching/modelled lessons with targeted planning and evaluation (9)
- Networking opportunities with other teachers (11)
- Consolidating mathematical pedagogy and content knowledge (6).

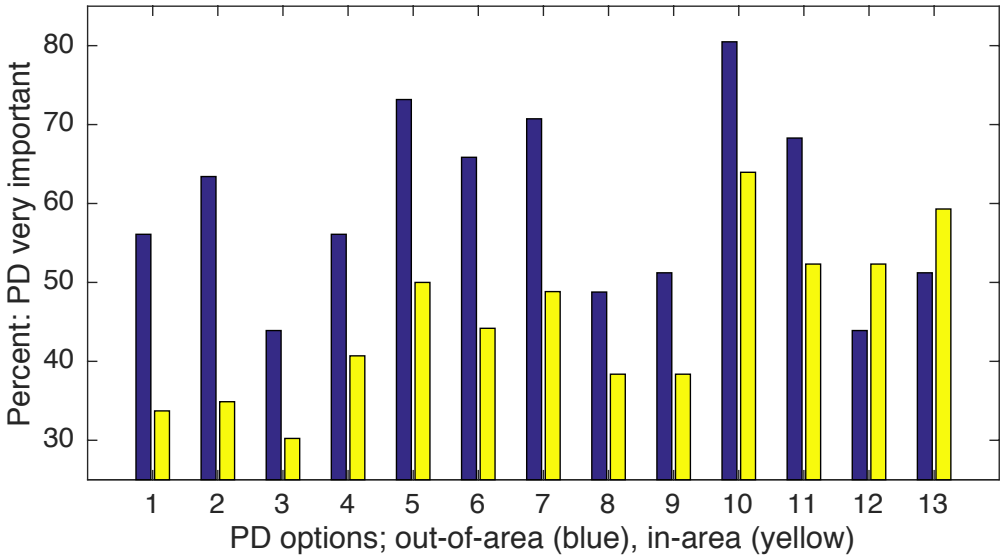

Figure 17: Percentages of teachers regarding PD options 1 to 13 as very important. The numbers on the horizontal axis correspond to the 13 PD options in the list. Each group of bars consists of the percentage from the out-of-area in dark blue, and the in-area teachers in yellow.

This list is largely content-related and suggests that the out-of-area teachers require more resources and expect to gain from others by working in teams and through networking. The needs of in-area teachers appear to be lower for the PD options; those regarded as very important by more than 50% of in-area teachers are given below, starting with the most desired option.

- Open access to a wide variety of resources for teachers and students (10)

- Tools and information for teachers, parents and students to increase awareness of mathematics and mathematics related fields as careers for girls (13)
- Networking opportunities with other teachers (11)
  Equal with
  Materials and information on careers in mathematics and mathematics in careers (12)
- Development of assessment tasks (5).

Open access to a wide variety of resources for teachers and students is the PD topic most desired by both groups of teachers, though only 64% of in-area teachers regarded it as very important compared to 80.5% of out-of-area teachers. Networking (11) also appears relatively high on both lists. These two PD topics are regarded as very important by the majority of primary teachers, too, with Open access … at the top of the list for the primary teachers, as well.

Figure 18 shows the choices and preferences of the two groups in more detail. The two panels in the top row show that 50% or more out-of-area teachers regard PD options 1 to 11 as very important. With the exception of the PD option mentoring staff (3), only a very small percentage of out-of-area teachers chose the not needed response to the 13 PD options, indicating that help is required and welcomed in all 13 PD topics.

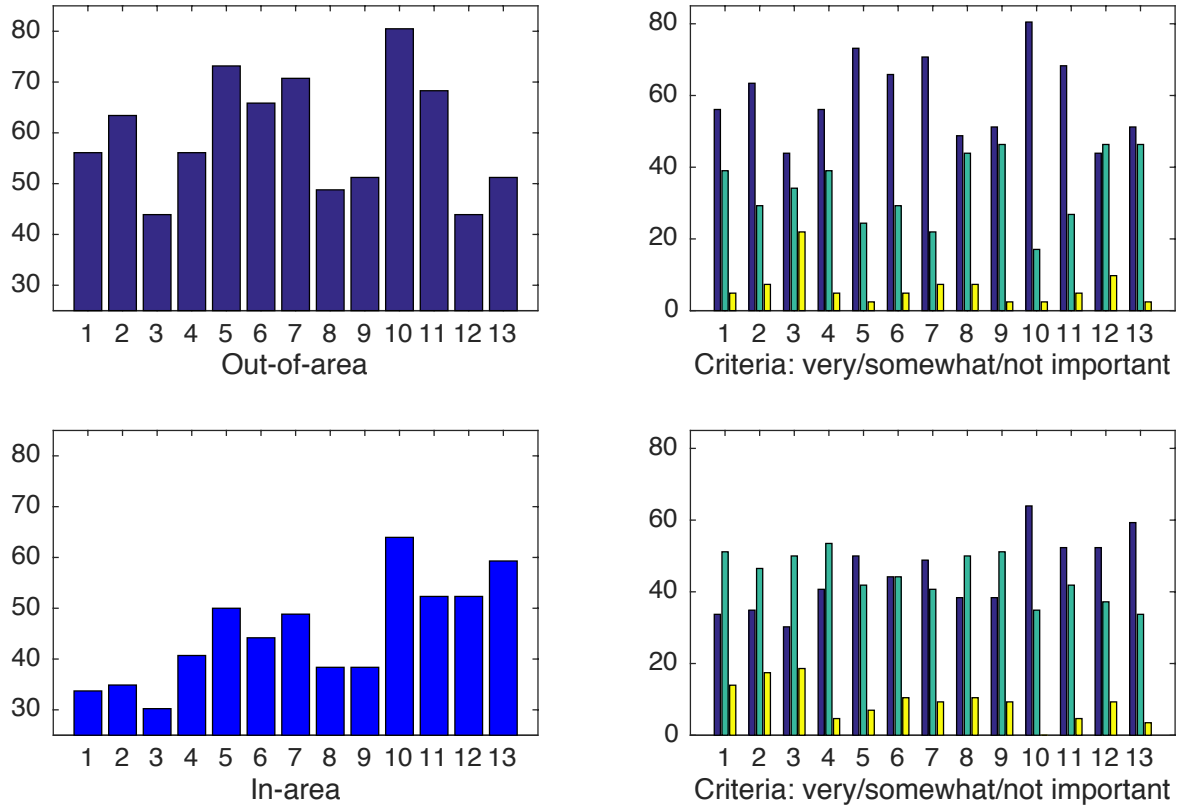

Figure 18: Percentages of out-of-area teachers (top row) and in-area teachers (bottom row) regarding PD options 1 to 13 as very important shown in the left panels and the first bars in each group in the right panels, In the right panels the percentages for somewhat useful is shown by the second bars in each group of three, and not needed in the third bars in each group. The numbers on the horizontal axis correspond to the 13 PD options.

The pattern of responses of the in-area teachers differs considerably from that of the out-of-area teachers: between 40% and 50% of in-area teachers regard PD options 1 to 9 as somewhat important only, and in six of the PD options the somewhat important percentage is higher than that of very important. For PD option 6 -- consolidating mathematical pedagogy and content knowledge – the same number of teachers regarded this option as very important and somewhat important.

The difference in the responses to the PD options points very strongly to the difference in skills, knowledge and confidence between the in-area and out-of-area teachers. The need for more mathematics knowledge and a diverse range of skills related to curriculum documentation and teaching of mathematics is expressed by the high proportion of teachers who choose very important for most of the PD options. PD options can address this lack, but more substantial training is required to decrease the proportion of out-of-area teachers in mathematics now and in future.

4.8 Summary

The secondary mathematics teachers fall into two distinct groups, broadly speaking those who have sufficient knowledge in mathematics and the teaching of mathematics and those who do not. The difference between the two groups is apparent in their confidence regarding mathematics and mathematics teaching, in their competence or lack thereof in curriculum documentation and in their very positive response to obtaining more help in the form of PDs.

The difference between the two groups is confounded by the much larger proportion of teachers with less than five years of teaching experience in the group without sufficient knowledge and skills.

Other subsets of out-of-area teachers by year level they teach or by content knowledge versus pedagogy training are of interest, but such analyses require more data and will have to be postponed until we obtain the 2017 teacher survey data.

5 Conclusions, Hypotheses and Future Directions

CHOOSE**MATHS** has been regarded very positively by principals and teachers in 2016, and schools expect gains in terms of improved knowledge, skills and teaching practices of teachers which will have a positive flow-on effect on the mathematical education of the students, and is hoped to lead to increased participation of all students in mathematics.

A comparison of primary and secondary teachers based on their own assessments shows the following.

- 86.6% of primary teachers are female, compared to 64.8% of secondary teachers.
- 97% of primary teachers are trained to teach mathematics at primary level, but only 75.6% of secondary teachers are trained to teach mathematics at secondary level and 32.5% of secondary teachers are teaching mathematics out-of-area.
- The distribution of less experienced teachers is about the same in primary and secondary schools: 37.2% of primary teachers have a teaching experience of less than five years compared to 34.1% of secondary teachers.
- Overall secondary teachers are more confident in mathematics content-related areas and considerably more competent in curriculum documentation than primary teachers, while primary teachers are better at including practical examples into their teaching than secondary teachers.
- The majority of teachers welcomes or is in need of professional development, and more than 70% of primary and secondary teachers regarded PD on access to a wide variety of resources as very important.

For secondary as well as primary teachers the self-assessed levels of confidence and competence in mathematics content and teaching of mathematics appear to be high. There are two reasons for the higher than expected levels of confidence.

- Less than 50% of teachers in the CHOOSE**MATHS** schools participated in the survey in 2016. It is very likely that many of the less confident teachers did not complete the survey.
- Bias occurs in the self-assessment during the initial phase of a new program, or as Fullan (p40, 2001) puts it ‘a dip in performance and confidence [occurs] as one encounters an innovation that requires new skills and new understandings’.

From 2017 onwards we will conduct the teacher survey electronically as part of staff meetings or PD sessions in the CHOOSE**MATHS** schools. Such meetings should lead to higher response rates and therefore also capture less confident teachers. However, as a consequence of a higher response rate and the performance dip, we expect the confidence and competence levels to decrease initially, before they rise in later years as a result of continued engagement of schools with CHOOSE**MATHS**.

The biggest difference in confidence and competence among primary teachers exists between teachers with little or no previous teaching experience and those with 5 – 10 years of teaching experience. School principals and the CHOOSE**MATHS** Schools Outreach Officers are aware of maths anxiety among primary teachers, but it was not possible to find convincing evidence of this in the 2016 data. It is likely that teachers who exhibit maths anxiety did not complete the survey in 2016. Capturing responses from this group of teachers is essential in obtaining better insight into the degree of maths anxiety and the needs of the

teachers. Based on a better understanding it will be possible to make recommendations for improvement.

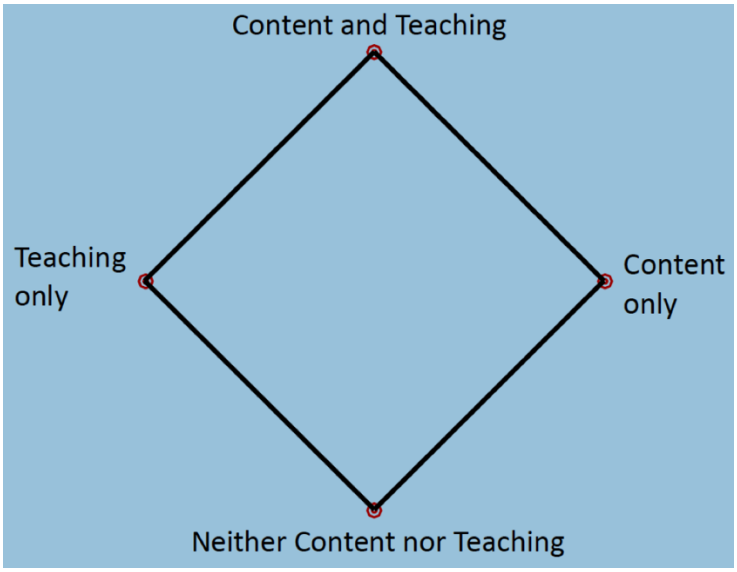

Figure 19: Components in tertiary mathematics content and mathematics pedagogy degrees.

For secondary teachers out-of-area teaching is a serious concern. According to Weldon (2016) out-of-field teachers are those who are at the lowest vertex in Figure 19, all others are in-field. Teachers without tertiary mathematics content and without pedagogy knowledge are clearly inadequately prepared to teach mathematics. This report does not focus on this group, but is concerned with the groups represented by the vertices on the left and right of Figure 19.

In the 2016 CHOOSE**MATHS** teacher survey we aimed to gain insight of teachers' perception and self-assessment regarding their out-of-area/in-area status. The self-assessment resulted in more than 32% of teachers regarding themselves as out-of-area teachers.

A key question is: Why do these teachers regard themselves as out-of-area? In the 2016 survey data nearly 37% of the out-of-area teachers are trained to teach mathematics at secondary level, and some have B.Sc. degrees majoring in mathematics. These teachers belong to the three vertices comprising in-field. What is lacking in their education and training? In the search for answers to this question, the 2017 CHOOSE**MATHS** teacher survey will, in more depth, examine the training, the components of mathematics content and pedagogy their degree(s) contain and the adequacy of their training and degree(s) in their in-service mathematics teaching. Obtaining such insight from larger sample sizes than those of the 2016 secondary teacher survey will yield information on what is lacking in teacher education and, as a consequence, will lead to recommendations on how to address this lack and prepare teachers more adequately for their mathematics teaching in secondary schools.

Bibliography

Beilock, S.L., Gunderson, E.A., Ramirez, G. and Levine, S.C. (2010). Female teachers' math anxiety affects girls' math achievement. Proceedings of the National Academy of Sciences, 107(5), pp.1860-1863.

Fullan, M. (2001). Leading in a Culture of Change, Wiley.

Li, N. and Koch, I. (2017). AMSI CHOOSE**MATHS** Research, 2017, no 2.

Underwood, C. (2016). Evaluation of the CHOOSE**MATHS** Program, Australian Council for Educational Research.

Weldon, P. R. (2015). Policy Insights, The teacher workforce in Australia: Supply, Demand and Data Issues, Issue 2, Australian Council for Educational Research.

Weldon, P.R. (2016). Policy Insights, Out-of-field teaching in Australian secondary schools. Issue 6, Australian Council for Educational Research.

Willett, M., Segal, D. and Walford, W. (2014). National Teaching Workforce Dataset Data Analysis Report 2014.