

**17 October 2016**

The Minister of Education

Hon Hekia Parata

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Dear Minister

**Concerning the recent assessment of the Level 1 Mathematics and Statistic standard 91027, *Apply algebraic procedures in solving problems***

I am a retired teacher of mathematics, so I was not directly involved in this assessment, but of course I took an interest when it hit the news. I have worked through both papers, and I have read some of the feedback from students, teachers, principals and parents. I was not intending to get involved but I have decided to put my thoughts on paper after reading a statement in a response from NZQA.

*"It is clear from the feedback that the communication processes we used in 2015 and 2016 to convey the changes to align the assessment to the standard were not adequate ....."* (Quote from letter from Kristine Kilkelly to Craig Bradley at Rangi Ruru Girls' School, 11 October, 2016)

**I strongly disagree with the implication that the changes have been made to *align the assessment to the standard*. I was the leader of the group that wrote this standard and I am in a position to state categorically that this 2016 examination was not moving towards the intention of the standard but was actually moving away from it, and constitutes a deliberate attempt to change the standard.**

I feel very sorry for the team who were contracted to NZQA to write this examination. They are now exposed to well-argued, reasonable and justified criticism from their colleagues in the profession. They must be feeling very bad about this. This examination has also brought NZQA into disrepute, because clearly the systems that are in place for quality control and checking of draft examinations have failed in this instance.

How could the systems fail? In this letter I will set out my thoughts as to how and why the system has failed. By doing this I hope that I can shed light on some matters, and encourage a review of policy and procedure so that this kind of disaster does not happen again.

**The 2016 examination**

There is no doubt that this examination was poorly designed with regard to the order of the questions, that some questions were worded in a very obscure manner which prevented candidates from understanding what response was required, that many questions were beyond the required standard and actually more suited to a Level 2 examination, and that the choice of questions was unbalanced with mostly quadratic situations rather than linear situations.

The inclusion of an "investigation" type question was signalled to schools (but no examples were provided). An investigation is best done in a non-time-limited situation, preferably in collaboration with others so that a rich mathematical discussion can take place. By its very nature, an investigation is an open-ended, unstructured question, and it may take several false starts before an investigator hits upon a productive line of thinking. It is arguable that it is not appropriate to put an investigation into a one-hour examination. At the very least, if an investigation is included in an examination, then it should have some scaffolding so that

candidates have some reasonable chance to make progress with it in a 10 minute time frame. This question in the CAT was unfortunate in the choice of numbers used for the first line of the pyramid. An apparently random set of numbers (like 3, 1, 5, 4) would have been a better choice, as it would have suggested the use of different letters (for example a, b, c, and d) which will be productive in finding the pattern. Unfortunately, the examiners chose a sequence (like 2, 4, 6, 8) which encouraged people to use a single variable ( $x$ ,  $x + 2$ ,  $x + 4$ ,  $x + 6$ ). This representation does not lead to the discovery that the middle numbers influence the answer more than the edge numbers.

I believe that the outcry from candidates, teachers and parents about this examination is entirely justified. I will not go into further detail about the actual questions because there have been many submissions from teachers already sent to NZQA which already cover this ground very well indeed.

### **Why did this happen?**

Of course I do not know the answer to this question but I have some theories. I believe that this happened because there are people in the Ministry of Education and/or in NZQA who have opinions about the level 1 Algebra standard and would like to change it. I will discuss three particular aspects of current policy with regard to mathematics.

### **Style of questions**

This statement in the 2016 assessment specifications for this examination makes the currently official policy of the authorities very clear:

*“To meet the requirement of the standard with respect to solving problems, candidates will not be able to provide evidence by following a direction to solve factorised quadratics, factorise, expand, write or solve a linear equation, or simplify an expression involving the collection of like terms in response to being told to. No part of any question will direct the candidate to perform a specific procedure unless there is an intermediary procedure required in order to solve a problem.”*

This policy *actually contradicts the registered standard*, and is an attempt to change the standard without the due process of consultation. When we wrote the standard we were very aware of the negative attitude among some officials towards what they saw as “skills questions”, and the whole issue was thoroughly discussed. We carefully wrote into the standard actual examples of the types of question expected to result in evidence of mathematical thinking at the “Achieved” level (as distinct from Merit or Excellence). The standard includes this definition of a problem:

*“Problems are situations that provide opportunities to apply knowledge or understanding of mathematical concepts and procedures and methods. The situation will be set in a real life or mathematical context.”*

According to the standard, the question “Factorise  $x^2 - 5x - 14$ ” is a problem by this definition, in a mathematical context. In answering this problem the student will give evidence for “Achieved” level thinking. To be specific, the correct answer will give evidence against the criteria stated in the standard:

*“Apply algebraic procedures involves:*

- *selecting and using procedures in solving problems*
- *demonstrating knowledge of algebraic concepts and terms*
- *communicating solutions using appropriate mathematical symbols”*

*Bullet point 2* is covered by the student demonstrating that they understand the meaning of the term “Factorise” (as distinct from Expand, Simplify, or Solve for example). The word “factorise” does not “give away” the procedure to be used. The candidate must understand that “factorise” means “rewrite the expression in the form  $(x - a)(x - b)$ ” .

*Bullet point 1* is covered when the student arrives at a correct solution, *selecting and using* the procedure they will have been taught and will have practised in class.

This procedure will involve something like these steps:

1. find factors of 14
2. choose the factor pair which have a difference of 5 (it is a difference rather than a sum because the product is negative 14
3. set up the brackets with the chosen factors  $(x - 7)(x + 2)$
4. Choose to put a negative with the 7 and positive with the 2, to get the correct coefficient of x to be - 5.
5. Write the answer  $(x - 7)(x + 2)$

This is not a trivial procedure for a candidate doing Level 1 algebra, because there are several points at which the candidate could easily make the wrong choice. The word “factorise” has not told the candidate what steps to follow. It is also not trivial because in this examination the candidate is working without any kind of calculator to help with the number work. This condition was strongly supported by the teaching sector during the consultation process when these standards were written.

*Bullet point 3* is covered when the student writes the answer down using correct notation.

So by correctly answering the question “Factorise  $x^2 - 5x - 14$ ” a candidate will have provided evidence for this standard at Achieved level.

I believe that this type of straight forward question is entirely appropriate and suitable in this examination. Algebra is difficult enough for most candidates and we must have some questions like this so that conscientiously prepared candidates whose thinking is at the “Achieved” level do actually have an opportunity to achieve the standard in a credible and satisfying manner by answering some questions correctly.

The standard writing group carefully worded this standard so that this type of question would be a valid way of assessing (though would only obtain evidence corresponding to the criteria for Achieved). It is clear that official thinking disagrees with the standard as we wrote it. I believe the current official thinking is unrealistic and lacks common sense. The people responsible for this policy would benefit from going to work in a school for at least two weeks every year, actually in a mathematics classroom with real Level 1 students, so that they retain a realistic idea of what is possible for an average student at this level.

In summary, I believe that the official policy, as quoted above from the assessment specifications for this examination, is wrong. It needs to be re-examined. It is this policy that is largely to blame for this disaster.

### **Word problems set in a real life context**

The official view seems to be that mathematics is only worth doing if it relates to a “real life problem”. This is a very utilitarian view of mathematics. Of course mathematics is useful in real life, in the sense that we could not have landed on the moon, or mapped the genome, or invented computers without mathematics. But, seriously, when in real adult life did you ever use elementary algebra to solve a problem?

Mathematics is a vast and wonderful subject with many branches and its own philosophy. One can enjoy the elegance and efficiency and power of doing mathematics for its own sake.

But, just as you can't have the pleasure of playing a Mozart sonata without practising scales, you cannot do mathematics without learning the grammar and syntax of algebra, which is the language of mathematics. Of course it is amusing for children if we set a maths problem in a real life context and it is practical and realistic to do this in topics like measurement and trigonometry. But to insist that problems in an algebra examination must be set in a real life context is inviting disaster, because it is extremely difficult not to be ambiguous or misleading when wording the question, and it creates extra non-mathematical difficulties because the candidate must read and correctly interpret the explanation of the situation. It is often the case that contexts used in questions are not actually familiar contexts for a school age student.

The "word problems" in this particular assessment are apparently "in a real life context" but they are totally artificial and not real problems at all. Rane and Hone each know perfectly well how much money they have. If we were interested we could ask them. Raj is kicking a ball around, which is fun, but he certainly will not be wondering "for what percentage of the horizontal distance the ball travels will it be 3 metres or more above the ground?"

We do not have to justify algebra by pretending that it is directly applicable to "real life problems". There are many good reasons for studying algebra, but this is not one of them. Any policy that insists that algebra must be demonstrated in the "real life context" is misguided and unhelpful, and leads to the kind of examination fiasco that has occurred this year with the CAT. *In fact such a policy will simply drive more NZ schools into using the Cambridge examinations for mathematics assessment, which I believe is unfortunate.*

### **Investigations**

The inclusion of an investigation in the 2016 CAT suggests to me that there is a well-meaning group of people within the Ministry of Education or NZQA who seek to improve the teaching and learning of algebra in our schools. Perhaps they believe that doing investigations will motivate students by showing them how algebra can be used to generalise and efficiently investigate numerical situations and patterns. Doing investigations encourages rich discussions about mathematics, and lifts students' thinking to a higher level. I agree absolutely with this view. BUT what is the correct method for bringing about this change? It is for the Ministry to work **with** teachers, providing suitable resources for the classroom, and suitable professional development for teachers. It is **NOT** for the Ministry to display the cynical attitude that "teachers will only change if we put it into the exam". The Ministry does excellent work providing resources and advice on-line for Mathematics and Statistics teachers in NZ. If they feel that algebra teaching is not up to the standard they would like, then more effort needs to go in this direction.

It is not appropriate that the CAT examination is used as a weapon to improve the teaching and learning of algebra. My guess is that an attempt to do just this has been part of the cause of the debacle of the 2016 CAT examination.

### **How did this paper pass through the checking systems at NZQA when it is so clearly out of line?**

The procedures for preparing examination papers are generally robust. The people involved are contracted to do the work, they are experts in their subject, and they have clear job descriptions. The people who worked with the examiner to develop the questions for the 2016 CAT must have received specific instructions from officials in the Ministry of Education about the required style and type of question. *Some of these instructions would have been in direct contradiction to the standard.*

Part of the responsibility of the people contracted to check the examiner's work is to check that the examination is appropriate to the standard. The people who checked this examination must have known

that some of the questions were not appropriate to the standard. Why did they not speak out? If they were independent and honest and following their job description, they would not have approved this examination. Were they instructed to ignore the standard and follow “new policy”?

I do not know the answers to these questions, but I strongly believe that an investigation should be undertaken into this failure of the checking system. It looks as though the people who were doing the checking were afraid to speak out.

NZQA needs to acknowledge that they are in this mess because an inappropriate attempt has been made to change the standard without proper consultation with the sector, and without correct procedures being followed. **Changing the style or difficulty of the examination is not an appropriate method for changing the curriculum, the teaching methods or the standard.** The victims are the candidates that sat this examination. They have had an appalling experience, and their grades will be meaningless. NZQA may claim that teachers were notified of the changes via the Assessment Specifications. However I think that the notification in the assessment specifications was quite inadequate and did not indicate that the level of difficulty of the examination would be markedly higher than usual. The assessment specifications are a way of alerting teachers to minor changes in the style of the examination, not a route by which NZQA can make a fundamental change in the mathematical level of the standard.

I believe that several fundamental errors of judgement must have been made by officials working in the Ministry of Education and the NZQA which have led to this disaster.

I do not say “disaster” lightly. For our education sector to thrive and prosper and continue to improve teaching and learning practice, the Ministry of Education and the teaching profession must have mutual respect and trust, and they must work together for the best possible outcomes for the education of our children. This unfortunate examination illustrates lack of respect for teachers from the Ministry of Education, and will lead to teachers, students and parents losing confidence and trust in the assessment process managed by NZQA.

Yours sincerely but sadly,



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