Strategies to Support PGCE Mathematics and Science Students Preparing for Assignments at Masters Level

Journal Item

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Abstract

The main aim of this study was to analyse and evaluate the effectiveness of support strategies being put into place for students who need to write assignments at Masters Level. In preparation for writing a 5000 word assignment on an aspect of teaching Mathematics or Science, 57 Science and Mathematics PGCE students were asked to write a 500 word synopsis which included an introduction, description of the main focus, questions that the assignment would address and possible strategies for teaching and learning.

A strategy not reported previously in this context was the use of peer assessment of the synopsis. Each synopsis was reviewed by two students and discussed in professional learning conversations. The assessments by students were used as feedback along with the University subject tutor's assessment of the synopsis. Data were collected from questionnaires and interviews to explore the perceived effectiveness of the peer assessment exercise and other support strategies. Findings were analysed to consider how support for future groups might be developed.

Keywords: Post Graduate Certificate of Education (PGCE); Peer assessment; Academic writing; Masters Level; professional learning conversations

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Introduction

The National Framework for Higher Education Qualifications in England, Wales and Northern Ireland (QAA, 2001) describes Masters level studies as advanced short courses, often forming parts of Continuing Professional Development programmes, leading to Postgraduate Certificates and Postgraduate Diplomas. Students need to demonstrate amongst other things, a thorough understanding of knowledge and the ability to critically evaluate research in the discipline, an understanding of how research techniques are used to build on the knowledge and interpret it, and the ability to work independently in order to continue to develop professionally (QAA, 2001).

The Post Graduate Certificate in Education has been a route into teaching for many years. Recently the 'Post Graduate' part of the title has meant that the award must show evidence of study at Masters level (Jackson and Eady, 2008). Alongside this the UK government decided that teaching should become a Masters profession as stated in The Children's Plan: Building Brighter Futures. The stated aim is to create a world class teaching workforce by introducing a new qualification: Masters of Teaching and Learning (DCSF, 2007).

Since 2005 PGCE courses have been awarded at two different levels in many English Universities. These are the Post Graduate certificate of education at Masters level (the Masters degree to be completed at a later stage) and the Professional Graduate certificate of education at Honours level (Haworth et al, 2009).
Masters level courses encourage students to reflect on their practice which is very important as reflective teachers build on their understanding and add to their professional knowledge. It is in making links between practice, professional knowledge and deep reflection which help to build on understanding of learning and teaching (Harrison, 2008). In this way Masters level thinking is an important part of learning to become a teacher. The Masters level PGCE course has the potential to enhance the professionalism of the teaching profession leading to higher self esteem within the profession and to being held in greater esteem by the general public (Jackson and Eady, 2008).

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Many PGCE tutors argue that expectations of PGCE students in the university sessions and in written assignments have long demonstrated Masters level characteristics (Haworth et al, 2009). This seems to be particularly true for Social Science and 'Arts' students. Moreover North (2005) has found that students from a Social Science and Humanities background achieved higher levels in undergraduate writing than Science students. On the other hand, it is very likely that the majority of Mathematics and Science students do not experience academic writing in the realm of Social Science in their undergraduate studies. This puts them at a distinct disadvantage compared to the rest of the PGCE cohort who come with degrees in English, the Humanities, Social Science, etc. It is worth noting that in some countries (e.g. the USA and Canada) academic writing is, in many universities, specifically taught to undergraduates (Adams, 2009). However in the context of supporting Maths and Science PGCE students in the UK, there is very little time to further develop the skill of academic writing. Therefore it is important that the time is used effectively.

Many secondary Mathematics and Science PGCE tutors feel they ought to support their students with writing at Masters level. Haworth et al (2009) reported on a survey of twenty one institutions that most felt the need to give extra support to their Mathematics PGCE students. These interventions included scaffolding for early assignments, guidance on writing, providing formative assessment of assignments, students reading and discussing academic and professional articles, tutorials, sessions on using the library, and support through a Virtual Learning Environment (VLE).

Peer assessment has not been described in any of the studies above as support for Mathematics and Science PGCE students with writing at Masters level, and should be considered as an effective learning activity. When students assess the work of a peer they have to analyse the work in order to consider the strengths and weaknesses. Analysing their peer's work can lead to a greater awareness of the quality of their own work. If done properly peer assessment becomes a learning activity instead of a marking activity and it can also lead to students becoming more

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active in their own learning (Sluijsmans et al, 2003). Topping et al (2000) argue peer assessment can have cognitive effects leading to increased self awareness and engagement, as well as a greater understanding of the assessment criteria and a range of social skills such as negotiation, justification and diplomacy. They conducted research with twelve post graduate students of Educational Psychology who were asked to peer assess each other's work but not to mark it. Their results showed that the students found the process challenging intellectually but effective in improving their writing skills and prompted self assessment in half of the students. They also gained in interpersonal skills.

Peer assessment helps students to see why assessment takes the form it does and how critical thinking is an important part of the assessment process (Smyth, 2004). Since PGCE students are encouraged to engage in critical thinking it would seem that peer assessment will help in this process as well. Therefore this exercise, resulting in learning conversations, is a modelling exercise for the PGCE students, promoting assessment for learning.

In order for students to peer assess each others' work they need to understand the assessment criteria and processes. Rust et al (2003) describe two main types of assessment process: the explicit process which is achieved by taking the written criteria at face value and the tacit process which depends on the interpretation of the criteria and an internalised understanding of what makes a good piece of writing. The moderation process between staff markers generally leads to a shared understanding of both explicit and tacit experiences. If students also share in the marking experience they ought also to be able to share in the forms of explicit and tacit assessment processes belonging to that institution. Rust and his colleagues undertook a research project where they asked over three hundred undergraduates to mark sample assignments using assessment criteria and grade definitions. Students attended workshops where they discussed the criteria and worked on agreeing final grades. The findings were that the workshops helped to transfer knowledge of both explicit and tacit assessment processes and that this led to improvement in the academic performance of the students who attended the workshops.

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The main aim of the study described in this paper is to analyse and evaluate the effectiveness of support being put into place for Mathematics and Science PGCE students who need to write assignments at Masters level. It was clear, from reading their first assignments, that some of the students were very good at this while others struggled. In order to support the students with writing the second assignment the focus was on the use of peer assessment of a synopsis the students needed to write in preparation.

Interventions to support Mathematics and Science PGCE students

At the University where this study took place, the Masters level credits were introduced in 2007. This study targeted specific interventions for the Secondary 19 Mathematics and 38 Secondary Science PGCE students in the 2008-9 cohorts. If through the interventions there is an increase in the proportion of Mathematics and Science PGCE students getting Masters level marks that will indicate progress is being made.

Support was given to the whole of the Secondary PGCE cohort through the Teacher Development Course which all the secondary PGCE students attend. There were: a three hour session on Research and Writing at Masters level and supplementary courses on Teacher as Researcher and Action Research in School. There was also a PowerPoint presentation to support the second assignment which could be used by subject tutors and was available on the VLE alongside other documents on writing assignments and the assessment criteria.

For the Mathematics students a piece of literature which may be academic writing or may come from research was uploaded onto the VLE each week in the autumn term. The students were encouraged to read these and to use them later in a practice assignment. A piece of academic writing which contained different kinds of references: journal writing, a book section and a report which exemplified the Harvard system of referencing was discussed with the students. Exemplar assignments from the previous year were also put onto the VLE.

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The students wrote their first university assignment (2300 words to support a 2700 word portfolio) in the latter part of the autumn term and over the Christmas holidays. These assignments were marked and careful formative feedback was given. Rewrites were allowed for students who did not achieve Masters level the first time. For the second assignment (5000 words) written in the spring term, students across all subjects were expected to produce a synopsis (500 words). This was sent to the tutors for comments before writing their assignment. The students were encouraged to focus on a specific topic and to consider the key questions they would be attempting to answer. For the Mathematics and Science students an extra intervention put in place to address this was the peer assessment of the synopsis for the assignment. The students were asked to email their synopses to their tutor and also to bring copies to a university session in order to take part in the peer assessment exercise. During this session the students assessed each others' synopses using a form with headings given in table 1 and table 2, being asked to make comments and give advice on the focus of the assignment, the questions being addressed and how they would collect data for their assignment. The students also received feedback from the university tutor after the peer assessment exercise was completed.

Table 1 Results of questionnaire on verbal and written feedback on the synopsis by fellow students.

Headings for peer assessment form	Gave me new good ideas	Gave me new ideas and confirmed my own ideas	Only confirmed my own ideas	Gave a mix of helpful and useless ideas	Gave me no help at all
Concentrating on the focus of your assignment	1/33 **3%**	20/33 **61%**	6/33 **18%**	5/33 **15%**	1/33 **3%**
Posing questions that will be addressed in your assignment	5/33 **15%**	18/33 **55%**	7/33 **21%**	3/33 **9%**	0/33 **0%**

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Headings for peer assessment form	Gave me new good ideas	Gave me new ideas and confirmed my own ideas	Only confirmed my own ideas	Gave a mix of helpful and useless ideas	Gave me no help at all
Thinking of teaching and learning strategies to try out	4/33 **12%**	14/33 **42%**	8/33 **24%**	3/33 **9%**	4/33 **12%**
Finding sources of literature	5/33 **15%**	8/33 **24%**	9/33 **27%**	4/33 **12%**	6/33 **18%**
				YES	**NO**
Was this feedback worthwhile in your opinion?				28/33 **85%**	5/33 **15%**

Table 2 Results of questionnaire on verbal and written feedback on the synopsis by tutor.

	Gave me new good ideas	Gave me new ideas and confirmed my own ideas	Only confirmed my own ideas	Gave a mix of helpful and useless ideas	Gave me no help at all
Concentrating on the focus of your assignment	9/33 **27%**	16/33 **49%**	5/33 **15%**	2/33 **6%**	1/33 **3%**
Posing questions that will be addressed in your assignment	10/33 **30%**	16/33 **49%**	5/33 **15%**	1/33 **3%**	1/33 **3%**

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Thinking of teaching and learning strategies to try out	6/33 **18%**	19/33 **58%**	4/33 **12%**	2/33 **6%**	2/33 **6%**
Finding sources of literature	5/33 **15%**	14/33 **42%**	10/33 **30%**	3/33 **12%**	1/33 **3%**
				YES	**NO**
Was this feedback worthwhile in your opinion?				29/33 **88%**	4/33 **12%**

Two weeks after the peer assessment activity a survey was conducted using a questionnaire regarding the peer assessment and the feedback the students received from the tutor. After the assignment was marked and handed back to the students a second questionnaire was conducted and eight students were interviewed. The students were interviewed in pairs[1] using a set of questions addressing their expectations of writing at Masters level at the beginning of the course, their preparation for the first assessment, what they did differently for the second assignment, what they struggled with most, what support was most helpful and why, and what extra support they would have found useful.

The departmental Research Ethics Officer approved the proposed methods of comparison of peer assessed and tutor assessed work, questionnaires and semi-formal interviews. All participating students signed an informed consent form.

Findings

Data from 2007-2008 (see Table 3) shows that of the group of Science students and especially the group of Mathematics students, fewer wrote their assignments at Masters level compared to the Secondary PGCE cohort in general. This information provided the impetus for our study designed to improve performance at Masters level writing for the next cohort.

[1] Transcripts of two interviews can be found in the appendix at the end of this paper.

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Table 3 Analysis of the data from the Mathematics and Science cohorts of 2007-8 and 2008-9

Subject	**No. of students achieving Masters**		**% of students achieving Masters**	
	2007-8	**2008-9**	**2007-8**	**2008-9**
All secondary PGCE subjects	126/152	131/142	83	92
Mathematics	5/11	14/19	45	74
Science	22/38	28/34	59	82

With the 2008-9 cohorts of Mathematics and Science students, a peer assessment exercise was undertaken to provide feedback on a synopsis the students prepared for their second assignment using a form with the headings as in Table 1. As can be seen, 85% of the students thought this feedback to be worthwhile. It gave 64% of students new ideas for the focus on their assignment and 70% of the students got new ideas for posing questions to be addressed in their assignment. On the comments section of the questionnaire some students reported having mixed feelings because they had not fully decided what the topic of their assignment was going to be.

With regard to the verbal and written feedback by their tutor (Table 2) 88% of the students thought this feedback to be worthwhile. It gave 76% of students new ideas for the focus on their assignment and 79% of the students got new ideas for posing questions to be addressed in their assignment. On the comments section of the questionnaire some students wrote that their peers did not have enough experience to give sufficient feedback and that the tutors' comments were more valuable. From the 33 students who handed in the questionnaire 18% ticked the box to indicate that the feedback from their peers and course tutor agreed with each other, while 70% felt they complemented each other. The 12% who were uncertain consisted mainly of students who did not yet know what to write their assignment about.

Some general comments were that the students would like: more tutorial input

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when choosing a topic and title first; to see the marking criteria before writing the synopsis and more information on what exactly needed to be in the synopsis; and to review their own synopsis using the marking grid.

Table 4 shows the results of the questionnaire on the support for the second assignment (UA2) collected after they had received their marked assignment. As is very obvious all students thought the feedback on the first assignment (UA1) was very useful. With regard to feedback on the peer assessment exercise the percentage of students who thought this was useful was now 71% (n=46) as compared to 85% (n=33) in the previous questionnaire (see Table 1) while 80% valued the tutor assessment as compared to 88% (n=46) in the previous questionnaire (n=33; see Table 2).

Table 4 Results of questionnaire on the support for writing the second university assignment (UA2).

Activities	**Extremely helpful**	**Helpful**	**Not helpful**	**Confusing**
Feedback from UA1	16/48 **33%**	32/48 **67%**	0/48 **0%**	0/48 **0%**
PowerPoint to introduce UA2	4/28 **14%**	21/28 **75%**	2/28 **7%**	1/28 **4%**
Science sessions on Nature of Science & Sensitive Issues	8/28 **29%**	14/28 **50%**	5/28 **18%**	1/28 **4%**
Writing the synopsis	7/48 **15%**	30/48 **63%**	10/48 **21%**	1/48 **2%**
Peer marking of synopsis	8/46 **17%**	25/46 **54%**	12/46 **26%**	1/46 **2%**
Tutor assessment of synopsis	12/45 **27%**	24/45 **53%**	9/45 **20%**	0/45 **0%**
Tutorial on structure and assessment of UA2	7/27 **26%**	16/27 **59%**	4/27 **15%**	0/27 **0%**

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Exemplar assignments	19/46 **41%**	15/46 **32%**	12/46 **26%**	0/46 **0%**
Other resources on VLE	5/46 **11%**	25/46 **53%**	15/46 **32%**	1/46 **2%**

Some of the students' comments were:

- Good to receive other ideas
- I didn't complete the synopsis properly
- We were focusing on different things so couldn't particularly guide each other
- Some people's feedback was much more useful than others
- Would have preferred to use criteria to mark own synopsis firsts
- My assignment changed so the synopsis was not relevant

To help the tutors prepare for next year's cohorts the students were asked what kind of extra support they would have liked. From Table 5 it is clear that most students would have liked extra tutorials in small groups, marking exemplar assignments using marking criteria, and receiving a session on the level descriptors of the marking criteria. Based on this feedback the above mentioned strategies will be implemented in the second phase of this study.

Table 5 Results of questionnaire on suggestions for support which would have provided further help.

Activity	**No. of students in favour**
Extra tutorial in small groups	28
Marking exemplar assignment using marking criteria	27
Self-assessment of the assignment	5
A session on the level descriptors of the marking criteria	22
Workshop on professional writing in TDC	8
Opportunity to read the work of your peers	11
A session on how to find the research literature	11

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From the interviews with the eight students the overall response was that they felt it was difficult to write these assignments at Masters level (not being used to this kind of writing during their undergraduate degree). They also said they struggled with finding the relevant literature and structuring the assignments. This was due to the difficulty of balancing the demands of the teaching practice and the requirements of the assignments. They found the feedback of their first assignment and reading the exemplars beneficial but thought it would have been more useful to have had more specific level descriptors to get a better understanding of how the marks were given. Two different responses are given in the transcripts below.

From these interviews it is clear that their inexperience caused anxiety for writing the first assignment, not fully understanding how to link the theory to their practice. They were better prepared for the second assignment for which they spent more time reading. Both students reported that the peer assessment of the synopsis was helpful, mainly because of having a chance to talk about it and generating other ideas. One of them would have liked more support from the tutor. This may be because students often consider that tutors' judgements are more valid and that assessment is the responsibility of the lecturer (Norton, 2009)

Analysis of data 2008-2009 compared to 2007-2008

In the academic year 2008-2009 14/19 (74%) Mathematics students achieved Masters with was an improvement of 29% compared to the year before (see Table 3). Of the Science students 28/34 (82%) achieved Masters which was an improvement of 23% (see Table 3). This suggests that the interventions put in place, including the peer assessment exercise, have had a positive effect.

Table 6 shows that a higher percentage of students with first class or 2.1 undergraduate degree were able to write assignments at Masters level as compared to students with a 2.2 or third degree. Important to note is that the percentage of students with a 2.2 or third degree achieving Masters went up from 35% in 2007-2008 to 67% in 2008-2009. The proportion has almost doubled showing that those students who need the most support in achieving Masters level have responded positively to the interventions.

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Table 6 The link between level of undergraduate degree and achieving Masters in 2007-2008 and 2008-2009.

		Class of undergraduate degree	
Level	**Year**	**1 – 2:1**	**2:2-3**
Masters	2007-2008	17/23 **74%**	9/26 **35%**
	2008-2009	28/32 **88%**	14/21 **67%**
Professional	2007-2008	6/23 **26%**	17/26 **65%**
	2008-2009	4/32 **12%**	7/21 **33%**

Discussion

The results from the questionnaires and interviews indicated that Mathematics and Science PGCE students welcome extra support for writing at Masters level. However, more structured interventions seem to be needed.

Whilst the Mathematics and Science students were involved in the peer assessment exercise many of them seemed to be unclear about how to engage in useful learning conversations. Some were too dependent on the tutor feedback. According to Norton (2009) it is important to relieve anxieties by using the peer assessment formatively and concentrate on the learning opportunities this process affords them. Moderation by tutors could deal with any worries about fairness. It may be that the students need to learn how to participate in meaningful learning conversations. One way to address this is outlined by Minjeong (2009) who found that when assessees are encouraged to give feedback on the feedback they received from their peer assessor this resulted in more active engagement on the meanings of the assessment criteria and their own performance in relation to it. It was also reported that the students who gave feedback to their peer assessor were able to show greater metacognitive awareness in their learning process (Minjeong,

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2009). From the interviews it was clear that these kinds of learning conversations did not often take place and their value was not understood. Training on giving feedback to the assessor should be considered in any future sessions. In combination with clear level descriptors this would enable the students to become more confident in their understanding of the requirements for writing at Masters level.

Conclusion and recommendations

The Mathematics and Science PGCE students need to learn how to structure an assignment in the form of an essay which requires reflection and analysis of their own practice with clear reference to academic and professional literature. This leads to critical evaluation of how the students' teaching affects their pupils' learning. This is very different from the kind of reports they had to write during their undergraduate studies. Educational Studies are part of Social Science which for Mathematics and Science students is a different academic challenge.

From this project it is clear that peer assessment of the synopsis has been a useful exercise for the students. However, the process of peer assessment needed more explanation and moderation by the tutor; this seemed essential. Other forms of support were also considered to be very important, in particular the formative feedback of the first university assignment. It is clear that extra tutorials in small groups and students marking exemplar assignments using marking criteria and level descriptors would benefit the next cohorts of Mathematics and Science students for writing their assignments at Masters level.

The Mathematics students did a practice assignment which helped the tutor to check their use of the correct style of referencing. In hindsight, and for subsequent sessions, the plan is to develop this assignment so that the students are asked to report reflectively on a school visit the cohort undertakes. They go to a local school and team teach small groups of students. It is an experience they all share and so the plan is for them to discuss and then write reflectively about their experience. They will be asked to include the academic articles they have been reading in their writing. Afterwards they will be asked to read and comment on the assignments of their peers. The aim is to encourage reflective thinking and writing and for the

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students to share ideas to support each other in this exercise.

A session on writing level descriptors using exemplar assignments and marking criteria would be another approach to respond to the students' suggestions. With regard to peer assessment a better structure for learning conversations would make the process more effective.

This study is part of an ongoing process to support Mathematics and Science PGCE students to access the Masters level teaching qualification.

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Appendix 1.

Transcripts of two interviews

1. **What did you do to prepare for the first assignment?**

Student 1– UA1? – erm – probably not as much as I should have done - I did do some reading for it, but – erm - but because of the pressures of the first time in teaching I didn't do as much background reading and preparation for it as I should have done – erm – so I did some reading and I – erm - got some resources together to use for the – erm – portfolio – erm – and I came to the – erm – I looked at the primary literature and I tried to look at papers that were related to my topic area. Erm- and …and – yeah – it was an analysis of the literature – erm – In terms of time spent writing UA1 I spent longer but again pressures of dealing with being on teaching practice. So – erm – so I think I did a lot of initial research but in terms of the writing of UA1 more time could have been spent doing that.

Student 2- erm – I thought that at M-level- erm- there would be, there would be more detailed analysis of the – erm- education literature. I didn't appreciate at first that you would the extent to which you would have to relate that back to your own practice- erm

2. **What did you do differently for the second assignment? Why?**

Student 1 I started much earlier doing my initial reading, so by the time it came to Easter when we were supposed to write it up I'd already half written it. So, I started much earlier in preparation, a lot more background reading, I spent a lot more time in the library going through all the journal articles doing cross-referencing and finding new bits of information. So, I felt much more prepared when it came to reading and writing.

Student 2 Similarly I – erm – spent a lot more time – erm – analysing the literature, especially because I was working on the nature of Science and that is something I knew very little about – erm – where again I fell foul of not spending enough time in the actual writing up. So, I wrote up over the second week of Easter and in hindsight I needed longer to do that.

3. **What did you struggle most with?**

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Student 1 Structuring it so it made sense…so it was a flowing kind of document…because a lot of the things I was looking at were separate from other parts of it and very interesting. But put them all together in a final assignment really knowing what you were looking for, I found that quite difficult.

Student 2 I found it – erm – it found it easy to discuss the literature but I found it hard to make a more critical analysis of my own practice…relating the literature to my own area of practice. I think making that connection is where I was weakest.

4. **What support was most helpful to you? Why?**

Student 1 – erm – In the sessions it was really helpful having examples of other peoples' work so that you can see…well, it just means you can see how it was marked. It shows the amount of information and depth of the reading you're required to do to be able to attempt the M level assignment...so that was quite helpful – erm – Having someone else look through the synopsis when we first starting out doing it was helpful because it gave you some ideas, maybe ways you can explore in more detail, different to someone else's' perspective on your writing and where else you can go to it. It helped with focus.

Student 2 Yeah – I think looking at exemplars of – erm – of past students' work was most helpful. What was difficult for – eh- the how Science works or the nature of Science essays that there were no… no exemplars were provided for that particular topic and so that made it quite difficult – erm – so that looking at past papers and past examples is very helpful. Looking at students' – erm – and having people looking at your synopsis is very helpful, although I did feel that that kind of peer analysis of each other's work is less helpful. What would have been more helpful was – erm – a more detailed analysis from the tutor – erm – of the synopsis. That would have been more helpful.

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