Ondata Research

Physics Mentoring Project Interim Report

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Contents

1. Executive Summary

The Physics Mentoring Project has now moved into its second year and this interim evaluation report covers cycle 2 of mentoring. The report considers the impact of the project in relation to the following evaluation aims:

- Aim 1: To explore the impact of the programme on the uptake of Physics.
- Aim 2: To explore the impact of the programme on the uptake of women in STEM subjects.

1.1 Project summary

Fourteen schools were recruited to participate in cycle 2 of mentoring. These came from across Wales and diverse socio-economic circumstances. The free school meals average for the participating schools was 21%, which is 5% above the national average (National Stats Wales, 2018).

Five universities supported the scheme with 40 mentors participating across the year and in cycle 2 this was made up of 25 mentors recruited from across these universities to support the programme. These were a mixture of undergraduate and postgraduate students with a gender split of 56% male and 44% female.

Following the successful cycle 1 (as outlined in the first interim evaluation report – Rushton and Thomas, 2019) the project team have reviewed the theoretical framework for mentoring and updated the training and support materials for mentors. The project has also increased the number of schools it works with from 9 to 14.

1.2 Project impact

On completion of the mentoring programme, mentees were asked to report their intentions in relation to taking a Physics A-level and going into a STEM career, directly addressing aims 1 and 2 above (this information is also collected pre-participation, allowing any change as a result of the mentoring programme to be monitored). As can be seen below in tables 1 and 2, the results suggest a positive impact in terms of participation in Physics and STEM careers.

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	7.32%	68.29%	24.39%	100%
Pre-participation (n)	3	28	10	41
Post-participation (%)	48.78%	31.71%	19.51%	100%
Post-participation (n)	20	13	8	41

Table 1. Pre- and post-participation intentions of taking a Physics A-level.

The numbers who reported as being "unsure" of whether to take physics A-level have dropped by more than half with the shift clearly moving from the "probably/definitely won't" end to "I will/probably will".

A similar trend is observed when considering the intentions around STEM careers:

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	46.35%	34.15%	19.5%	100%
Pre-participation (n)	19	14	8	41
Post-participation (%)	58.53%	26.83%	14.64%	100%
Post-participation (n)	24	11	6	41

Table 2. Pre- and post-participation responses indicating whether or not they are considering a STEM career.

Again, there is a decrease in "unsure/probably/definitely won't" and a movement towards "I will/probably will".

This increase in positive attitudes towards Physics A-level and STEM careers builds on cycle 1 results and larger gains are observed in cycle 2.

1.3 The impact of being a mentor

In addition to the benefits of participation in the project experienced in schools, there is a strong body of evidence showing the positive impact participating as a mentor has. This includes the development of skills and enhanced employability. This is more fully discussed in section 5.

1.4 Conclusion

There are some areas recommended for review in relation to working in different school contexts, the form and content of mentoring sessions and relationship management along with more strategic considerations relating to the year groups targeted and the potential for scaling the project up. These are all highlighted to further enhance what is already a very effective and highly regarded project.

The project team in particular are thought of very highly by the schools and mentors they support. It is through their attention to detail, high level organisation skills and investment in relationship management that has brought about the positive results seen in this report.

2. Methodology

The sources used for this report are outlined in detail below. Further contextual information and documentation was provided by the project team.

Census survey:

- The same survey that was developed for cycle 1 was deployed pre- and post-participation in cycle 2. They were given to the whole year group (Y10 or Y11 or both year groups, depending on the school).
- Survey 1 was used to identify potential participants for the physics mentoring project and those who had selected “I am unsure” in response to whether they were considering taking A-level Physics were highlight to the school’s teacher. The teacher made the final decision on participation.
- Survey 2 enables monitoring of changed intentions. This is given to both mentees and the other members of the school cohort. This is important as it offers the opportunity to have a natural control group to show that any differences in intentions between those taking part in the Physics Mentoring Project and those who did not can be attributed to participation in the project. As there is a third cycle of mentoring taking place in 2020, the comparison to the natural control group will be included in the final evaluation report to be published in June 2020.
- Once again there is a large baseline dataset (over 1500 responses) this will be incorporated into the final evaluation report and responses from mentees are the ones considered in this report. Responses were collected online and in paper format.

Mentor and mentee reflections:

- At the end of each week mentors and mentees completed a structured worksheet to help guide reflection.
- These include information about the mentees’ level of enjoyment and understanding of what was covered in the session, whilst mentors were able to reflect on the strengths and weaknesses of the session before considering how this might inform the following session.

Teacher interviews:

- Two teachers were interviewed, one from a rural school and the second from an urban school.
- The interview was semi-structured, and the questions focussed on their school’s experience of participating in the Physics Mentoring Project.

Due to the addition of a third cycle of mentoring, the evaluation programme has been updated:

September 2019	• Reflection sheets reviewed prior to cycle 2 starting. • Survey 1 to pupils.
October 2019	• Evaluators to attend and observe mentor training.
December 2019	• Mentor feedback session at awards and recognition ceremony.
January 2020	• Survey 2 to mentees participating in cycle 2. • Post-intervention interviews with teachers. • Interim report including initial results from cycle 2.
April 2020	• Survey 2 to mentees participating in cycle 3 and rest of school cohorts. • Teacher survey. • Data collection completion.
June 2020	• Data compilation and clean up, analysis and final report writing.

Table 3. 2019-2020 Evaluation timeline.

3. Project summary – cycle 2

3.1 Overview

In cycle 2 there were 14 schools participating in the mentoring programme (this is an increase from 9 in cycle 1). Schools come from across Wales with a broad range of socio-economic circumstances. For example, the range of pupils qualifying for free school meals (FSM) was 9.4 – 42% and the average for participating schools was 21% (well above the national average of 16% - National Stats Wales, 2018). Therefore, the project team are working with a wide range of schools and showing success in a variety of circumstances.

In cycle two the following mentors were recruited and trained:

University	
Aberystwyth	4
Bangor	3
Cardiff	11
Swansea	7
USW	0
Total	25

Table 4. Summary of mentors by university.

The gender split was 56% male and 44% female, with two Welsh speakers amongst the group and seven returning mentors from cycle 1 in 2018-19.

3.2 Changes to the Physics Mentoring Project for cycle 2

- Increased number of schools: from 9 in 2018-19 to 14 in 2019-2020.
- Project team formalised the theoretical framework around the mentoring (using the Science Capital Teaching Approach).
- Mentor training and handbook was reviewed and updated.
- Session content was reviewed in the context of the training and handbook updates.

3.3 Mentoring sessions in schools

Mentors spent five or six weeks in a school with the length of sessions ranging from 30 minutes to 1 hour depending on the circumstances within the school. The topics covered across the sessions were broad, examples include: electromagnetic spectrum, energy transfer, motors, music, radioactivity, sound.

> *"I've learned that I should trust myself a little bit more planning my own sessions. In the previous sessions I felt I may have relied a little too much on the other activities we've been given, whereas one that I have come up with myself actually went down really well,*

as it was something I had tailored to my sessions specifically, rather than building a session around it."
Mentor

In general, the mentors used the reflection sheets to good effect, carefully considering how they could improve the session for the following week. This included either changes to the activity content or how to better involve all mentees.

Teachers have provided positive feedback regarding the mentors, describing them as "enthusiastic and encouraging".

3.4 Incorporating the Science Capital Teaching Approach

The notion of science capital, developed, refined and validated by Archer and colleagues (Archer et al., 2015; DeWitt & Archer, 2017) refers to one's science related resources and dispositions, and how these are valued in the field of science. The concept draws attention to the variation in resources, attitudes, social contacts and relationships possessed by a learner that in turn helps them to 'get on' in science, or not. Some students, for example, are able to utilise or exchange their science-related resources and dispositions in learning situations. Others do not have the particular knowledge, contacts or dispositions that are expected and valued in science settings: their resources do not fit. The concept of science capital thus helps to explain why some students feel comfortable in science learning settings and see themselves able to participate in science-related study or careers in the future, whilst others do not feel comfortable: they do not see science as something for them.

In addition to explaining varied participation, a science capital perspective can help to broaden our understanding of how learning and engagement may best be supported. It directs attention to the ways in which particular resources are valued over others. It highlights the role played by the wider field in determining what counts, or not, as scientific behaviours. It challenges educators to consider the ways in which learning settings are structured and the extent to which they favour learners from dominant social backgrounds (Archer, DeWitt & Osbourne, 2015). It encourages educators to reflect on the norms and expectations of what constitutes engagement (Godec, King, Archer, Dawson & Seakins, 2018). The science capital teaching approach is a framework developed in partnership with teachers (Godec, King & Archer, 2017) – built on the principles of a science capital.

The science capital teaching approach was introduced as a theoretical framework and the mentor training and handbook were strongly linked to this. Based on mentor reflections, it is clear that this has been a success in contributing to building a rapport between the mentor and mentees and providing interest and context to the physics concepts being discussed.

"The mentees interact best with examples/things they are used to seeing every day."
Mentor

Mentors took full advantage of the information gathered in session one in order to tailor the content of the sessions around the interests of the mentees and discuss how physics plays a role in the areas raised, e.g. cycling and music.

3.5 Impact of participation on mentees

The pre- and post-participation surveys for mentees monitor changes in intention to take Physics at A-level and plans for a career in STEM.

The data included in the tables below comes from mentees who completed both surveys and where the surveys were matched to each other. As of time of writing, mentees from 8 schools had responded and had their surveys matched.

The same positive trends are observed in the second cycle of Physics mentoring as in cycle one:

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	7.32%	68.29%	24.39%	100%
Pre-participation (n)	3	28	10	41
Post-participation (%)	48.78%	31.71%	19.51%	100%
Post-participation (n)	20	13	8	41

Table 5. Pre- and post-participation intentions of taking a Physics A-level.

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	1	14	6	21
Pre-participation (n)	4.76%	66.67%	28.57%	
Post-participation (%)	6	9	6	21
Post-participation (n)	28.57%	42.86%	28.57%	

Table 6. Pre- and post-participation intentions of taking a Physics A-level – female mentees only

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	2	14	11	16
Pre-participation (n)	12.5%	68.75%	18.75%	100%
Post-participation (%)	13	9	3	18
Post-participation (n)	72.22%	16.67%	11.11%	100%

Table 7. Pre- and post-participation intentions of taking a Physics A-level – male mentees only

There is a strong shift away from those who are unsure/probably/definitely won't take Physics A-level to the will/probably will. There are of course many factors that play a part in pupils' decision-making but these results show a particularly large shift towards more positive intentions and coupled with the feedback from teachers, mentors and mentees through reflection we can say that participation in the Physics Mentoring Project played a key role in the decision-making process.

The second aspect to examine is whether or not mentees are considering a STEM career (the tables include information broken down by gender, however this will be discussed further in the final evaluation report):

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	46.35%	34.15%	19.5%	100%
Pre-participation (n)	19	14	8	41
Post-participation (%)	58.53%	26.83%	14.64%	100%
Post-participation (n)	24	11	6	41

Table 8. Pre- and post-participation responses indicating whether or not they are considering a STEM career.

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	42.86%	42.86%	14.29%	100%
Pre-participation (n)	9	9	3	21
Post-participation (%)	57.14%	23.81%	19.05%	100%
Post-participation (n)	12	5	4	21

Table 9. Pre- and post-participation responses indicating whether or not they are considering a STEM career – female only.

	I will/I probably will	I am unsure	I probably won't/definitely won't	Total
Pre-participation (%)	56.25%	31.25%	12.5%	100%
Pre-participation (n)	9	5	2	16
Post-participation (%)	66.66%	22.22%	11.12%	100%
Post-participation (n)	12	4	2	18

Table 10. Pre- and post-participation responses indicating whether or not they are considering a STEM career – male only.

Statistical tests will be carried out on the survey data when the full set is examined for the final evaluation report.

Again, there is a strong shift from those who are unsure and probably/definitely won't. As well as contributing to the personal and education growth of young people, mentoring can increase interest and engagement in STEM subjects and careers (Jett, Anderson & Yourick, 2005; Tenenbaum, Anderson, Jett & Yourick, 2014), and this is being borne out through the Physics Mentoring Project.

In terms of the impressions of teachers of the impact on pupils, one makes an important point that the mentees only get out of this experience what they are willing to put in. Neither the mentors nor teachers can require mentees to take part, therefore student selection is particularly important. However, teachers are keen to stress that this experience is not just for students in the top-set and C/D grade boundary students can find that their attainment is very positively impacted through the improved confidence they have following participation in the Physics Mentoring Project.

It is important to see the Physics Mentoring Project not just as an intervention that works with small numbers of pupils in participating schools, rather it is an opportunity to influence the interests and positively impact on the general feeling towards STEM subjects and careers within a school. This isn't something that will occur after participating in one cycle but, will be something that can be sustainably built over time. In some schools, success is being measured on whether interest in STEM is increased rather than just on whether they have more pupils going on to A-level Physics. Another school uses the Physics Mentoring Project as an opportunity to encourage pupils to consider options for their future. Word is spreading from the mentees to others in their cohort about the positive experience they have had, prompting more pupils to want to get involved.

The theoretical framework of the Science Capital Teaching Approach provides the context for the Physics Mentoring Project to meet its primary aim of increasing participation in post-16 Physics. However, it also supports a broader ideal of encouraging a greater diversity of young people to access STEM careers, and this is reflected in the success measures that some schools ascribe.

3.6 The role of the project team

The project team are experienced in working across different school environments and work hard to support teachers and their local circumstances. Not only do schools have different socio-economic circumstances, they also have their own histories of take-up at Physics GCSE influenced by many different factors. This can include the lack of a specialist physics teacher, a general lack of awareness of the benefits of STEM qualifications and a lack of interest in STEM as they don't see the relevance to their lives.

All of these aspects, and others, combine to make running the Physics Mentoring Project within a school a challenge. Teachers comment on how "easy" the project team make the whole experience and that they are very "accommodating" and don't hesitate to make changes or concessions depending on the school's local circumstances.

A strong measure of success of how well the project team manage the mentoring project is that teachers describe their involvement and time commitment as "minimal". This is important at a time when teachers are under increasing time and resource pressures and this makes it more likely that the school will continue to participate in the project in an ongoing basis.

4. Areas for further consideration

This section outlines some aspects which arose through mentor, teacher and project team feedback. These areas link to the school context in which the project is working, the operation of the mentoring sessions and the flow of information in and out of schools.

The areas highlighted are there either to provide further context to support the project team in their decision making or provide options for action to be taken.

School context:

- Pupils being chosen who have no intention of choosing physics.
  In some instances, mentors have reported that there were some in their mentee groups who were not interested in taking physics. In one example, the teacher had chosen the pupils to participate because they were top-set double science and it was felt they would benefit from having additional time studying physics. Unfortunately, despite communicating with schools the aim of the project the project team do not have a final say over who participates. However, perhaps if the mentors identify these situations early on in the programme, the project team can discuss this further with the school.
- Lack of availability of Physics A-level.
  Whilst some mentees were expressing an increased interest in Physics A-level at the end of the mentoring programme, they expressed concerns about whether in reality they would be able to access the qualification. Some reported that they would need to travel to another school, and this was clearly a factor in their decision-making.

Mentoring sessions:

- Connecting content between mentoring sessions
  In some schools the mentoring sessions have to take place during lunch hour. This can be due to various reasons, including availability of the supervising teacher and the need for pupils to be on school transport at the end of the school day. This can mean that not enough of the session content can be covered in one week. Mentors should be encouraged to spread the activity over two weeks if they feel that it would be beneficial to the mentees. There were one or two instances of this but in general, mentors brought up a new topic each week.
- Reflection process with mentees not always fully engaged with or documented.
  The responses provided by mentees were mostly single words or sentences. Some mentors report that the mentees *“don’t like engaging with them”*. However, when faced with this issue, most mentors emphasised the importance of reflection and one mentor

in particular was keen to emphasise *“how useful it [reflection] can be to guide their sessions.”* Perhaps after receiving the first week’s set of reflections, the project team could provide some feedback on the length and content of the reflection sheets. This is an area where mentors could use a small amount of additional support or prompting. A fuller review of the mentee reflections will be considered in the final evaluation report.

- Aim to increase the number of Welsh speaking mentors.
  Where possible the project team tried to pair Welsh-speaking mentors with Welsh medium and bi-lingual schools, however due to timetabling constraints in the school and mentor availability this wasn’t possible. However, the project team should consider how to recruit more Welsh-speaking mentors as there were instances where English-speaking mentors and Welsh-speaking mentees had issues identifying the correct vocabulary when translating the physics concepts between Welsh and English.

Relationship management:

- Information to be requested from schools.
  Some, but not all, mentors received an outline of the GCSE topics that had been covered by the mentees in their group. Teachers should be strongly encouraged to provide this to all mentors as it very much helps inform mentors when they are choosing suitable topics for the mentoring sessions. If this information is not received, mentors should be encouraged to find out what topics the mentees have recently studied as part of session 1.
  In many cases, the teacher sits in on the mentoring sessions. This could be used as an opportunity to gain some constructive feedback for the mentors, particularly in the first two weeks. This could take the form of a short set of questions being sent to the teacher to gather their impressions. The aim would be for the information provided to be aimed at further improving the sessions.
- Information provided to schools.
  Teachers would find it helpful to have more information about the types of topics covered within the sessions to share when promoting the project to pupils. There are also instances where the teachers could use some information tailored to senior leadership teams, in particular how the Physics Mentoring Project supports the curriculum and what the benefits of participating are to the school. This would help when teachers are negotiating for a suitable time slot in which to run the project. For example, one school had set up a pre-school session and this affected who could participate as the teacher was looking for volunteers to come in early and even those who did volunteer did not necessarily attend regularly. One way to manage this would

be for the project team to share a summary of the evaluation report indicating the results from the most recent cycle and describing the key benefits to the school.

Project-level areas for consideration

The following suggestions are recommended for consideration however, it is not being advocated that all of these changes are taken forward. For example, changes to the cohort being worked with should be trialled before scaling the project up.

- Consider switching to younger age groups due to timetabling and availability issues.
    - Timetabling issues: Some schools had mock exams running during the period of mentoring. This meant that sessions were either cut short, cancelled or had low attendance. Cycle 3 is about to launch in schools but the time pressure I the term leading up to exams means that seven schools are not continuing from cycle 2 to cycle 3.
    - Varied attendance between sessions: Early morning sessions not everyone turned up. Some saw participation as a punishment.
- As schools are participating in this project to grow interest generally in STEM and to offer pupils opportunities to consider their future options, it would be beneficial for the project to have a longer-term commitment so that schools knew they could build on participation and progress made year on year.
- There is the potential to scale-up the project to target a higher proportion of Welsh secondary schools. For example, the MFL Student Mentoring Project has grown over the course of five years to work with more than half of the secondary schools in Wales. There have been consistent results from the first two cycles of the Physics Mentoring Project and this would suggest that the model is suitable for scaling.
- Geography and the availability and suitability of public transport can be a limiting factor when it comes to participation. It may be desirable to consider a blended learning approach where both face to face and online sessions form part of the programme. Again, this is an approach which has been successfully adopted by the MFL Student Mentoring project through their “Digi-Languages” scheme.

5. The impact of being a mentor

5.1 Motivation for becoming a mentor

The project team have been successful in recruiting mentors to the project whose motivation parallels the main aims of the Physics mentoring project. For example, mentors have described their motivations as follows:

"The prospect of inspiring young students to pursue STEM, especially physics, to promote the subject and to ensure that it is possible to study physics regardless of your gender, background, etc."

Mentor (2019-2020)

"I believe very strongly in STEM Outreach and giving young people the tools to make informed decisions about their future."

Mentor (2019-2020)

"The idea of encouraging STEM uptake, especially in girls, when role models can be lacking."

Mentor (2019-2020)

When asked how participating as a mentor would positively impact on them (as part of a pre-training survey), responses were focussed around skills development (e.g. communication skills), increased employability and improved confidence.

"I think this experience could help me in my future to improve my CV and find a job."

Mentor (2019-2020)

Several referenced the opportunity to experience teaching, including:

"I am unsure what I am going to do after university, but teaching is definitely a potential career I am considering. I hope the mentoring scheme will help me to decide."

Mentor (2019-2020)

Following the completion of cycle 3 information will be gathered from mentors about their intentions of going into a teaching career and how participation in the Physics Mentoring Project has influenced this decision. This will be included within the final evaluation report.

5.2 Mentoring training

There is some suggested reading for mentors before they attend the training session and this has been very useful in clarifying what mentoring is. There were some mentors who were the project to be more about teaching subject content and through the suggested reading their expectations were managed and the scene set for what was to come in the training weekend.

The post-training survey responses from mentors were all very positive. The organisation from the project team and the quality of the trainers were frequently mentioned.

"Phenomenal training, very in-depth and a great experience."

Mentor (2019-2020)

Mentors particularly appreciated the experience of being able to observe a mentor deliver a session.

"I think the observation was a fantastic opportunity and the weekend felt structured and informative."

Mentor (2019-2020)

As a result, many commented on how well prepared they felt at the prospect of going into schools and that *"The training really boosted my confidence!"*

An important aspect of the training has been bringing together mentors from across the different universities. This allowed people to make new friends and this was a highly reported benefit by mentors and this environment was particularly beneficial as it encouraged peer learning:

[The best thing about the training weekend was] "Being able to talk to people about any questions I have and learn from their experiences"

Mentor (2019-2020)

Some mentors felt that the Saturday was a long day and that there was a high density of information being delivered. However, they recognised the importance of the information included in the course and struggled to identify areas which may not be necessary. One aspect the project team may consider is thinking about whether some of the activities or reading could be done beforehand, reducing the time spent going through some of the content. Mentors were also keen to have more frequent breaks in the programme, if even for a short time.

5.3 Employability and skills development

Ondata Research worked with a group of around 15 mentors at the Award and Recognition ceremony held in December 2019 at the Centre for Alternative Technology. This session was focussed on their experiences of mentoring and how participating will benefit them in their future careers.

The mentors highlighted the following as the key skills developed as part of the Physics Mentoring Project: organisational skills, time management and communication skills. Another key aspect, something that was raised as part of their expectations in the pre-training survey, was confidence-building.

Graduate attributes are a framework of skills, attitudes, values and knowledge which a university community agrees that its graduates should develop by the end of their degree programmes, through participation in both curricular and extra-curricular activities (Hill & Walkington, 2016; Hill, Walkington & France, 2016).

In the wider literature, graduate attributes have been defined by Bowden, Hart, King, Trigwell, and Watts (2000, p. 3) as:

the qualities, skills and understandings [that] include but go beyond the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future.

In his model of graduate attributes (Figure 1) Barrie (2004) outlines three overarching enabling graduate attributes of (1) Scholarship, (2) Lifelong learning and, (3) Global Citizenship, with the five translation graduate attributes forming the pieces of the jigsaw puzzle.

Figure 1. The graduate attribute model of Barrie (2004).

The Physics Mentoring Programme offers university students the opportunity to develop both the graduate attributes of Lifelong learning and Global Citizenship. This model could provide a coherent framework against which students can identify opportunities they have encountered during the Physics Mentoring Project and self-assess their personal development.

A common area of apprehension amongst the mentors was that the mentees would like them or respond to them, as a result behaving badly. Overall, mentors reported that they were pleased to find that the relationships with students actually came quite quickly. This was due to preparation and effort on behalf of the mentor, for example taking care to learn everyone’s names in week 1 and take time to have one-to-one conversations with each mentee.

With regards to future benefits, these were identified by the mentors as:

a. Good project to have listed on your CV.

b. Example experience to use in interviews.

c. Helps provide you with experience if you want to teach.

d. Helps you get into other opportunities, e.g. Scouts or other volunteer work.

Whilst the aims of the project are linked to the outcomes within schools, the benefits to the undergraduate and postgraduate students should not be overlooked, especially at a time when there is a need for additional teacher numbers in Physics across the UK (House of Commons Library 2018). Offering the opportunity to develop skills and improve employability are attractive to prospective university students, therefore having the option to participate in this project adds greatly to the university experience.

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