Is the cost of home experiments a potential barrier to learning? Experiences from two stage one science modules

eSTEeM Final Report

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Executive Summary

Practical work in the form of home experiments has always formed an integral part of the science curriculum for teaching and assessment. The move, however, from printed materials to online delivery has been accompanied by a change in the way science students are expected to engage with home experiments. Up until 2015, students would receive a kit box in the post that contained the necessary materials and equipment required to perform any home experiments within their modules. As students are no longer receiving a practical kit in the post, they are now required to source all materials and facilities needed, themselves.

The current stage one curriculum (S111 and S112), compulsory in many science qualifications, has the expectation that students will be able to purchase and have ready access to equipment needed to perform all experiments at home, with some contributing to core module content and assessment. Some of this equipment is costly, and some items are not easily accessible to some students. Furthermore, there is an expectation that students will have ready access to certain items of household equipment such as fridges and freezers.

This eSTEeM funded project had four overarching research questions:

- Are financially impoverished students being disadvantaged by the expectation to purchase additional equipment needed for home experiments in core level one science modules?

- Are financially impoverished students being disadvantaged by the expectation to use facilities assumed to be in the home (e.g., fridges and freezers)?
- Is the expectation to use facilities assumed to be in the home (e.g., fridges and freezers) and the requirement to purchase equipment for home experiments a barrier to achieving the learning outcomes associated with practical work?
- Is cost the only barrier to achieving learning outcomes associated with home experiment practical work?

The project report summarises findings from an online survey and subsequent semi-structured interviews which showed that students are experiencing issues including but also in addition to cost, associated with the requirement to perform home experiments. Other factors such as availability of consumables and environmental impact are also impacting on students being able, or willing, to conduct home experiments as part of core module content. The importance of producing alternative resources as a viable alternative to home experiments is a key recommendation for modules in both presentation and production.

Currently, the only alternative resource for any student unable to carry out the home experiments is to provide them with a table of data from which to conduct analysis. However, this does not support development of students' investigative skills, namely observational skills, or context of why and how the experiment is being conducted. This project piloted a different mechanism for students unable to undertake home experiments for any reason, which is to have the experiment conducted on a video which all students have access to. Students watch the video of the experiment being performed and take their own

observations. This allows such students to still achieve the same practical based learning outcomes as other students who can set up home experiments themselves, thereby improving parity of student experience.

Other key recommendations from the project emphasise the need to re-evaluate the use of home experiments at module design, removing the assumption of module teams that all students have ready access to equipment and consumables. Further, it is recommended that module teams take a collaborative approach to constructing equipment lists so there are no duplications, and an agreed description of the items needed. This comes from the finding that there were items on the equipment list identifying the same item in different ways, for example, a calculator was described first as a "calculator", but a second entry on the list required a "pocket calculator". The unnecessary repetition may result in students buying an item more than once as the instructions are not clear. Such opacity may also disadvantage certain students with neurodiversity who require clear instruction.

A wider recommendation focuses on the need to provide home experiment kits either at a small additional fixed cost or means tested for students on low income.

Aims and scope of the project

Project Background

Practical work has always been an important part of the science curriculum, in particular at stage one, and has traditionally been conducted via home experiment. In previous stage one science modules (such as S104), students were sent practical kits, containing all the equipment needed to perform the home experiments within the module (Figure 1) however, aligned with a wider OU move from printed materials to fully online delivery, there has been a change to the way students are asked to engage with these home experiments.

Figure 1 Examples of practical kits previously set to students to support home experiments in stage 1 science.

The current interdisciplinary stage one science curriculum (S111 and S112), compulsory in several qualifications, now has the expectation that students will

source all consumables, equipment and facilities needed - including for experiments that contribute to core module content and that are formally assessed. Some of this equipment is costly nor may it be easily accessible to some students depending on their geographical location, or work environment. Neither S111 nor S112 currently provides a home experiment kit and although S111 has previously sold equipment kits through the Open University Students Association (OUSA), this is no longer an option.

Concerningly, it is important to highlight that students may not be aware that core module content, and formal assessment of the module, in the form of home experiments has additional associated costs. Costs are not specified nor broken down in detail pre-registration, which means students only become aware of the need to make their own arrangements, at their own expense once they have already enrolled and started studying.

S111 has 18 home experiments, 8 of which (44%) are assessed in continuous assessment. S112 has 9 home experiments, 5 of which (55%) are assessed within the continuous assessment strategy for the module. Collectively, for students doing both S111 and S112, 13 out of 27 (48%) home experiments that they are expected to conduct at their own expense, form part of their formal continuous assessment.

Currently the only alternative for the home experiments is for students to be given a set of data to analyse, which is not an equitable learning experience with regards to the development of practical skills relating to setting up and experiment and/or subsequent data collection via observation. Furthermore, in both S111 and S112, students are required to ask their tutor for access to these

alternative resources and seek permission to use them in assessment. Comments provided by students in this project highlighted how the requirement to ask can also be problematic. This, and similar comments, are included throughout the 'Findings' section of this report.

Outputs disseminated by a previous eSTEeM project exploring the awarding gap for Black students vs White students on one of the modules of interest, S112 (MacBrayne and Bellamy, 2023), discussed the views of Black students collected during an online focus group. An unexpected theme from this focus group centered around additional costs associated with home experiments and module team expectations that students can readily access certain items of household equipment:

> *The experiment it assumed that you had certain things in your house, it assumed that you had a freezer and a fridge, it assumed that, you know, you had everything in your house and they don't support you.*
>
> **Anonymous Student**

This gave further justification for this project to explore how the issue of additional costs might be influencing student experience on modules which require students to undertake home experiments and provide the resources for these themselves.

Literature Review

It is not unusual for higher education institutions (HEIs) to have additional costs associated with their courses, and a government study showed that at least 1 in 5 HEIs charge students for such things as materials to overseas study costs (KMPG LLP, 2019). However, this project aims to explore the impact of such costs applied at The Open University, particularly considering the recent and highly significant cost of living increases. A study by the Office for Students has shown that the increase in the cost of living has had an impact on HE students with as many as 1 in 4 having considered dropping out of their course as a direct result (OfS Insight, 2023). Studies by Universities UK, Student Minds and The Sutton Trust amongst a plethora of others all reflect the scale of the impact that the cost-of-living increase is having on HE students. The Sutton Trust reported how almost half of all undergraduate students were having to prioritise paid work over attending lectures (The Sutton Trust, 2023); a Student Minds survey reported that 72% of students felt that the cost-of-living increase was impacting their mental health (Student Minds, 2023); and Universities UK reports that over 75% of students highlighted that their studies might be impacted as a direct result of the cost of living increases (Universities UK, 2023).

Unsurprisingly, studies also show that students from income deprived backgrounds are experiencing the impact of the cost-of-living increase disproportionately (The Access Project, 2024). Widening participation literature (Jury et al., 2015; Burke, 2012; Gorard and Smith, 2006) has previously identified

three specific challenges faced by students from income deprived backgrounds at the beginning of their engagement with Higher Education:

Situational: adults from the poorest backgrounds are time-poor and debt-averse (with very limited availability/potential for flexible deployment of 'spare' financial resources) – in this setting, activities such as home experiments may not always be accessible, given the additional costs incurred.

Institutional: universities adhere to inflexible systems which are obstacles to the participation of the poorest adult learners - in this setting, given the contribution of home experiments towards core assessment, and the lack of widely available alternative resources, students may assign barriers to learning outcomes associated with practical work at the beginning of their engagement with Higher Education.

Dispositional: both situational and institutional barriers can exacerbate the poorest students' low confidence in relation to overcoming educational barriers – in this setting, this may also exacerbate the stigma and embarrassment associated with students having to admit to their module tutor that they are unable to set up home experiments due to not having the financial means to purchase the consumables required.

At present there are limited OU research and scholarship projects that focus specifically on the attainment of learning outcomes for students on a low income (regardless of IMD postcode of residence), particularly when considering cost-of-living increases. Previous scholarship projects relevant to this proposed project have been focused outside of the STEM faculty. For

example, Butcher and Curry (2022) investigated digital barriers facing adult students returning to education and revealed that challenges in relation to disposable income often compounded challenges intersecting with other aspects of disadvantage such as having a declared disability (including mental health conditions). This project sets out to explore whether the costs associated with home experiments in S112 were a barrier to achieving learning outcomes.

Index of Multiple Deprivation and Socioeconomic Status – a possible link?

There is a dearth of research investigating awarding gaps for Higher Education students by Index of Multiple Deprivation (IMD) status and socioeconomic status, both of which could be relevant to this project, which focuses on additional costs associated with core module activities. Both measures are widely used in the health sciences to identify differences in UK outcomes (e.g., Evans et al., 2016, Bush et al., 2022) and to a more limited extent in research relating to compulsory education (e.g., Nieuwenhuis and Chiang, 2021). Other studies focus on a particular area e.g., digital poverty (Helsper, 2021) or use proxies for deprivation e.g., free school meals. A search of the literature has found nothing on IMD awarding gaps at HE level in the UK, although there is some similar work from other parts of the world (e.g., Sealey, 2011).

Indeed, the Open University has identified an awarding gap between its student's residing in IMDQ1 (most deprived 20%) and IMDQ5 (least deprived 20%) but a search of the scholarship exchange and scholarship centre websites

finds IMD status only as a subsidiary characteristic, e.g., its intersection with ethnicity in a previous eSTEeM project (MacBrayne and Bellamy, 2023).

The Access, Participation and Success (APS) Strategy (OU, 2020) details the University's strategic approach to supporting students from underrepresented and disadvantaged backgrounds to access HE and achieve equitable outcomes – this project was proposed to feed into this strategy by investigating the factors which could be influencing the current student success awarding gap for students for whom additional costs associated with module home experiments could be unattainable. It is possible that such students may be more like to reside in IMD1 postcodes vs students residing in IMD5 postcodes. Although this project is not focusing on awarding gaps specifically for IMD1 vs IMD5 postcodes, it remains a relevant consideration as any outputs and recommendations resulting from this project could directly influence such awarding gaps.

Project Aims and Objectives

The project aimed to explore the experiences of students who have studied S111 and/or S112 with regards to home experiments. The initial data collection phase focused on student surveys and follow up interviews exploring student experience and outcomes of home experiments, and whether the requirement to engage with home experiments at their own expense hindered students' engagement, experience, or achievement. The later phases of the project explored the implementation of adjustments, including the development of a video resource (equivalent to an early, costly home experiment within S112) which provided students the opportunity to collect their data themselves by a means other than a home experiment. Students were therefore able to achieve the same learning outcomes, but without the potential stigma associated with having to admit to not having the financial means to purchase equipment to their tutor. Furthermore, students unable to carry out home experiments due to a disability would also benefit from the option of performing an online equivalent, giving a more authentic alternative to learning than simply providing a set of data in alternative resources.

At the onset of the project, it was envisaged that key outputs would include information on issues faced by financially impoverished students on low incomes studying S111 and/or S112, noting that this may not necessarily be limited to students residing in IMD Q1 postcodes. Students studying S111 and S112 concurrently could potentially be impacted the most significantly (192 students in 21J).

It was anticipated than longer-term outcomes from dissemination of these outputs would inform approaches for incorporating fully accessible and inclusive practical work within new module design. It was also hoped that the longer-term outcomes will include developed understanding of the needs of students on lower incomes amongst tutors and others who support students, and more inclusive tuition practice. This should help develop tutors' confidence and ability in supporting this student group which should have a positive impact on students' experiences and performance.

Research Questions

The project had three main aims:

- To develop understanding of issues faced by students on low income when studying modules which require the purchase of equipment to perform home experiments that form part of core module content and assessment.
- To raise awareness of these issues amongst STEM staff including tutors, tutor and student support staff, and module teams.
- To consider how production and presentation module teams could adapt their practice to respond to the needs of low-income students throughout the module presentation.

To address these aims, two overarching research questions were posed:

- Are financially impoverished students being disadvantaged by the requirement to purchase additional equipment needed for home experiments in core level one science modules?
- Is the requirement to purchase equipment for home experiments a barrier to achieving the learning outcomes associated with practical work?

It is hoped that a follow on/extension of this project could be applied to other modules within STEM that use home experiments, and that the outputs of this proposed project could be used to inform interventions in science modules to enhance student satisfaction and success.

Activities

Phase 1 - Student Survey

A JISC electronic survey was sent in March 2023, via email to a subset of students who had completed both stage one modules, S111 and S112, in any presentation. This was to ensure that unintentional bias was not introduced into the data by having one module underepresented.

Invitations were issued to 1858 students. To increase survey response rate, the recommendations of Saleh and Bista (2017) were adopted in which responders were asked for their help personally, were told why they had been selected fo for the survey, what the researchers hoped to achieve, and what the intented wider benefits and impact of this would be. Reminders were issued 2 weeks after initial invite. Students were informed of estimated time to complete the questionnaire (approx. 30 minutes).

The student survey asked a range of quantitative and free text questions relating to their experience of the home experiments on S111 and S112 which formed part of the core module content and assessment. Home experiments were defined as being those that required some form of physical set up, not virtual experiments (ISEs) or remote experiments (e.g., accessing an instrument on campus via a weblink). Students were asked if they had set up the home experiments themselves, or whether they had asked permission to use the alternative resources provided by the module team, together with whether the

requirement for purchasing equipment adversely affected the achievement of relevant learning outcomes

Phase 2 - Student Interviews

Out of the 195 responses received for the JISC survey, 87 students (44.6%) said that they were willing to be interviewed by a member of the project team.

The project had been awarded funding to interview 10 students. In order to identify which 10 students to invite to interview, survey responses were reviewed to obtain a cross sectional sample of students to invite for further discussion. Students were initially shortlisted based on whether they had provided free text responses to the open survey questions as it was felt that these students may have more to contribute to the project outcomes. A cross section of 10 students was selected to take into account specifics related to the project such as whether all or some of the home experiments had been set up, whether alternative resources had been used, and specific free text answers worthy of further exploration.

Out of the 10 students approached, 8 accepted the invitation to interview at the first contact attempt. A further 2 students responded to say they were no longer able to participate, consequently 2 more students were selected from the original shortlist.

Interviews were conduced on a 1:1 basis using Microsoft Teams, with a member of the project team, between July and September 2023.

The exact nature of the interviews was guided by student responses, allowing the conversations to develop according to how students answered particular questions, and the information they were willing to share. A detailed interview plan can be found in Appendix A, showing how the interview was semi structured around sourcing experimental materials (including costs), setting up the experiment and discussing results. All of the students interviewed had undertaken some or all of the home experiments contributed to core module content and assessment in both S111 and S112.

Phase 3 - Development and evaluation of suitable alternative resources

Phase 3 of the project related to the production of a new alternative resource for a home experiment that would support the achievement of practical based learning outcomes without additional cost.

It was decided to focus on the production of a new alternative resource for an early assessed experiment in the module S112 (week 2), which contributed towards a question within TMA01.

Outputs disseminated by MacBrayne and Bellamy regarding the awarding grap for Black students vs White students on S112 (MacBrayne and Bellamy, 2023)

revealed that Black students on S112 scored particularly low on the TMA01 question associated with this early home experiment.

The experiment required students to prepare a set of solutions of different concentrations using one of sugar, salt or sodium bicarbonate, and store these solutions in a household fridge or freezer. After a period of time, observations on the appearance of the solutions needed to be recorded, with this data being included in the TMA01 submission. If a student is unable to perform this experiment themselves, they are required to contact their tutor to ask for alternative resources to be made available. The alternative resources for this experiment consisted of a single Word document containing a data table showing the observations the student would expect to achieve, which the student would then include in their TMA01 submission. This did not give rise to an equitable learning experience as students were not achieving the same practical focused learning outcomes as students who had set the experiment up themselves and recorded their own observations. Furthermore, there is the associated issue of students having to ask their tutor at a very early stage in the module for permission to have access to alternative resources, at a stage where they have not yet established a strong tutor: student relationship and hence may be embarrassed to admit they they did not have the means to set up the experiment themselves.

Two video resources were prepared by two module team members of S112. The first video illustrated the experimental set up (to show students how such an experiment would be set up in a laboratory and home setting). It was hoped that this video would also benefit students who were planning to set up the

experiment themselves, providing a means for these students to compare their own experimental techniques to the module team, or to inform their approach to the experiment from the onset. A second video was produced in which a module team member used the results from their experiment to show students what results they could expect to see if they had set up the experiment themselves, but with the onus on the students themselves to take their own observations from close up visualisations in the video, thus providing more of an authentic practical experience to simply providing a table of observations. An example of such a close up is illustrated in Figure 2.

Figure 2 Example of a visual closeup from the new S112 Topic 2 video allowing students to record their own visual observations.

Both videos were made available on S112 as supplementary resource for 23J (as there was insufficient time to render to the VLE). 190 students viewed out of approx. 1400 hence evaluation was delayed until 24J, when both videos were made available on S112 24J within the main VLE to all students irrespective of whether they needed/wanted alternative resources.

Evaluation took place in 24J in the month immediately following the submission of TMA01 (November 2024) via use of Real Time Student Feedback. This method was chosen to enable the whole student cohort to give feedback as opposed to being constrained by the limits of an SRPP obtained sample.

Findings

Phase 1 - Student Survey

91.8% of survey respondents said that they were aware before module start, that S111 and S112 utilised home experiments.

The majority of students who responded to the survey (85.6%) stated that they had attempted all of the home experiments on both modules. Out of the 14.4% who said that they did not complete all experiments, 92.9% said that they did complete some.

Figure 3 illustrates the rationale used by students to inform their choice of what experiments to undertake, with 45.7% of respondents who completed some of the experiments did so only because they were assessed.

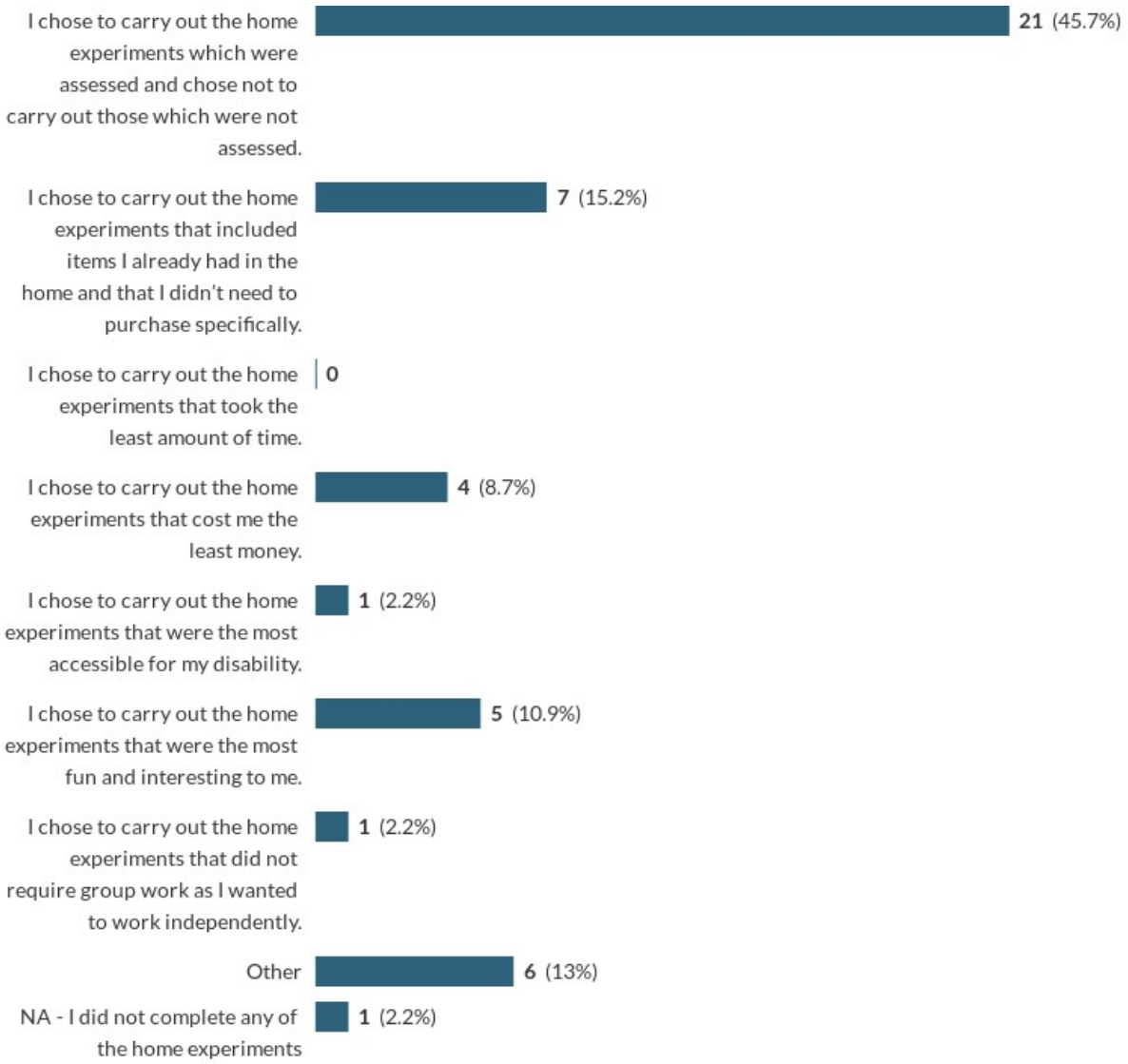

Figure 3 The proportions of students whose undertook home experiments in S111 and S112.

15.2% of respondents who completed some of the experiments did so because they already had the items required and did not need to make additional purchases. 'Other' reasons for not undertaking all experiments included (but were not exclusiveto): insufficient time for all experiments, no access to certain items in their country and no access to certain items due to travelling.

The online survey explored whether students saw the value in home experiments, using a mixture of open ended and Likert scale questions.

The vast majority of students (85.7%) strongly agreed or agreed that home experiments reinforced their understanding of the underlying science (Figure 4), and similarly 84.1% recognised the benefit to underlying skill development (Figure 5).

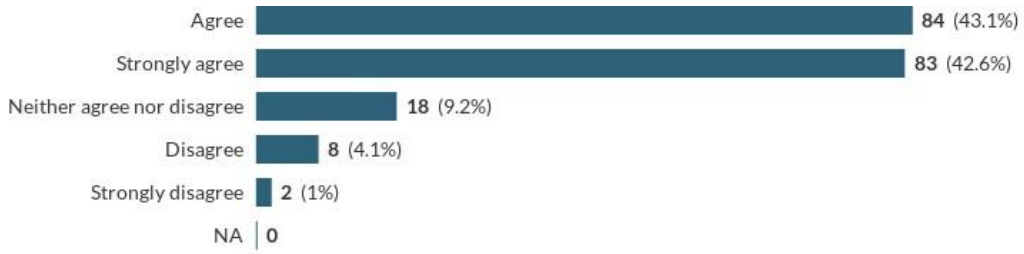

Figure 4 Do students see the benefit associated with increased understanding of underlying science?

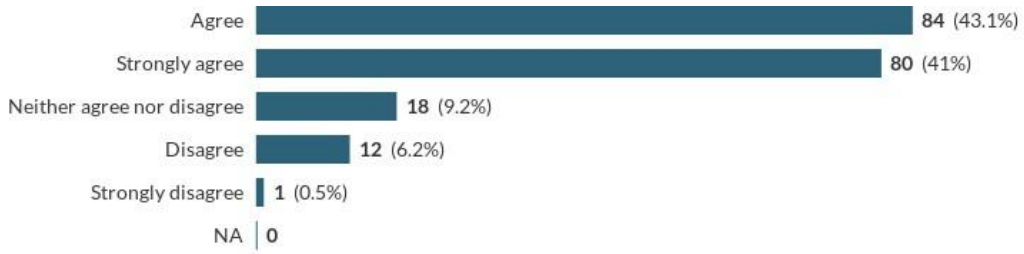

Figure 5 Do students see the benefit associated with wider skill development?

A more mixed response was obtained to the question which asked students whether they expected the University to provide all of the materials and resources needed to set up the home experiments themselves, for example, in the form of a home experiment kit (Figure 6).

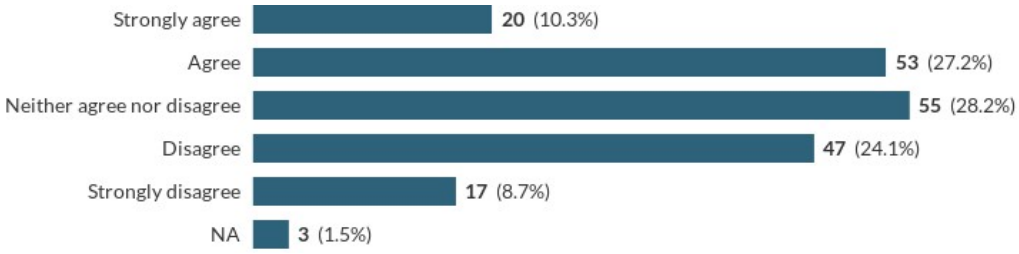

Figure 6 Should the Open University provide all resources and materials needed to set up home experiments?

Only 10.3% of survey respondents strongly agreed with the statement that the University should provide a home experiment kit. In total 37.5% of respondents either agreed or strongly agreed that such a kit should be provided, in comparison to 32.8% who disagreed or strongly disagreed.

Students were questioned about alternative resources. In response to a question concerned with the need to ask permission from their tutor to use these, or have access, again a mixed response was obtained (Figure 7).

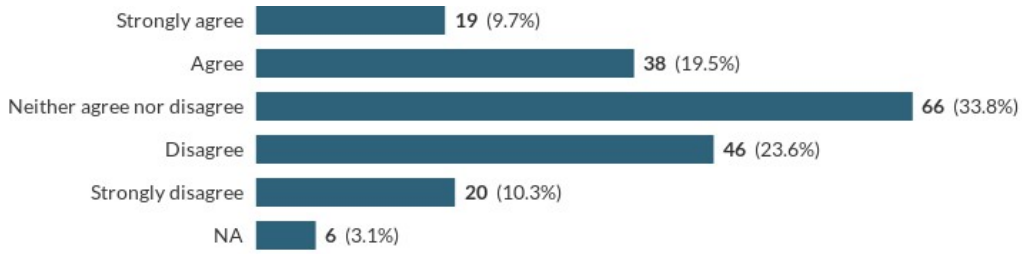

Figure 7 Would students like alternative resources to be made readily available, removing the need to ask permission from their tutor to have access or utilise in assessment?

The fact that less than one third of the survey respondent did not expect alternative resources to be made readily available was a little unexpected in the first instance, however given that the vast majority of students responding to this survey had performed all of the home experiments themselves and had no need to use the alternative resources, then this is not entirely unsurprising.

Concerns had been raised by the S111 and S112 module team, that if alternative resources were made widely available, some students would just use these resources instead of setting up the experiment themselves, even if they had the means to do so. The survey responses illustrated that this was not the case.

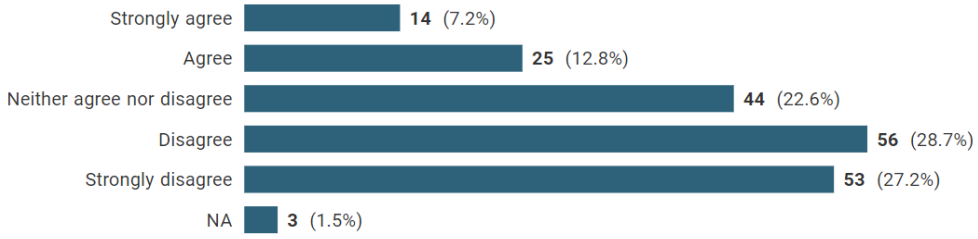

Figure 8 "I would use alternative resources instead of performing an experiment in my home, even if I was able to perform the experiment myself, to save time"

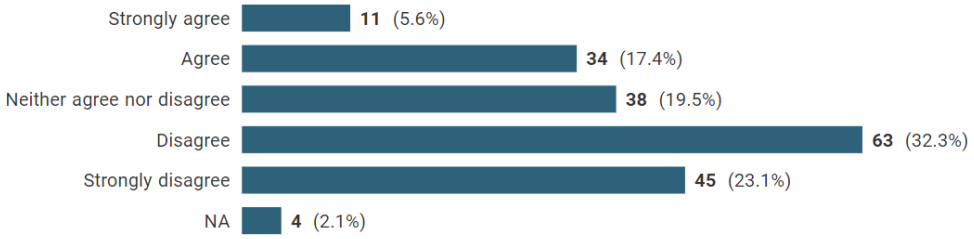

Figure 9 "I would use alternative resources instead of performing an experiment in my home, even if I was able to perform the experiment myself, to save cost."

As illustrated in Figure 8 for time reasons, and Figure 9 for cost reasons, students demonstrated a willingness to still set up the home experiment for themselves even if alternative resources were freely available.

Thematic analysis of the free text, open ended questions within the survey revealed several dominant themes:

Theme 1: Cost of Materials

Students used the free text comment boxes within the survey to comment on the high costs associated with materials they were required to purchase, in particular on S111:

> *The cost of all this really added up, and as I won't be needing to use any of these items again, it is a lot of wasted money.*

Anonymous Student

> *I completed all the experiments I could afford and that I could fit in to my life.*

Anonymous Student

> *Some of the experimental costs creep up so if some of the more expensive ones could be changed to reduce the need to do them. There are a few that could be removed to limit the financial impact as videos could be used.*

Anonymous Student

> *For the home experiments practical kits including all (or most) of the materials should be provided at the beginning of the module. If this could not be included in the cost of the module, then it could be charged at a small fee. This would be more cost effective than for each student to have to purchase all the equipment themselves.*

Anonymous Student

Several students showed a willingness to purchase a kit that contained all items they would need to undertake home experiments. It should be noted that the Open University Students Association used to sell a home experiment kit for S111 at a nominal fee but had to discontinue this due to availability and cost of materials.

Theme 2: Time

The second dominant theme within the survey free text comments related to the time associated with the setting up of home experiments.

> *...the time it took to gather supplies and perform the experiment outweighed the benefits.*

Anonymous Student

> *I dreaded practical work the most because of the time it took.*

Anonymous Student

> *I do think the quantity could have been reduced as some did feel irrelevant to study but still took a lot of time which could have been spent on learning the module material.*

Anonymous Student

Despite the time required for home experiments being included within student workload during module production, some students still perceived the practical work to be time consuming, and not particularly beneficial. Both S111 and S112 provide breakdowns of the recommended time to allow for practical work at the start of each topic, however, free text comments from students indicate that this was an underestimate of the time required, especially when other factors such as the need to source materials are taken into account.

Theme 3: Availability of Materials

Some students cited difficulties in obtaining materials that they required for the home experiments.

> *I live in a small town therefore some of the items were not accessible to me due to shops not selling them.*

Anonymous Student

> *I did not have some items available in my country.*

Anonymous Student

> *Some of the materials were hard to get hold of (or I had to order a fairly large quantity over the internet) and a couple of times I only realised that you didn't need all the materials (i.e. some were optional) after I had ordered them.*

Anonymous Student

International students in particular noted that they could not purchase certain items (e.g., a particular brand of yeast) and that this hadn't been taken into consideration when the experiment was designed.

Theme 4: Environmental Impact

A related theme to the availability of materials was the quantities in which students were required to buy consumables needed for home experiments. For example, one experiment in S111 requires a single LED light bulb, however in general, such items need to be purchased in multiples, leading to wastage.

> *Some materials eg . Vitamin capsules while not expensive could only be bought in large quantities, these types of thing could be supplied by OU to reduce waste.*

Anonymous Student

> *Also, using kit friendly to the environment- there was a lot of plastic involved in all the investigations I had to do.*

Anonymous Student

> *I think it would be useful from an environmental perspective, if kits were sent out to students so that extra materials don't need to be bought and wasted.*

Anonymous Student

This further reinforces the need for module teams to consider the provision of home experiment kits, to avoid students having to purchase excessive number of items results in cost and materials wastage.

Theme 5: Alternative Resources

The final theme evident from the free text responses related to the provision and use of alternative resources for students unable to set up home experiments themselves. In both S111 and S112 students are required to ask their tutor for permission to have access to and use alternative resources in assessment relating to home experiments, and give reasons as to why they cannot set up the experiments themselves.

> *When asking my tutor if I could use alternative resources, I felt a bit judged and like I had to thoroughly justify why I couldn't complete the experiment. I do understand why practical work is encouraged over the alternative resources, however it wasn't easy or nice having to explain my mental health issues and financial difficulties every single time.*

Anonymous Student

> *It would be beneficial to give more alternative options for some experiments that don't use everyday household items so that they could still be performed at home or make the alternative resources more easily available so that it doesn't make students feel like they've failed and need to admit it to the tutor.*

Anonymous Student

In addition to students not wishing to admit to their tutor that they couldn't carry out the home experiments due to embarrasment or fear of judgement, there was also a logistical aspect to having readily available alternative resources for home experiments:

> *I am sailing 6 months a year and have difficulty buying normal stuff, such as a chocolate bar or use a microwave. But that is what alternative resources are for!! Brilliant!*

Anonymous Student

The free text survey comments illustrate that students value having alternative resources available, and for the majority of survey respondents, having access to readily available alternative resources did not mean that the experiments were not undertaken at home if possible.

Phase 2 - Student Interviews

Ten students were interviewed on a 1:1 basis with a member of the project team. Questions were open ended and allowed students to share their experiences of home experiments within their study of S111 and S112.

All the 10 students interviewed had undertaken some, or all the home experiments in S111 and S112. Unfortunately, no students came forward for interview who had not performed any home experiments and were reliant on alternative resources alone, or who simply missed out assessment related to practical work.

Themes identified from thematic analysis of each interview transcript mirrored those of the survey free text comments, but in general all students spoke positively about their experiences of performing their own practical work in the form of home experiments:

> *...when you're actually putting everything into practice and doing the experiments, you feel like you're doing real science...*

Anonymous Student

Due to the personalised nature of the discussions, some students chose to reveal other insights into the logistics of performing home experiments as part

of module study. One student noted how more than one person was required to collect data which could lead to difficulties for students living alone or in isolation:

> *…my other half was hanging out my bedroom window, dropping ping pong ball down from a height…it was one of those that I found incredibly frustrating…But I wouldn't be able to do it myself. There's no way on Earth I would be able to do it myself.*

Anonymous Student

Conversely, another student noted difficulties encountered when trying to set up home experiments within a busy household:

> *If you signed up for online learning, your home might be chaos for one reason or another. You know you might have children at home, for example. I think lots of people are parents, or you might be living in a shared house and the home experiment sort of take over the kitchen quite for quite long periods of time.*

Anonymous Student

Concerns were also raised by a student about whether home experiments would be viewed by potential employers as valid experience of practical work:

> *I don't think anyone's going to want to employ me in a lab based on what I've done it the with the OU home experiments and that's just a harsh fact, isn't it?*

Anonymous Student

This suggests that some students are not aware of the in-person opportunities available for students on qualifications served by S111 and S112 such as the School of Life, Health and Chemical Science lab schools, held on campus in Milton Keynes and opportunities for fieldwork in the School of Environment, Earth and Ecosystem Sciences.

Phase 3 - Development and evaluation of suitable alternative resources

The final phase of the project aimed to create, provide and evaluate alternative video resource as part of current eSTEeM project to improve parity of experience.

The RTSF questionnaire used to evaluate the new video resource for 24J was available to all 1365 students who were registered on S112 24J at that time. A total of 426 complete responses were received (31.2%) although 527 responses in total included incomplete responses (38.6%) which were still evaluated.

The majority of respondents (61%) watched the new video resources in order to inform their approach to TMA01, with a further 7% watching the video after the RTSF questionnaire had raised their awareness of this resource.

Only 20 respondents said that they watched the videos to use as an alternative resource in the TMA as they were unable to set up the experiment themselves, with only 1% of respondents saying that watching the videos was easier than setting up the experiment at home, thereby reinforcing the findings illustrated from the original survey regarding motivation for use of alternative resources (Figures 8 and 9).

As illustrated in Figure 10, 67% of respondents felt that the videos enhanced the development of their practical science skills, with 49% respondents wishing to see wider use of video resources in this way.

Response	Average	Total
I felt the video enhanced the development of my practical science skills.	67%	268
I did not feel that the video added anything new to the development of my practical science skills.	6%	24
I would like to see more widely available alternative resources, such as videos like this, embedded within the learning material for all home experiments, without having to ask for them, or permission to use them.	49%	198
Watching the video provided me with enough information to make my own observations for the purposes of the assessment.	39%	155

Figure 10 Development of practical skill skills from new alternative resources

The final section of the RTSF questionnaire provided a free text comments box for students to elaborate further on their answers or share their experience of using these videos.

Thematic analysis of the free text responses revealed 4 main themes:

Theme 1: Help with own experimental set up and comparison of results

Out of the 322 students who watched the video, 281 students (68%) said they did this in order to observe the experiment being set up, so that they could replicate this themselves in their own home. A further 29% of respondents noted that they used the videos to check their own experimental results against:

I found the video very helpful when watched alongside reading the written instructions. I felt more confident setting up my own experiment after observing it done first

Anonymous Student

This was my first experiment in years so I watched the video with the intention of seeing how they set it up in real time. I found it very helpful to have a visual to compare to and to see the results after to compare to my own.

Anonymous Student

It was very helpful to see an experiment carried out in practice - I found it far less daunting to do the experiment myself having watched the video.

Anonymous Student

I particularly like the "zoomed-in" views provided on the video as these are useful as comparisons with my own results.

Anonymous Student

This demonstrates that despite alternative resources being readily available, students still had the desire and willingness to set up practical work for themselves and valued the opportunity to bench mark their own results against what could be expected, thus further enhancing their learning experience.

Theme 2: Style of learning

A theme that had not previously arisen from the survey or interviews related to how the new videos provided a different style of learning for students.

> *I think its important to have different resources as we all learn differently (visual, hearing, doing).*

Anonymous Student

> *The video is important as it gives you a connection that it is difficult to get with online learning, I also like to have different ways of taking in information and learn. It can be difficult to be just told a method or theory and adequately visualise what is being said and learn effectively.*

Anonymous Student

> *I like videos the more the better! Breaks up the reading and it's visual. Feels like your closer to the tutors and the experience.*

Anonymous Student

> *I find myself more of a visual learner, so video/image sources I find easier to process what it is I'm studying compared to reading tables etc.*

Anonymous Student

This proved to be one of the dominant themes from the RTSF responses, illustrating how students value different methods of engaging with their learning. It is thought that this may have increased engagement with

Theme 3: Use of the videos as an alternative resource

Although the majority of survey respondents had watched the videos with the intent of performing the experiment themselves, the free text comments revealed that students liked the reassurance of having the videos available as a back up.

It is nice to have this alternative so I do not have to stress if I am ill that I am letting people down by being unable to physically do the experiment.

Anonymous Student

It is very handy to know that the videos are there as a backup to my own experiments.

Anonymous Student

If you are unable to do the experiment at least you won't fall behind.

Anonymous Student

However, one comment from a respondent illustrated the importance of transparency within the module materials regarding use of the videos as an alternative resource:

> *Due to the previous module being requiring the messaging to a tutor to be allowed to use certain resources in case of not being able to perform the experiment, I assumed that I would be marked down and didn't realise that the video was available for viewing without needing permission from my tutor.*

Anonymous Student

This further reinforces the need for consistent practice between modules to ensure parity of student experience across a qualification stage.

In contrast to the original quantitative survey, the respondents from the 24J RTSF questionnaire showed a greater desire for alternative resources to be made widely available in this way to support the development of practical focused learning outcomes. 49% of RTSF respondents said they would like to see more widespread use of videos to have available as an alternative resource that they could use if needed, without having to ask for permission. This is in comparison to less than one third of the original survey respondents who did not expect alternative resources to be made readily available. As the RTSF focused only on a single presentation (the current 24J presentation) this could reflect the changing needs of the OU student demographic for stage one science study.

Impact

a) Student experience

This project has impacted on student learning directly as now, in S112, students now have freely accessible alternative resources for all home experiments without need to ask permission. There was a video resource for Topic 2, but now there is an additional video that has been made for Topic 17 in the same, accessible style. Further, this project is anticipated to contribute to increasing student success however, as the implemented changes have not had a complete academic year to run yet, it is too early to attempt any data anaylses. Whilst key recommendations are positioned for S112 and S111 in particular, there is significant potential for other modules to benefit. For example, any other modules may be inspired to create videos, and/or have free access to alternative resources for all students without asking. Also, there is the potential for other modules requiring home experiments to consider kit boxes/funding/reducing requirement for assessment of experiments at students' own expense. There is also the potential to highlight inequity in accessing equipment and/or facilities to other module teams, and have others consider any assumptions made that students have access to certain items.

b) Teaching

The outcomes of this project have made the authors more aware of the issues that students might be facing, particularly in the role of being an Associate

Lecturer. It has facilitated the authors to challenge their assumptions that students will easily be able to carry out home experiments, and be more mindful of how both consumables and facilities are not always accessible to some students. Outcomes to this project have also enabled the authors to engage in proactive support of students for whom home experiements might be a challenge for *any* reason. Further, one author is currently the incumbant LHCS EDI Lead and project outcomes have been fed back within the capacity of this role to STEM EDIA and how this is very much an equity issue that the OU needs consider more widely.

c) Strategic change and learning design

This project is yet to influence any strategic change or learning design however, the authors are hoping to use findings to lobby for strategic change around the support of practical learning more broadly across the faculty and wider university. It is hoped that the Open University will explore solutions to students bearing the additional costs of home experiments particularly in the case of where said experiments contribute to formal assessment.

d) Recommendations

Whilst home experiments are popular with some students and provide a means for students to meet learning outcomes related to practical skills, not all students are able to engage in home experiments which is particularly

problematic when it comes to those which form part of mandatory assessment. The project has three main recommendations:

1. The OU should consider providing home experiment kits

Students showed willing to purchase (up to £50) a home experiment kit that would contain all of the items needed for home experiments in one module (similar to the OUSA S111 kit) so consideration should be given to the production of these kits with a recommendation to explore costs and logistics associated with making these available.

Home experiment kits could be means tested for students on low income.

2. Module teams should re-evaluate how they approach home experiments

Module teams should consider cost and availability of raw materials which may need to be purchased, avoiding the assumption that students will have certain items readily available (e.g., access to a fridge) and that students have the disposable income to purchase specific items.

Module teams should also consider the use of a standardised list of equipment to avoid unnecessary repeats (e.g., 'pocket calculator' versus 'calculator') to ensure students aren't making unnecessary purchases and provide this at the beginning of the module to cover all home experiments.

3. Suitable alternative resources should be made available to all students as standard, and their purpose better explained

Every home experiment should have alternative resources readily available (avoiding the need for students to ask for access to them) and the resource should be able to offer a reasonable parity of experience.

Students should be supported to understand use of alternative resources is not a negative thing – especially if managing mitigating circumstances.

Dissemination

Project outputs have been disseminated as follows:

- eSTEeM conference 2025 (planned oral presentation)
- SPS Scholarship seminar March 2025 (oral presentation)
- eSTEeM conference April 2024 (oral presentation)
- LHCS Scholarship Day April 2024 (oral presentation)
- eSTEeM conference April 2023 (poster presentation)
- eSTEeM EDI Seminar December 2023 (oral presentation)

Figures and tables

Figure 1 Examples of practical kits previously set to students to support home experiments in stage 1 science.

Figure 2 Example of a visual closeup from the new S112 Topic 2 video allowing students to record their own visual observations.

Figure 3 The proportions of students whose undertook home experiments in S111 and S112.

Figure 4 Do students see the benefit associated with increased understanding of underlying science?

Figure 5 Do students see the benefit associated with wider skill development?

Figure 6 Should the Open University provide all resources and materials needed to set up home experiments?

Figure 7 Would students like alternative resources to be made readily available, removing the need to ask permission from their tutor to have access or utilise in assessment?

Figure 8 "I would use alternative resources instead of performing an experiment in my home, even if I was able to perform the experiment myself, to save time"

Figure 9 "I would use alternative resources instead of performing an experiment in my home, even if I was able to perform the experiment myself, to save cost."

Figure 10 Development of practical skill skills from new alternative resources

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University approval processes

If your project required specific approval from university committees, please provide the appropriate information below. This is a necessary requirement for future publication of outputs from your project.

- SRPP/SSPP – Approval from the Student Research Project Panel/Staff Survey Project Panel was obtained according to the Open University's code of practice and procedures before embarking on this project. **Application number 2023/2407.**
- Ethical review – An ethical review was obtained according to the Open University's code of practice and procedures before embarking on this project. Reference number **HREC/4671/MacBrayne**
- Data Protection Impact Assessment/Compliance Check – A Data Protection Impact Assessment/Compliance Check was obtained according to the Open University's code of practice and procedures before embarking on this project. Data Protection registration number **28-04-132**

Appendix

Appendix A Interview Plans – students who have completed some or all home experiments in S111 and S112