**How can we get more students to study mathematics or physics?**

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| **Professor Michael J. Reiss and Dr Tamjid Mujtaba**  **Institute of Education, University of London**  [We attach a photograph that would be ideal (showing students doing something interesting in a physics lab). It is not essential that this figure is used but great if it can be. This figure was lent to us by the Institute of Physics. If you want to use it for this purpose, you will need to get permission from Clare Thomson [Clare.Thomson@iop.org](mailto:Clare.Thomson@iop.org).]  Toolbar   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | [Undo (Ctrl+Z)](javascript:;) | [Redo (Ctrl+Y)](javascript:;) |  | [Bold (Ctrl+B)](javascript:;) | [Italic (Ctrl+I)](javascript:;) |  | [Insert/Remove Bulleted List](javascript:;) | [Insert/Remove Numbered List](javascript:;) |  | |
| **Key findings**  Our study indicates that young people are more likely to continue with mathematics or physics once these subjects become optional (i.e. after the age of 16 in England) if four conditions are fulfilled:   * If they believe that they will benefit from studying the subject in terms of job satisfaction and/or material rewards, such as a bigger salary. * If they demonstrate conceptual understanding in the subject, in other words ‘do well at it’ in more than a superficial way. * If they have been well taught at school in the subject. * If they have been encouraged to continue with them by a key adult. This will usually be someone in their family or one of their teachers at school. If this person is a family member, they may not be good at mathematics or physics themselves, but they will be positive about the worth of studying these subjects.   From a policy point of view, given that governments have little control in the short term over how parents view subjects, two things are particularly important to encourage post-16 participation in mathematics or physics. First, students need to develop deep conceptual understanding in these subjects and be clear as to the benefits of continuing to study them. Secondly, students need to have long-term relationships with excellent teachers; chopping and changing teachers is disruptive. |

**The nature of the research**

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| Both in the UK and worldwide, there is still a shortage of studies in mathematics and science education that examine student engagement over time and research the reasons for the take up or non take up of mathematics and science once these subjects become optional.  In the UPMAP (Understanding Participation rates in post-16 Mathematics And Physics) Project we study these issues with particular reference to mathematics and physics. Our presumption is that once students are no longer required to do certain subjects, participation depends at least in part on how students see themselves, the subjects and themselves in relation to the subjects. None of these is fixed. Each can shift as a result of experiences both inside and outside the classroom.   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | [Undo (Ctrl+Z)](javascript:;) | [Redo (Ctrl+Y)](javascript:;) |  | [Bold (Ctrl+B)](javascript:;) | [Italic (Ctrl+I)](javascript:;) |  | [Insert/Remove Bulleted List](javascript:;) | [Insert/Remove Numbered List](javascript:;) |  | |
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| |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | The UPMAP Project has three strands. In Strand 1 a total of 23,000 students completed questionnaires in either year 8 or 10 and 7000 of these students also completed them two years later. The questionnaires explored things like performance, confidence and liking for mathematics and physics.  Factor analyses of these questionnaire returns indicated eight physics-specific constructs that correlate with intention to study physics post-16. In descending order of effect size these are:   1. extrinsic material gain motivation 2. advice-pressure to study physics 3. intrinsic value of physics 4. home support for achievement in physics 5. emotional response to physics lessons 6. perceptions of physics lessons 7. physics self-concept 8. perceptions of physics teachers.   A further analysis using individual items from the survey rather than constructs (aggregates of items) supported the finding that extrinsic motivation in physics was the most important factor associated with intended participation. In addition, this item-level analysis indicated that within the advice-pressure to study physics construct the encouragement individual students receive from their teachers is the most important factor (amongst all items which explored students’ perceptions of teachers) that encourages them to intend to continue with physics post-16. The findings from mathematics are similar.  [See attached figure. Caption: Factors that explain 15 year old students' aspirations for post-16 physics. (Factors are shown in decreasing order of importance.)]  In Strand 2 we worked with 12 of our schools in more depth. Interviews were undertaken in each of these schools with six students when they were 15 years old, 16 years old and 17 years old. Interviews explored such issues as: student views of the role of parents and other significant adults, peers, teachers and out-of-school experiences on subject choice; student understandings of the nature of mathematics and physics; student views of their abilities in mathematics and physics.  The work we undertook in these schools showed the importance that good schools can make. The best schools were ones that were well managed, where the teachers felt positive about the difference they could make for their pupils and where pupils believed that their teachers were really interested in them as individuals and in their learning.  In Strand 3 we worked with 51 first year undergraduates under the age of 21 in four universities. Interviews explored the students’ experiences of and feelings about their education, their family and occasions on which they felt they had made a decision about their future. One of our key findings was that we discerned no evidence that experience of the sorts of innovations typically designed to increase mathematics or physics uptake – for example ‘fun projects’ or competitions – had been key with respect to a desire to study either mathematics or physics. It seems as though a lot of time and energy may be being wasted on such activities, often funded by well-meaning charities and companies. In the worst cases, it was clear that such activities had actively put students off studying physics or engineering. | [Undo (Ctrl+Z)](javascript:;) | [Redo (Ctrl+Y)](javascript:;) |  | [Bold (Ctrl+B)](javascript:;) | [Italic (Ctrl+I)](javascript:;) |  | [Insert/Remove Bulleted List](javascript:;) | [Insert/Remove Numbered List](javascript:;) |  | |
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| We have worked with a number of professional organisations so that the findings become embedded in practice. Please feel able to contact us at [m.reiss@ioe.ac.uk](mailto:m.reiss@ioe.ac.uk) or [t.mujtaba@ioe.ac.uk](mailto:t.mujtaba@ioe.ac.uk).  **Acknowledgements**  A full list of our publications is available at our project website [www.ioe.ac.uk/UPMAP](http://www.ioe.ac.uk/UPMAP). We are grateful to the Economic and Social Research Council for funding the study and to all the participating students, teachers and schools for participating in it. Other team members: Celia Hoyles, Bijan Riazi-Farzad, Melissa Rodd, Richard Sheldrake, Shirley Simon, Fani Stylianidou. |
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