Extending student knowledge and interest through super-curricular activities

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Abstract

Any teacher of physics is likely to consider super-curricular reading as an important strategy for successful students. However, there are many more ways to extend a student’s interest in a subject than reading books, and undirected reading (such as providing a long out of date reading list) is not likely to be as helpful as targeted or directed study. I present an approach to directing and supporting additional study pioneered at St Paul’s School in the last 2 years based on two significant steps:

- Providing a large, searchable database of reading and other material such as podcasts rather than simply a reading list.
- Encouraging students to visualise and plot their trajectory toward a specific goal using a graph.

Supplementary material for this article is available online.

Introduction

Physics teachers often find themselves preparing students who are interested in further study not only in physics but also in many closely and more tangentially related areas including chemistry, mathematics, astronomy, engineering, materials science, computing and medicine. It is also strongly accepted that a marker of a successful student (both in terms of results but also in terms of being accepted into the next phase of study) is that they demonstrate an independent interest in both the topics studied at school and topics they are keen to study next [1]. In many cases this ideal is supported at schools and universities by providing a reading list—typically a list of books which the department members enjoyed when they were students, supplemented by some recommendations from universities drawn up in a similar fashion [2–4]. This approach has several obvious flaws including:

- There are many forms of information available other than books these days, most of which are more appealing to modern students and more accessible - for simplicity we shall still refer to ‘reading’ though in reality it could mean attending a lecture, listening to a podcast etc.
- Such lists are rarely updated.
- The range of material is limited as book publication cycles are slow and in specialist areas there is not much material available.
A good example is materials science where many people still recommend the J E Gordon books which the author read as a student in the early 1980s! Colleagues who have worked as professional engineers and materials scientists have recommended more modern books as being better suited.

- Lists rarely come with any indication of why a student might read them or what order to read them in.

Presenting students with such lists is almost completely contrary to how we teach—there is no learning objective, no plan, no feedback or assessment and no differentiation other than by the student. Whilst ideally at some point our students will all become autodidacts and draw up their own reading lists, it is unreasonable to expect them to do that at an age when we feel they need guidance in learning a topic in the first place.

If, in our classes, the vast majority of our students went on to study pure physics then we might feel justified in providing a list of books we as physics teachers have enjoyed. In reality of course, the majority of our students will go on to related fields and so it is also important to provide breadth and expect our students to relate their physics to those other interests. For a student considering medicine, rather than encouraging them to read the Feynman Lectures, a set of articles on how physics has influenced medicine is more likely to encourage them to keep up their physics studies and will help them bring diversity of views and ideas to the classroom.

**Plotting a trajectory**

St Paul’s School is a selective and highly academic school for 13–18 year olds, nearly all of whom go on to study at top universities in the UK or USA. The majority follow an academic path. We were, therefore, keen to develop a super-curricular support resource which worked for such students. However, the approach developed is trivial to adapt to other needs and is focussed on students considering where they are trying to go, reflecting on how they are helping themselves and providing feedback on that process. At the centre of this process is a simple 2D plot whose x-axis is a measure of the difficulty level of the reading and whose y-axis is the extent to which the material is off-topic for their current physics studies.

The benefit of such a plot is that it allows students to think about their reading in terms of a trajectory on the graph. A student considering maths at a top university will want to be reading material of a high level—beyond A level—but not far removed from the mainstream physics. For example, the mathematical detail in an undergraduate book on physics which fleshes out in greater depth the topics studied at A level would be more beneficial than, say, a newspaper-level article on the Higgs Boson. On the other hand, a student planning on studying materials science needs to be going further off-syllabus to find out more about their topic, but not to such a high difficulty level—there is a lot of breadth and new material to cover first. Neither student will be in a position to jump directly to the end point of their trajectory but by plotting their reading can easily see if they are, at least, heading in the right direction and perhaps appreciate why one thing was too difficult at this stage, but might be accessible later—see figure 1.

Because our students are aiming very high we chose to make A level material difficulty in the middle of the plot—a ‘5’ out of ‘10’. In an environment where super-curricular reading is aimed at generating interest and supporting the basics of study, this could be placed higher on the plot, allowing more detail of the trajectory up to A level rather than beyond it. This is a purely local decision, based on local needs. We also decided to place ‘on syllabus’ at the bottom of the y-axis, there being no real concept of ‘less than on syllabus’. Hence our graph could be labelled with some fixed points. Interpolation and extrapolation becomes a matter of subjective judgement based on local decisions and no-one would call
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Figure 2. An example of how different reading might be placed on the graph for students aiming beyond A Level material.

Building a database

Once the scales are understood and sketched out, a database can be constructed. We chose to build ours in a spreadsheet (available as supplementary material (stacks.iop.org/PhysED/53/025001/mmedia)) as it can easily be filtered and shared on our school’s intranet. The headings we chose for the database were:

- Topic
- Type of resource
- Name of resource
- Link (to web page, internal document on intranet etc)
- Off-topicality (y-axis)
- Difficulty (x-axis)
- Quality
- Comments

Topics were essentially the A level topic areas plus additional ones as resources were added such as astrophysics, philosophy of science, mathematics. The types of resource allowed were:

- General Book
- Webpage
- Blog
- Podcast
- TV Program
- Film
- MOOC
- Historical Book
- Problem Book
- Topical Book
- General Book
- Video
- Magazine/journal
- Nobel Lecture
- Other

Again this can be adapted to suit local needs. Populating the database seems a daunting task but the wide variety of resources makes it easy. We started with our usual book lists and those from universities. We added to that the textbooks and magazines such as New Scientist, Scientific American, Physics Review and Young Scientists Journal [5–8] which are commonly read and scanned in a number of choice articles from recent years to share directly. Podcasts provided both general links for things like Infinite Monkey Cage, Inside Science and Life Scientific as well as specific links to In Our Time episodes. The ‘Very Short Introduction’ series of books from OUP [9] was added along with a selection of MOOCs, all easily found through online searches. Physics Education’s review pages [10] were also a fertile source of up to date and classic book reviews and we quickly found ourselves with over 400 items in the database. A bubble plot of the number of items in each part of the graph showed the coverage needed to be increased in the bottom left (figure 3).

Encouraging and tracking reading

Of course it is one thing to suggest to students that they should be reading (attending lectures, watching podcasts etc). It is another thing entirely to assess and provide feedback, processes upon which the essence of pedagogy depends. The system outlined here provides students with a framework to either do this themselves or to provide a mentor or teacher with the information needed to
comment usefully. To assist with this, however, we require all students to keep a log of their reading which is shared with their teacher. This log is modelled on the Activity Log common to the Extended Project Qualification [11] and contains headings:

- Week
- What I have read/watched
- References including links
- Reflections (and further reading)

The information on this log feeds usefully into feedback on reports, university references and at parent meetings where evidence rather than anecdote can be provided. Inevitably some students show very little evidence of further reading but some find this a very valuable resource, allowing them to develop their studies and reflect more effectively on why and what they are reading.

Summary

Traditional student reading lists, whether issued by schools or universities, are rarely helpful in promoting super-curricular study because they are not diverse enough in the range of activities involved in self-study, do not provide objectives or feedback and do not allow for assessment of progress. Nevertheless the encouragement of super-curricular study is strongly supported [12, 13]. In this short article I have tried to provide an outline of a mechanism which answers these objections for the physics teacher who inevitably is preparing students for a wide range of possible areas of further study.

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1 The executive summary identifies ‘In the North East of England, attainment levels are on average below those in Wales, yet applicants from the North East are admitted to Oxford and Cambridge at the average rate for the UK—a lot higher than Welsh applicants. This does not mean that attainment levels are irrelevant, but rather that high achievers must also be supported through programmes of super-curricular activity which develop the key skills necessary for progression to Oxford, Cambridge and other competitive universities’.
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References

[1] Staircase 12 An Oxford University website to assist students applying for places http://staircase12.univ.ox.ac.uk/content/what-are-super-curricular-activities (Accessed: 23 October 2017)

[2] https://share.trin.cam.ac.uk/sites/public/Tutorial/Cambridge-wider-reading-suggestions.pdf (Accessed: 23 October 2017) (University of Cambridge)

[3] www.kings.cam.ac.uk/study/undergraduate/offerholders/reading-lists/nat-phys.html (Accessed: 23 October 2017) (King’s college London)

[4] www.york.ac.uk/physics/undergraduate/faqs/ (Accessed: 23 October 2017) (University of York)

[5] New Scientist www.newscientist.com/ (Accessed: 23 October 2017)

[6] Scientific American www.scientificamerican.com/ (Accessed: 23 October 2017)

[7] Physics review www.york.ac.uk/physics/public-and-schools/secondary/phys-review/ (Accessed: 23 October 2017)

[8] Young Scientists Journal https://ysjournal.com/ (Accessed: 23 October 2017)

[9] Very Short Introductions Title List www.veryshortintroductions.com/page/title-lists (Accessed: 23 October 2017)

[10] Physics Education Journal homepage http://iopscience.iop.org/journal/0031-9120 (Accessed: 23 October 2017) (Book reviews are often open access)

[11] See for example https://qualifications.pearson.com/en/qualifications/edexcel-project-qualification/level-3/coursematerials.html/#filterQuery=Pearson-UK:Category%2FCoursework-materials (Accessed: 23 October 2017) (For the template provided by the Edexcel examination board)

[12] Hemsley L. 2016 Nurturing aspirations for Oxbridge: an exploration of the impact of university preparation classes on sixth-form historians Teach. Hist. 165 28–36 (London)

[13] Final Report of the Oxbridge Ambassador for Wales http://dera.ioe.ac.uk/20351 (Accessed: 23 October 2017)

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