Astronomy Education in the United Kingdom

This overview is part of the project "Astronomy Education Worldwide" of the International Astronomical Union's Office of Astronomy for Education.
More information: https://astro4edu.org/worldwide

Structure of education: All education at state-funded schools and colleges across the UK is free of charge.

There are also private (independent/public) schools which charge fees and which account for 7% of pupils. Most schools are run in the English language with some in Wales run in Welsh, some in Northern Ireland is Irish and some in Scotland run in Scottish Gaelic. Most primary/secondary schools are non-religious (63/82%) but there are a number of Christian denominational schools (36/17%) and a minority of faith schools representing mainly Islamic and Jewish communities (0.3/1.2%). Most state schools are for both girls and boys, though a number exist for single-sex only (10.6%).

Across the UK, education is compulsory between the ages of 5 (4 in Northern Ireland) and 16 (18 in England). Prior to this many children will attend nurseries, childminders or pre-schools, which in England and Wales, follow the Early Years Foundation Stage (EYFS) curriculum set out for children aged 0-5.

In England and Wales pupils attend primary school (Key Stages 1 and 2) for six years . Students begin secondary provision in Year 7 at age 11, beginning Key Stage 3 (KS3): Years 7-9. During this time, students follow a broad curriculum and study all the subjects offered by their school. Following KS3, students enter Key Stage 4, (KS4) corresponding to school years 10-11. At the end of Year 11 (at age 15 or 16, depending on their birthday) students typically take General Certificate of Secondary Education (GCSE) exams (or international iGCSE) qualifications in 5-10 subjects. Between the ages of 16 and 18, students are required by law to be in some form of education or training in England, in Wales post-16 education is optional. Students can choose to remain in school for two more years after age 16, where they can study up to 4 A-Levels (university entrance exams) and/or Level 3 vocational qualifications. Alternatively, they may study at a Further Education College or complete work-based apprenticeships or traineeships.

Children in Scotland start primary school aged between 4½ and 5½ depending on when their birthday falls. They complete seven years of primary school, starting in P1 going up to P7. After this, they start secondary school for a compulsory four years with the following two years being optional (years S1 to S6). The education system in Scotland is distinctly different from the rest of the UK: there is a focus on breadth across a range of subjects, rather than on greater depth over a smaller range of subjects. Scottish students take ‘Nationals’ qualifications (usually in S4) and will select around 6-8 National subjects to complete at Level 4 to 5 (called N4 or N5) depending on their attainment. Students can leave school after completion of Nationals at age 16, or they may choose to remain at school to study

for additional National exams and/or Highers and Advanced Higher exams, or other vocational qualifications across years S5 and S6.

In Northern Ireland, the school system is broadly similar to that of England and Wales: all schools follow the Northern Ireland Curriculum which is divided into Key Stages and based on the National Curriculum used in England and Wales. Children who have reached the age of four on July 1st start school the following September, a year earlier than the rest of the UK. Students complete seven years of primary school education before moving onto secondary school. After five years of secondary education, aged 15 or 16, students sit GCSE examinations. This marks the end of compulsory education in NI. However, students may elect to stay at school or attend a Further Education College for another two years to complete A Levels or vocational qualifications.

Education facilities: UK state schools have typical class sizes under 30 pupils with practical subjects like science, art and technical subjects having smaller classes. Independent school class sizes tend to be smaller. All UK schools have access to full amenities including sanitation, running water and good internet connections. Staying away from home ('boarding') is also common in independent schools. School buildings are generally well-maintained, but it is not uncommon for students to spend part of their education in temporary classrooms due to maintenance problems/lack of space in certain areas. A number of robotic telescopes are freely accessible on-line by school pupils through the National Schools' Observator and the Faulkes Telescope Project.

Governance and organisation: State schools are generally run by local district and city councils. Many Academies now exist in England, which though state (public) schools, are more independent in their governance. Academy trusts also exist, where for reasons of economies of scale, several Academies are run together.
The Curriculum is set by the central government Department of Education (England), Department of Education and skills (Wales), Education Scotland (Scotland) and Department of Education (NI), and all schools are overseen and inspected by an independent body (depending on the type of school). The curriculum undergoes regular reform and the last was in 2017 (England), with a major revision of the curriculum in Wales scheduled for 2022.
Several exam boards exist (Pearson/Edexcel, AQA, Oxford & Cambridge, Cambridge Pre-U and Eduquas; WJEC in Wales; SQA in Scotland; CCEA in NI) each offer a similar range of qualifications. Exam Boards are profit making organizations (Edexcel) or charities, funded by charging for exam entry and administration and, in the case of Pearson, is a multinational publishing company.

Teacher Training: Primary school teachers mostly study undergraduate degrees in education at a university. Secondary physics teachers typically study for a joint degree in physics and education at a university, or study for a postgraduate certificate in education qualification (PGCE) after a physics or similar undergraduate degree.
For those that have completed a closely related degree, but require additional subject knowledge training, additional subject enhancement courses in physics can be completed, typically with a few "in-service" training days per year. Qualified Teacher Status (QTS) is also offered to those already in employment. In Scotland, trainees typically complete a professional graduate diploma in education (PGDE) rather than a PGCE. In Northern Ireland newly qualified teachers are known as Beginning Teachers and complete two years of early professional development in addition to the induction.
There are several other programmes that graduates can complete to gain QTS in England. QTS may be awarded to trainees completing their initial teacher training via school-based training programmes such as the *School Direct* or *SCITT* initiatives, or via the *Graduate Teacher Programme* (GTP), where graduates are employed as an unqualified teacher while working towards QTS.
In order to work in the state education system, teachers with QTS must then successfully complete an additional induction year as a newly qualified teacher (NQT) to gain full professional status.

Astronomy in the curriculum: England and Wales: The English and Welsh national curricula have many access points for astronomy and thus plays to pupils' enthusiasm and interest. At primary school, astronomy is often studied in detail, with project work and 'working scientifically' (data recording and analysis skills) encouraged. In early primary education KS1 (years 1-2) children should observe seasonal changes and learn to recognise the Sun and the Moon and observe the varying length of the day and the relative Sun position throughout the year. In Key Stage 2 (year 5) students learn about the size and shape of the planets and their orbits around the Sun, the Moon and its orbit and solar and lunar eclipses. They also learn about the Earth's rotation to explain night and day and the Sun's movement across the sky during the day. In the working scientifically strand of the space curriculum, students are expected to build models of the solar system or simple shadow clocks and sundials to make observations. Students specifically learn how astronomers arrived at the present-day heliocentric view of the solar system and learn that gravity causes unsupported objects to fall towards Earth.

In the first years of secondary school (KS3) children learn about gravity, the seasons and the Earth's tilt, day length at different times of the year in different hemispheres, climate change and the physical processes important for life on other planets. They also learn about our Sun as a star, other stars in our galaxy, other galaxies and the light year as a unit of astronomical distance. At KS4 (years 10-11), students have the choice of taking either three separate sciences for their GCSEs ('triple science') or taking a combined science GCSE course with reduced content for which two GCSEs are awarded .

Students taking the separate physics GCSE study a module on space physics. This includes topics such as the formation of the solar system, the planets, orbital stability for natural and artificial satellites, the life-cycles and evolution of stars and cosmology. Unfortunately, those that complete combined science GCSEs do not complete this module. However, both combined science and triple science students will study general physics modules on fission and fusion (which touch on stellar processes), gravity, and electromagnetic radiation (which touches on areas such as satellite communications and the greenhouse effect).

In addition to the GCSE, the A-level (ages 16-18) physics specifications have modules on telescopes, black-body radiation, stellar evolution, exoplanets and cosmology, which in some cases are optional.

1.5.2 Scotland: In Scotland students learn about astronomy from early primary school. At the early level (P1) children learn to recognise the sun, moon and stars and link them to the daily patterns of life. In the first level (P2-4), students observe the sun and moon at various times and describe the patterns of movement and changes over time, relating the movements to the length of a day, a month and a year. During the second level (P5-7), students learn about the solar system including the motions of the planets. During the third and fourth levels (S1-3) students consider how our knowledge of the universe has changed over time and consider questions such as what is needed for life on other planets.

For Nationals and Highers, the sciences are studied as separate subjects. For Nat5 courses, students electing to study physics will study space exploration and cosmology. Those studying for Highers learn about gravitation, special relativity, redshift and the expanding Universe and spectroscopy. Those completing Advanced Highers are introduced to general relativity and the physics of black holes, black-body radiation, stellar stellar formation, classification (HR diagram) and evolution, stellar fusion and hydrostatic equilibrium.

1.5.3 Northern Ireland: At Key Stage 1 and 2 in Northern Ireland there is little statutory astronomy content in the national curriculum. However, pupils learn about light at KS1 and potential areas of study set out in the national curriculum include the study of stars and the Sun as natural sources of

light. Similarly, at KS2 it is suggested that students consider questions around the survivability of humans in space (as part of the 'Interdependence' strand of the science curriculum) and learn about rocket motion (under the 'Movement and energy' strand). Students are, however, required to learn about shadows and how they change over the course of the year at KS2.

It is at KS3 that students begin to learn about the solar system and the Universe in detail. At GCSE, students can elect to take a single GCSE in science, a double award in science (2 GCSEs but including equal components of biology, chemistry and physics) or three separate sciences where they will take a Physics GCSE. All three of these qualifications include a module on space physics. The double science award space module is very similar to those included in different English and Welsh exam board curricula. Material covered includes the solar system, star formation and evolution and cosmology. The single science award space module is shortened, primarily by removing the life-cycle of stars section and study of the cosmic microwave background radiation. The physics GCSE space physics module has an additional section covering space travel and life on other planets. Here, students consider the vast distances involved in space travel and learn how exoplanets are discovered and how astronomers study their atmospheric composition in the search for life supporting molecules.

GCSE Astronomy: Uniquely at this level, a GCSE in Astronomy exists as an extra optional subject. It is run as a one- or two-year course, broken into 8 topics on 'Naked-Eye' astronomy and 8 on 'Telescopic astronomy'. It is often offered as a stretch and challenge course and also to encourage STEM subjects beyond 16 and mostly taught out of school timetable or via clubs. It covers many topics that a first year University course would cover, but in much less mathematical detail. The course is very observationally based and, though there is no marked coursework, pupils have to complete 2 observational projects. The options do not require either dark or indeed night skies and the use of online telescopes is encouraged. Around 2,500 pupils a year take the exam, and the gender split is totally unlike Physics, at ~40:60 girls:boys. The majority of entries are from the state sector and academies.

Astronomy education outside the classroom: There are a large number of science or astronomy outreach centres, some large and centrally funded like the National Space Centre in Leicester; Royal Observatory Greenwich in London; Observatory Science Centre at Herstmonceux, Sussex, or Jodrell Bank Discovery Centre in Cheshire.
Most counties have at least one active local astronomy club, run by amateur astronomers and overseen by the Federation of Astronomical Societies. These are open to all ages and specifically encourage young members. Several observatories exist with public access arrangements. Outreach now forms a core part of many University Physics and Astronomy departments and graduates in particular are encouraged to engage with the local community and local schools.
The UK is uniquely well-served for access to robotic and remotely-controlled telescopes.
Many voluntary youth organizations such as the Scouts, Girl Guides and Boys' Brigade run astronomy education events themselves and/or visit outreach centres.

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For specific information about astronomy education in the United Kingdom or on this document please contact the Office of Astronomy for Education (oae@astro4edu.org).