Evolving 5-19 Biology

Transferable Skills in Biology Education

Royal Society of Biology

Introduction

Transferable skills are key to work and study at all levels. Transferable skills development doesn't start and end at fixed time points, rather it is a continuous process that includes learning and experience across an individual's education, work and life.

Transferable skills like teamwork, communication and critical thinking are vital to all areas of education and work. Whilst not all programmes of study or jobs require all skills in the same proportion, or at the same time, we all need to draw on these skills regularly throughout our working life. In this document we use the term 'transferable skills' to refer to all the skills learners may develop over and above their subject specific skills and knowledge. Rather than being an extra, we see transferable (or 'core' or 'essential') skills as vital to learning and employability.

From age five onwards, as detailed in RSB's *Evolving 5-19 Biology*[1 2 3], children need to develop the skills they require to learn effectively. These will build year-on-year, through their education and into work. These skills can and will be developed through biology education at all stages. All learners should experience curricula and assessments that prepare them to be scientifically literate, able to make scientifically informed choices, and ready them for the diverse and evolving world of work. This might be fairly simple at earlier stages of biology education, thinking about what went well or badly during an experiment or group session for example, but through secondary and further/higher education we can ask students to think more deeply about their own skills development and how they can use similar skills in different contexts.

It should be noted that in the primary phase of education (age 5 - 11), children study a broad science curriculum, rather than studying Biology as a discrete subject. During this phase, children develop scientific and transferable skills across the entire science curriculum, as they move from year to year.

This document is aimed at a wide audience, due to the importance of skill development from the early years of science education through to the workplace. It is aimed at those involved in, and with an interest in, science education, including those in STEM and wider industries with responsibility for schools' outreach and higher education partnerships. CPD and ITE providers, teachers, policy makers and further/higher education professionals will all benefit from accessing and engaging with the examples of skills progression provided here. In this document we explore technical, interpersonal and cognitive skills across primary and secondary education, and provide insight into how those skills are further developed in higher education courses and the workplace. These are illustrative examples only, and do not represent the range and depth of transferable skills development through biology education.

Technical skills: making observations

Advances in biology, and in our understanding of the world more broadly, require us to observe what is happening around us, and use these observations to make conclusions and apply them in a wider context. In biology education, learners can be guided to understand how best to measure biological phenomena, how to record data and analyse this appropriately. It is also important to link personal findings to those from others in the field, and be able to use knowledge to discuss similar or different results. Findings need to be communicated, whether this is limited to the immediate educational context, or across a wider team in a research discipline or workplace.

Primary: Primary children learn to appreciate that 'making observations' refers to much more than looking at things – though their very first experiences will be about 'looking closely' and recording these observations in a broad variety of ways. These youngest learners will talk to each other and adults to develop their scientific vocabulary, and adults will guide learners to encourage them to record important details in their drawings. They will record observations by taking photographs, and use real examples of their observations in their records, such as leaves and feathers, etc. These photographs, drawings and real artefacts will be included in tables, graphs and charts, as these means of recording data are introduced. Photographs and drawings will gradually be supplemented with words and numbers, as children progress through school, and they will move from non-standard to standard measurement, include repeat measurements, and increase their accuracy in the use of equipment such as thermometers and timers.

Secondary: Students at secondary school will build on the observational skills learnt at primary school through biology practical work. They will be able to judge whether qualitative or quantitative measurements are more appropriate for an investigation, and will learn how to describe what is needed to make an observation accurate. Students will learn to take readings as accurately as possible with a range of equipment and be able to discuss the validity of the reading. An understanding of sources of error and resulting uncertainty in measurement is developed. Students will be able to compare readings made in class groups and comment on differences in observations between groups. Students use progressively more complex apparatus as they progress through secondary school and use observation skills to make judgements about the appropriateness of the set-up. They will also make judgements about how best to record observations in a clear and concise manner. By the end of secondary school students are able to manipulate and evaluate their data to make judgements and draw conclusions.

Higher: In higher education, learners will carry out experiments, starting with well-characterised protocols and methods with known results, and moving on to novel research, based on an understanding of the field. Learners will develop their experimental design skills, be able to collect data accurately with minimal human error, and use statistical methods to analyse their data. Towards the end of higher education, learners will be able to read primary research papers in a particular area and use the knowledge they acquire to formulate hypotheses and experimental or observational protocols to test these.

Workplace: Biologists in the workplace may carry out a range of observational work. This might include running complex sets of experiments in a research or industrial setting. This will likely be novel work, furthering our understanding of biological processes. The work might also be applied, for example, using existing knowledge and understanding to test whether a certain procedure or chemical might be of use in agriculture or healthcare. All the observations made must be recorded accurately, analysed appropriately and communicated clearly. Care must be taken to protect intellectual property or sensitive data.

Interpersonal skills: working in a team

Almost every type of work requires us to collaborate with others to some degree, and often it is central to the job. Being able to communicate effectively in a team, selecting the appropriate style, tone and form of communication, listening to others and knowing when to ask for help are all important in a successful team. Reflecting, both individually and as a team, on the functioning of the team can be hugely beneficial, and science in the 'real world' is dependent on effective interdisciplinary teams.

Primary: Children can think that 'scientists' work in isolation in the workplace, and this can be seen as a negative aspect to their potential career aspirations. Giving small groups of 3-4 children specific roles within teams replicates roles taken in the workplace. Working in teams in science lessons gives children an opportunity to focus on particular skills such as oral and written communication, challenging each other's ideas in a respectful manner, working collaboratively to solve problems arising during the planning and carrying out of their practical work, and understanding that 'failure' is part of the scientific process and developing resilience.

Secondary: In secondary school students typically work with a partner or in a group when doing practical work. They learn how to explicitly divide tasks so that all members of the group are engaged, and to check in with each other so that all members remain on task. This fosters a sense of collaboration in science lessons and students build confidence in their skills together. It also allows students to develop their own specific skills so that over time they may inhabit different roles such as motivator, leader or observer. By allowing students to reflect on a practical session, they begin to see what they have done well together and how they could proceed differently. There are opportunities for discussion and debate in Biology lessons enabling students to share ideas and collaborate to present a point of view. Project work as homework, particularly at A-level, can be set to be completed in groups enabling students to independently collaborate.

Higher: Learners may work in teams in both formal (in-class) and informal (self-directed study) environments in higher education. Many programmes in higher education will include team projects, and learners will often be assessed on the work they produce as a team. Learners in higher education might be asked to work on a longitudinal project with a group of peers, being accountable for their area of work within the team, project management, and their input into the final product. Reflection on teamwork is a key component of teamwork in higher education, and learners will be expected to use informal and formal feedback from others, alongside their own reflections, to further develop their team working skills. Increasingly, major project/dissertation assessments in higher education may be conducted within a teamwork context, with each student making clear their individual contribution.

Workplace: Biologists will be expected to work in teams throughout their career, whether that is departmental or in project groups. They may fulfil a specific role within a team, and be expected to communicate their work with others in order to complete tasks, research or large scale projects. This could expand into management, where giving feedback to team members is important, allowing others to complete their role successfully, as well as achieving their own objectives and targets. Being able to build relationships with colleagues and networking can improve opportunities for collaboration and joint projects

Cognitive skills: asking questions about the biological world

Understanding that we don't know how many things work in the natural world, and dealing with uncertainty, are key concepts in biology and science education more broadly. Knowing how to ask questions and find answers is a vital skillset that develops through biology education. To ask and answer questions, learners must first be able to understand the evidence already available in the field, and critically evaluate this. They must then be able to frame a new research question, work out how best to answer it and then use findings to come to conclusions and, ultimately, contribute to furthering our understanding of the natural world.

Primary: Younger learners are naturally curious and it is important to be able to guide and frame questions within a scientific context. Learners may not be able to identify scientific ideas, but teachers and adults around them should guide questioning to further their understanding. Learners should also be encouraged to question what they are learning, and why plants and animals interact or behave in ways they observe. They may be able to link their understanding with information they have sourced in research, and pairing this with their developing communication and teamwork skills, will help them to develop their initial scientific practices ready for the curriculum in secondary school.

Secondary: Secondary school students naturally ask good scientific questions and the more biology a student learns, the more questions they have. Students are encouraged to keep asking questions and are taught to use available resources to answer them. Internet search engines are commonly used so students learn to make judgements about the validity of the answer based on the reliability of the website. Learning dense curriculum content can sometimes make the knowledge seem unquestionable, but students should be encouraged always to ask a question about what they have learned. Students learn that all knowledge can be questioned and good evidence is needed to give a robust answer.

Higher: As learners progress through higher education, they will be expected to consult a range of sources of information to increase their understanding of the living world. The use of journal articles, including primary research papers, will be expected in higher education, and we encourage learners to read widely around the topics they study. Learners will develop the ability to use search engines and databases to locate specific and reliable information, and be able to critically evaluate what they find. They should also be able to use existing knowledge in the field to develop experimental approaches to answering currently unanswered questions about biology. Towards the end of higher education, learners should be able to formulate a novel research question and indicate how they might use a series of experiments to answer it.

Workplace: Asking scientific questions in the workplace could mean a huge variety of different things, depending on the field of work. In an applied laboratory and computational sense, it might be asking whether a set of molecules might show promise as potential drug candidates for a specific target. Testing this would require a biologist to draw on what is known in the literature, and then apply this knowledge to devising the best way to answer the question. In other areas of work, biologists might ask questions related to environmental or health policy, for example, which would require them to gather evidence, consult with stakeholders and reach conclusions that would be shared and debated.

About the **Royal Society** of **Biology**

The Royal Society of Biology (RSB) is a single unified voice for biology: advising government and influencing policy; advancing education and professional development; supporting its members, and engaging and encouraging public interest in the life sciences. The RSB represents a diverse membership of individuals, learned societies and other organisations. Individual members include practising scientists, pupils at all levels, professionals in academia, industry and education, and non-professionals with an interest in biology.

The RSB seeks to support biology education at all levels, and actively engages with education policy through formal consultation responses, convening special interest groups and collaborating and coordinating with other science organisations.

As part of our next steps following publication of *Evolving 5-19 Biology: recommendations and framework for 5-19 biology curricula*, this document forms part of a suite of summaries and further consideration into aspects of the framework, with a view to signposting resources to, and disseminating best practice for teachers who are developing school, curriculum and qualifications policy, evidence-based teaching orders and interdisciplinary areas of study.

www.rsb.org.uk/curriculum

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References

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