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OPINION

# Plant biology education: A competency-based vision for the future

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## Societal Impact Statement

Plant biology is an essential discipline for addressing global challenges from food security to climate change. In order to achieve this, we need to educate plant biologists who can contribute to research, enterprise, policy, public engagement and beyond. This article explores the potential of competency-based education, which emphasises what students can do rather than what we know. A flexible and adaptable model of competency based plant biology education is presented, along with practical suggestions and examples. This provides a framework through which we can educate plant biologists equipped to address major scientific and societal challenges of the future.

## Summary

Plant biology is an essential discipline for addressing global challenges from food security to climate change. In order to achieve this we need to educate plant biologists who can contribute to research, enterprise, policy, public engagement and beyond. In this article, I explore some of the issues and challenges facing plant biology education from authentic research driven curricula to the impact of AI. In order to effectively educate the plant biologists of the future I propose moving to a competency based approach to education. Competency based education emphasises what students can do rather than what they know. I present a three-domain competency model for plant biology, structured around (i) knowledge and information literacy (ii) disciplinary and professional experience and (iii) self-awareness and personal development as three interdependent aspects of competency. I accompany this with twelve proposed competencies for plant biologists. The model is flexible, robust and adaptable to specific local requirements and future demands of plant biology education. In reimagining plant biology education in this way we can present our discipline as exciting and relevant to students, and equip them with the capabilities required to contribute to plant biology activity from research to public policy.

KEYWORDS

competency based education, education, higher education, plant awareness, plant biology, postgraduate, sustainable development, undergraduate

## 1 | INTRODUCTION

Plant biology is essential for addressing many of the great challenges we face. Whether it is combating climate change, achieving global food security, development of novel pharmaceuticals or maintaining biodiversity, plant biology has a critical role to play. We therefore need to educate and train plant biologists who can contribute to fundamental science and societal needs. It is an exciting time to be in plant biology education, but there are also significant challenges we face. Here I explore how education might ensure future plant biologists have the right knowledge and skills to meet these challenges head on.

My focus is primarily on undergraduate and postgraduate taught education, but will be relevant to school level, postgraduate research and professional training. I use the term 'plant biology' as an umbrella term to cover all plant facing work, from pure laboratory based plant science to applied agriculture, and includes work with algae and photosynthetic bacteria. I write with a focus on plant biology, but my arguments are equally applicable to all areas of the biosciences (and beyond). It should be noted that, at least in the UK, there are a relatively small number of students on specialist plant biology degrees, with significantly more students studying plant biology in the context of a more general biology course. Where relevant I give examples from our teaching at the University of Hull or from the literature to give context or illustrate how the concepts described may be achieved in practice.

## 2 | MAJOR ISSUES FACING PLANT BIOLOGY EDUCATION AND RESEARCH

### 2.1 | Growing the pipeline

It has long been recognised that plant biology is less attractive to students than other areas of bioscience (Stagg et al., 2009). Many have noted the phenomenon of 'plant awareness disparity' (a more inclusive term than 'plant blindness' which has ableist connotations; Parsley, 2020), whereby people overlook the role and importance of plants in everyday life (Jose et al., 2019; Thomas et al., 2021). This has repeatedly translated into curricula that devalue plant biology and the pivotal role it plays in areas from biotechnology to sustainability (Stagg & Dillon, 2022). To make plant biology attractive to future students, we need to emphasise the exciting nature and relevance of our discipline, and its transformative impact on society. This is difficult in a knowledge driven curriculum. Why focus on detailed biochemistry of photosynthesis in introductory biology classes, when students could explore the biotechnological methods for manipulating plants, or environmental impacts of ensuring food security? This would be more engaging and relevant to students, potentially increasing enrolment in advanced classes covering the biochemical details. For example, student interest can be enhanced through using 'useful plants' (e.g. spices, medicinal and drug plants) as case studies (Pany et al., 2019). There have been some moves in this direction. GCSE biology (the most common biology qualification for 16 year olds in England, Wales and Northern Ireland) now includes some plant pathology (AQA, 2015), but still focuses on biological content rather than applications and real world relevance. Students also need to make connections between fundamental science and potential careers in plant biology, from research to enterprise to public engagement. Projects such as www.plantsciencefutures.org.uk provide valuable case studies and resources for educators to use, highlighting careers and applications as well as cutting edge science ('Plant Science Futures, 2023), but are rarely embedded into taught curricula.

### 2.2 | Developing scientific literacy

Science qualifications should develop scientific literacy, which can be defined through the three competencies of (i) being able to explain phenomenon scientifically (ii) evaluate and design scientific inquiry and (iii) interpret data and evidence scientifically (OECD, 2017). It has been argued that you cannot train a scientist without them actively participating in scientific inquiry (Uno, 2009). However, too many curricula have students passively consuming products of research (i.e. new facts and theories) rather than engaging in the authentic scientific process itself (Healey & Jenkins, 2009). In many programmes, undergraduates only participate in genuine research via their final year research project, and some departments restrict availability of projects to high achieving students (Healey et al., 2013). In other contexts, undergraduates may not even be exposed to genuine research unless they complete an independent internship or lab placement, which is exclusionary to many (Bangera & Brownell, 2014). To be inclusive all students should be exposed to research. However compulsory practical classes are often taught in 'cook book' style, with students following instructions to obtain a known result, rather than engaging in the messier and authentic process of open ended scientific inquiry (Bangera & Brownell, 2014; Brownell & Kloser, 2015; Healey & Jenkins, 2009).

Inquiry based curricula have multiple advantages for students, including improved scientific thinking, ownership of work, graduation rates and likelihood of progressing to higher level research (Bangera & Brownell, 2014; Brownell et al., 2015; Lopatto, 2007). At the same time, we must recognise that undergraduate education should prepare students for a variety of careers, not just research. Students therefore need appropriate exposure to the scientific process, but do not necessarily need to join a research group for their final year project. Embedding open ended inquiry driven practicals in earlier years helps address both concerns. There are many published examples of plant based Course Based Undergraduate Research Experiences (CUREs) and inquiry driven practicals (e.g. Laungani et al., 2018; Mills et al., 2021). We also need to train plant biologists to effectively engage with, and critically evaluate research literature (Hubbard, 2021; Hubbard et al., 2022).

### 2.3 | Sustainable development

The UN has defined 17 Sustainable Development Goals (SDGs) to shape the future (United Nations, 2015), many of which are unachievable without plant biology (Henkhaus et al., 2020; Jez et al., 2016; Langdale, 2021). SDG2 is *"End hunger, achieve food security and improved nutrition and promote sustainable agriculture"*. Plant biology also feeds into affordable and clean energy (SDG7), responsible production and consumption (SDG12), climate action (SDG13), life below water (SDG14) and life on land (SDG15), and makes indirect contributions to others. It has been noted that plant awareness disparity is an active barrier to sustainable development (Amprazis & Papadopoulou, 2020; Thomas et al., 2021). We need to educate plant biologists about sustainability (QAA, 2021), and raise awareness of botanical sustainability issues for non-plant biologists. This ranges from smart agricultural solutions to reduced dependency on single use plastic in laboratories (Kuntin, 2019). Education for Sustainable Development (ESD) explores societal, environmental, economic and cultural aspects of development, combining them in a holistic manner to improve the lives of people and the planet (Dale & Newman, 2005; Vare & Scott, 2007; Venkataraman, 2009).

## 2.4 | Justice, equity, diversity and inclusion

If we are to tackle global challenges, we need plant biologists who represent global diversity. We cannot do this without creating inclusive educational environments that allow all to reach their full potential regardless of demographic background, personal characteristics and current circumstances (Hubbard & Gawthorpe, 2022; Montgomery, 2020). Plant biology has traditionally been dominated by white European perspectives (Mabry et al., 2024). Our discipline has a need to decolonise through challenging its history of exploitation and establishing more equitable ways of working. For example, 'parachute science' is still widespread in ecology, whereby Western scholars publish work conducted in other lower income countries without acknowledgement of or partnership with local experts (Odeny & Bosurgi, 2022). Students should be prepared to challenge these practices, and build inclusive partnerships that recognise global expertise and embed co-creation (Gewin, 2022). Geography should not be a barrier to access and engagement with high quality teaching resources and training (Williams et al., 2015). As a community, we also need to address the systematic underrepresentation of scientists from marginalised backgrounds, particularly on the grounds of race, disability and socioeconomic status (Miriti, 2020; Montgomery, 2020; Royal Society, 2014).

## 2.5 | Societal, regulatory and political context

Plant biology does not happen in a vacuum. Societal and political factors influence what science is supported and funded, what impact that science has and the relationship between science and legislation. For example, the divergent legal statuses of genetically modified crops around the world demonstrate political influence within our discipline (Turnbull et al., 2021). Agricultural biotechnology is often pitched against environmentalism in the social and political landscape (Buttel, 2005), but to achieve sustainability biotechnology will likely be part of the solution (Blancke et al., 2015; Ervin et al., 2010). Students must learn to engage with and learn from the genuine economic, safety, environmental and political concerns of stakeholders, rather than assuming 'irrational' resistance to technology can be overcome simply by explaining the science better (Blancke et al., 2015; Solli et al., 2014). This requires awareness and respect for differing world views and cultural standpoints, reiterating the need for diverse backgrounds and perspectives within plant biology. Students also need to understand the legal contexts in which they operate (both as students and as future scientists and employees), including health and safety, environmental protection and equality laws. We also need plant biologists who understand how to achieve legislative and political influence and communicate their science effectively to policymakers (Grifo, 2011). Scientifically educated people are also needed within regulation, policy, media and non-governmental organisations to embed sustainable science based practices.

## 2.6 | Commercialisation, enterprise and intellectual property

For plant biology to have real world impact it has to leave the lab. Students increasingly need an awareness of commercialisation, product development and enterprise. Multiple business models will be required, from small start-ups partnering with academic institutions, to large scale commercialisation by multinationals. Scientific intellectual property also requires protection through patents and copyright, but in an ethical and open way that encourages innovation (Brown, 2003). Students should understand the importance of ethical and responsible business practices; much opposition to agricultural biotechnology stems from perceived exploitation of farmers by large multinational corporations rather than objection to the science (McHughen, 2013). While plant biology programmes should be science focussed, student awareness commercialisation, intellectual property and enterprise are increasingly relevant as we translate our science into real world products.

## 2.7 | Technology and artificial intelligence

Plant biology has always embraced multiple forms of technology from agricultural mechanisation to aerial remote sensing to high throughput genomics and phenotyping platforms. Computational modelling and 'big data' based approaches including machine learning have significantly enhanced our understanding of plants from the molecular to the ecosystem scale (Xu & Rhee, 2014). New forms of Artificial Intelligence (AI) will, and are already transforming our discipline (Harfouche et al., 2023). AI is particularly well suited to identifying patterns in large datasets, but will also play a role in experimental design and data collection in ways we cannot predict. Understanding how to maximise the value of technology and AI while using it ethically and responsibly will require new ways of thinking (Ewen, 2023), and better tools for data management and reproducibility (Harfouche et al., 2023). In addition to educating future students, the technological capabilities of current plant biologists may need to be developed rapidly, so they can be adaptable and able to accommodate new technologies as they arise.

## 3 | A COMPETENCE-BASED MODEL FOR PLANT BIOLOGY EDUCATION

The substantive challenges outlined above require a shift away from knowledge focussed education. Core disciplinary knowledge will always be at the heart of science education, but it should also give students skills and attributes needed for contribution to grand societal challenges both within research and beyond.

Competence based education focuses on what students can *do*, rather than what they know. It prioritises student mastery of their skills and knowledge, as well as the attitudes and behaviours needed for success (Gervais, 2016). Those familiar with Bloom's revised taxonomy of learning (Anderson & Krathwohl, 2001) may position competence based education as a tool to move students from the lower cognitive levels of 'remember' and 'understand' to the higher levels of 'analyse', 'evaluate' and 'create'. Viewing education in this way can fundamentally change assumptions about the purpose of learning and curriculum design (Lawrence et al., 2023). Competence based education has been used in other contexts including the Programme for International Student Assessment (PISA) framework (Mulder, 2012; OECD, 2017; Wenzl et al., 2016), but has yet to be widely adopted within plant biology education.

Competence can be defined as "*having the experience, knowledge, and self-awareness to attend to a task effectively; with agility, under any circumstance, and to do so ethically*" (Lawrence, 2020; Lawrence et al., 2023). These three constructs (experience, knowledge and self-awareness) are interdependent and all equally important. Building on this, I present the following competency model for plant biology education (Figure 1).

### 3.1 | The stem: knowledge and information literacy

The stem provides the core structure for the plant and connects different parts of the plant together. Disciplinary plant biology knowledge will always be at the centre of the curriculum. Core knowledge provides a structure from which knowledge can be applied, evaluated and creatively built upon. I therefore position knowledge as the stem of a plant, providing the core support on which transferable skills and competencies can be attached, and the mechanism through which different aspects of learning connect. The stem must be strong and healthy, so students must also know how scientific knowledge is generated, what sources of knowledge to trust, how to evaluate knowledge, and how to use and evidence that knowledge in their work.

### 3.2 | The leaves: disciplinary and professional experience

The leaves are the site of primary production, doing the useful photosynthetic work required for the plant to grow. I position disciplinary and professional experience as the leaves, as this is where students can demonstrate their learning and growth. I define disciplinary experience as the skills needed in plant biology as a technical discipline (e.g. laboratory/field skills, experimental design) and professional experience as skills needed by professionals in science and science-related careers (e.g. communication and awareness of legal and societal contexts). Just as a plant invests differently in sun and shade leaves according to need, different programmes may invest more heavily in particular skills and experiences than others.

### 3.3 | The roots: self-awareness and personal development

The roots are the 'hidden half' of the plant that are often overlooked but are essential for healthy growth. I position self-awareness and personal development as the roots, as these underpin the ability to learn and gain knowledge and skills. Being able to reflect on personal strengths and weaknesses, and identify opportunities for personal and professional development is essential for learning. This domain also includes leadership skills, networking and career development, allowing learners to progress in their career and become leaders of the future.

### 3.4 | The environment: the changing educational context

For a plant to grow it must be able to respond to a fluctuating environment. Some changes encourage growth, while others are a threat to productivity and even survival of the plant. The same is true in education. Some changes allow for development of new and exciting forms of education while other changes pose threats, which must be confronted or managed. As educators we must be flexible and open to change so that our teaching remains relevant and sustainable to deliver.

Just as no two plants grow identically because of their innate plasticity, the model does not impose a single curriculum. It grants flexibility to educators to define which elements of the curriculum to prioritise, while establishing a baseline set of competencies for students to meet (Huxley-Binns et al., 2023). A research intensive plant science programme might give greater weighting to technical and experimental skills, while a multidisciplinary agricultural programme may prioritise aspects of enterprise or stakeholder communication. The dynamic and plastic growth of the plant helps it to overcome environmental challenges, so flexible adaptive curricula help us respond to new educational contexts in an appropriate and timely manner.

FIGURE 1 Competency model for plant science education. Competencies emphasise what students can do rather than what they know. Three interdependent competency domains of (i) knowledge and information literacy, (ii) disciplinary and professional experience, and (iii) self-awareness and personal development are represented as the stem, leaves and roots respectively, with individual competencies presented in their respective domains.

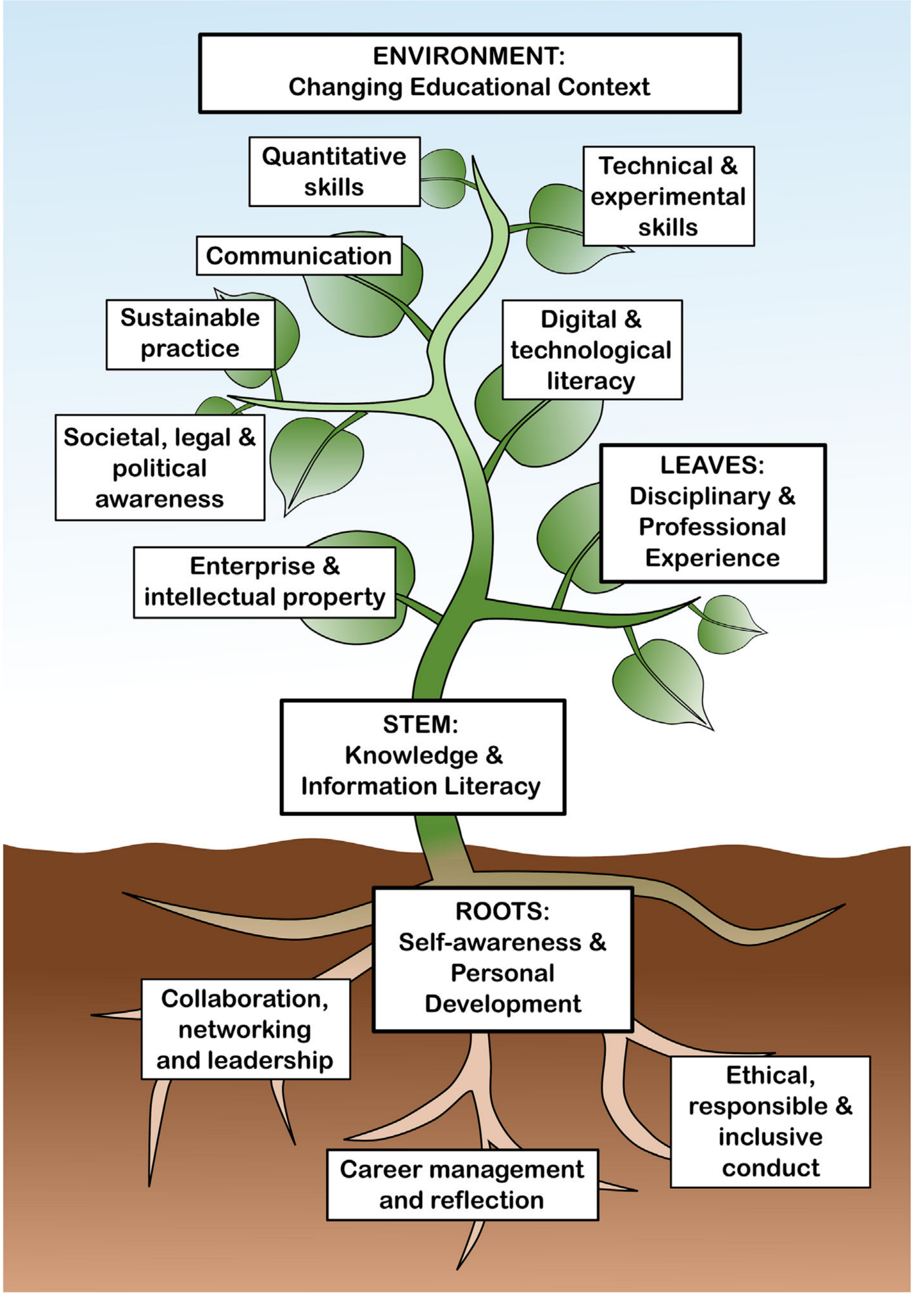


Table 1 outlines a proposed set of twelve competencies for future plant biology education, partially based on Henri and Morrell (2023). I do not propose that all plant biologists should be experts in all competencies, but that students of plant biology should have a fundamental awareness of all twelve. Students should understand why they are relevant to plant biology as a discipline and to their own future careers. Some competencies can be introduced at earlier levels of education, while others might be more appropriate at more advanced levels. Some might be assessed explicitly in their own right (e.g. communication), whereas others might be assessed alongside other competencies (e.g. digital and technological skills assessed as part of a broader assignment).

## 4 | IMPACT OF COMPETENCE BASED EDUCATION ON PLANT BIOLOGY EDUCATION

### 4.1 | Curriculum design and pedagogy

If plant biology educators are to introduce these competencies into the way we teach, we need to reimagine our curricula (Huxley-Binns et al., 2023; QAA, 2021). Many educators are concerned about making space for transferable skills in a crowded knowledge driven curriculum, and the knock-on impacts on student and staff workload and wellbeing (OECD, 2020). To introduce these elements into

**TABLE 1** Proposed competencies for plant sciences education. Competencies focus on what students can do rather than what they know, and are grouped into the three areas of (i) knowledge and information literacy (ii) disciplinary and professional experience and (iii) self-awareness and personal development. Example activities/assessments given to provide practical suggestions of how competencies might be achieved in practice. Competencies partially based on Henri and Morrell (2023).

| Competency | Description | Example activities/assessments |
|---|---|---|
| **Knowledge and information literacy** | | |
| Knowledge application | The ability to apply disciplinary and interdisciplinary knowledge to a variety of scenarios. Knowledge ranges from fundamental science to applied methodologies. Includes the ability to critically evaluate information. | Literature review<br>Peer review/critical appraisal<br>Problem based learning<br>Research proposal<br>Viva/technical interview |
| Information literacy | The ability to identify appropriate sources, assess the accuracy of information and use sources effectively, including those generated by AI. This includes awareness of the peer review process, scientific publishing models, preprint servers, predatory journals etc. | Literature review<br>Annotated bibliography<br>Peer review/critical appraisal |
| **Disciplinary and professional experience** | | |
| Technical and experimental skills | The appropriate technical skills for research and development in the discipline. These might be laboratory based, field based or computational, and includes experimental design. | Assessed practicals<br>Demonstration of technical skill<br>Inquiry driven practicals<br>Research project<br>Scientific poster |
| Numerical and quantitative analysis skills | The skills to analyse quantitative data. Includes the choice and execution of appropriate statistical analysis and mathematical modelling approaches | Analysis of datasets<br>Annotated code (e.g. R/python scripts)<br>Production of publication quality figures/tables<br>Inquiry driven practicals<br>Research project<br>Scientific poster |
| Digital and technological skills | The ability to select and use appropriate digital, AI and technical tools responsibly. This includes the appropriate and ethical use of generative AI. | Any assessment using digital tools<br>Critical appraisal of AI generated content |
| Communication | The ability to communicate science and scientific ideas to a range of audiences, including scientific experts, the general public and relevant stakeholders (e.g. in policy, media) | Presentation<br>Podcast<br>Infographic<br>Policy briefing note<br>Social media content<br>Documentary (could just be a script)<br>Blog<br>Scientific poster |
| Societal, legal and political awareness | The understanding of how societal structures and organisations influence what science is done, how it is funded, how science and policy/legislation interact and how politics influences all of the above. | Research funding proposal<br>Business proposal<br>Policy briefing note<br>Commercial report |
| Sustainable practice | The understanding of sustainability issues and how they relate to disciplinary science. Includes awareness of UN sustainable development goals (SGDs), and an awareness of the impact of plant biology on social, environmental and economic aspects of sustainability. | Problem based learning using SDGs<br>Environmental impact assessment<br>Commercial report |
| Enterprise and intellectual property | The understanding of how science is commercialised. This includes intellectual property, patents, commercial awareness and ethical business practices. | Mock patent application<br>Business proposal<br>Investment pitch<br>Commercial report |
| **Self-awareness and personal development** | | |
| Ethical and responsible conduct | The ability to work ethically, safely and responsibly, and why this matters in science and society. Includes consideration of equity, diversity and inclusion, and understanding of appropriate legislation. | Ethics assessment of proposed research<br>Risk assessment<br>Environmental impact assessment |
| Collaboration, networking, and leadership | The ability to work effectively with others, including conflict management and professional working practices. Includes working across multiple disciplines, building a personal profile, networking and leadership skills. | Group projects<br>Minutes of group meetings<br>Peer reflections on group working<br>Interdisciplinary projects |
| Career management and reflection | The ability to identify appropriate careers, apply for jobs, and build a personal profile. This includes identification of personal strengths and weaknesses and seek out opportunities for training and development | Reflective diaries/accounts<br>Mock CV and job application<br>Shortlisting of mock job applications<br>Viva/interview |

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programme design we need to be really clear on what our priorities are. We need to give students the tools to be able to uncover new knowledge, but not teach every last topic. Can we justify teaching yet another metabolic pathway or signalling network when this leaves no room for ethics or sustainability education? Plant biology is such a broad and fast moving field that no one is an expert in all areas, so we can and should be selective in what topics we choose to include (Uno, 2009). We should focus on areas that enable students to think critically, participate in authentic scientific inquiry, and make connections between taught content and 'real world' issues (Uno, 2009).

We need to think about how we teach, as lecture based teaching may be ineffective for addressing these real world skills and competencies (Gruppen et al., 2016; Uno, 2009). Competence based education requires a more flexible approach to curriculum implementation, whereby students are given time to master their skills, rather than following the inflexible pace set by an instructor (Gruppen et al., 2016). Medical and engineering education frequently use problem based learning (PBL) to integrate knowledge application with skill development (De Graaff & Kolmos, 2003; Wood, 2004). This could easily be transferred to plant biology education. For example, second year plant biologists at Hull are asked to make food security based recommendations to the government of an independent Republic of Yorkshire in 2100, having been given climate, land use and other relevant scenarios (Box 1; Hubbard et al., 2023). This type of learning requires students to develop (inter)disciplinary knowledge, and integrate it with real world competencies.

## **BOX 1** Example Competence Based Assessment: Food Security Proposal

Here I present an example of a competence based assessment used in a 2nd year undergraduate plant biology module (Hubbard et al., 2023) to illustrate how competencies might be implemented in practice.

**Assessment brief:**

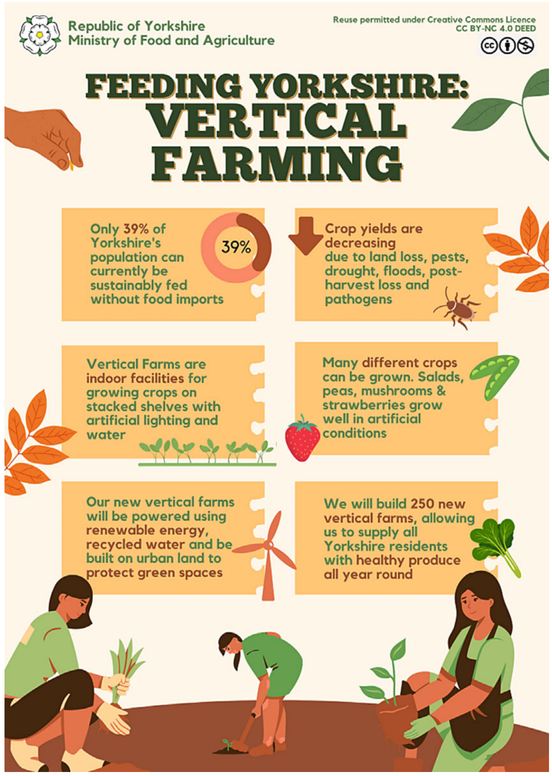
The year is 2100, and Yorkshire is an independent country. You work for the Ministry of Food and Agriculture, which is developing a 20 year food security strategy. You have access to a 'Key Facts' document contains information on climate, land use, primary crops, etc. You should write a proposal describing **one plant-based approach** to improving regional food security.

**Assessment format:**

- Part 1: 1500 word project proposal (using standardised template form), referenced appropriately.
- Part 2: Infographic presenting the same project proposal for the general population (see example).

Competencies assessed:

- Knowledge application
- Information literacy
- Communication
- Societal, legal and political awareness
- Sustainable practice




Example Infographic for Yorkshire Food Security Assignment produced using a free template and free icons within Canva (www.canva.com). Reproduced with permission.

### Notes

- This was implemented as a group project (2–3 students) but could be done individually, or as an interdisciplinary project (e.g. with geographers, engineers).
- The assignment was introduced during a taught session with industry guest speakers (a farmer, a scientist from a vertical farming company).
- Two compulsory workshops were scheduled to allow students time to discuss and refine ideas with teaching staff.
- Students were encouraged to use online tools to generate infographics (e.g. Canva, Piktochart) which include free high quality design templates so students could concentrate on content not graphic design.
- Students were required to include a Creative Commons license to indicate intellectual property.
- Students were allowed to submit a draft version of their proposal for formative verbal feedback, provided via a 15 minute 1:1 appointment with a member of teaching staff.
- The assessment could also take the form of a project pitch presentation, potentially assessed by guests from industry to provide real world authenticity.

Inquiry driven learning can also develop multiple competencies (Uno, 2009; Brownell & Kloser, 2015). At Hull we embed inquiry based projects into foundation, first and second year modules, giving all students multiple opportunities to engage in open ended discovery based science before deciding if a final year research project is the right option for them. Educators can also reimagine the final year project to include greater flexibility and authentic learning in multiple contexts, not just a traditional research project (i.e. where a student joins an established research group to work on an individual project for a period of time and writes up in the format of a dissertation or scientific paper). For example some institutions have developed a suite of 'capstone projects' covering options from laboratory research to social justice or enterprise driven projects, allowing students to demonstrate their learning in a context relevant to their career plans (Jones et al., 2020).

We also need to use inclusive pedagogies that cultivate a diverse pool of future plant biologists. Extracurricular programmes have been effective in increasing the attractiveness of plant biology (Levesley et al., 2012), but to reach all students we need to embed these competencies into core curricula. We can also combine competence based education with strategies to address underrepresentation of marginalised groups within bioscience, including mentoring, decolonisation of the curriculum and inclusive assessment (Hubbard & Gawthorpe, 2022; Miriti, 2020; Montgomery, 2020).

### 4.2 | Assessment methods

Effective competency based education relies on appropriate and authentic assessment methods (Gervais, 2016). Traditional time limited closed book exams are of limited use in assessing many of these competencies, although might still have a place if used appropriately. To embed competencies into taught courses we need authentic ways for students to demonstrate their skills, while maintaining required academic standards (Schultz et al., 2022). Authentic assessment can be interpreted in multiple ways, but typically involves modes of assessment that build skills students will need for future employment or study, and focuses on higher level synthesis and evaluation of knowledge (Schultz et al., 2022; Villarroel et al., 2018). Authentic modes of assessment might include individual or group projects, presentations, vivas or production of artefacts such as museum displays or commercial style reports. Authentic assessment often includes elements of student choice, which can also improve inclusivity. For example, 2nd year biotechnology students at Hull are given a choice of producing a podcast or infographic to explain an ethical issue in biotechnology, and can work as individuals or in groups. This gives students autonomy over how they work, and means that students with e.g. visual impairments can choose to produce the podcast without the need for an individual alternative assignment. Assignments also need to build student competence and confidence in the appropriate use of digital tools and AI as these will become skills required in multiple sectors (Ewen, 2023). However, the rise of generative AI means that assessment design must be robust to ensure it is genuinely assessing student learning (Hack & Knight, 2023), and students supported to use AI in an appropriate way that is compatible with academic integrity (Francis & Smith, 2023).

### 4.3 | Professional development, training and capacity building for educators

For educators who have little to no personal experience of either using or teaching and assessing these competencies, introducing them into curricula is a genuine challenge. As an educator who has only ever worked in academic departments, I am very aware of my own lack of knowledge when it comes to scientific policy and enterprise, which impacts on my ability to teach these important topics. Research focussed academics are increasingly developing enterprise, policy and partnership skills through knowledge exchange activities, but educators also require upskilling in these areas to be able to embed these into curricula. Research and Education focussed academics can support each other here (Tierney, 2016). Teaching focussed academics can support colleagues in developing competency driven education, while research focussed academics can support education focussed colleagues by involving them in knowledge exchange activities and partnerships. Reimagining education also requires support and training from senior management, and workloads adjusting to reflect the effort required to develop new curricula.

## 5 | CONCLUSIONS

Plant biology is an exciting discipline that really can change the world. If we can reimagine plant biology education, we can inspire the next generation and ensure a healthy pipeline of future plant biologists. If plant biology was bold in implementing competence based education underpinned by real world relevance, we may increase the attractiveness of our discipline, encouraging more students to study specialist plant biology programmes or taking more plant biology options within general biology courses. As well as training future researchers, we need to design curricula that lead to a range of careers, enabling students to use their plant science to make impact in policy, media, law, education and public engagement. The competence based framework presented here provides one model of how this might be achieved in a flexible and discipline relevant way. While I have explored this in the context of plant biology, the model is relevant to all areas of biology (and beyond); all bioscience students would benefit from this approach. Plant biology could lead the way, becoming a flagship discipline for competence based approaches. Adopting this model could maximise the value of plant biology education and empower the next generation of plant biologists to tackle global challenges and build rewarding careers.

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## CONFLICT OF INTEREST STATEMENT

No conflicts of interest relate to this article.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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