Using Infographics to Help Students Understand and Communicate Anatomy and Physiology

Derek A. Scott, PhD, FRSB and Alison McE. Jenkinson, PhD
School of Medicine, Medical Science & Nutrition, Foresterhill Health Campus, University of Aberdeen
Aberdeen, Scotland, UK AB25 2ZD
Corresponding author: d.scott@abdn.ac.uk, a.jenkinson@abdn.ac.uk

Abstract
Poster presentations to communicate scientific knowledge/understanding are a commonly used assessment tool. It can be a challenge for students (and staff!) to deliver clear information with minimal text on the poster. We have found that this format did not encourage imaginative project topics or posters. To enhance communication skills, imagination, and student engagement, we adapted an existing physiology research project and increased the emphasis on communication skills with the use of infographics. This paper describes how students may produce their own biomedical infographics and discusses the issues that educators may need to consider when integrating infographic assessments into their teaching. https://doi.org/10.21692/haps.2020.106

Key words: infographics, biomedical, assessment

Introduction
Infographics (information graphics) are a method of communicating complex information visually to a broad audience. Infographics usually use diagrams, color, symbols, graphs, or art to convey ideas to an audience, with only minimal text. They have been increasingly used by various organisations to communicate science or technical information to the general public through a variety of media such as newspapers, websites and posters (Rogers, 2012). Health providers may use infographics to help patients understand how to improve their health, seek help, or prevent disease (Arcia et al. 2016; NHS Digital 2019). Infographics benefit from a strong visual component that can make it easier for a viewer to understand the messages (Majooni et al. 2018). Davidson and Hargis (2016) have argued that infographics can be effective tools for second language learners. Infographics can be shared easily via web/social media platforms, thus increasing the reach of the author's message (Brunning 2020). Common examples of infographics include the periodic table of elements, transit maps (e.g. London Underground Map), and electoral maps. Infographics have been used to assess understanding, and creative and communication skills of several student populations (Krauss 2012; Davidson 2014; Polman and Gebre 2015; Falk 2016; Gebre and Polman 2016).

Undergraduate anatomy and physiology students are commonly asked to undertake literature research projects, reporting their results in the form of a traditional scientific conference style poster (Krilowicz and Downs 1999; Andraos-Selim et al. 2010). However, this style of assessment may only train a student in how to communicate science in that format and to a specific audience type. Increasingly, academic researchers are required to deliver their research outcomes to non-scientific audiences to encourage wider dissemination of information and outreach. Many institutions aim to provide students with broader skills to be able to communicate scientific and complex information to a range of populations, and infographics can provide a vehicle by which this can be achieved.

In addition, many students do not wish to follow a traditional scientific research career path (Choate and Long 2019) and may find that developing a traditional scientific poster is less engaging. To help students become more engaged with a physiology literature research project, we revised an existing assessment to involve students designing and developing an infographic poster to communicate their findings. We were inspired by the apparent simplicity of infographics to convey complex information. Our approach was supported by VanderMolen and Spivey (2017) who reported enhanced research skills, communication, and approach to learning when their students undertook an infographic-based assignment, with 80% of respondents preferring an infographic assessment to a written short paper. In this article, we report our experiences of this type of assessment and explain how others in our school have adapted this initial idea to meet the needs of the students in their own programs.

Materials
Students were provided with a range of different types of infographic examples they could find online and a list of references they could use to explore what is or is not effective in terms of communicating scientific ideas. A simple search engine search for ‘physiology infographic’, ‘anatomy infographic’ or ‘medical infographic’ revealed numerous examples. Learners were also encouraged to explore social
media, newspapers, or websites to understand how such outlets use infographics as part of their published content (Figure 1).

There are a range of books that focus on the use of infographics, which help to illustrate how science can be communicated effectively using such an approach (Brunning 2015; Parker and Baker 2016). Students were also directed to various online resources to help them develop infographics of their own, even if they had limited digital experience or access. There are YouTube videos that focus on drawing infographics using software such as MS PowerPoint or Google Draw, which many learners can access, as well as free versions of specialist infographic software such as Piktochart, Canva and Venngage, to name but a few.

Students were advised that they did not need to pay for more specialist access or resources, and that they were free to choose any resource they felt most comfortable with to develop their infographic. If students had issues with IT/internet access, they could use a simpler approach of hand-drawing or crafting an infographic on paper or card. The assessment was designed to incur minimal costs and use only basic or free software so that it can be used by as many instructors and students as possible.

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**What to do**

- Develop a question relating to a physiological problem.
- The infographic should be able to:
  - Give some background to the subject/question
  - Make it clear what the question is or why this is important
  - Use real scientific data from research papers to provide evidence
  - Come to a final conclusion or answer the question
  - Communicate complex information quickly to a wide audience so they actually remember what your point was and what you found, even after they go home that night!

**This physiological question could relate to any of the following areas:**

- Clinical
- Sports-related
- Pharmaceutical/pharmacological
- A special situation such as pregnancy, hypoxia, high-altitude/pressure, heat, cold etc
- A comparison with physiological processes/function with other species
- Infection/Immunity
- Disease/Injury
- Evolution/developmental
- Nutrition
- Or anything else you find interesting and can find data about!

*Figure 1.* An excerpt from the guidance provided to students when starting work on their infographics. This is part of a more extensive document that attempts to provide students with detailed instructions, structure and focus at the start of their project.

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Methods
This work was undertaken at a Scottish ‘ancient’ university where students study on a 4-year BSc (Hons) program. The majority of students enter directly from school, but there are also students who enter at different stages from technical/further education colleges, and there can be international/exchange students who are in the class for a semester or academic year. This course (PY3002 Integrative Physiology) takes place at the beginning of Year Three of the students’ degree programs. In Scotland, this would equate to Level Ten of the Scottish Credit and Qualifications Framework (SCQF) (SQA, 2020). The course is compulsory for students majoring in physiology and is a common elective for students studying sport-related programs and neuroscience. It is also offered as an elective for exchange students with a relevant academic background. Students must have previously taken courses covering fundamental cellular and organ system physiology, and they are required to have some knowledge of biochemistry and physiology.

The focus of this course is to get students thinking about how physiological systems integrate, and how we apply physiology in ‘real-life’ situations, for example in pathophysiology, athletic training, and adaptation to stressors, etc. The average class size has been approximately 50 students over the past three years. The project is led by one member of academic staff, with other staff coming to view student projects at the end of the course during a student symposium, which can be done virtually rather than as an actual physical event.

The course lasts for 11 weeks with an extra week for exam revision or final assessment activities. The course assessment involves a final exam on course material that constitutes 67% of the final grade, with the remaining 33% coming from continuous assessment activities. Students undertake three short-answer case studies in their own time (10%), two all-day practical classes involving human data capture/analysis (8%), and the infographic project (15%). The traditional heavy weighting towards a high-stakes written exam is being reviewed across our entire institution and will likely be changed for the next academic year due to the COVID-19 pandemic necessitating changes in how we teach and assess learners.

Students were told they can assume their audience are non-scientists who may have the equivalent biological knowledge of a high school graduate. Students were provided with the grading rubric to be used to assess their final infographic. Students were told to use peer-reviewed literature to inform their research and were asked to provide outline ideas about what they will research by week two of the project. Initial feedback on the project topic is provided so that students can progress with their research and infographics. Students were also encouraged to ask family and friends to provide informal feedback on the effectiveness of their infographic throughout so they can assess whether they are pitching the content of their infographic correctly for the audience for whom it is intended. This interim feedback approach has been used by VanderMolen and Spivey (2017), and was considered by Blackburn (2019), to mitigate any concerns by students with regard how to tackle what can be a very different form of assessment for them. We stressed that this is not an art assignment, a concern that had been raised in the study undertaken by Blackburn (2019) when working with chemistry students.

At the end of the project research period, students sent the file or link to their infographic to the instructor for assessment. The infographic could either be printed out for viewing or posted on a class virtual learning environment/social media account (e.g. Twitter). The infographic was then graded by the instructor using the published rubric. We encouraged peers (for 5% of the final assignment grade) to provide a wider range of constructive feedback and also display the infographics on poster boards during a ‘mini-symposium’ so authors can gather opinions from a range of peers, graduate students and faculty. Finally, to more formally assess student writing skills, students submitted a one-page abstract summarising the content of their infographic and providing detailed supporting evidence for the content. The grading rubric for this abstract was published in advance. The final grade for the assignment was derived from the following elements:

1. Instructor’s grade for the infographic poster - 75% of assignment grade.
2. Peer grade for the infographic poster – 5% of assignment grade.
3. Formal written abstract to summarise project - 20% of assignment grade.

Similar grading rubrics to assess student infographics have been used by Blackburn (2019), Davidson (2014), and Davidson and Hargis (2016), with Blackburn (2019) also stressing the need to include some written component of assessment if students are expected to demonstrate mastery in future learning activities. All learning/guidance materials for the entire assessment were placed on the learning...
management system/virtual learning environment so that students could access them at any time.

Ethics/IRB approval was not required for this project as all data discussed were derived from the University’s central anonymized course review that was conducted independently from the authors. Any material from this course review can be published and is freely available. This material was also an audit of an assessment activity that was already taking place. All quotes were derived from the course review documentation or the student-staff liaison meeting, again where the authors were not present to influence any comments. Anonymised material from these meetings may be published and are freely available. In addition, examples of student work included in this study are permitted to be published and have already been made publicly available via the class social media account. The examples provided have been anonymised by the authors.

**Assessment**

The grading of this activity can be based upon criteria such as participation, acquisition of new skills, completion of required tasks, demonstration of understanding of the topic, strength of the peer-reviewed evidence, ability to communicate ideas/concepts effectively, awareness of accessibility issues when designing the infographic (e.g. for those with color blindness/visual impairment). An example rubric that can be used by instructors or peers is provided in Figure 3. The rubric was provided to students at the start of the project to ensure that they clearly understood how they would be assessed.

**Figure 3.** Example grading rubric used by faculty and peers to assess infographic.
This activity can enable students to achieve multiple HAPS Learning Outcomes depending upon the specific topic/organ systems that they choose to investigate. In addition, this assignment allows students to meet all the HAPS Content Integration Goals and the Cognitive Skill Development Goals (HAPS 2020). The most prominent of the HAPS Goals achieved by students are:

1. Use appropriate terminology to discuss anatomy and physiology.
6. Propose evidence-based hypotheses to explain physiological responses or the functions of anatomical structures.
7. Apply knowledge of anatomy and physiology to real-world situations.
9. Interpret and draw appropriate conclusions from graphical and other representations of data.
10. Apply information literacy skills to access and evaluate peer-reviewed resources.
11. Approach and examine anatomy and physiology issues from an evidence-based perspective.
12. Adapt information to effectively communicate with different audiences.
13. Recognize that our individual differences (ethnicity, gender, culture, etc.) shape our understanding of anatomy and physiology.
14. Foster respect for individuals across differences within educational and professional settings.

Overall, the assessment approach should help students understand expectations about the balance between demonstrating academic knowledge and understanding and imparting that knowledge in an easily digestible format for a non-specialised scientific audience.

Student Feedback on Activity
The first cohort of students to undertake this exercise reported in class that they wanted clear criteria regarding the audience for the infographic. They felt this would make it easier for them to make decisions about the content of the infographic, the amount of detail required, and the overall design of the infographic. For example, an infographic for a young child might use different images/language/color than one designed for an older professional with more knowledge of science. Based on this feedback, more detailed guidance was provided. A similar approach was used by Davidson and Hargis (2016) when their students requested more context to help stay focused when creating their infographics.

Further detailed feedback on this activity has been gained through student-staff liaison meetings and anonymised course evaluation forms over the last five years, with modifications/improvements being made to the assessment to enhance the learner experience. This activity is used with a class that has a diverse student population including:

1. Students who have studied at the institution for the past two years
2. Students who have come directly from a further education (community) college into this course.
3. International exchange students.
4. Students majoring in physiology, sport science (kinesiology) and neuroscience, with some students from other non-biomedical departments taking this course as an elective.

Allowing students to choose an area of anatomy or physiology that suits their own interests enhances engagement and means that students can develop knowledge and skills linked to their future career intentions. For example, students keen to follow a clinical career often study a pathophysiological topic and a military cadet explored injuries caused by improvised explosive devices. The novelty of the experience for everyone in the class encourages informal discussion and can help new students integrate more effectively.

When considering the feedback provided by students during the project and from class evaluation surveys/meetings, several comments seem to have consistently appeared over the past five years. Quotes were extracted from the anonymised university-administered course evaluation surveys conducted independently from the faculty involved; these are public documents and anonymised data/quotes may be published without ethics/IRB approval:

“This project has allowed me to be creative whist still doing science.”

“It’s not the science bit that’s hard, it’s how you pitch it at the correct level that’s the difficult thing!”

“I found this more enjoyable than doing a traditional science poster.”

“I can remember what people’s infographic posters were about weeks later, but I can’t remember what anyone has done in a traditional scientific poster.”

“It’s easy to think this is simple, but it does take a bit of planning and work. I probably needed to manage my time a bit better and not leave producing the final infographic until the very end.”

“I appreciated the freedom of choice in this project – I could combine something I was really interested in outside of my academic studies with physiology.”

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“I have been using these new skills to help the societies and organizations I am involved with.”

“Could teachers use this as a way to summarise the key points of a block of lectures or a practical class?”

“Since doing this project I realise that infographics are everywhere.”

In response to some of the comments received over the past few years, we have provided students with a basic project plan at the start of their projects to help them manage their time and workload more effectively. This outlines the key milestones that they should have achieved by each week if they wish to stay on track and submit on time without a last-minute rush.

We have also added in a final feedback session where we ask students to reflect upon the skills they feel they have enhanced or learned, and how they might use this experience to improve their résumé. This discussion always provides examples of how students have enhanced their employability. For example, how they have used the skills outside of the classroom or how students have learned advanced IT/time management skills etc. Davidson and Hargis (2016) also reported improved awareness and development of transferable skills within their student population after undertaking an infographic-based assessment.

Other small changes that were introduced in light of feedback and experience was the format of citations within the infographics. Our school usually prefers the Harvard citation style for student assignments, but this can take up space and add too much text to an infographic. For this assignment, we allowed students to either use the numerical Vancouver citation format, or to provide a separate list of their citations if it was felt that the citations within the infographic might reduce its visual impact.

During the first trial of this assessment it also became clear that some students developed long infographics that were more suitable for scrollable webpages, whilst others were more appropriate as a poster or A4 brochure. We allowed such diversity but made it clear that students must have an appropriate rationale for their choice of format. Colleagues who have adapted this activity for their own purposes have chosen to specify formats appropriate for their class and the focus of their assignments. Examples of student-created infographics are shown in Figures 4 and 5, with other student-authored examples published by Blackburn (2019) and Davidson and Hargis (2016).

Figure 4. Example infographic created by a student during their project.
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In terms of student attainment and satisfaction, when this assessment was introduced 42/44 students achieved a grade within the 70-100% range, with the average grade being 72.0 ± 4.8 % (error values represent standard deviation). During the previous traditional scientific poster assessment, the average grade was 63.0 ± 1.3 %, with only five students scoring within the 70-100% range (n=47). As a comparator, the average written course exam grade (four essays over three hours) was 58.1 ± 2.6 %, and the average overall course grade was 67.0 ± 6.0%.

Infographics were double marked to minimise any risk that we had lowered academic standards when grading this novel assessment. In terms of student satisfaction, 90% of students (n=44) rated the infographic assessment at either four or five on a five-point scale, where five indicated that it totally met their learning needs.

When considering why students were achieving higher grades, faculty suggested that students were better at communicating the science in a clearer way than with the previous conference poster format. Another comment was that the students were no longer including excessive information and text and that the new format was forcing them to be more selective in the information they presented.

Instructor Feedback on Activity
Staff feedback has been focused on how creative and imaginative the students were, and the sheer range of topics that have been researched each year. With our previous traditional scientific poster session, it was common to have students researching very similar topics and there would be repetition every year. Since the introduction of the infographic format, none of the >250 projects have been identical. Examples of teacher feedback (derived from student-staff liaison committees and informal feedback at the poster symposium) include:

“[Teacher feedback comment]”

Figure 5. Example infographic created by a student during their project.
“Amazing topics that I would never have thought about. We used to regularly get students doing the same thing i.e. effect of caffeine on heart rate, but some of these topics are truly advanced.”

“The students are so creative – you can see they are really passionate about their subjects and they have learned skills that they could use as part of their future careers.”

“The students seem to worry less about the complexity of the science they are presenting but worry more about how effectively they are communicating it.”

“This has made me wonder whether I should review how I present complex information in my lessons or at conferences. How many people actually remember what I present in its current form the next day?”

Permission was granted by staff to use anonymised quotes. Anonymised comments from staff-student liaison committees are published and can be reported without IRB/ethics approval.

The originality shown by the students in developing infographics and selecting appropriate information echoes similar results reported by Blackburn (2019). Due to the success of this activity and the positive feedback from instructors and students, similar assignments have been created by colleagues for classes with very diverse international graduate populations, such as our Master of Science programs. One of these class assignments related to drug discovery and clinical pharmacology. The students in this class were given a very specific brief that they must produce a one-page A4 infographic that should act as a drug company handout and social media post. Their task was to communicate why a specific drug being trialled should receive more investment. Their audience was specified as a business investor with no science background. Another class focused on diabetic physiology and the students in this class produced an infographic that educated a diabetic patient about some aspect of their care or monitoring. These graduate level classes completed their work over four weeks and similar positive feedback from staff and students have been received in relation to these assignments.

Limitations and Future Developments

Despite the success of these activities, there are some caveats that an instructor should be aware of. Firstly, some students can find too much choice overwhelming. Therefore, a feedback session with students within the first two weeks can be helpful for students in narrowing down a topic or focusing on a specific question. Some students will try to cover too large a topic as their project, whereas others may choose something so specialised that it can be difficult for them to find a variety of peer-reviewed references to support their project work. Early informal feedback sessions can be useful to support those students who are new to an institution and are still dealing with the challenges of studying in a different environment.

It should be made clear from the very start that this is NOT an art assignment. The early publication of a detailed grading rubric can reinforce this and help students stay on track and assess for themselves whether they are achieving the learning outcomes associated with this activity. We also stress that students should try to use commonly available or free resources whenever possible, mainly to avoid any student feeling they cannot participate because of financial concerns, but also to highlight that these are useful skills and resources for when they leave the university environment.

In terms of the tools and software that students use, some will report that they find the free resources limiting in terms of templates, or that it may be harder to use if their primary device is a tablet. We provide reserved time on classroom PC’s to avoid such problems and access to more advanced templates is becoming less of an issue now that a greater range of free infographic templates are becoming available for PowerPoint. There are instructional videos freely available online to help students make their own creations without a template.

One issue that may not be immediately obvious to some students is that their infographics should be designed to be read or understood by those with accessibility issues. We have altered our grading rubric and introductory materials to highlight that font, color, and format may pose issues for individuals with color blindness, visual impairment, or learning disabilities, which encourages greater awareness of these issues.

The participation of international exchange students often means that the class gets to learn about topics that are of major importance in parts of the world they may know little about. For example, previous international students have produced infographics about diseases that are more prevalent in their home country, or compared animal experimentation legislation between the UK and their country of origin. This diversity adds to the educational experience of the class and can mean that we cover far more specialist anatomy and physiology during the course than we normally would during scheduled classes and homework.

In terms of future improvements to our infographic assessments, our current work is focused on ensuring that such projects can still be undertaken effectively in blended or online mode should that be necessary due to future limitations posed by the impact of COVID-19. We propose to...
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dvelop a series of short instructional videos hosted on our learning management system to help students start their projects even if they cannot attend classes in person.

We have also undertaken some limited work using infographics as part of various Honors research projects. These projects have involved creating large scale infographics to form a public exhibit that educates the public about key figures in biomedical research entitled ‘Women in Physiology’, and the creation of educational training posters for healthcare providers to improve their ability to diagnose delirium in older adults.

In addition, we are increasingly seeing infographics being included as part of the summary of the research work or as a mechanism to disseminate the outcomes to a wider audience. Further student-led work has developed a range of infographic information panels throughout our university botanic gardens to educate the public about the health and experimental uses of various molecules derived from plants. A separate project developed gamified revision resources that used infographics to help students remember the names and actions of drugs.

Conclusion

Our experiences have shown that infographic-based assessments can enhance student creativity, engagement, and communications skills when studying anatomy and physiology. Our initial use of them during a student literature research project has led to other applications throughout our curricula and provided a new way to assess student appreciation of biomedical concepts and evidence their wider graduate attributes.

About the Author

Derek Scott is Professor and Chair of Physiology & Pharmacology Education in the School of Medicine, Medical Sciences and Nutrition, University of Aberdeen. He teaches aspects of physiology, pharmacology and developmental biology at both the undergraduate and graduate levels and is actively involved in education development through the Physiology Society of Great Britain.

Alison Jenkinson is a Professor in the School of Medicine, Medical Sciences and Nutrition at the University of Aberdeen and Dean for Widening Access, articulation and Outreach. In addition to investigating practical examination assessments, Alison also explores the role of free radicals and antioxidants in disease.

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