

ARTICLE

An Attitudinal Survey of Undergraduate Neuroscience Students Regarding Their Views on the Relevance of Lectures to their Education**Gerard W. O’Keeffe¹, Aideen M. Sullivan¹ & Marian M. McCarthy²**¹*Department of Anatomy and Neuroscience, University College Cork, Cork, Ireland;* ²*The Centre for the Integration of Research, Teaching & Learning (CIRTL), University College Cork, Cork, Ireland.*

Advances in technology have seen a significant growth in the integration of e-learning into university education. Coupled with this trend are the learning approaches used by “Generation Connected” or GenC students, whose prolific use of digital technology is a defining characteristic. This has resulted in questions being asked as to whether in-class university lecture time is still relevant to university education. Here we conducted a case study with a group of undergraduate neuroscience students to assess their views on the relevance of attending lectures, why they attend or the reasons for non-attendance, and on what makes a good lecture. This is with a view to informing the design of new teaching approaches that may be more beneficial in maximising student engagement, and facilitating learning.

Significant advances in technology have led to the increasing integration of e-learning in university education in recent years (Trelease, 2016). Furthermore, there have also been changes in the learning strategies used by undergraduate students who are now part of “Generation Connected” (GenC). One of the defining features of GenC is their prolific use of digital technology (Friedrich et al., 2010). This is reflected in studies showing that more than 80% of university students own three or more devices that are Internet-ready (Caruso and Salaway, 2007; Smith and Caruso, 2010; Vedantham and Hassen, 2011). Coupled with this changing student demographic, has been the rise of the debate regarding the usefulness of the academic lecture. Equally in the science, technology, engineering and math fields (STEM), there have been significant changes in teaching practices with many universities eliminating traditional lectures and replacing them with small classes in peer-led learning formats. Previous work on the development of causal reasoning skills in the sciences suggests that lectures should invite students to analyze the modes of inquiry that scientists engage in and then reflect on what this means for their own scientific thinking (Wong et al., 2009). This has led to a debate regarding the usefulness of traditional lectures versus active learning in university education (Freeman et al., 2014).

The role of the traditional lecture in STEM has been the recent focus of a meta-analysis of 225 studies examining the effectiveness of traditional lectures versus active learning approaches in undergraduate STEM courses (Freeman et al., 2014). This study concluded that students in courses with traditional lecturing were 1.5 times more likely to fail than students in classes with active learning (Freeman et al., 2014). However, lectures have been the main form of instruction since the first universities were built (Brockliss, 1996). Is this a case of the classical signature pedagogy of

The survey instrument was a ten-item questionnaire that collected both qualitative and quantitative data. Over 90% of students were of the view that lectures were beneficial to their learning, while only 4% thought they were an outdated mode of education. Three main themes emerged when students were asked what makes a good lecture: 1. Engagement, 2. Time, and 3. Varied format. We discuss the implications of these findings and suggest how these student views could be woven into the design of teaching approaches to increase the relevance of in-class lecture time in undergraduate neuroscience education.

Key words: Neuroscience; Undergraduate; Education; Pedagogy; Lecture; Relevance; Engagement; Attendance.

university education persisting as a result of historical norms even though it has lost its utility (Shulman, 2005)? Perhaps the problem is not with the lecture format per se, but rather with the type of teaching approach used therein. As suggested by McCarthy, lectures require pedagogical framing instead of presentational packaging, and must rise to the challenge of prioritizing student understanding, or become outmoded (McCarthy, 2008). Perhaps rather than the monolithic debate of “lecture or no lecture,” the debate would benefit from a focus on whether students still find lectures useful, what factors influence their decision to attend lectures, and what they consider makes a good lecture. The need for this is reflected in recent work showing that many neuroscience students often favor lecture sessions over active learning approaches, including group work, peer-review sessions and quizzes (Nagel and Nicholas, 2017). Understanding the reasons why this is the case is the focus of this study. Our view is that by understanding why students find lectures useful, and why they are most likely to attend, this will be useful to faculty who teach neuroscience. It may also be helpful to consider student opinions on the lecture format when designing or implementing new modes of teaching and learning in order to maximize student engagement.

While it is expected that students across disciplines may share overarching common views, it is important that individual disciplines gather discipline specific student feedback. Here we carried out an attitudinal survey of fourth-year Bachelor of Science (BSc) undergraduate students majoring in neuroscience, regarding their views on the relevance of attending lectures, why they attend or not, and on what makes a good lecture. We discuss the implications of these findings, and how they might be useful for faculty in the development or refinement of the lecture format in undergraduate neuroscience education.

MATERIALS AND METHODS

Survey population

In November 2015, all fourth-year students (n=24) enrolled in the BSc Neuroscience program in the Department of Anatomy and Neuroscience at University College Cork, Ireland, were invited to complete an entirely anonymized survey. Seventeen participated for a 71% response rate. Lectures in the neuroscience curriculum at our institution are one hour in duration. Lectures are supported by the University's web-based learning portal. From this platform lecture presentations, practical laboratory guides, learning resources and announcements are posted in advance or immediately after the lecture / laboratory sessions. Lecture delivery has some integration of multimedia systems, including video clips depending on the particular course. Academic-led social media is not actively integrated into the neuroscience curriculum.

Survey instrument

The survey instrument was a ten-item questionnaire which collected quantitative information using multiple choice questions, or 5-point Likert scales. The survey instrument has been designed and developed by institutional colleagues in a previously published survey used to assess the relevance of lectures in engineering education (Fitzpatrick et al., 2011). With regards to questions on their views on lectures, students were also given the opportunity to comment on their answer. Given the low number and mixed variety of questions, we could not calculate the alpha co-efficient and Kendall Tau b to support reliability and validity. However, as this survey has passed a peer review process (Fitzpatrick et al., 2011), it has face and content validity as a result. The survey was checked for ease of understanding by a colleague, and was first issued to three graduate students and no issues were found.

Data analysis

All data from Likert scale questions were converted to ordinal data with 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree. These data were entered into GraphPad Prism 6 (GraphPad Software, Inc., San Diego, CA) or exported to the Statistical Package for Social Scientists (SPSS), version 22 (IBM Corp., Armonk, NY). Descriptive statistics along with Pearson's Chi-squared tests (X^2) tests were carried out to assess significant deviations in preferences from chance, which we define as equal numbers of students selecting each answer to a question. Preference for a particular answer was assessed relative to the total number of expressed preferences for each question. Data were considered to be statistically significant at $p < 0.05$. Student comments were entered into Word, version 14.0 (Microsoft Corp., Redmond, WA) and a thematic analysis was performed manually.

RESULTS

Students view lectures as beneficial to their learning despite significant online activity.

All students were enrolled in the fourth year of the BSc Neuroscience program prior to completing the survey. All

students owned at least two internet-ready devices, with just under 50% of respondents owning three or more. We also assessed whether students used the sites Wikipedia® and YouTube® in their study of Neuroscience as we have previously discussed the pitfalls and potential of these approaches (Barry et al., 2016a; Barry et al., 2016b). 59% of students confirmed that they used Wikipedia®, while 88% confirmed that they used YouTube® in their study. Students were next asked to rate their level of agreement on a 5-point Likert scale (with three statements), whereby one indicated they strongly disagreed with the statement, and five indicated that they strongly agreed with it.

Statement 1. "I think lectures are beneficial to my learning."

94.1% of students had a positive response (agree or strongly agree) when asked if lectures were beneficial to their learning (mean Likert score = 4.47) (Fig.1A, B). X^2 testing on the overall number of responses showed a strongly significant deviation ($X^2 = 23.3$, $df = 4$, $p = 0.0001$). Of all five choices, "Strongly Agree" showed the largest number of expressed preferences (58.8%), indicating that this choice was the most strongly favored by the student population. Students were also asked to comment on their answer; selected examples are shown below grouped by their level of agreement with the statement shown in parentheses (e.g., (5) = strongly agree).

- "Depending on the lecturer → personalised explanations help with understanding." (5)
- "I find it easier to take in information when someone is explaining it to me." (5)
- "Information is easier to remember and understand when lecturers go through it." (5)
- "They provide information and you can ask specific questions." (5)
- "Gives an opportunity to ask questions and confer with classmates." (4)
- "Some lecturers just read off their slides – kind of pointless at times." (4)
- "Often find they move too fast. I learn visually." (3)

Statement 2. "If the lecturer provides a good set of notes on the material covered in the module, then there is no real need to attend lectures."

Only 23.5% of students had a positive response to this statement (mean Likert score = 2.41) (Fig.1A, B). Of all five choices however, "Disagree" showed the largest number of expressed preferences (47%). Students were also asked to comment on their answer; selected examples are shown below, grouped by their level of agreement with the statement (e.g., (1) = strongly disagree).

- "Just reading sometimes makes it more difficult to truly learn – having someone to explain and answer questions is essential in my opinion." (1)
- "I struggle with visual learning (diagrams) and lecturer's explanations help hugely when no text is provided." (1)
- "Sometimes the way they say it out loud explains it more clearly, hearing and reading it covers it twice, more likely to remember." (2)
- "Notes are all I work on anyway though I am aware that won't apply to most." (3)

- “If notes are the actual lecture other than supplementary it can be confusing coming to lectures where the lecturer just reads from the slides or goes off-topic.” (4)

Statement 3. “Lectures are now an out-dated mode of education in the modern world of information technology, distance learning and self-directed learning.”

In keeping with the overall trend, no student had a positive response to this statement (mean Likert score = 1.82) (Fig.1A, B). Of all five choices, “Strongly Disagree” (41%) and “Disagree” (35.3%) showed the largest number of expressed preferences. These data clearly show that students still hold a positive view on the relevance of lectures, despite their use of on-line resources. Students were also asked to comment on their answer and selected examples are shown below grouped by their level of agreement with the statement.

- “Lectures help give a personal touch to learning and allow students to become more aware of the departments work.” (1)
- “Technology such as internet pages and YouTube do aid in learning but it's difficult to get the basics from them.” (1)
- “Having a lecturer who is knowledgeable about the subject to ask questions is very important.” (2)
- “They offer a face to face way of learning. Essential I believe. Rarely is there a class where I don't ask questions.” (2)
- “Still important but technology has certainly devalued them a bit.” (3)
- “Much of the info can be found online, but the context and helpful examples are conveyed in class.” (3)

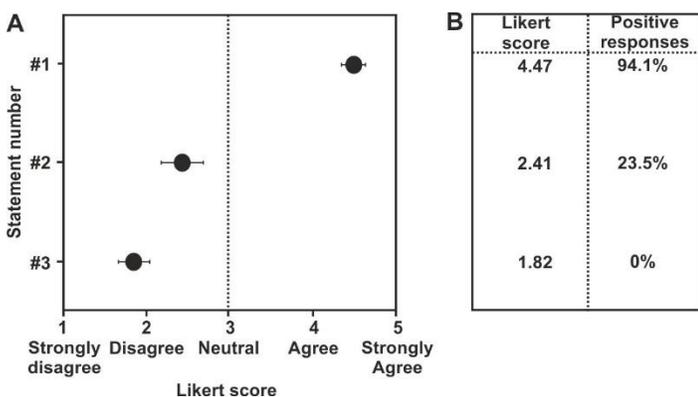


Figure 1. Student views on lectures. **A.** Students were asked their views on lectures in a pre-module survey using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The graphs show Likert scale data represented as the mean score from statement 1, 2 and 3. Error bars represent the standard error of the mean. **B.** Also shown are descriptive stats showing the mean Likert score and the percentage of positive responses indicating those that agree (4) or strongly agree (5).

Factors influencing student attendance at lectures.

Having determined that students found lectures to be beneficial, we next examined the factors that influenced their decision to attend lectures, or the reasons why they did not. For this, students were asked the following question and

given a choice of 15 response options and asked to tick all that apply. For a complete list of the options students could select from for each of the following questions, see (Fitzpatrick et al., 2011).

- If you do not attend lectures of certain modules regularly (i.e., every week), tick any of the following reasons below if they contribute to the reasons for not attending.

In the next question, students were asked the following question and given a choice of 11 response options and asked to tick all that apply;

- If you do attend lectures of certain modules regularly (i.e., every week), tick any of the following reasons below if they contribute to the reasons for your attendance.

Interestingly, the top three reasons why students stated they did not regularly attend lectures were as follows. The percentage of students who selected these answers is shown in parentheses.

- Continuous assessment deadlines and in-class exams from other lecturers means I concentrate on these rather than lectures (47%).
- Part-time job makes it difficult to attend lectures (41%).
- Do not gain much benefit from lectures (35%).

So, based on this, students appear to not attend lectures as a result of time and course pressures, economic reasons and a perceived lack to benefit from attending. Interestingly the top three reasons why students did attend lectures were as follows, with percentage of students who selected these answers shown in parentheses.

- I feel that I would miss out on something important if I miss lectures (94%).
- Good standard of teaching (82%).
- Attending lectures helps me understand the course material a lot better than just reading through the module notes (71%).

So, for courses where students did attend regularly, they appear to do so mainly due to fear of missing something important, and they feel that attending lectures helps them to understand the course material. They are also more likely to attend if they perceive there to be a good standard of teaching. These data are interesting in that in courses where they do not attend, one of the main reasons for doing so is that they feel they do not derive much benefit from lectures, but they are more likely to attend if they perceived a good standard of teaching. Given this, we next sought to understand what it is about a lecture that students perceive as being “good.” To do this, students were invited to write in their own words a comment on the following statement:

- What in your opinion does a really good lecture consist of? Please comment.

The students’ responses were collated, entered in Word and a thematic analysis was performed to identify any recurring or common themes in these responses. We identified three themes; 1. Engagement, 2. Time, and 3. Varied format. Each one of these three themes is shown below with student comments listed under each theme. Words in each student response that demonstrate the alignment with each theme have been underlined.

1. Engagement:

- “A lecturer that interacts with the class and asks questions and opinions.”
- “When the lecturer engages the class and asks us to think rather than talk at us.”
- “A lecturer that does not just read off the PowerPoint but goes out of their way to ensure understanding.”
- “Actively engage the class – it is hard but keep trying. Keep asking us questions so that even if we are not answering, it will still spark off ideas.”
- “Engaging the class; Discussion, debates.”

2. Time:

- “A concise, precise breakdown of an isolated topic. Less topics covered and at slower speed.”
- “Clear and accessible online notes, additional important information in class with time to make notes.”
- “Allow time for students to take notes in class (i.e., don’t speed through the whole lecture).”
- “Lecturers shouldn’t cover more than is possible in the time frame of the lecture and end up rushing.”

3. Varied format:

- “Ties in ideas, concepts from other areas of the course into their lecture so we can see how things relate and will therefore be able to make connections ourselves.”
- “Good videos to explain concepts/mechanisms (for visual learners).”
- “Including short videos to help visualise certain things that can be complicated.”
- “Video animations.”
- “Give links to students for later studies.”
- “Diagrams are my enemy. Text heavy accompaniments to diagrams are always much appreciated.”
- “Extra content provided outside of slides shown in the lecture.”

These responses show that students value lectures in where there is engagement with the lecturer, where they have sufficient time, and where the lecturer provides or uses multiple entry points into the material.

DISCUSSION

In this study, we find that students overwhelmingly find lectures to be beneficial to their learning. We also found that they were likely to attend if there was a good standard of teaching, and that they equate good teaching with active engagement. Specifically, we found that 94.1% of students had a positive response (agreed or strongly agreed) when asked if they thought that lectures were beneficial to their learning. These findings agree with a study by Fitzpatrick et al. who found that 79% of students who were enrolled for a Bachelor of Engineering degree in Process & Chemical Engineering had a positive response when asked if they thought that lectures were beneficial to their learning (Fitzpatrick et al., 2011). We found that only 23.5% of students had a positive response to the statement that there was no need to attend lectures if a good set of notes was provided. This again largely agrees with Fitzpatrick et al., who reported only 28% of students had a positive response

to this statement (Fitzpatrick et al., 2011). In our study, no student either agreed or strongly agreed that lectures were an outdated mode of education while Fitzpatrick et al. reported only 8% of students had a positive response to this statement (Fitzpatrick et al., 2011). These results are also reflected in the student responses in each study. For example, Fitzpatrick et al. reported that one fourth-year student commented;

“Only so much can be learned online or through podcasts. Lectures allow for clearer explanations of material. Before the exams, its helps to be able to picture the lecturer talking about the topic in question” (Fitzpatrick et al., 2011).

This is also reflected in our current study in students’ comments such as: “*Technology such as internet pages and YouTube do aid in learning but it’s difficult to get the basics from them*” and also that “*Much of the information can be found online, but the context and helpful examples are conveyed in class.*” Collectively these data show that Neuroscience students still find lectures to be beneficial to their learning and are not an outdated mode of education in a modern world of technology.

We also sought to assess the factors influencing the decisions of Neuroscience students to attend lectures. The top reason given for attendance was that students felt they could miss out on something important if they missed lectures. A study of 245 undergraduate engineering students found that that the top reason students gave for why they attended lectures was that they “*will learn something that is not available online (such as: hands on experience or demonstration, face-to-face feedback from the instructor and the students).*” (Alam and Jackson, 2013). There are parallels between these studies in that students feel they would or could miss something important if they do not attend lectures. It is also interesting to note that one student in our study used the same language when describing lectures, saying “*they offer a face-to-face way of learning.*”

Interestingly, our findings on the top reasons for students not attending lectures are also in agreement with a previous study (Fitzpatrick et al., 2011). Students also stated that continuous assessment deadlines and in-class exams from other lecturers meant they were unlikely to attend. Intriguingly, in both studies, the third most popular answer was that students do not gain much benefit from lectures. This is also reflected in the reasons why students do attend lectures, as “*a good standard of teaching*” was in the top three reasons in both studies (Fitzpatrick et al., 2011). While it could be argued that this is a local phenomenon as both studies were carried out in Ireland, the overall conclusion is also supported by other work in this area. In 2006, Clay and Breslow surveyed 47 undergraduate students at MIT on their attitudes towards attending lectures and reported the relative importance of factors used to decide on lecture attendance (Clay and Breslow, 2006). They found that the top four factors in their decision to attend a lecture were: 1) the quality/clarity of the lecture, 2) deadlines for other academic work, 3) use of relevant examples, and 4) lecturers’ ability to engage/entertain. What is common

between all of these studies is the quality or standard of teaching in a given lecture. Also in agreement with the Clay and Breslow study, we found that deadlines for other academic work were a significant factor in influencing students' decision not to attend a lecture. Furthermore, students also in the Clay and Breslow study were asked to provide recommendations for ensuring high attendance rates. The students' suggestions from their study included:

- *"It's a real pleasure to be able to walk out [of class] ... and know what happened, and how it all fits together.... One way to do this might be to finish the lectures by stepping down from the position of professor, and taking the view of the students, to try to talk more on a level with them. As a 'student' [the professor] could run through everything he had 'learned' in that class, describing it in broad, quick strokes. Then the students could leave, confidently knowing that what seemed so new and overwhelming just a few [minutes] ago could be explained very simply."* (Clay and Breslow, 2006)

Interestingly, this suggestion also mirrors those of students in our survey who also suggested that in a good lecture, the lecturer should:

- *"Speak to students in a less formal manner. Makes topics more relevant to students and day-to-day living."*
- *"Speak to students rather than just lecturing."*

Interestingly, the parallels between these studies suggest that engagement of faculty with students in the teaching environment would have a positive impact on attendance. This is supported by a large national study showing that students report higher levels of engagement and learning at institutions, and on courses where faculty members interact frequently with them on issues related to their learning, and challenge students academically (Umbach and Wawrzynski, 2005). However, it seems that engagement is not sufficient and this is highlighted by one student in the Clay and Breslow study who stated that;

- *"[T]o make the lectures useful, the new knowledge must be integrated into what we already know. ... [It] must be continually related back to known material, so the students can make the small connections that keep the new facts/concepts tied into the existing knowledge structure"* (Clay and Breslow, 2006).

Again, this suggestion of relating new ideas and concepts to other areas of the course and to students' prior knowledge was also mirrored by a student in our study who suggested that a good lecture should:

- *"Ties in ideas, concepts from other areas of the course into their lecture so we can see how things relate and will therefore be able to make connections ourselves."*

This is interesting when one considers the work of Grotzer and colleagues, who proposed that in order for students to develop their causal reasoning skills, lessons should invite students to analyze the modes of inquiry used by scientists, before reflecting on what this means for their own scientific thinking (Grotzer, 2003; Wong et al., 2009). Equally when these statements are considered in the context of the revised Blooms taxonomy, students are

referring to the relationships between factual knowledge, that is knowledge of the basic elements of the discipline, and conceptual knowledge, which is the inter-relationships between individual aspects of factual knowledge (Krathwohl, 2002). As one student in the current study put it, a good lecture should be one such that they can see how things relate and are therefore able to make connections. There is also a metacognitive element to these statements, in that they suggest that students are more likely to attend lectures in which there is scope for them to reflect on how they know and why they know. This type of metacognitive experience has been shown to be important for developing conceptual understanding in science (Schraw et al., 2006; Zepeda et al., 2015). This suggests that providing opportunities for reflection may ultimately benefit the lecture process.

Study limitations and future directions

One limitation of this study is that the class size (n=24) in the 4th year BSc Neuroscience program is relatively small. Therefore, the quantitative analysis presented in this report would be improved by surveying students over several years to increase the numbers for quantitative analysis. That said, the quantitative analysis is supported by student comments. This can be summarized as students still find lectures beneficial to their learning. These conclusions while supported by the evidence, need to be interpreted with some care in that students are being asked their views on a teaching format that has formed the predominant mode of teaching in their university education. Asking them to comment on whether lectures are still useful to them is confounded by the fact that they have little experience of other forms of teaching for comparison.

So, what is the relevance of this study to the "lecture versus no lecture" debate for neuroscience education? Active learning approaches such as the flipped classroom that have advanced and advocated the concepts of "discovery learning" and "active learning," have been shown to promote both student engagement and learning (Prince, 2004). While in our view, these approaches are very beneficial, it should be noted that in a recent study, Jensen et al. reported that the flipped classroom is not superior to the traditional classroom when both utilize an active-learning, constructivist approach, and propose that learning gains in either condition are most likely a result of the active-learning style of instruction (Jensen et al., 2015). This suggests that it is not the lecture format per se is the problem, but rather the teaching approaches that are used therein. As a student put it, *"ask us to think rather than talk at us."* In this issue (O'Keeffe et al., 2017), we also report how we designed and implemented a new teaching approach in an undergraduate neuroscience course incorporating some of the feedback received here.

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