

## Social media and anatomy education: using Twitter to enhance the student learning experience in anatomy

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Research Report

**Social Media and Anatomy Education: Using Twitter to enhance the student learning experience in anatomy**

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Running title: Use of Twitter in anatomy education

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## ABSTRACT

Neuroanatomy is a difficult subject in medical education, with students often feeling worried and anxious before they have even started, potentially decreasing their engagement with the subject. At the University of Southampton, we incorporated the use of Twitter as a way of supporting students' learning on a neuroanatomy module to evaluate how it impacted upon their engagement and learning experience. The #nlm2soton hashtag was created and displayed (via a widget) on the university's virtual learning environment (VLE) for a cohort of 197 Year 2 medical students studying neuroanatomy. Student usage was tracked to measure levels of engagement throughout the course and frequency of hashtag use was compared to examination results. Student opinions on the use of Twitter were obtained during a focus group with eleven students and from qualitative questionnaires. The hashtag was used by 91% of the student cohort and, within this, more students chose to simply view the hashtag rather than make contributions. The completed questionnaire responses (n = 150) as well as focus group outcomes revealed the value of using Twitter. A negligible correlation was found between student examination scores and their viewing frequency of the hashtag however, no correlation was found between examination scores and contribution frequency. Despite this, Twitter facilitated communication, relieved anxieties and raised morale, which was valued highly by students and aided engagement with neuroanatomy. Twitter was successful in creating and providing a support network for students during a difficult module.

**Key words:** neuroanatomy education, undergraduate education, medical education, social media, Twitter, Millennial generation, neurophobia, learning experience

## INTRODUCTION

Despite the difficulty and complexity of neuroanatomy, the topic has been subjected to reduced curriculum teaching hours in the United Kingdom (UK), United States (US), Australia and New Zealand (Heylings, 2002; Drake et al., 2009; Craig et al., 2010). Neurophobia is a recognized fear of neural sciences and clinical neurology amongst medics (Jozefowicz, 1994). Current evidence suggests that students are becoming increasingly anxious and worried about learning this discipline (Jayakody et al., 2014). The phenomenon of neurophobia is evidenced in professional practice by doctors who lack confidence with neurological cases (Ridesdale et al., 2007) and amongst medical students in the UK, Ireland, and US (Flanagan et al., 2007; Zinchuk et al., 2010). There is a strong likelihood that the pace of medical school teaching and the memory of a poor learning experience maybe responsible for the origin of these negative connotations towards the subject and have resulted in a surface approach to learning (Smith and Mathias, 2010). Interventions by medical educators are important in combatting this destructive cycle so that more young medics are inspired to specialize in areas of neurological medicine. In one study a medical student chose to reflect on his personal experience of neurophobia and urged medical educators to support their students' learning by engaging with them using current and relevant methods (Giles, 2010).

When looking to make teaching interventions, it is important for medical educators to keep up to date with how students interact and learn (DiLullo et al., 2011; McKenna and D'Alessandro, 2011); otherwise, educators risk losing the ability to interact with and engage their students. Interaction forms the basis of the Social Constructivism learning theory, first described by Vygotsky (1978) who proposed that cognitive function was a product of social interaction and

collaboration with others. The theory suggests that learners hold a “Zone of Proximal Development”, where cognitive structures that are still in development, can only fully mature by collaborating with others (UCR, 2015). Humans hold the unique quality of being cognitive self-agents who inherently seek out learning experiences and interactions with others in order to better themselves, in a process which is an extension of the social constructivism theory known as emergent interactive agency (Bandura, 1986). Vicarious learning may be a basic example of such human agency since learning is achieved by observing the experiences of others (Bandura, 1971). Humans’ personal agency gets extended to collective agency, where people hold a shared belief that the collective power of their knowledge and experience will allow them to attain shared desired results, through social synergistic transactions (Bandura, 2001). Connectivity is therefore imperative to facilitate any social system of learning (Wenger, 2000) such as social constructivism. This highlights the importance of creating a social network or community of practice, to allow the “containers” of knowledge and experience (the community members themselves) to communicate and interact with their co-members (Wegner, 2000).

One modern and increasingly popular way for educators to achieve interaction is through the use of technology enhanced learning (TEL) approaches such as eBooklets (Cecot et al., 2014) and drawing screencasts (Pickering, 2014). Although such TEL methods support students and facilitate learning outside of the classroom, the priority of these methods may not be to develop a community of practice to support learning through social constructivism (Vygotsky, 1978). Instead, TEL methods which emphasize increasing connectivity and facilitating social interactions, may be a better choice for educators aiming to increase student engagement and support learning of challenging subjects using social learning systems.

To date, some TEL initiatives (such as podcasts) have been used to support and engage medical students at the University of Southampton during their neuroanatomy learning in an effort to reduce their anxieties; however, only 24% of students rated the facilitatory podcasts highly (Jayakody et al., 2014). Online discussion boards received minimal engagement too, as evidenced by Oliver and Shaw (2003), who concluded that students were happy to contribute to such forums for assessment purposes, but rarely did so to seek learning support.

In many ways, it is surprising that this type of online learning support is unpopular amongst today's generation of students who have grown up with internet resources and information technology as an integral component of everyday life. This Net Generation, alternatively known as the Millennial Generation of students are said to display aptitudes, attitudes, expectations and learning styles correlating to their digitally enriched upbringings (Roberts, 2005; DiLullo et al., 2011). For these digital natives who tend to communicate in the moment using instant messages or social networking sites (Skiba, 2008), it is possible that online discussion boards and email are no longer be current enough methods for communicating with students, due to the delay in receiving a reply. This was evidenced by The Chronicle for Higher Education who reported students' opinions that "e-mail is for old people", implying that students prefer to communicate using more instant-response applications; however, students continue to depend on email to communicate with those who they consider to be "old people", such as their professors (Carnevale, 2006).

Today's students are also already incorporating social media (Hall et al., 2013; Foley et al., 2014) and online digital resources, particularly YouTube<sup>®</sup> (YouTube, San Bruno, CA) (Jaffar,

2012; Mukhopadhyay et al., 2014) into their learning experiences. The use of dedicated Facebook<sup>®</sup> (Facebook, Menlo Park, CA) education pages have been shown to successfully increase student engagement, motivation and examination self-confidence in anatomy education (Jaffar, 2014). This suggests that students are willing to become members of a community of practice using a social media network. They may perceive it to be a worthy investment of their time to support their learning, since there is no financial cost involved. However, students have reported an unease with having their lecturers' presence on Facebook, within what they perceive to be their private personal space (Jaffar, 2014) and evidence suggests that this may limit the level of student interaction, even on an academic Facebook page (Szwelnik, 2008) and therefore the potential for social learning.

One alternative to using Facebook is Twitter<sup>®</sup> (Twitter, San Francisco, CA), another freely available online social network which allows people to connect virtually and communicate by "microblogging" nuggets of information (Tweets), in 140 characters or less (Skiba, 2008). Twitter has been used in several higher education non-medical programs including: Masters of education (Bista, 2015); urban planning and construction (Kassen-Noor, 2012); nursing (Thames, 2009); marketing (Rinaldo et al., 2011). As reported in these positions of literature, Twitter fostered active student collaboration and participation; facilitated students to share learning ideas, form their own opinions, verify information and apply that information to practice; and finally helped to engage students in course material due to increased interaction between students and lecturers. Furthermore, Junco et al. (2011) reported increased examination scores among pre-health professional students following course engagement with Twitter and

extended these findings to highlight that faculty participation is essential for these improved outcomes, when integrating Twitter into a course (Junco et al., 2013).

It has been suggested that Twitter may be preferred over Facebook and LinkedIn<sup>®</sup> (LinkedIn, Mountain View, CA), as the social networking site for integration with medical education since its intent is to communicate topics or ideas (Forgie et al., 2013), and as a microblogging platform it is more amenable to ongoing public dialogue (Grosseck and Holotescu, 2009; Ebner et al., 2010; Schroeder et al., 2010; Smith and Caruso, 2010; Junco et al., 2011). This may be due to the character limit feature of a Tweet, which allows the user to make concise contributions and/or suggest links to other related Twitter conversations via hashtags, which stimulates others to respond. Kind et al. (2014) support this idea, suggesting that Twitter may be the most suitable platform to listen to conversation and then share credible information by collaborating with others. Twitter permits users to create multiple accounts, allowing the potential for students to hold academic/professional accounts and separate these from their personal Twitter activity, which they may wish to keep private. This feature, which is not supported by Facebook (Facebook, 2015), may allow students to feel less inhibited about investing their time engaging in an academic community of practice to support their learning. Some reported limitations of using Twitter for educational purposes include: the challenge of sharing information in character-limited Tweets, which may discourage participation in students unfamiliar with Twitter; and worry among educators that this style of communication may encourage poor grammar and writing skills among students (Bista, 2015).

With the obvious risk of medical students disengaging with the difficult course content of neuroanatomy, and indeed their educators, the literature suggests that Twitter would be an



appropriate pedagogical tool to sustain student engagement (Thames, 2009; Junco et al., 2011; Rinaldo et al., 2011; Kassen-Noor, 2012; McArthur and Bostedo-Conway, 2012; Junco et al., 2013; Lee and Gould, 2014; Bista, 2015). Twitter is already being used by medical students and professionals to build communities of practice for transferring knowledge and interacting with peers, but furthermore to create support networks for sharing discouraging workplace experiences (Choo et al., 2015). This suggests that not only would Twitter be a suitable TEL method to facilitate social constructivism, it may also allow students to find solace and support within a community of practice and through their collective power enjoy shared desired learning results (Bandura, 2001). This would make Twitter a natural educational adjunct to support medical students during the anxiety-raising neuroanatomy course, to tackle the onset of neurophobia.

Despite the increased awareness and efforts amongst medical educators to incorporate social media into their teaching, excepting Hennessy and Border (2015), there are limited reports on how Twitter can be used to support subjects like anatomy, particularly neuroanatomy. This study aims to examine whether Twitter can be used to create an informal online space for neuroanatomy discussions between students and teachers and whether this is conducive to learning, increased student engagement and relieving student anxieties. Therefore, this study aims to answer the following questions: (1) Do medical students engage with an academic Twitter hashtag to support their neuroanatomy learning? (2) For which aspects of their learning do medical students use the hashtag during their neuroanatomy course? (3) Does the frequency of student use of the hashtag have an effect on student end of course examination scores?

## METHODS

### **Study participants and context**

Second-year students enrolled on the Nervous and Locomotor 2 (NLM2) anatomy course of the Bachelor of Medicine undergraduate program, during the 2014/5 academic year (n = 197) were invited to participate. The study took place within the Centre for Learning Anatomical Sciences (CLAS) at the University of Southampton and was approved by the University's research ethics committee (submission identification # 12991).

The NLM2 anatomy course comprises of neuroanatomy plus head and neck anatomy and indicates such anatomy content when referred to hereafter. In line with the core syllabus recommendations described by McHanwell et al. (2007); Smith et al. (2016) during this eight week course, students are expected to complete ten hours of lectures, two hours of workshops and twelve hours of practical laboratory classes. During practical classes, students work in small groups and are guided by workbooks to complete learning activities using the following resources: cadaveric prosections, plastinated specimens, plastic models, dry and plastic bones, potted specimens including pathology pots, radiographs, MRI and CT scans, iPads and textbooks. Two teaching fellows (co-authors of this study: C.M.H. and S.B) support students learning during scheduled teaching hours along with two trained fourth-year medical student demonstrators. Students are encouraged to return to the anatomy laboratory during unscheduled hours to continue their learning. Supportive learning resources are available to students on the University's Virtual Learning Environment (VLE), which include: interactive quizzes and radiology packages, pre-recorded video demonstrations on cadaveric specimens and podcasts. The NLM2 module assessments take place at the end of semester 3 with NLM2 anatomy course

content being assessed predominantly during a laboratory based practical examination, described by Smith and McManus (2014). Students also complete a written paper where anatomy content is examined in an integrated way via a combination of long (20 mark) and short (10 mark) answer structured questions, many of which are case based to test neuroanatomical knowledge in a clinical context.

### **Development of the Nervous and Locomotor 2 (NLM2) anatomy course hashtag**

Hashtags are a labelling system commonly employed by Twitter users. The “#” symbol is used to signify a keyword in the body of a Tweet. When this symbol is inserted directly before a character string it labels the Tweet with a hashtag. By clicking on a hashtag, Twitter users can easily view all other Tweets containing it. A hashtag (#nlm2soton) was created by the NLM2 teaching fellows, both of whom owned Twitter accounts. A display window (widget) containing all tweets labelled with #nlm2soton was added to the NLM2 course homepage on the university’s VLE. In this way, all students could view the feed regardless of whether they owned a Twitter account. However, contributing to the hashtag was not possible without logging into Twitter.

The hashtag was launched to the student cohort during the first NLM2 lecture. Students were given no specific instructions on how to use the hashtag but were encouraged to develop it as they preferred. Students were informed that the NLM2 teachers would be monitoring the hashtag regularly in an effort to support learning and answer questions. Since students could access the hashtag freely via any internet-enabled device including their personal smart phones, they were reminded of their responsibility towards maintaining their professionalism when using such

devices (Tran et al., 2014). Students were reassured that the hashtag was an optional learning support resource and that their participation in #nlm2soton was purely voluntary and would not be graded.

During the NLM2 anatomy course, at least one of the two NLM2 teachers checked the hashtag daily on Monday through Friday and, where appropriate, they Tweeted replies to student queries, shared learning resources or retweeted/favorited Tweets. As the course progressed into the revision period, teachers regularly checked and contributed to the hashtag at weekends.

### **Post-module Analysis of hashtag use**

Once the NLM2 module had been completed, analysis of how the hashtag was used was completed using the following methods.

#### Survey Instrument

All students were invited to voluntarily complete a validated written questionnaire (Appendix 1; Cronbach's alpha = 0.90). This contained multiple choice, five-point Likert scaled, and open answer items (18 in total) which asked: (1) Demographic details including gender and age group. Students were classified according to the following age groups: <20 years, to represent the students who have recently left school (school-leavers); 20-25 years, to represent students who had possibly completed a previous higher education course; and finally, 26-35 years, to represent the more mature students. (2) Viewing and contribution frequency of #nlm2soton. (3) Perceived usefulness of the hashtag during various aspects of their NLM2 learning (such as receiving feedback from teachers, communicating with peers and teachers, boosting morale).

The questionnaire was also used to ask students for consent to use their NLM2 practical examination scores for correlation testing with their frequency of hashtag use.

Responses were coded and analyzed using non-parametric Mann-Whitney U tests due to the ordinal nature of the data. Correlations were performed using Spearman's rank coefficient. All statistical analyses were performed in IBM SPSS, version 21.0 (IBM Corporation, Armonk, NY).

### Hashtag thematic analysis

Common hashtag Tweet themes were identified by the main researcher (C.M.H.), using a direct extraction of data method similar to Wright et al., (2014). Themes evolved following line by line coding (Charmaz, 2003) through the hashtag feed using the document analysis technique to code similar phrases, patterns, relationships and commonalities within Tweets (Creswell, 2012; Schreier, 2012). Once codes were identified they were then grouped into themes. Any Tweet or interaction with a Tweet (in the form of a favorite, retweet or reply) made by students or teachers, was counted as a single entry and categorized into a theme. Tweets and Tweet interactions within each theme were counted and calculated as a percentage of the overall total. The reliability of Tweet coding was checked and themes were agreed upon with the senior author (S.B.) for consistency. Intra-rater reliability was performed on the counted tweets and interactions by the main researcher recounting the entries three times, however no inter-rater reliability analysis was performed.

Despite the limitations of this manual method (including an unknown outreach of Tweets and number of impressions left on its audience), employing analytics tools such as Twitter Activity would not have sufficed since this software does not offer analysis for the activity of hashtags

and its multiple contributors. Twitter Activity provides analysis only for Twitter users' own Tweets and not the Tweets or contributions made by others, such as students (Twitter, 2016). This manual method was implemented since the researchers were unaware of suitable software that would provide analysis for the full lifespan of the hashtag.

### Focus group

A single, one-hour focus group was conducted with 11 volunteers from the NLM2 student cohort, who were chosen using a convenience sampling procedure as follows: all volunteering students were emailed if they had expressed interest in attending the focus group; and the first 11 students to confirm their attendance were chosen. The two NLM2 Teaching Fellows facilitated the session and asked a series of open questions designed to encourage students to share deeper views on how the hashtag impacted their learning and their experience of the NLM2 anatomy course. The session was audio recorded and transcribed. The document analysis technique was used to perform line by line coding (Charmaz, 2003) of the student responses to code for commonalities within responses (Creswell, 2012; Schreier, 2012). For reliability, this was carried out by two researchers independently who grouped their respective codes into themes. A number of common themes were identified, compared and collapsed into three broad categories (Burnard, 1991). For example, both researchers identified themes surrounding “quick and concise interactions with lecturers” and “increased ease approaching lecturers” which resulted in researchers mutually agreeing on a broader entitled theme that the hashtag “Facilitated communication with lecturers”. There were no areas of disagreement between the researchers during this process.

## Student evaluation

To ascertain whether the Twitter hashtag impacted on students, the NLM2 module evaluation reports for the past three academic cohorts were sourced from the module leader. Within the evaluation report two anatomy specific course components were rated by students; anatomy workshops and anatomy practical classes. The ratings were converted to numerical scores (1 = Poor, 2 = Below Average, 3 = Average, 4 = Good, 5 = Excellent) and mean ratings were calculated for the three academic cohorts (2012-13, 2013-14, 2014-15). One way ANOVAs were conducted to establish whether the mean student ratings of the workshops and practical classes differed between the student cohorts over three academic years.

## RESULTS

### **Questionnaire responses**

One hundred and fifty students successfully completed the questionnaire giving a response rate of 78%. Demographical information of the participants is summarized in Table 1.

### **Frequency of hashtag use and portal of choice**

Thirty three percent of the students reported that they engaged with the hashtag by contributing to Tweets and most did so once per month (Figure 1). An additional 58% of the students reported that they simply viewed the hashtag feed and the majority did so at least once per week (Figure 1). Overall, 91% of the participant sample reportedly used the #nlm2soton hashtag.

When asked which method students used to access the hashtag feed thirty four percent used Twitter directly, 35% used the VLE widget and 31% used a combination of both methods. Forty five percent of students reported to being prior Twitter users. Mann-Whitney U tests revealed

that students who already had a Twitter account viewed and contributed to the hashtag significantly more often than those who did not ( $U = 917.5, P < 0.001$ ) and ( $U = 1198.5, P < 0.001$ ) respectively.

### **Perceived usefulness of the hashtag during Nervous and Locomotor 2 (NLM2) learning**

Figure 2 illustrates mean Likert scale ratings for how the hashtag affected various aspects of students' NLM2 anatomy learning experience.

### **Comparison of Twitter use between demographic groups**

Statistically, gender had no influence on how frequently students contributed to the hashtag ( $U = 2360, P = 0.4392$ ), viewed the hashtag ( $U = 2155, P = 0.0926$ ) or on perceptions of its usefulness towards various aspects of NLM2 anatomy course learning, for example boosting morale ( $U = 2390, P = 0.7695$ ). While there was no difference between how often students within the three age groups viewed the hashtag, students within the < 20 year old age group made contributions to the hashtag significantly more often than the 20-25 year old age group ( $U = 1795, P = 0.0139$ ). The < 20 year old age group also perceived the usefulness of the hashtag more positively when compared to the 20-25 year old age group for various aspects of their NLM2 anatomy course learning. There were statistically significant differences for the following criteria: (1) receiving feedback from teachers ( $U = 1599, P = 0.0035$ ); (2) ease of communicating with teachers ( $U = 1756, P = 0.0323$ ); and (3) boosting morale ( $U = 1802, P = 0.0497$ ).

Furthermore, the <20 year old age group considered Tweets made by peers and teachers to be of equal value, which was found to be significantly different to the attitudes of the 20-25 year old



age group ( $U = 1665$ ,  $P = 0.0134$ ). This identified a trend towards the <20 year old age group being more receptive to the hashtag when compared to the 20-25 year old age group.

### **Common Tweet themes**

Five common themes were identified from the Tweets posted on the #nlm2soton hashtag feed. These themes and their respective dominance with respect to the total number of Tweets are detailed in Table 2.

### **Focus group findings**

Three main categories were identified from the focus group responses regarding how the #nlm2soton hashtag was valued by students. These are detailed below and evidenced with supporting student quotes.

### **Learning and encouraging student engagement**

Student 2 described that the hashtag helped when learning topics such as *“muscles and their innervation and by going through the Tweets, it helped me remember those particular details”*.

Student 6 added that the hashtag also aided learning since *“during revision I kept going back because I’d remember seeing the answer.....so I’d just scroll back through and check rather than re-asking, and also the diagrams which I’d used...and stuff I’d seen before.”* However

Student 6 pointed out that *“people who were interested in something could look into certain tweets if they wanted to”* using the search option.

Student 7 explained that *“you could see how others use acronyms which were often better ones”* than had been previously used to assist learning. Student 6 reiterated this sense that *“a lot of*

*people enjoyed just seeing what others were asking....seeing their answer and learning from them”* which would suggest it facilitated student engagement within an online learning community.

Student 8 spoke about how the hashtag prompted learning by being exposed to *“stuff that you hadn’t thought about revising, you could see that others had been .....that reminded you to revise it”*. This encouragement to learn was reiterated by Student 1 since *“As medical students as well we always want to know what other people know..... [a peer student] will tell me something he’s revised.....and then I’ll go home, be like, I don’t know it, but with the hashtag it’s nice to see..... that you’re on the right track with everyone else.”* Furthermore, Student 9 added that *“sometimes I had to google the words [appearing on the hashtag] afterwards but it reiterated how much you needed to get on with it and how much you know really”*.

### **Facilitated communication with lecturers and additional feedback method**

Student 4 described the benefits of the hashtag for communication including the *“Speed at which lecturers responded especially during revision week when I was stuck on a topic. It was good too because you have to be really concise on what you say and get straight to the point and likewise with the responses from lecturers, they were quick and straight to the point. I found that really useful”*. Student 3 added that the 140 *“character limit kept [responses] really concise because it’s easy to just waffle off so that was really nice”*.

Student 5 added that the hashtag was *“much better than email for asking lecturers questions and you could share that feedback with everyone because it’s online and available to everyone”* further suggesting that the hashtag stimulated an online community for learning, not only amongst the students but between students and lecturers. However, Student 10 felt that

*“sometimes Twitter is too short a response if you want to have something explained to you in a bit more detail, so I think it’s important that you can still email”.*

Student 6 explained how lecturers *“were more approachable in the labs because we had spoken to you on Twitter, so I think it built a strong relationship between us and the NLM2 teachers.....it did kind of bring us closer together”* which suggests that building an online learning community can transfer into the classroom environment. However, Student 11 did express some hesitations when using Twitter academically as follows: *“you don’t really know how you can speak to lecturers on Twitter”* and suggested that *“at some point away from NLM2 we should be taught how to use social media as medical students so that.....we are comfortable and confident at using it”.*

### **Built a supportive network and reduced student anxieties**

Student 6 felt this support network was created as a result of *“the barriers it has broken down”* and carried on to explain that as a consequence NLM2 *“was the module that people most enjoyed...and it did become more interesting. I think that was because there was more interaction which came from Twitter”.* Student 3 reiterated that there were *“rumors that it [the course] is really hard and it wasn’t really that hard in the end....as in, it wasn’t as hard as everyone said it was going to be. Twitter helped to dispel some of the rumors that NLM2 was so hard”.*

Student 9 added that *“the encouragement that teachers could give us....demonstrated that teachers know it’s hard - what we are doing and this gave us more motivation to carry on really”*, which reinforced the support students felt.

Student 4 explained that this sense of support “*made me feel a bit more relaxed especially during the last couple of weeks during revision because I was feeling stuck, like I just don’t know what to do anymore for the best so I just kept reading stuff. I think it was good to see that other people were thinking the same things and it brought a bit of banter to it and it was nice to see that. It made me feel more relaxed*”. This suggests that students’ anxiety levels were reduced, particularly during the revision period as Student 11 explains that the hashtag offered “*clarification and reassurance as well because that’s when you’re learning most of the topics and so seeing [the hashtag feed].... you can see whether you are right or wrong or whether you’ve got a clue what’s going on*”.

### **Effects of hashtag use on examination performance**

One hundred and nineteen students consented to having their NLM2 practical examination scores correlated with frequency of hashtag use, including both views of the hashtag and contributions to the hashtag. Spearman’s correlation coefficient revealed a small but significant relationship between examination scores and viewing frequency ( $r_s(119) = 0.189, P = 0.04$ ). No significant relationship was found between examination scores and contribution frequency ( $r_s(119) = 0.047, P = 0.62$ ). However, all students who failed the examination reported lower frequency levels of hashtag use (never, once per month or once per week) than students who passed (Figure 3).

### **Student evaluation**

Student evaluation ratings of anatomy workshops and practicals are presented in Figure 4, highlighting 2014-15, the year the Twitter hashtag was introduced. Mean ratings for anatomy workshops increased significantly during the year the hashtag was introduced ( $P < 0.05$ );

however, there was no significant difference in mean rating for anatomy practicals ( $P = 0.13$ ). Significant increases in mean ratings for anatomy workshops and anatomy practicals were also observed between the year 2012-13 and 2013-14 before the introduction of the Twitter hashtag ( $P < 0.0001$  in all cases).

## DISCUSSION

The motivation behind this study was to assess Twitter as a tool to enhance the student experience for medical students during the challenging and anxiety provoking NLM2 anatomy course. This course follows Biggs's Constructive Alignment Theory (Biggs and Tang, 2011); however, it is consistently perceived by students as challenging. There is a need for students to feel sufficiently supported during their learning in order to maintain their engagement with the course. It has been well reported that students have various and often multimodal learning preferences (Meyer et al., 2016) and further factors such as personality (Finn et al., 2015) and the spatial ability of students influence successful learning of anatomy (Fernandez et al., 2011). Medical educators recognize the diverse learning needs of students as well as the ever-changing learning resources students use which, most recently includes social media. Facebook and YouTube have successfully enhanced the learning experience of medical students while learning anatomy (Jaffar, 2012, 2014; Barry et al., 2016). Although Twitter has been found to increase student engagement in course content and build supportive networks (Rinaldo et al., 2011; Kassens-Noor, 2012), this has yet to be reported for medical students while learning anatomy. This study examined students' use and perceptions of using Twitter and found that 91% of students used the Twitter hashtag (33% of these observed and made contributions and 58% simply observed) during the NLM2 anatomy course, which is comparable to 94% when a

dedicated education page was used on Facebook (Jaffar, 2014). While the hashtag was used for educational purposes such as sharing learning ideas and asking questions, it also provided a platform for students to increase morale and share their worries and anxieties. The hashtag helped to engage students in learning and facilitated communication with teachers, as well as creating a support network amongst students. The level of Twitter engagement by students had a negligible positive impact on examination performance. This suggests that the use of Twitter in this context is limited to enhancing the student experience rather than improving knowledge.

### **Contributors versus observers**

In contrast to the anatomy Facebook page created by Jaffar (2014), where 89% of students contributed to instructor-designed, interactive activities displayed on the page, the majority of students in this study chose to follow and observe the Twitter feed rather than contribute to it. Creating interactive activities on Twitter proved to be challenging (particularly prior to the recently developed Twitter poll tool) due to the 140 character limit and this may explain the higher levels of participating students observed in the Facebook study. This is not to say that interaction cannot currently be achieved by Twitter but it does suggest that the nature of how students use Twitter will differ to Facebook since interaction on Twitter requires students to create and share thoughts through concise dialogue. Junco et al. (2011, 2013) showed that when students are required to interact on Twitter as part of a course exam performance increases, which suggests that mandatory, structured Tweeting can facilitate learning. To our knowledge, there have been no reports that educational Facebook pages yield such results.

In this study, the accessibility of the (view only) widget on the VLE may have contributed to the high proportion of viewers versus contributors however, the widget was important for inclusivity

of all students. The results reveal that the 55% of students who were not prior Twitter users viewed and contributed to the hashtag significantly less and many of these students expressed a reluctance to create a Twitter account. It appears that students with previous Twitter experience showed more confidence and interest in using the hashtag; however, some of these active Twitter users chose not to make contributions. White and LeCornu (2011) described internet users as either “residents” or “visitors” and concluded that visitors (observers) predominate over a small number of noisy residents (contributors). This reflects students’ behavior in this study and may be the most robust explanation of these patterns (Wright et al., 2014) which will not be fully understood without further research. Qualitative analysis of our focus groups suggests that many students felt they would benefit equally from observing the contributions of others and learning from them. This style of vicarious learning through observation of others’ learning experiences is well-understood (Bandura, 1971) and it has been demonstrated that when students engage in collaborative observational learning (that is, interacting in dialogue while observing) of a tutoring session, learning can be just as effective as receiving the tutoring session (Chi et al., 2008).

### **Twitter increased student engagement with the Nervous and Locomotor 2 (NLM2) anatomy course**

Though only a minority of students contributed to the hashtag feed, nearly all of the student cohort viewed and used the hashtag. As with Jaffar’s (2014) findings when using Facebook, the evidence from this study suggests that the Twitter hashtag did facilitate increased student engagement with the NLM2 anatomy course. This is likely as a result of the hashtag creating an informal online community for the NLM2 students and teachers. Similar to findings of previous

studies the hashtag facilitated communication between instructors and students (Ebner et al., 2010) and helped students engage in a virtual community environment (Dunlap and Lowenthal, 2009). The qualitative data illustrates that students were exposed to and prompted to learn about topics by engaging in this environment. Pedagogically, it seems that Twitter can effectively create a learning community, an essential condition for social learning (Wenger, 2000), since increased connectivity between members facilitates the collaboration and interaction opportunities needed for social constructivism (UCR, 2015). We believe that NLM2 students, through their own personal agency, invested in the value of Twitter for this form of social learning and recognized that they could achieve greater results by learning amongst others, through the power of collective agency (Bandura, 2001).

It should be emphasized that teacher availability is essential for successfully using Twitter as a support tool in higher education. The findings of this study support those of McArthur and Bostedo-Conway (2012) who found that teacher immediacy (intensity of interaction with their audience) positively correlated with frequency of student Twitter use. Therefore, although NLM2 students valued the type of quick and concise form of communication that the hashtag offered, their engagement with the hashtag would have been likely to fall if the NLM2 teachers were not able or willing to give this time commitment. Between two NLM2 teachers this included replying to a total of 28 student tweets with an average response time of 5 hours 35 minutes. However, the time invested by teachers in Twitter might be offset against the time spent responding to individual student enquiries via email since Twitter offers a “one-to-many communication channel” for teachers (McArthur and Bostedo-Conway, 2012), demonstrating a positive time cost benefit for teachers to use Twitter. Although no formal measurements were taken in this study, the NLM2 anatomy lead (senior author S.B.) did notice a reduction in the



number of individual student querying emails received following the introduction of Twitter compared to previous years.

### **An online social support network – tackling neurophobia**

This study revealed that the Twitter hashtag contributed to reducing student anxieties and enhancing student enjoyment of the NLM2 anatomy course. Twitter is used by professional and trainee healthcare providers to express emotion and receive encouragement from a support network (Choo et al., 2015) and the NLM2 hashtag served a similar purpose during this difficult anatomy course. In contrast to how Jaffar (2014) used Facebook to support students in a more content learning sense, in this study it appeared that once students developed a sense of familiarity with the hashtag they started to also use it as an outlet for their frustrations of feeling overwhelmed by content. The release of their anxiety and stress is evidenced by the posting of pictures that represented their emotions. The humor shared between students seemed to act as a coping strategy that they used for motivation to continue their educational activities, a trend recognized in previous studies (Bista, 2015; McArthur and Bostedo-Conway, 2012) whereby Twitter fostered active student collaboration.

The qualitative results suggest that students begin the NLM2 anatomy course with a lowered level of self-efficacy (Bandura, 1977) that is, a lowered belief in their ability to learn neuroanatomy, due to the rumors they have acquired from senior colleagues. It is likely that students' perceived self-efficacy diminishes further due to the emotional arousal of anxiety triggered by the stressful and taxing experience (Bandura, 1977) of completing this difficult course. This study suggests that students seek out support that goes beyond learning complicated anatomical content. They appear to crave moral support and reassurance from their peers that

they are not uniquely experiencing reduced self-efficacy and the challenges of learning the NLM2 anatomy course content. The NLM2 hashtag incidentally seemed to provide this type of support. Firstly, it allowed students to observe their peers asking questions and learning about challenging topics and through “vicarious experience” this may have enhanced the observer’s perceived self-efficacy to perform the same learning task (Bandura, 1977). Secondly, since the hashtag was effective at increasing morale and diminishing anxiety arousal (possibly through humor and the creation of collective group agency), any fear avoidance behavior around learning course material may have been reduced (Bandura, 1977). The hashtag and the widget would have allowed even the observing students to benefit from this self-efficacy boosting type support. This was a welcome surprise for the NLM2 teachers, who have spent many years attempting to relieve the anxieties that students experience and potentially contribute to the development of neurophobia.

The positive impact of the NLM2 hashtag was reflected in increased student evaluation ratings for the NLM2 anatomy course components in 2014-15. This trend of increasing student ratings was evident prior to the introduction of the Twitter hashtag, highlighting the positive effects of previous efforts to support students. However, mean ratings peaked following the introduction of the NLM2 hashtag. With students expressing this positive perception of the neuroanatomy subject, there is a possibility that these students may at least feel comfortable when confronted with neurological conditions in medical practice and will be less inclined to continue the cycle of neurophobia.

## **Net generation students and Twitter**

Students under the age of twenty were more receptive to the NLM2 hashtag than older students. Evidence from the current study implies that this age group contributed more to the hashtag overall and considered the hashtag to be more valuable for receiving feedback, communicating with lecturers and increasing morale than students in the older age group. This is not something which has been reported in the medical education literature previously (Jaffar, 2012, 2014; Barry et al., 2016). Although Hall et al. (2013) found that second year pharmacy students used social media the most for academic purposes when compared to all other four years, this study involved graduate students, therefore year of study may not have equated to age.

This study revealed a trend which suggests that recent school-leaving students are more comfortable using Twitter as an acceptable way of conversing with peers and teachers. As they are acclimatized to receiving responses from online resources at “twitch speed” (Prensky, 2001) it is not surprising that this group values the quick and concise communication platform Twitter offers, since this is what they have come to expect. Although this involves online virtual interactions these students are favoring the principles of social constructivism when using social media to assist their learning by collaborating with others (UCR, 2015). If teachers want to stay connected and engaged with the upcoming generation of students, they must consider incorporating social media into teaching resources (Barry et al., 2016).

## **Effects of hashtag use on examination performance**

In the current study the frequency with which students contributed to the hashtag had no relationship with how they performed on the NLM2 anatomy course practical examination. Although a minor positive correlation was found between viewing frequency and examination

performance, we believe that this correlation is too small to be meaningful. These results differ from the findings of Junco et al., (2011, 2013) who reported a definite significant difference in examination performance between a Twitter versus non-Twitter group of pre-health care college students. However, these studies involved a very different experimental procedure which included a control group, something which might be considered unethical in whole cohort studies. The current study investigated organic and authentic use and it is therefore unsurprising that the more frequent hashtag contributors were not necessarily the top examination performers. Students had free reign over if and how they used the hashtag which was not driven by instructor activity and unlike the methods of Junco et al. (2011), students were not trained on how to use Twitter or instructed to set up an account and follow specific other users. Although we believe that the method used in this study effectively allowed students to use Twitter as a support network, there may be an optimal balance by which this can be maintained while also having instructors stimulate Twitter activities, since the evidence shows that this enhances learning. This would align with the pedagogy which suggests that collaborative learning should involve peer interaction as mediated and structured by the teacher (UCR, 2015).

Students who failed the examination rarely or never used the hashtag. Since they were less likely to participate, these students fit the “Visitor” behavioral patterns of social network use (White and LeCornu, 2011). This supports Wright et al.’s (2014) assertion that student activity levels on an online support network may be indicative of their wider academic engagement and ability to be progressively fluid with their learning strategy when required. This lack of engagement could serve to identify potential at-risk students and offer them appropriate and timely academic support. In an era where social media is ubiquitous and when graduates are required to be digitally literate (Wright et al., 2014), it may also be necessary to include training on using social

media for academic purposes, as suggested by one of the students in this study in the focus group.

This study has demonstrated that an academic Twitter hashtag can have a positive impact on the learner. Although it was not reflected strongly in examination performance, this impact has manifested itself through students feeling more confident and comfortable with neuroanatomy subject material. The benefit for individual students is that learning neuroanatomy was more enjoyable and less anxiety provoking, which has been illustrated by the increased anatomy course evaluation ratings as well as through the positive individual student comments documented during the focus group.

### **Limitations**

Although this study has been informative about the use of Twitter in anatomy education it has some limitations. Use of tracking analysis software such as Twitter Activity to identify students' level and frequency of interaction with Tweets would have allowed more accurate content analysis. However, software such as this is limited to analyzing a Twitter user's own Tweets and does not allow analysis of the entire content of a hashtag including the identification of common Tweet themes, therefore further hashtag content analysis would still have been required.

This study took place over a short 14 week period and there was a sense that students were getting increasingly more comfortable with using the hashtag as time went by. It would be interesting, therefore, to continue this study over consecutive modules and observe if student contributions and behaviors would change with time.

This study did not identify and separately investigate the driving behavior behind the observers versus the contributors; therefore, it would be useful to interview these groups further and to investigate whether their behavior is correlated to learning style or personality.

The method used in this study was to let the NLM2 students develop the hashtag as they preferred which may have delayed students contributing to the hashtag due to uncertainty, a lack of confidence or shyness. Considering the positive effect on learning observed by Junco et al. (2011, 2013) when students were trained on how to use Twitter and instructors initiated learning activities on Twitter, further research may be beneficial to determine the optimal balance of instructor - student led Twitter activity and whether students require training on how to use Twitter within a professional/educational setting.

## CONCLUSION

The NLM2 hashtag was used by 91% of students for academic purposes such as sharing learning ideas and asking course related questions. Furthermore, it played a major role in creating an online support network for students during their learning by enhancing communication methods and breaking down barriers with teachers as well as increasing morale amongst students. The hashtag allowed students to express their worries and anxieties and receive empathy from their peers. Although the hashtag had a negligible impact on examination scores, the evidence strongly indicates that incorporating Twitter into medical education can create a supportive network for students and positively affect their learning experience.

Future suggested research should include longitudinal studies to investigate the influence of this intervention on alleviating the onset of neurophobia and to explore whether students become more receptive to contributing to Twitter if it is used as a continuing learning resource.

There is no doubt that social media including Twitter plays an integral role in how students learn in current society; however, medical educators have yet to fully discover its potential as an educational adjunct and understand how it can be best incorporated into education practice.

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## TABLES

Table 1. Summary of Demographic Characteristics of Students who Completed the Questionnaire.

<b>Variable</b>	<b>n (%)</b>
<b>Gender</b>	
Female	80 (53.3)
Male	64 (42.7)
Unknown	6 (4.0)
<b>Age</b>	
< 20 years	60 (40.0)
20-25 years	76 (50.7)
26-35 years	2 (1.3)
Unknown	12 (8.0)

Total number of completed questionnaires (n = 150)

Table 2. Descriptions, percentage of total and examples of each of the five observed Tweet themes from the contributions made to the #nlm2soton hashtag.

Theme	Theme description	Total Contributions n (%)	Example
Sharing ideas	Messages with learning ideas including recreated diagrams, acronyms, learning tips and links to other learning resources.	362 (35)	“Motor branches of facial nerve: Two Zulus Buggered My Cat! Temporal, Zygomatic, Buccal, Marginal mandibular, Cervical :)”
Morale boosts	Messages and images with a humorous or positive perspective on the student’s situation.	265 (25)	“It's all a bit wibbly wobbly, brainy wainy”
Questions and answers	Students asking direct questions about course content and responsive answers by teachers or students.	240 (23)	Q: “Does the corticospinal tract pass through the genu AND posterior limb? Thanks” A: “I would say posterior limb only”
Worries	Messages involving students expressing feelings of being overwhelmed by the amount of course content and its difficulty, often in the form of an image.	105 (10)	“So much anatomy!” “One 45 minute podcast by Scott takes me about 6 hours to get through. so yeah I love #nlm2soton”
Course information	Queries and announcements mostly regarding general course timetabling changes and availability of course resources.	76 (7)	“@ScottBorder1 will there be a podcast uploaded for today's lecture please?”

Total number of tweets (n = 1048)

# APPENDIX 1

## Twitter Questionnaire

Please circle the most appropriate response that indicates your feeling towards #nlm2soton:

During term time, on average I viewed the #nlm2soton feed	Never	Once a month	Once a week	> Once a week	Once a day
During term, on average I engaged in discussion on the #nlm2soton feed	Never	Once a month	Once a week	> Once a week	Once a day
I had already used Twitter before being introduced to #nlm2soton	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton was a useful adjunct to learning anatomy this semester	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton was a valuable way of receiving feedback from faculty members to assist my learning	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton made it easier to communicate/engage with peers	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton made it easier to communicate/engage with teachers	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
Tweets made by peers were as useful as tweets made by teachers	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton built a spirit of engagement with the module, not achieved otherwise	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
#nlm2soton boosted morale/lifted spirits during the module	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
I would like to see Twitter used in future courses and modules	Strongly disagree	Disagree	Mutual	Agree	Strongly agree
I engaged with #nlm2soton through	Twitter		Blackboard		Both
For you, what was the best thing about the #nlm2soton					
Was there anything that stopped you engaging with #nlm2soton					
Please predict your practical exam mark	Fail	50-60%	60-70%	70-80%	80%+

**Please encircle your details.**

**Sex:** Female Male      **Age:** <20      20-25      25-35

**Prog:** BMEU      Former BM6      BM5 direct entry      BM5 international student

If you are happy for us to compare your feedback with your exam results please sign and give your student number. All data will be kept anonymous in any research we conduct.

**Sign:** \_\_\_\_\_ **Student number:** \_\_\_\_\_ **Date:** \_\_\_\_\_