HANDS-ON NEUROANATOMY LEARNING EXERCISE FOR UNDERGRADUATE STUDENTS

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ABSTRACT
Neuroanatomy is a daunting subject for an undergraduate student. Its understanding and knowledge however, is key to successfully perform various interventional clinical procedures and interpret traditional and newly emerging medical imaging in the fields of neurology, neurosurgery and interventional radiology. In order to help the students to internalize and form a visual picture of the key structures in the central nervous system the students were asked to design 3-D physical models for clinically relevant topics in neuroanatomy. An anonymous feedback questionnaire to assess the efficacy and utility of the exercise was then given to the students. Our results show 74.9% of students agreed that this activity increased their interest in learning of neuroanatomy and helped them to visualize the 3-D anatomy of the structures better. 80% of students actively participated in the execution of model of their own group, and 48.2% also demonstrated interest in the model making exercise of their peers. Despite the lack of interest shown in the model making activity of their peers, 73.9% of the students agreed that the presentation of the models made by their colleagues benefitted them too. The students enjoyed and benefitted from this hands on neuro-model making activity and recommended such exercises for the future batches to create interest, enhance learning and decrease “neurophobia”.

KEY WORDS: neuroanatomy, undergraduate, three-dimensional models, physical models, anatomy, anatomy teaching.

INTRODUCTION
The study of anatomy involves visualization, comprehension and understanding of complex spatial relationship between structures in the body. The knowledge and understanding of anatomy is key to successfully perform various interventional clinical procedures and interpret traditional and newly emerging medical imaging. [1,2] Classically, gross anatomy teaching of a body part, in India, involves a series of didactic lectures supplemented with hands on cadaveric dissection, study of bones and normal radiographs along with developmental anatomy which is taught using 3-D models. This integrated teaching approach along with self-learning is sufficient for the student to form an initial 3-D spatial impression of the human body. Unfortunately, this technique fails miserably when it comes to the complex understanding of neuroanatomy. Traditionally, neuroanatomy course is covered for over four weeks with the same above-mentioned resources. Practical laboratory exercises involve visualization of 2-D freshly cut and proscribed brain slices by the student repeatedly with a qualified anatomy teacher. The complicated and intricate relationships between various brain structures, is difficult for an undergraduate student (recently passed out from school) to internalize with this method of teaching. The paucity of time and constantly decreasing availability of specimens for teaching and dissection further hinders learning of the subject. This leads to fear of neuroanatomy. Jozefowicz (1994) referred to this dread and anxiety of studying neuroanatomy and thereafter neurology in medical students as “Neurophobia”. [3] Surprisingly, this dislike of neuroanatomy among the undergraduate and postgraduate students has been reported by educators across the world. [4,5,6,7]

To enhance active learning, increase the interest of students in neuroanatomy and break the monotony of the anatomy curriculum, we decided to involve students in designing of 3-D physical models with materials easily available to them. The students were later presented with a feedback questionnaire to assess the perceived efficiency of this teaching module.

MATERIALS AND METHODS
The study was carried out in the Department of Anatomy at Maulana Azad Medical College, New Delhi. Each year 250 students enter into the MBBS course and study
anatomy for a year. The subject of Neuroanatomy is taught to the undergraduate students for over four weeks through a series of lectures and small group practical session usually six months after their joining. This particular exercise was initiated after a period of three weeks of neuroanatomy learning by the students. At the start, the entire module was explained to the student and their consent was taken. The mean age of the student was 18-20 years. They were divided into small groups of 25 students each with a total of 10 groups. Each group was given a topic for preparing a 3-D model using indigenously available low-cost materials. The topics selected were clinically relevant, and included -Tracts (Corticospinal, Dorsal column & Spinothalamic); Spinal Lesions; Cerebrospinal Circulation; Blood Supply of Brain; Cerebellum; Visual Pathway; Thalamus and Basal Ganglia. The groups were given 5 hours of practical laboratory sessions to prepare the model and a presentation was to be made thereafter by the members of the group to the entire class.

After the successful execution of the exercise, the students were asked to fill an anonymous feedback questionnaire to assess the efficacy and utility of the exercise. The questionnaire contained 9 objective questions with a three-point scale response which asked the student to indicate whether they agreed, disagreed or were undecided over the item. The questionnaire was formulated to assess whether the above mentioned activity a) succeeded in generating student interest in the subject, and, b) helped them to generate a 3-D visual mental picture of the topics given. The data obtained was then analyzed using SPSS version 20 software.

RESULTS

One hundred and ninety-five students returned the duly filled feedback questionnaire. The quantitative data indicated that 74.9% (146) of students agreed that this activity increased their interest in learning of neuroanatomy and helped them to visualize the 3-D anatomy of the structures better. However, 20.5% (40) students felt that this activity resulted in wasting their time. 80% (156) of students actively participated in the execution of model of their own group, and about only 48.2% (94) also demonstrated interest in the model making exercise of their peers. Despite the lack of interest shown in the model making activity of their peers, 73.9% (144) of these students agreed that the presentation of the models made by their colleagues benefited them too (Table 1; Fig1).

Table 1: Responses of the students to the questions asked in the feedback questionnaire. The responses were calibrated in percentage. The total duly filled questionnaires received back were 195.

<table>
<thead>
<tr>
<th>Q. no</th>
<th>Content</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Model making activity increased my interest in learning neuroanatomy.</td>
<td>74.9% (146)</td>
<td>14.4% (28)</td>
<td>9.7% (19)</td>
<td>1% (2)</td>
</tr>
<tr>
<td>2.</td>
<td>It helped me to understand the 3D arrangement of the structures better.</td>
<td>75.4% (147)</td>
<td>12.8% (25)</td>
<td>11.3% (22)</td>
<td>0.5% (1)</td>
</tr>
<tr>
<td>3.</td>
<td>This activity resulted in wasting time.</td>
<td>20.5% (40)</td>
<td>24.6% (48)</td>
<td>54.9% (107)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>It helped me to learn neuroanatomy better.</td>
<td>72.3% (141)</td>
<td>22.6% (44)</td>
<td>5.1% (10)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I would recommend such activity for future.</td>
<td>77.4% (151)</td>
<td>14.4% (28)</td>
<td>8.2% (16)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>I actively participated in the model making activity in my group.</td>
<td>80% (156)</td>
<td>8.2% (16)</td>
<td>11.8% (23)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I was interested in the model making activity of other groups too.</td>
<td>48.2% (94)</td>
<td>26.2% (51)</td>
<td>25.6% (50)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>The presentation of the model to the whole class helped me to further refine my knowledge.</td>
<td>73.9% (144)</td>
<td>14.4% (28)</td>
<td>10.8% (21)</td>
<td>1% (2)</td>
</tr>
</tbody>
</table>
Fig.1: Graph showing the responses of students asked in the feedback questionnaire.

We also collected qualitative data regarding the resources utilized by the students. Majority referred to the internet and their textbooks for further guidance. The materials used for making the models included the usual -cardboard, wool, oil paints, glue, plaster of paris to innovative and unusual like a cauliflower (using which as a template a cerebellum was made by paper mache), tree leaves and branches (for arbor vita) and also one group mentioned -passion (Fig 2,3, 4 a,b).

Fig.2: Photograph showing the model of basal nuclei and its circuitry. The materials used in making this model included -cardboard, clay, toothpicks and thermocol.

Fig.3: Photograph depicting the corticospinal tract made by using wool, board pins, cardboard, oil paints and glue gun.

Fig.4 a, b: Photograph depicting cerebellum and its circuitry made by using various types of papers for paper mache, thermocol, shoe box, plastic pipes, scooby strings and tree leaves.

DISCUSSION
The aim of our activity was to generate interest among students for neuroanatomy and help them to visualize and internalize its key spatial relationships. Our results show that almost 75% of the class benefitted from this exercise directly or indirectly. While 80% (156) actively participated in the designing of the model in their own group. However only 48.2% (94) showed interest in model-making of their colleagues. Anatomy courses all over the world have shown a decline in the total teaching hours. Drake et al., (2009) analyzed data from over 130 medical colleges in United States regarding the total anatomy teaching time and the time devoted to its various allied courses. They reported that the total
teaching hours have reduced for gross anatomy and especially neuroanatomy/neuroscience course over the years (1955-2009) especially in the laboratory classes.[8] No such data was available for the Indian medical institutions, however currently of the recommended total-550 anatomy teaching hours by the Medical Council of India (a regulatory body), a mere 72 hours are devoted to teaching neuroanatomy (MCI, 2017).[9]

Neuroanatomy is a daunting subject because it involves visualization and internalization by a student of the spatial and functional relationships between structures for understanding and further clinical correlation.[10] Various multimedia modules and tools have been utilized by researchers for this purpose. Compared to traditional lecture and textbook based programs, these learning tools have been proven to be statistically equal or superior module of learning.[11] The lack of resources and the large number of students hinder administration of computer based tests to our students. However, the students need to understand the 3D placement of structures and hence such an activity was initiated. The uniqueness of this exercise was that the students made the models on their own using materials that were available to them easily and were of low cost. 75.4% (147) of students agreed that making of 3D models helped them to understand and improve the visualization of the complex 3D relationships between various structures in the brain. Educators across the globe have been adopting similar activities like in the present case, and found that active learning teaching modules, help in better understanding and retention of knowledge compared to passive learning.[12] The physical models used by our students although are of low fidelity however are crucial for understanding the spatial relationships of anatomical structures.[13] Estevez et al.,[14] Vanags et al.,[15] also devised a model making activity for their first-year medical undergraduate students. Their results, like ours, suggest that such hands-on activity are effective teaching tools for students to internalize the spatial relationship between neuroanatomical structures. Vanags et al.,2011 asked their students to label the brain regions on shower-caps placed on another participant’s head. They showed that this simple activity of spatial learning improved their student’s ability to recall and localize the areas of the brain. Interestingly the improved cognition and recall was seen in both the non-participating shower-cap wearer and the student labeling it.[15] Team based active learning tasks have generally been shown to generate interest in all the participants. Vasan et al.,2011 when compared the data of team based learning anatomy curriculum with the lecture based other preclinical courses found that students performed better when learning collectively as a group.[16] Our results also show that inspite of their disinterest in the model making of their peers (25.6% (50) students), 74.9 % (146) students agreed that this task of model making and presentation benefited them and 80% (156) of the students actively participated in the activity. The students worked as a team constructively and directly or indirectly influenced each other’s understanding of concepts. Such team effort is usually constructive as they motivate the student to be a responsible participant.

CONCLUSIONS
Worldwide educators are supplementing their traditional teaching with digital and physical 3-D models. Our results show that this type of supplementation is appreciated and enjoyed by the students since it helps them to better visualize complex interrelationships between structures which can otherwise be daunting. The students in our department are regularly exposed to pre-fabricated models in embryology and gross anatomy. But the manipulation of structures to generate a 3D model made by themselves excited the students, hence 77.4% (151) recommended such activities for the future batches too.

REFERENCES
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