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ORIGINAL ARTICLE

Principle-Oriented versus Information-Oriented Approach towards Neuroanatomy: A Selective Profile of Neuroanatomy Textbook

Farida Yeasmin[1], Md. Shah Alam[2], Jerin Jafrin[3], Shahana Hossain[4], Mohammed Iqbal[5], Khondker Manzare Shamim[6]

[1]Associate Professor, Department of Anatomy, Tairunnessa Memorial Medical College, Gazipur, Bangladesh; [2] Indoor Medical Officer (IMO), Department of Skin & VD, Dhaka Medical College Hospital, Dhaka, Bangladesh; [3]Lecturer, Department of Biochemistry, Dhaka Central International Medical College, Dhaka, Bangladesh; [4]Professor & Head, Department of Anatomy Tairunnessa Memorial Medical College, Gazipur, Bangladesh; [5]Professor, Department of Anatomy, Monno Medical College, Kishorganj, Bangladesh; [6]Professor & Ex-Chairman, Department of Anatomy, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

Abstract

Background: Neuroanatomy is an integral part of the undergraduate medical curriculum, and it is often considered by students as a difficult subject. It is assumed that students' learning may be facilitated if learning and its assessment are structured around generalizable rules or 'principles' of the subject rather than trying to memorize plenty of apparently disconnected 'information'. **Objective:** This study was performed to assess the principle-oriented versus information-oriented approach towards neuroanatomy. **Methodology:** It was a cross-sectional, observational, and descriptive study. The current edition of two Neuroanatomy textbooks that are commonly recommended for medical undergraduates was analyzed. **Results:** Analyses of the textbooks revealed that the mean proportion (±SD) of sentences presenting primarily 'Principle-oriented text' is 24.52 (±4.41)%, and the mean proportion of sentences (±SD) presenting primarily 'Information-oriented text' is 75.48 (±4.41)%. The mean proportion (±SD) of illustrations having 'Principle-oriented aspect' is 27.10 (±3.21)%, and the mean proportion (±SD) of illustrations having 'Information-oriented aspect' is 72.89 (3.21)%. **Conclusion:** The results of the present study provide a baseline data on the principle-oriented aspect of neuroanatomy textbooks that are commonly recommended in Bangladesh. The study also suggests that the issue of a principle-oriented approach in the teaching-learning and assessment of neuroanatomy is a valid issue to be addressed in the undergraduate curriculum planning and implementation. *[Journal of Current and Advance Medical Research, July 2024;11(2):79-87]*

Keywords: Principle; information; neuroanatomy; textbook; principle-oriented; information-oriented

Correspondence: Dr. Farida Yeasmin, Associate Professor, Department of Anatomy, Tairunnessa Memorial Medical College, Gazipur, Bangladesh; Email: faridayeasmin.shelly@yahoo.com; ORCID: https://orcid.org/0009-0009-5237-5799

Introduction

Neuroanatomy is a scientific study of the anatomy of the nervous system which is an integral part of the anatomy portion of the undergraduate medical curricula worldwide[1,2]. The medical undergraduate course aims to produce general physicians. To be a good physician, one must have adequate knowledge of normal and abnormal features of the nervous

system. And for this, a good amount of learning material has to be dealt with by any medical undergraduate student. Neuroanatomy is a descriptive subject. Our textbooks and other learning materials on the subject contain quite a large volume of information that sometimes seems unrelated to each other. This leads many students and even some teachers, to approach the subject as something to be grasped through rote memorization. But if a student only tries to memorize neuroanatomical information without a proper understanding of the topic (he) cannot correlate them, when necessary, with each other or with their functional and clinical implications. The official website of the Faculty for Teaching Excellence of Utah Valley University presents seven principles of learning (based on the cognitive science of how people learn). This suggests that courses should be organized around helping students understand and this big concept and instructions should focus on helping students understand, explain, and apply these concepts rather than focusing on memorization a large amount of content[3].

Here 'principle' represents a general idea derived or inferred from specific instances or occurrences[4]. It is also defined as a rule or law concerning a natural phenomenon or behavior of a system[5]. In a more elaborate definition, 'principle' is an elementary assumption, concept, doctrine, maxim, or position generally held to be fundamental or true for a body of knowledge, conduct, procedure, or system of reasoning and used as a basis for production and action[6]. In the context of the present study 'principle' means from which others are derived.

The term 'information' is described as fact, data, or instructions in any medium or from[7].

In the context of the present study, information can be distinguished from principle by regarding information as a statement expressed in such a way that it applies to only one situation, condition, part, etc.

For example, a student examining the brain found that a section through its frontal lobe shows an outer grey matter and an inner white matter. A section through the temporal lobe also shows an outer grey matter and an inner white matter. Now these two ' information' on two different brain regions represent a single 'principle'- the cerebrum is composed of an outer grey matter and inner white matter. If a student develops a general understanding of a 'principle' s(he) will be able to use it whenever he) is faced with the question of the composition of the cerebrum.

The term 'text' has been defined in different ways from different perspectives. According to Dictionary.com Unbridged, based on the Random House Dictionary, the text means the main body of matter in a manuscript, book, newspaper, etc, as distinguished from notes, appendices, headings and so on[8].

Word Net 3.0 Farlex clipart collection (2003 – 2012) has described 'illustration' as a visual representation (a picture or diagram) that is used to make some subject pleasy or easier to understand[9]. In the present study, the term illustration has been used for any photograph, micrograph of any type, diagnostic image, realistic/semi-realistic/ schematic diagram, flow chart, or any other form of an image, that has been reproduced in a book.

No literature is available on any 'principle-oriented' approach toward the teaching-learning and assessment of Neuroanatomy in medical undergraduate courses in the country. In 2013 a study was done on feedback from teachers and postgraduate students on the anatomy component of the MD Gastroenterology discipline of BSSMU regarding principle-based questions and information-based questions. It has been observed that 85.0% of respondents felt about the lack of a problem-based approach in the whole course, and about 56% of respondents in the course created more recall level knowledge[10].

Considering the above context, it is not difficult to understand that addressing neuroanatomical 'principles' concerning the teaching-learning and assessment in undergraduate neuroanatomy is an important and relevant issue in the planning and implementation of the Anatomy curriculum in a meaningful effective manner in people's healthcare.

Methodology

Study Settings and Design: This cross-sectional study was carried out in the Department of Anatomy at Bangabandhu Sheik Mujib Medical University (BSMMU), Dhaka from January 2012 to December 2012. Two Neuroanatomy textbooks were selected for the analyses of texts and illustrations. They were Clinical Neuroanatomy by Richard S. Snell, 7th edition, Lippincott Williams & Wilkins, Philadelphia and Essentials of Neuroanatomy by A K Datta, 3rd edition, Current Books International, Kolkata.

Study Procedure: The basic selection of these textbooks was as follows. Personal observation and

informal conversation with the undergraduate teachers of Anatomy revealed that these two Neuroanatomy textbooks are mostly recommended for undergraduates by the teachers in our country. These textbooks were widely available and their recent editions were also easily available. Clinical Neuroanatomy by Richard S Snell has 18 chapters and the other textbook, Essential Neuroanatomy by A K Datta has 17 chapters. The chapters, Surface Anatomy (brain and spinal cord), and "Principles of Imaging and Yoga and its Impact in Medical Sciences" by Datta (2008) were excluded from the present study, as their contents do not match the contents of Snell (2010). Thus, broadly speaking, 15 chapters of the former matched 18 chapters of the latter textbook. Although the organization of the two textbooks is not similar, the contents of the selected chapters cover all the contents of the undergraduate curriculum of Bangladesh. The principal nerves of special organs were excluded from the study as they were not included in any of the selected textbooks.

To make estimations more meaningful, the portions of the textbooks that are almost unlikely to contain any 'Principle-oriented text' were excluded from the study. Thus, the following were excluded:

Exclusion criteria regarding categorization of text and illustrations with respect to "principle" and "information"

In the case of Snell (2010):

a. Clinical cases, Chapter objectives, texts within tables, Clinical problems, Clinical problem solving, Answers and explanation to clinical problem solving, Review question, Answers and explanation to review questions and references every chapter
b. Color atlas of brain
c. Appendix
d. Texts that do not contain any neuroanatomical component

In the case of Datta (2008):

a. Applied anatomy
b. Texts that do not contain any neuroanatomical component
c. References every chapter

In the present study the term Sentences presenting primarily 'Principle-oriented text' represented any sentence, more than half of which depicts one or more 'principles'. Examples: Three sets of neurons convey information from the periphery to the sensory cortex (Datta 2008, p 217).

Sentences presenting primarily 'information-oriented text' represented any sentence, more than half of which depicts one or more 'information'. Such a text cannot be used to explain other text and is not applicable to more than one situation, part, condition etc. Example: Thalamus is a large egg-shaped mass of gray matter that forms the major parts of the diencephalon (Snell 2010, p 372)

The term 'Illustration having Principle-oriented aspect' meant an illustration depicts one or more 'Principle'. Example: Figure I and Figure II.

The term 'Illustration having Information-oriented aspect' meant an illustration that depicts only one 'Information' no 'principle'. Example: Figure III and Figure IV.

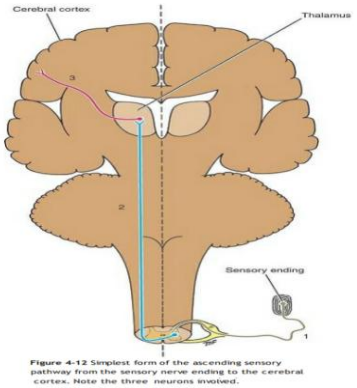

Figure I: Illustration having Principle-oriented aspect showing involvement of three sets of sensory neurons, a common phenomenon applicable for general sense carried by the spinal cord. (Snell 2010, p 144)

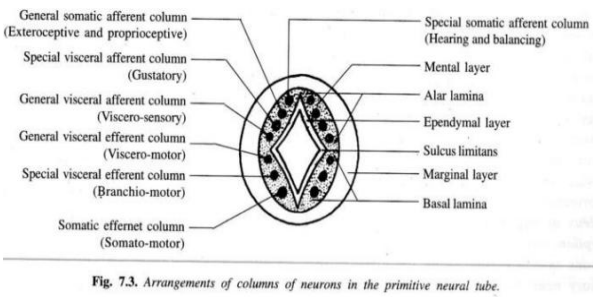

Figure II: Illustration having Principle-oriented aspect showing the arrangements (relative-orientation) of different functional components of the cranial nerves which is common to all the cranial nerve nuclei located in the brain stem. (Datta, 2008, p 119)

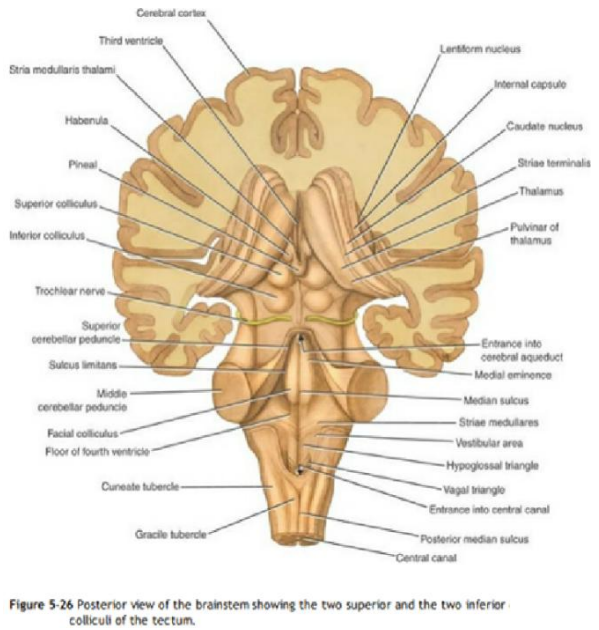

Figure 5-26 Posterior view of the brainstem showing the two superior and the two inferior colliculi of the tectum.

Figure III: Illustration having Information-oriented aspect showing posterior view of the brainstem, which only related to brainstem. (Snell, 2010, p 214)

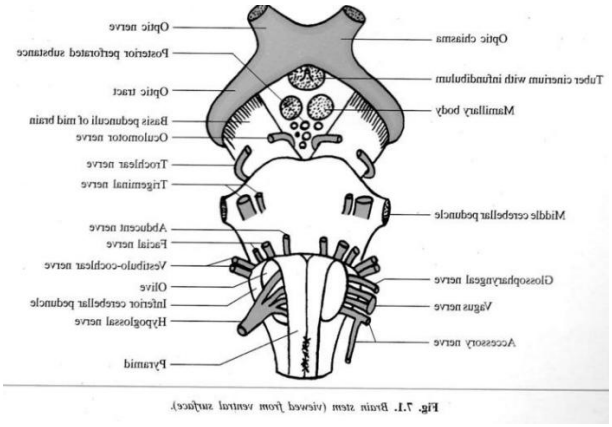

Figure IV: Illustration having Information-oriented aspect showing ventral surface of the brain stem and to the specific nerves only. (Datta 2008, p 118)

The Estimation Procedure

Following the operational definitions, the sentences presenting primarily 'Principle-oriented text' and the sentences presenting primarily 'information-oriented text' were separated out in the textbooks using color codes. A red pen was used for the former and pencil for the latter (as shown in Figure V). Whether a sentence has more than half of it as 'principle' or as 'information' determined its category. It was found that some text was used more than once.

There were marked with a green pen for repeated principle-oriented text (RP) and with a blue pen for repeated information-oriented texts (RI). Then four categories of sentences were counted and recorded as such on the textbook page itself. The recorded on the pages were summated for the two categories of the sentences.

The summations were expresses as percentages of the total number of sentences in analysed parts of each selected chapter of each textbook. The overall proportion of each category of sentence was calculated for each textbook, and the mean value of the two was also calculated. Single-use and repeats were considered separately.

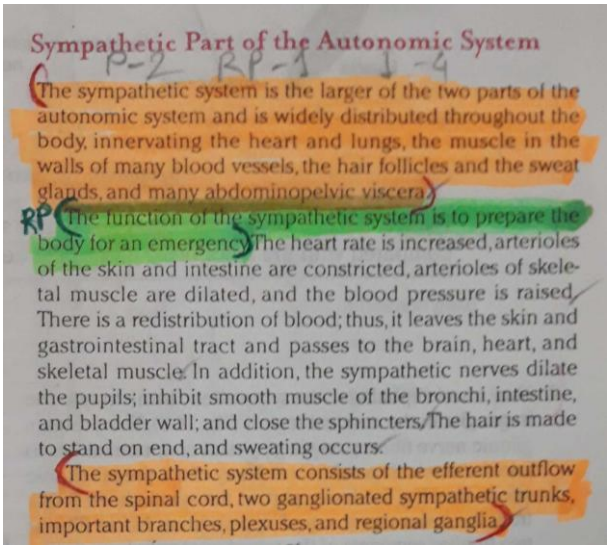

Figure III: Methods of determining the proportions of sentences presenting primarily 'Principle-oriented text' and sentences presenting primarily 'information-oriented text' in a selected Neuroanatomy textbook (Snell 2010, p 397). The red color brackets indicate Principle (P), green indicates Repeat principle (RP), and pencil marks indicate Information (I)

Methods of estimating of the proportions of 'illustrations having Principle-oriented aspects'

and 'illustrations having only information-oriented aspects'

All illustrations from the selected portions of both Neuroanatomy textbooks were counted except photographs, photomicrographs, diagnostic images and illustrations having no neuroanatomical information because they are unlike to present any neuroanatomical 'principle'. Then the illustrations, having any 'principle-oriented aspect' were identified and counted. The proportion for such illustrations (out of all the counted illustrations) was calculated for each textbook. Then the mean proportion for the two textbooks was calculated. The rest was considered 'Illustrious having only information-oriented' aspects. Illustrations were used more than once (as in Snell 2010) study those repeated were marked as illustrations single-use and repeats were considered separately.

Results

In the present study, 18 chapters of Snell (2010) and 15 chapters of Datta (2008) were selected for estimating the relative proportions of sentences presenting primarily "principle-oriented text' and of sentences presenting primarily 'information-oriented text'. The estimates were as follows:

The analyzed portion of Snell (2010) has 3695 sentences and that of

The analyzed portion of Datta (2008) has 3190 sentences.

The proportions of the two categories of sentences in different chapters of the two textbooks are shown in Fig 3.1 and 3.2. In both textbooks, within these introductory topics related to Neuroanatomy that have the greatest value.

Analyses of Snell (2010)

In Figure 6, it is observed that the highest proportion of sentences presenting 'Principle-oriented text' (74.86%) is presented in chapter 3 (Nerve fibers, peripheral nerves, receptor and effector endings, dermatomes, and muscle activity). The second highest proportion is (73.23%) in Chapter 4 (the spinal cord and the ascending and descending tracts), and the third highest (64.61%) is in Chapter 2 (The neurobiology of the neuron and the neuroglia). Thus, a total of 27.64% of sentences present primarily 'Principle-oriented text', and the rest of the sentences present primarily 'information-oriented text', of this proportion, 2.76% sentences are repeated.

Of the sentences presenting 'information-oriented text', 3.76% are repeated. In Chapter 13 (Hypothalamus and its connections), Chapter 15 (The meninges of the brain), and Chapter 16 (The ventricular system, the cerebrospinal fluid, and the blood-brain and blood-cerebrospinal fluid barriers) 100% of the sentences present primarily 'information-oriented text'.

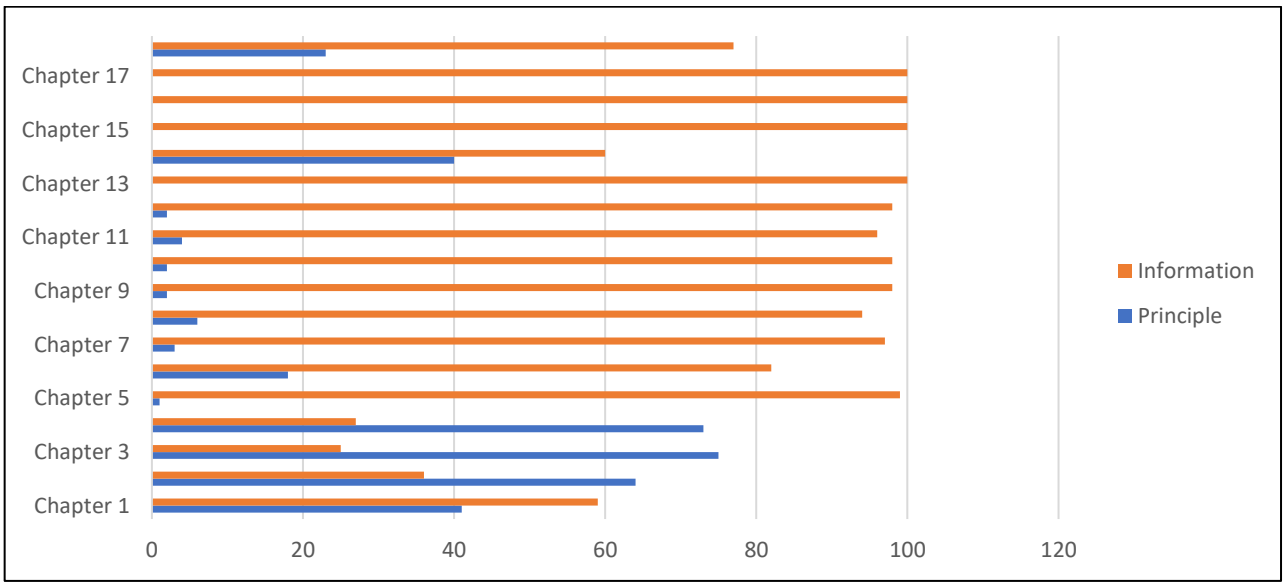

Figure VI: Relative proportions of sentences presenting primarily 'Principle-oriented text' and sentences presenting primarily information-oriented text' in specific proportions of different chapters of the Neuroanatomy textbook by Snell (2010)

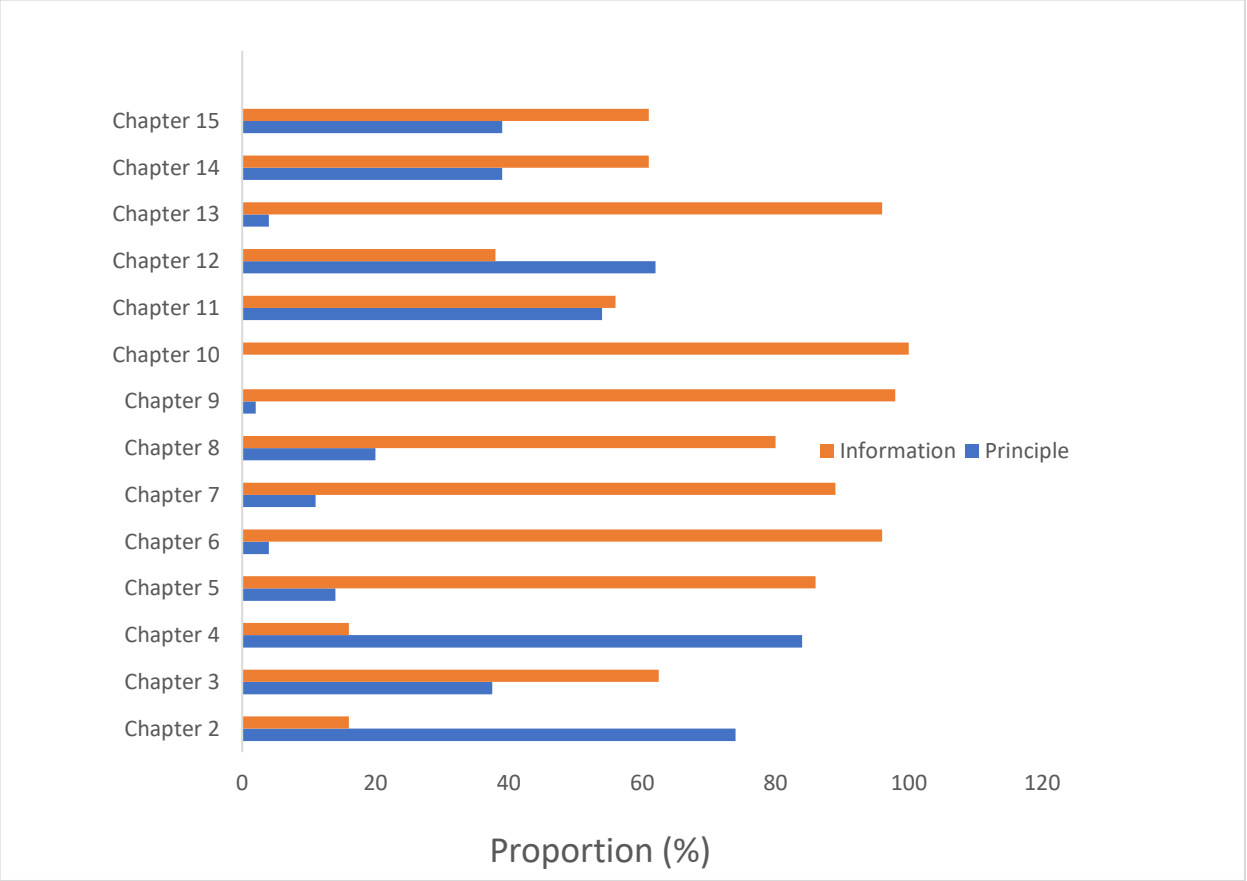

Figure VII: Relative proportions of sentences presenting primarily 'Principle-oriented text' and sentences presenting primarily 'Information-oriented text' in specific proportions of different chapters of the Neuroanatomy textbook by Datta (2008)

Analyses of Datta (2008)

In Figure 7, It is observed that 21.4% of the sentences present primarily 'Principle-oriented text', of which 1.99% of sentences are repeated. The highest proportion of sentences presenting primarily 'Principle-oriented text' is 84.00% in chapter 4 (innervation of skeletal muscles and their tendons). The second highest proportion (74.07%) in Chapter 2 (Structure of the nervous tissue) and the third highest (68.75%) in Chapter 2 (General Considerations).

The highest proportion of sentences presenting primarily 'information-oriented text' is found in chapter 10 (the meninges and cerebrospinal fluid), the proportion is 99.67%. the next highest is 97.86% in Chapter 9 (The forebrain) and the third highest 95.68% in Chapter 13 (cranial nerves).

The combined estimation

Table 1 shows the proportions of sentences presenting primarily 'Principle-oriented text' and sentences presenting primarily 'information-oriented text' in the two Neuroanatomy textbooks. The mean value of the sentences presenting primarily 'Principle-oriented text' in the two textbooks is 24.52% (about one-fourth), the rest being sentences primarily presenting 'information-oriented text'.

Table 1: Relative Proportions of Sentences Presenting Primarily 'Principle-Oriented Text' And Sentences Presenting Primarily 'Information-Oriented Text' in the Specific Portions of Selected Neuroanatomy Textbooks

Types of Sentences	**Proportion in Neuroanatomy Textbook (%)**		**Mean Proportion in Two Textbooks ± SD (%)**
	Snell (2010)	Datta (2008)	
Sentence Presenting Primarily 'Principle-oriented text'			

Types of Sentences	**Proportion in Neuroanatomy Textbook (%)**		**Mean Proportion in Two Textbooks ± SD (%)**
Single-time use	24.88	19.41	
Repeated use	2.76	1.99	
Total use	27.64	21.4	24.52 ± 4.41
Sentence presenting primarily 'information-oriented text'			
Single-time use	68.60	76.76	
Repeated use	3.76	1.84	
Total use	72.36	78.60	75.48 ± 4.41

Table 2: Relative Proportions Of 'Illustration Having 'Principle-Oriented Aspect' and Illustration Having Only 'Information-Oriented Aspect' in the Specific Portions of Selected Neuroanatomy Textbooks

Type of illustration	**Proportion in Neuroanatomy Textbook (%)**		**Mean proportion in two textbooks ± SD (%)**
	Snell (2010)	Datta (2008)	
Illustration having 'Principle-Oriented Aspect'			
Single-time use	26.71	24.48	
Repeated use	2.67	0.00	
Total use	29.38	24.83	27.10 ± 3.21
Illustration having an 'information-oriented aspect'			
Single-time use	65.66	75.16	
Repeated use	4.96	0.00	
Total use	70.62	75.16	72.89 ± 3.21

Analysis of the illustrations: The number of illustrations from the two selected Neuroanatomy textbooks was as follows:

a. Snell (2010) – 262 illustrations
b. Datta (2008) – 149 illustrations

Thus, a total number of 411 illustrations were analyzed. The proportion of illustrations having a 'principle-oriented aspect' in the two textbooks is shown in table 2.

It is observed that in both the proportions of Illustration having a 'information-oriented aspect' is more than that of Illustration having a 'principle-oriented aspect'. It was also observed that Snell (2010) has more illustrations having a 'principle-oriented aspect' than Datta (2008). Some of Snell's illustrations were repeated.

Discussion

The present study revealed that less than 25% of the sentences analysed in the two textbooks presented primarily 'Principle-oriented text', and the rest (>75%) presented primarily 'information-oriented text'. The difference between the two books is not very remarkable, though Snell's share of principle-orientation is greater. In fig 5 it is shown that in chapters of Snell (2010) on neurons and neuroglia, spinal cord and nerve fibers, etc. the proportions of sentences presenting primarily 'Principle-oriented text' vary between two-thirds to three-fourths of all the sentences analysed, on the other hand, the chapters on the hypothalamus, meninges and ventricles, and CSF have no principle-orientation at all. The chapters on the cerebrum, brainstem, cranial nerve nuclei, basal nuclei, reticular formation, and thalamus have less than 10.0% of sentences presenting primarily 'Principle-oriented text'. Four more chapters have about 15.0% to 40.0% of their sentences presenting primarily 'Principle-oriented text'. With Datta (2008) their results were similar. The chapters in general considerations, structures of the nervous system, and innervation of skeletal muscle contained about 65% to 85.0% of sentences presenting primarily 'Principle-oriented text'. On the contrary, chapters on the forebrain, brainstem,

cranial nerves, meninges, CSF, and blood supply contain only around 10% of sentences with principle orientation. Seven more chapters have about 15.0% to 50.0% of their sentences presenting primarily 'Principle-oriented text'.

The analyses showed that the orientation of the texts towards 'principles' varies widely, and there is scope for bringing a more principle-oriented approach to teaching in several aspects of Neuroanatomy.

Regarding illustrations, those having a principle-oriented aspect' constituted, on average, just more than 25%. This seems acceptable, as anatomical illustrations have much descriptive function at specific levels. Anatomy is a visual subject. 'illustration' has been defined as 'the use of examples to make ideas more concrete to make generalisation more specific and detailed' [11]. This is true for many neuroanatomical illustrations that are descriptive in nature, showing neuroanatomical structures only. However, many illustrations contain elements that represent 'principle' aspects. Contemporary textbooks contain many schematic diagrams, some of which (especially flow charts) fall into this category. As the connections of neuroanatomy are not visible to the naked eye, and human neuroanatomical connections cannot be easily illustrated in diagnostic images, schematic drawings may be a good choice to demonstrate generalizable connections.

Conclusion

The present study has put some light on and helped in developing an evidence-based insight into the situation of how the contemporary Neuroanatomy textbooks have incorporated neuroanatomical principles in their presentations, learning and formulation respectively.

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None

Conflict of Interest
We declare that we have no conflict of interest.

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Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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ORCID
Farida Yeasmin: https://orcid.org/0009-0009-5237-5799
Md. Shah Alam: https://orcid.org/0009-0008-7659-7321
Jerin Jafrin: https://orcid.org/0009-0008-5583-0497
Shahana Hossain: https://orcid.org/0009-0008-0086-2088
Mohammed Iqbal: https://orcid.org/0000-0002-2346-361X
Khondker Manzare Shamim: https://orcid.org/0009-0004-9923-4102

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