Teaching Methodologies in Structural Geology and Tectonics: An Introduction

Soumyajit Mukherjee

Abstract This introduction chapter of the book provides a summary of its nine key chapters. Structural geology and tectonics has progressively become more quantitative. To keep the pace, instructors of these subjects need to upgrade their teaching contents. This book presents issues related to (i) evaluation system of students using the peers, (ii) use of new instruments in measuring structural data from rocks, (iii) paleomagnetic studies in tectonics, (iv) sub-surface structural interpretations required in industries, (v) field studies in structural geology, (vi) interdisciplinary aspects of structural geology, (vii) teaching structural geology and tectonics in Indian context, (viii) conducting practical classes in structural geology with map interpretations and (ix) and simple geomechanical problems and solutions.

Keywords Pedagogy · Geosciences · Classroom teaching
Geoscientific fieldworks · Practical exercises in structural geology

Structural geology (and tectonics) has undergone a revolution in the last few decades in their contents and mode of teaching, from Hills (1940) up to Fossen (2016). From descriptive science, it has become significantly quantitative (e.g., Allmendinger et al. 2012) leading to new challenges in the way it is to be taught in the present days. New methods of teaching structural geology have been discussed in several conferences in recent years, such as GSA 2004 (Internet reference-1) in Colorado, EGU 2017 (Internet reference-2) in Vienna, and the Rock Deformation Structures-2018 in Delhi.

Innovative ways of teaching in structural geology and tectonics are discussed in this edited book. The main purpose of this edited volume is to reach the (new) instructors of structural geology and tectonics worldwide with novel ideas. The aim is to execute improved modes of teaching in academia and industry involving classical and modern techniques, both inside and outside the classroom.

This book consists of nine key chapters out of which Chaps. 5 and 10 are (co)authored by industry persons. The remainders are written by the academicians.

S. Mukherjee (✉)
Department of Earth Sciences, Indian Institute of Technology Bombay,
Powai, Mumbai 400076, Maharashtra, India
e-mail: soumyajitm@gmail.com; smukherjee@iitb.ac.in

S. Mukherjee (ed.), *Teaching Methodologies in Structural Geology and Tectonics*,
Springer Geology, https://doi.org/10.1007/978-981-13-2781-0_1

Interestingly, Chap. 9 is authored by a Teaching Assistant that shares his personal experience and approaches in instructing structural map interpretation. Interdisciplinary aspects of structural geology and tectonics have been discussed in Chaps. 4 and 7. A total of 13 authors and coauthors from 5 countries have been involved in this book.

In Chap. 2, Frehner (2018) describes innovative dual self- and peer-evaluation and grading system for students undertaking his Master's-level coursework. The exercise builds confidence in students in evaluating other's work, which they would require in their career. In Chap. 3, Novakova and Pavlis (2018) test 25 smartphones with different configurations for accuracy of measuring attitudes. iPhones give more accurate results than the smartphones with Android software. The authors rightly ask to understand the level of accuracy of the mobile device in measuring attitudes before using them in actual research work. Chapter 4 by Oliva-Urcia and Pueyo (2018) details how paleomagnetic studies are done in structural geology and tectonics, especially to unravel deformation kinematics. They explain sampling, processing, and interpretation processes involved in such studies. Gunderson and Huffman (2018) in Chap. 5 remind the need of structural teaching keeping in mind that most of the students would join the workforce as geoscientists rather than solely as structural geologists. They emphasize in this context subsurface structural interpretation involving cross-sectional construction, and geomechanical and seismic studies related to structural geology and tectonics. The authors provide a guideline in few cases how the instructor can proceed with some of these subjects. Greenberg (2018) in Chap. 6 reminds the great importance of field studies in the coursework for the geoscience students. He lucidly presents the Black Hills of South Dakota as the potential field area where students have been undergoing several structural exercises. Sketching structural and other geological features continues to remain as an indispensable aspect of field studies (e.g., Geikei 1882; Khrul 2017). In Chap. 7, Abolins (2018) presents how students have been effectively utilizing GIS in structural geological studies in a field course. The most important outcome of such a multidisciplinary approach has been improved 3D visualization skills to students. Mukherjee (2018) in Chap. 8 points out that the structural geology syllabi in some of the Indian Institutes require upgradation. To enhance problem-solving skill of students, specific branches of mathematics and physics in the syllabus need to be added. Through PowerPoint presentations, the instructor can discuss such new issues even within the existing limited time frame of semesters. Chapter 9 by Bose (2018) presents his personal experiences as a Teaching Assistant and how he has been planning map interpretation classes for students. Chapter 10 by Dasgupta et al. (2018) presents how image logs have been used in geomechanical issues-an interdisciplinary subject where structural geologists have been interested these days. They provide simple problems as well as solutions.

References

Abolins M (2018) Geographic Information Systems in an undergraduate structural geology course: a pilot project at Middle Tennessee State University in Murfreesboro, Tennessee. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 201–219. ISBN: 978-981-13-2781-0

Allmendinger RW, Cardozo N, Fisher DM (2012) Structural geology algorithms: vectors and tensors. Cambridge University Press, Cambridge. ISBN: 978-1-107-01200-4

Bose N (2018) Teaching structural geology map interpretation to Masters' students: the experience of a teaching assistant. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 233–235. ISBN: 978-981-13-2781-0

Dasgupta T, Dasgupta S, Mukherjee S (2018) Image log interpretation of geomechanical issues. In: Mukherjee S (ed) Teaching Methodologies in Structural Geology and Tectonics. Springer, pp 237–251. ISBN: 978-981-13-2781-0

Fossen H (2016) Structural geology, 2nd edn. Cambridge University Press. ISBN -13: 978-1107057647

Frehner M (2018) Self- and peer-evaluation of individual project work: an innovative course assessment method to increase student motivation. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 5–41. ISBN: 978-981-13-2781-0

Geikei A (1882) Geological sketches at home and abroad. Macmillan and Co., London

Greenberg JK (2018) Structural geology field exercises of intermediate to more-advanced complexity from the classic Black Hills of South Dakota. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 159–200. ISBN: 978-981-13-2781-0

Gunderson KL, Huffman KA (2018) Teaching structural geology techniques for applied subsurface interpretation and characterization. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 123–157. ISBN: 978-981-13-2781-0

Hills ES (1940) An outline of structural geology. Methuen & Company Limited

Internet reference-1. https://gsa.confex.com/gsa/2004AM/finalprogram/session_13363.htm. Accessed 16 July 2018

Internet reference-2. https://blogs.egu.eu/divisions/ts/category/teaching/. Accessed 16 July 2018

Khrul JH (2017) Drawing geological structures. The geological field guide series. Wiley Blackwell, p 232. ISBN: 978-1-405-18232-4

Mukherjee S (2018) Teaching structural geology in Indian context. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 221–232. ISBN: 978-981-13-2781-0

Novakova L, Pavlis TL (2018) Modern methods in structural geology of 21 century: digital mapping and digital devices for the field geology. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 43–54. ISBN: 978-981-13-2781-0

Oliva-Urcia B, Pueyo EL (2018) Paleomagnetism in structural geology and tectonics. In: Mukherjee S (ed) Teaching methodologies in structural geology and tectonics. Springer, Heidelberg, pp 55–121. ISBN: 978-981-13-2781-0