Online-based surveys in the Lectures on Mechanics II

Maximilian Schmitter (maximilian.schmitter@tuhh.de),
Christian J. Cyron (christian.cyron@tuhh.de)
Institute of Continuum and Materials Mechanics

TUHH
Hamburg University of Technology

Lectures on Mechanics II

- Module Mechanic II: Mechanics of Materials, 6 ECTS

- Fundamental concepts and laws of statics such as stresses, strains, Hooke's linear law.

- The students apply the mathematical/mechanical analysis and modeling. The students apply the fundamental methods of elastostatics to simply engineering problems. The students estimate the validity and limitations of the introduced methods.

- 90 min. per week

- 891 inscribed students (summer term 2019)

- Grading: written exam + midterm

Methods

- Didactic concept: Introduce multiple choice questions, using CONCEPTESTS and parts of CONCEPT INVENTORIES [4, 5, 2] in elastostatics during the lecture. Presented by an open access, browser based software called PINGO [3].

- Evaluation: Conduct surveys to quantify the students' attitude in learning physical related topics with CLASS [1] and to quantify the impact of multiple choice questions.

Conclusion/Results

- No limitation concerning the IT infrastructure was observed during the whole course of the lecture.

- Ád 1 from objectives: Lectures were more relaxed and were not so overdriven by theory.

- Ad 2 from objectives: Students had a lively subject-related discourse with each other while they memorized and repeated basic concepts in theory.

- Ad 3 from objectives: PINGO is a smart and easy going system to conduct multiple choice questions.

- Ad 4 from objectives: No improvement in learning attitude patterns within the two conducted surveys (Figure 3).

- Increase in acceptance to perform multiple choice questions (Figure 4).

- Continue the online-based surveys in the Lectures on Mechanics II and update and redesign multiple choice questions according to Figure 2.

## Acknowledgement

Status Quo

- Comprehensive introduction into elastostatics

- Presentation of the theory with interactively filling out of empty boxes in the script.

- Students do not dare to ask questions during the lecture because they think that they expose themselves to their fellow students.

Objectives

1. Improve the interaction between the lecturer and the students.

2. Activate and increase the learning rate in understanding fundamental concepts of the theory during and between the weekly lectures.

3. Introduce an indicator for the lecturer and for the students, how well basic concepts of the theory was understood and presented.

4. Quantify the students' attitude in learning physical related topics.

Didactic concept: multiple choice questions in elastostatics

- Designed a pool of new multiple choice questions for the field of elastostatics [4, 5, 2].
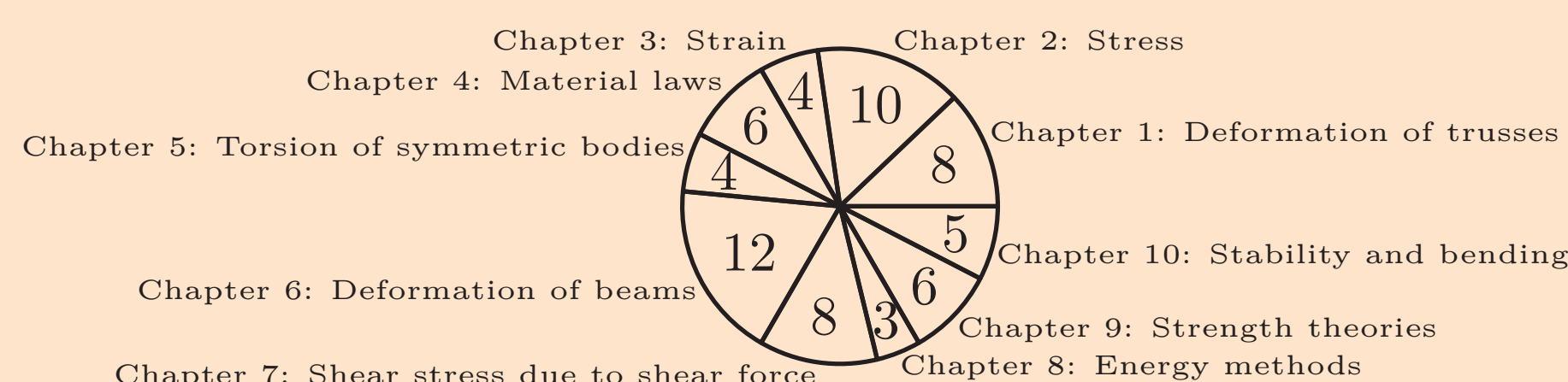
Figure 1: Number of generated multiple choice questions (in sum 66) separated by chapters according the lecture script.
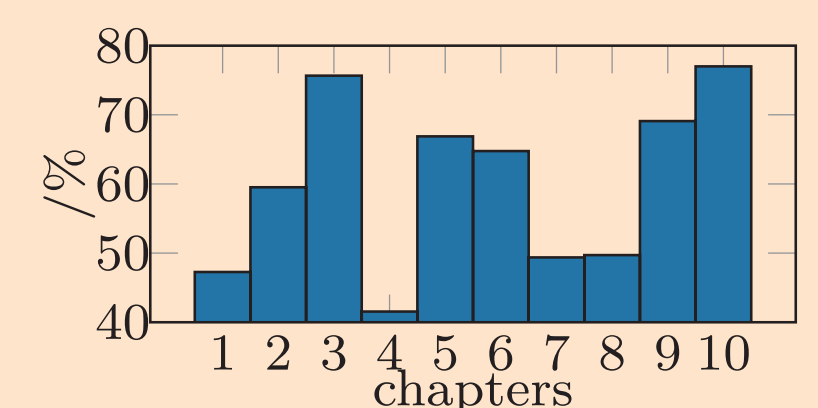

Figure 2: Percentage of correct answers separated by chapters according the lecture script.

- For each lecture unit a subset of this pool of questions were conducted using an open access, browser based software called PINGO [3].
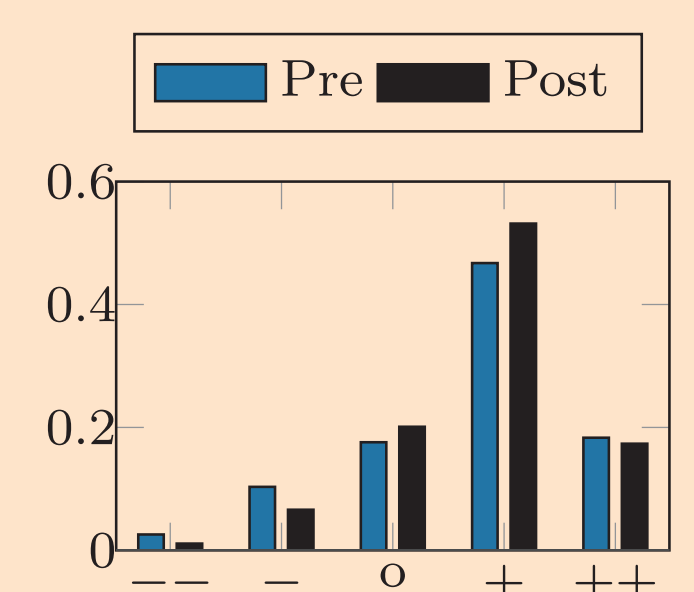
Evaluation: Survey concerning CLASS and impact of didactic concept

- 2 exactly the same surveys with 36 questions according CLASS [1] at the beginning (Pre) and around the mid term (Post) of the semester. Answer options $++$, $+$, o, $-$, $--$, i.e. full agreement to complete rejection of the statement.

- 271 and 121 valid received questionnaires for Pre and Post.
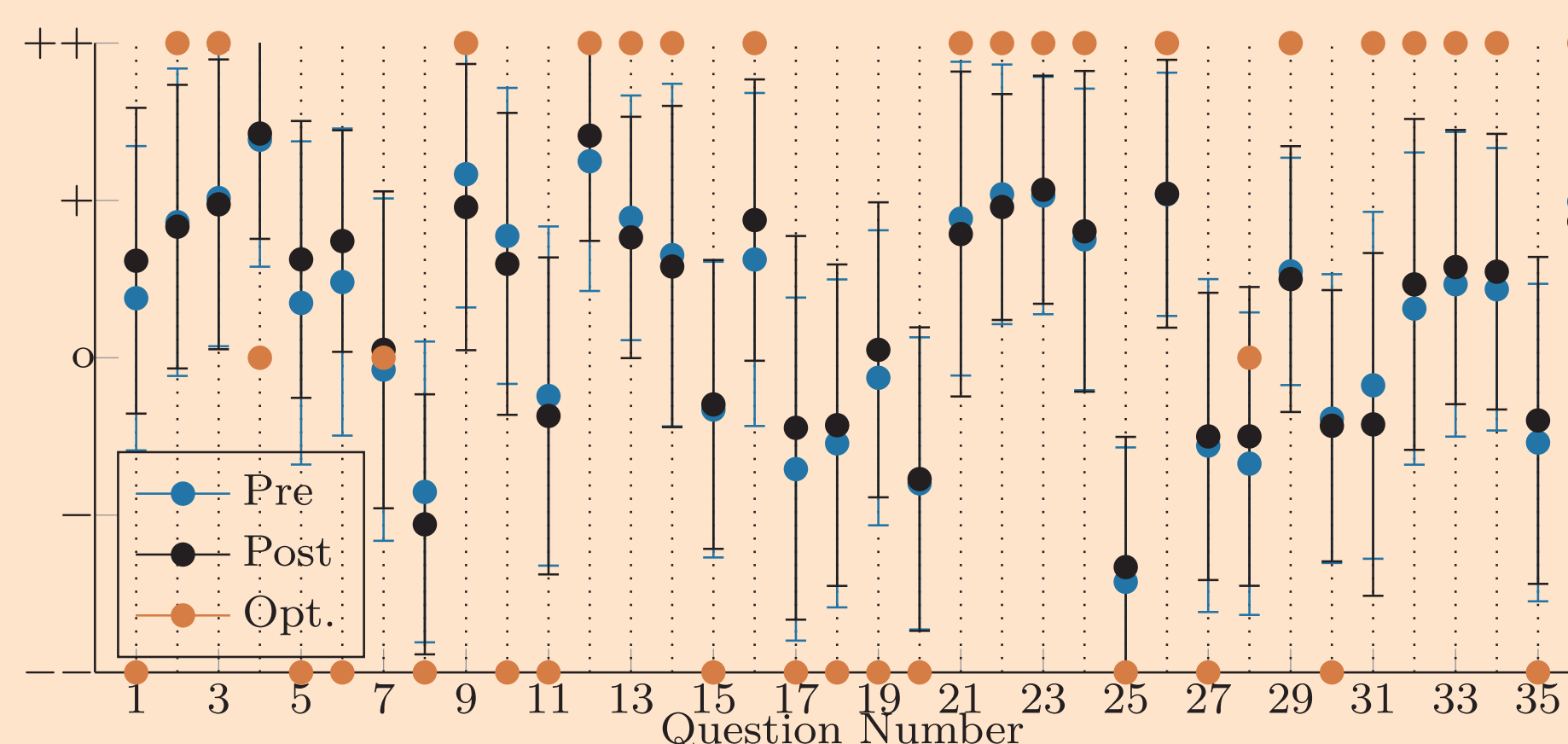
Figure 3: Comparative statistical analysis (mean and standard deviation) of the two conducted surveys with optimal learning attitude patterns (Opt.).

Figure 4: Histogram of answers to quantify the impact of multiple choice questions. The higher the values to the right, the more acceptance.

- Metric (scaled sums of squares $]-\infty, 1]$, with one for optimal fit) how well these results fit to optimal learning attitude patterns (Opt.), Figure 3: Pre 0.389 and Post 0.348.

- Impact of multiple choice questions (Figure 4) quantified by answers of question number 16, 22 and 33.

References

[1] W. K. Adams, K. K. Perkins, N. S. Podolefsky, M. Dubson, N. D. Finkelstein, and C. E. Wieman. New instrument for measuring student beliefs about physics and learning physics: The colorado learning attitudes about science survey. *Phys. Rev. ST Phys. Educ. Res.*, 2:010101, Jan 2006.

[2] R. Edwards, R. Englund, and S. Sweeny. Direct assessment of mechanics of materials learning with concept inventory. In *2017 ASEE Annual Conference & Exposition*, Columbus, Ohio, June 2017. ASEE Conferences.

[3] W. Reinhardt, M. Sievers, J. Magenheim, D. Kundisch, P. Herrmann, M. Beutner, and A. Zoyke. Pingo: Peer instruction for very large groups. In A. Ravenscroft, S. Lindstaedt, C. D. Kloos, and D. Hernández-Leo, editors, *21st Century Learning for 21st Century Skills*, pages 507–512, Berlin, Heidelberg, 2012. Springer Berlin Heidelberg.

[4] J. Richardson, P. Steif, J. Morgan, and J. Dantzler. Development of a concept inventory for strength of materials. In *33rd Annual Frontiers in Education, 2003. FIE 2003*, volume 1, pages T3D–T3D, Nov 2003.

[5] A. Shane, P. Brown, and M. S. Barner. Board #13: Examining engineering concepts in practice: Is conceptual understanding relevant to practice? In *2017 ASEE Annual Conference & Exposition*, Columbus, Ohio, June 2017. ASEE Conferences.