Student Activation through Exercise Problems with Errors

Under the Qualification Programme „Research-based learning at TUHH“

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1. Goal

This project aims at activating students through exercise problems that are designed to stimulate interaction between the students, lecturers and course materials. The higher level of activeness facilitates the process of generating the theoretical and practical knowledge inherent to the content of the course.

2. General Framework

- Name of course: **Stochastics** (engl.) Summer Term 2019

- Type of course: Consists of 1 weekly **lecture** and 1 weekly **exercise session** and monthly **projects**.

- Parameters: ≈ **100** undergraduate students of CS, GES, IIW, AIW
  ≈ **30** students in each exercise session
  ≈ **5** hours workload (for preparation)

- Learning Objectives: Students can **explain basic definitions and tools,** they can **apply algorithms** to solve stochastic decision problems and are **capable of checking their understanding** of complex concepts.

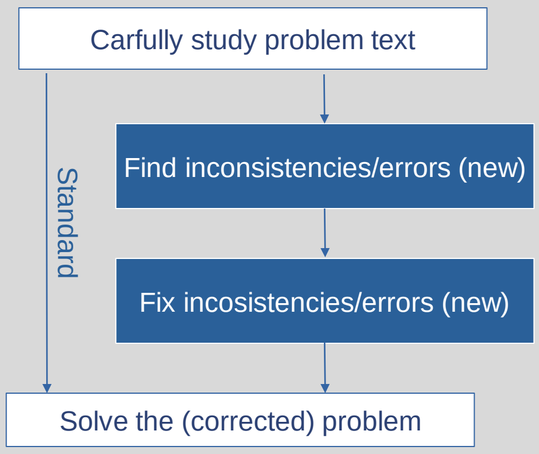
3. New Feature for Exercise Problems

The problem sheets for the exercise sessions introduce a new type of **exercise problems that contain errors on purpose**. They add to the classical repertoire of exercise problems of **proving** a statement, **determining** a quantity via calculation scheme or **modelling** a concrete problem.

This new feature gives the problem multiple secret objectives, cf.[1]:

- **to critically think** about the problem content and also to stimulate the **discussion among colleagues**
- to **reveal lack** of subject knowledge.

Thereby, instead of simply applying recipes to solve problems, students may enhance intellectual abilities that are **fundamental to doing research**.



4. Challenges and Evaluation Concept

In the preparation for the project, students and lecturers of the 2018 course were asked (questionnaire) and evaluation results from past semesters were taken into consideration. This showed the following **challenges** for the implementation:

- Deal with **missing knowledge basis** from Mathematics I-III.
- Not to overwhelm students with **numerous exercise problems**.

In order to evaluate the impact of the featured exercises, weekly evaluations (total of 13) were carried out. Students should list all problems of the problem sheet that **lead to discussions** and encouraged the **improvement of their understanding**. Furthermore, the **popularity of single exercise problems** (4 problems per exercise sheet) was assesed (rating 1-5).

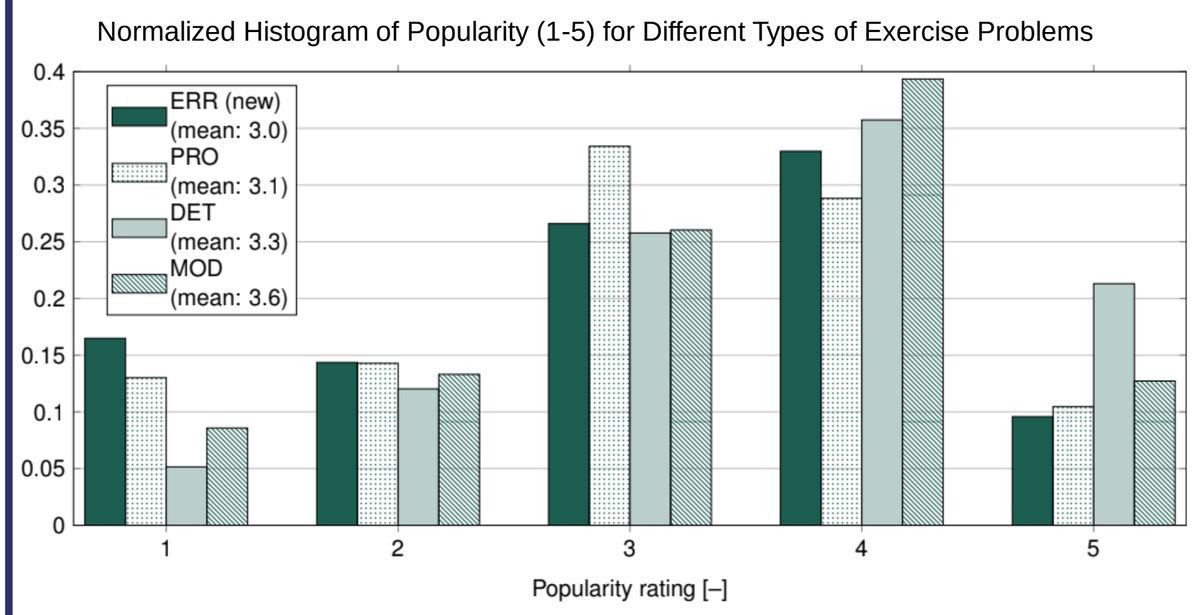
5. Student’s Remarks

- *No more “what is wrong” tasks, it makes me paranoid.*
- *Exercises [that] contain errors on purpose are confusing.*
- *[…] they made me very afraid [...] do them if you understand the topic.*
- *Not very suited for students who already have trouble following along.*
- *I liked them as a training to be sceptical.*
- *[...] helped me […] because I had to think about my understanding […].*

Gathered from TAP results, CheckING and general comments on evaluation sheets.

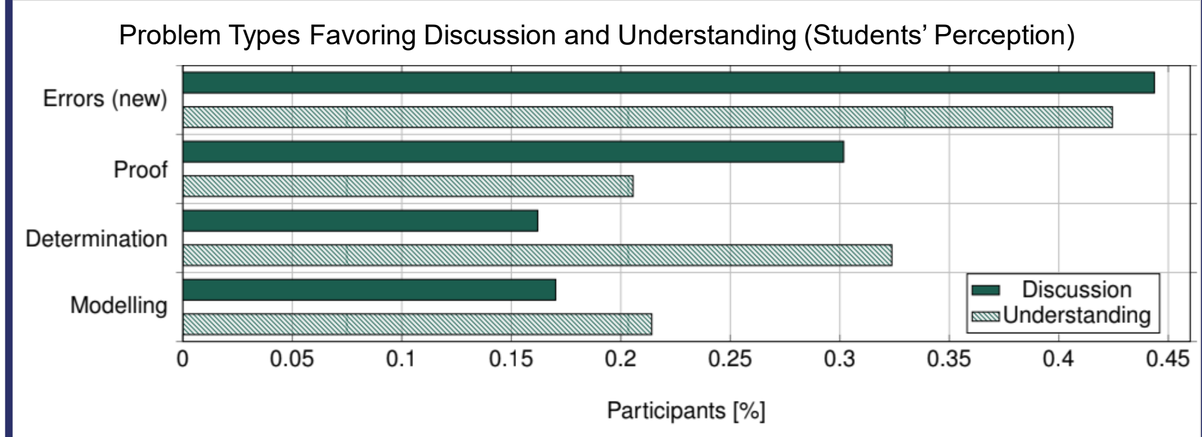
5. Descriptive Analysis of Evaluation Data

We compare the students‘ popularity rating associated to the different types of exercises. The ratings range from 1 (unpopular) to 5 (popular).



One can observe that error-type and proof-type problems share the same level of popularity, both being also the problems that had the most votes for being very unpopular. Also modelling-type and classical determination problems have a similar popularity distribution.

The following diagram compares how students perceive the activating effects of different types of exercise problems with respect to the created discussions and the effect of gaining better understanding of the underlying theory.



One can observe that 45% of the students experienced that problems with errors created discussions, whereas only 15% shared this opinion about classical determination and modelling tasks.

The results suffer from the following **bias**: As the evaluations were carried out at the beginning of the session, students gave more feedback to problems at the top of the problem sheet. Problems at the bottom of the sheet were seldom prepared beforehand.

6. Conclusion and Outlook

The popularity distribution of the exercise types suggests that exercises that contain errors on purpose **are as unpopular as classical exercises** with proofs. But they also show the **potential of creating a discussion stimulus**. The exercises can be reused in the next year (with or without the correction).

A challenge that has to be overcome is the **deterrent effect of problems with errors**. It must also be noted that **not all types of problems are suitable** for introducing errors at undergraduate level.

One possible suggestion: to use the discussion potential of errors in solutions of exercises in the scope of peer-to-peer evaluations. Contact with errors in problems starting from the first semester itself could also **change the attitude** from that of deterrence to picking up a challenge.

7. References

[1] P. A. Bartlett, K. Dunnett (2019). *Secret objectives: promoting inquiry and tackling pre-conceptions in teaching laboratories*. arXiv preprint available at https://arxiv.org/abs/1905.07267