Teaching Quantitative Exercise Courses

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Introduction

Overview

1. Introduction

Quantitative knowledge and skills are essential in many academic disciplines, as well as in professional life. In addition to mastering mathematical operations and strategies for problem solving, quantitative thinking and reasoning is crucial. It is the foundation for understanding the natural sciences (Nature of Science, NOS) and for creative problem solving. However, students often experience learning these skills and competencies as immensely challenging. This series of articles discusses strategies teachers of exercise courses may use to support and help students acquire quantitative competencies.

2. Challenges

The transition from secondary school to university can be one reason students new to the university might face difficulties in mathematics and statistical exercises. Students bring from school ideas and **expectations** about math that helped them to succeed in high school, but might not at the university level. Working through problems quickly and mechanically is no longer successful when students

have to learn **conceptual and procedural knowledge** (and their connections).[1] Problems and their solutions are **complex**; solving them often needs **planning** and may require a **range of different competencies**.[2]

The difficulties and failures that students may experience can have an unfavourable effect on their **motivation** and, consequently, on their **perceived self-efficacy** (https://infopool.univie.ac.at/en/home-page/teaching-learning-at-the-university/perceived-self-efficacy/), i.e. a person's conviction of being able to master tasks using their own capabilities. People with high levels of perceived self-efficacy tend to perform better academically and have **attitudes and work habits**, such pursuing ambitious goals, perseverance, or developing (creative) solutions independently, that are especially important in STEM disciplines.[3]

Students who do not major in mathematics, tend to have problems understanding the **connection** between **concepts** (e.g. in physics) and **mathematical elements**, or they consider them separate.[4] This can lead to a lack in understanding the **relevance** of mathematical exercises, which in turn can adversely affect student motivation and engagement.

In addition to fundamental problems with **conceptual understanding**, some students have poor work habits that you, as the teacher, can help improve in an exercise course (e.g. by means of detailed requirements and instructions).[5] Such poor work habits include:

- inaccurate reading (e.g. students read superficially or begin problem solving before they have read all of the instructions);
- imprecise thinking (e.g. students prioritise speed before precision, do not double-check the procedure, draw conclusions too quickly, use units and measured values incorrectly);
- faulty or sloppy problem analysis (e.g. students do not break up complex tasks into components; cannot find access to the solution process because they proceed in an unstructured manner);
- lack of perseverance (e.g. students give up after one unsuccessful attempt, try to guess the solution, apply problem solving strategies mechanically).

Different students in a class often have **varying levels of knowledge and skills**. In this case, you can also support your students by designing your classes appropriately. The next section in this series provides ideas for designing exercise classes: Instructional Strategies (/en/start-page/course-types-disciplines/teaching-quantitative-exercise-courses/1-instructional-strategies/).

Tip: If you decide to redesign your course, we recommend you **start small** (e.g. with one new activity in a class session) and introduce new elements gradually. This way, you can identify what suits both your teaching personality and your course, and what works for your students. This will also keep your additional workload manageable (compared to redesigning an entire course). The course **content** and **objectives** are further factors determining which methods are appropriate (see Outcomes-oriented Choice of Methods (https://infopool.univie.ac.at/en/home-page/teaching-advising/outcomes-oriented-choice-of-methods/#c605746)).

Continue reading

Teaching Quantitative Exercise Courses (1): Instructional Strategies (https://infopool.univie.ac.at/en/home-page/course-types-disciplines/teaching-quantitative-exercise-courses/1-instructional-strategies/)

References

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[2] Frischemeier, Daniel, Anja Panse, and Tobias Pecher. „Schwierigkeiten von Studienanfängern bei der Bearbeitung mathematischer Übungsaufgaben". In *Lehren und Lernen von Mathematik in der Studieneingangsphase*, edited by Axel Hoppenbrock, 229–41. Wiesbaden: Springer, 2016, p. 232.

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[4] Heller, Patricia, Ronald Keith, and Scott Anderson. „Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving". *American Journal of Physics* 60, No. 7 (1992): 627–36. doi.org/10.1119/1.17117 (https://doi.org/10.1119/1.17117).

[5] See Frischemeier, Daniel, Anja Panse, and Tobias Pecher. „Schwierigkeiten von Studienanfängern bei der Bearbeitung mathematischer Übungsaufgaben". In Lehren und Lernen von Mathematik in der Studieneingangsphase, edited by Axel Hoppenbrock et al., 229–41. Wiesbaden: Springer, 2016; Nilson, Linda B. „Quantitative Reasoning and Problem Solving". In Teaching at Its Best: A Research-Based Resource for College Instructors, 3rd ed., 193–98. San Francisco: Jossey-Bass, 2010; here: S. 194-195.

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