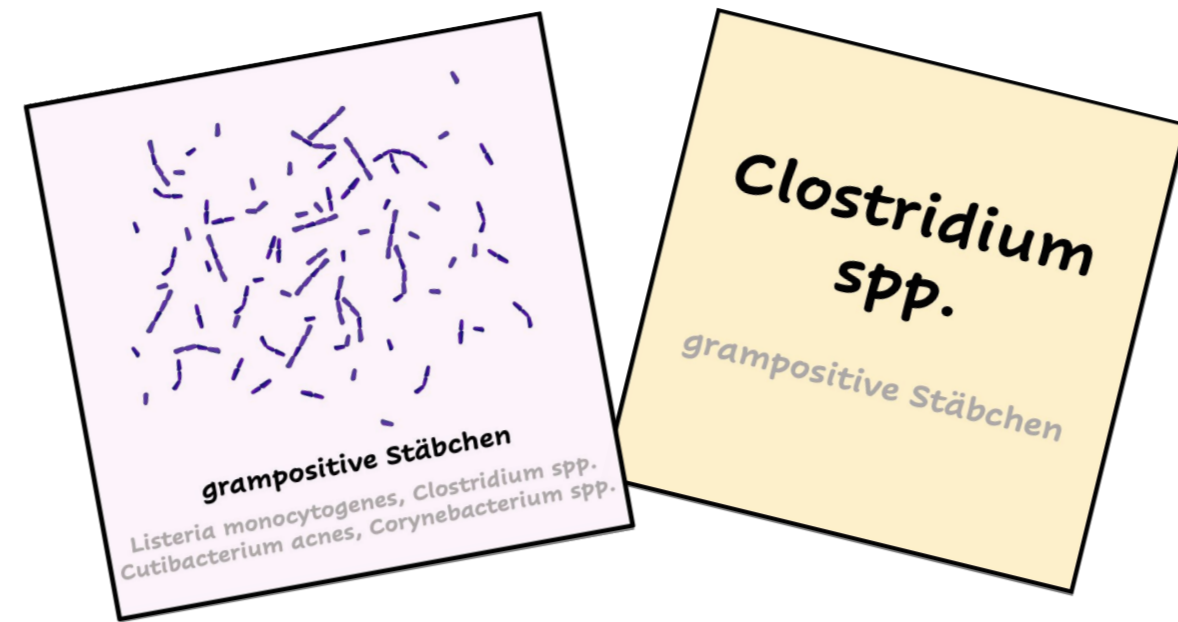


Objectives

See one, do one, teach one. This guiding principle has been used to train doctors for over 100 years. Until now, however, this method has not been equally applicable to all specialist areas. By using gamified learning elements and an AI-based chatbot, we have investigated how both learning and teaching can be enriched and how theoretical subjects such as antibiotic stewardship can also come closer to the guiding principle.



Methods

We offered short courses focusing on antibiotics, with a total of 46 medical students participating. All students were given a questionnaire about microbiology, infectious diseases, pharmacy and qualitative questions regarding their proficiency of selecting antibiotics for therapy. Students were followed up with the same questionnaire for up to 12 months. Courses used popular game mechanics for teaching, an app for self-studying and an AI for evaluating answers given to freeform questions.

Figure 1: e.g. pairs game with academic content encouraged students engagement

Gamified learning activates students, enables instant feedback and identifies knowledge gaps.

Results

1. Substantial and sustained improvement in factual knowledge after the course
2. Reduction in uncertainty when selecting antimicrobial therapies
3. AI-based freeform answer reviews can reveal student learning gaps using large language models (LLM)

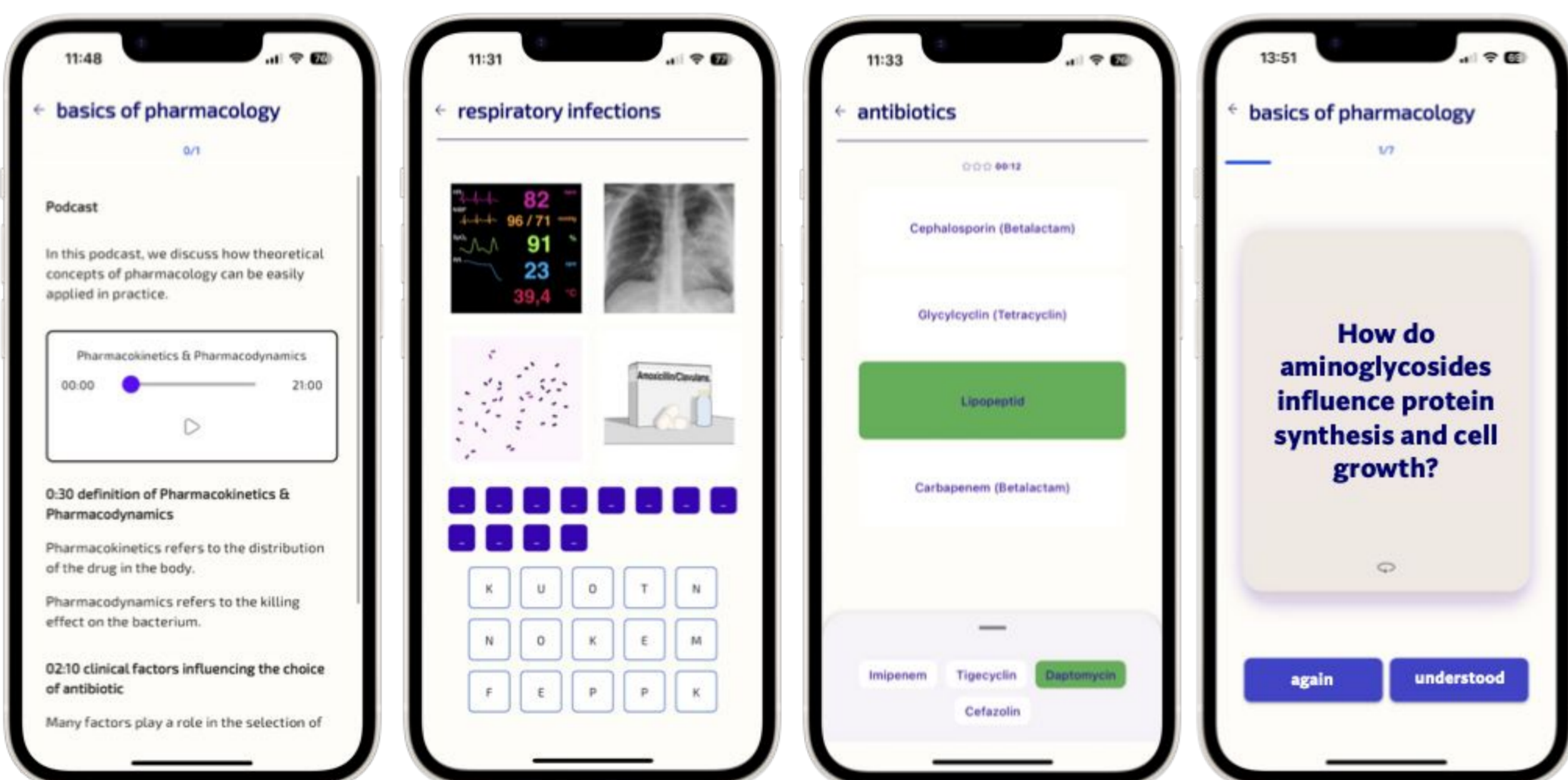


Figure 2: (from left to right) Podcast and additional reading material for students to prepare for the next lesson in a flipped classroom format. Game “4 pics 1 word,” where a word corresponding to all four images shown should be correctly guessed. Game “speed matching,” where pairs of matching concepts should be found under a time constraint. Flashcards are used with a spaced repetition schedule to support the long-term memorization of learned concepts.

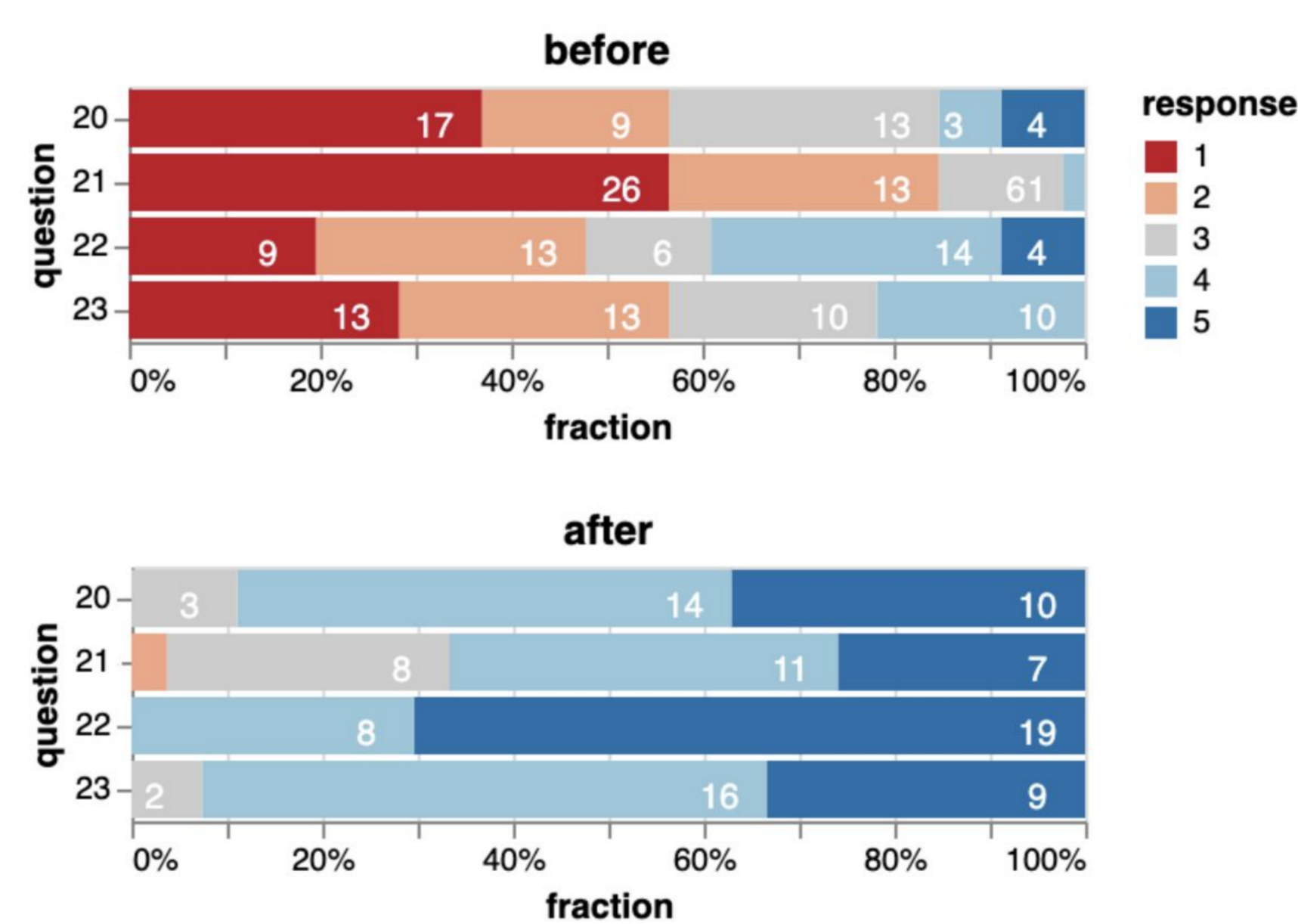


Figure 3: Subjective confidence rating of 46 students regarding antibiotic therapy initiation before (upper panel) and after (lower panel) the course. Rating was performed on a Likert scale from 1 (“no agreement”) to 5 (“full agreement”). A substantial improvement can be observed across all questionnaire items in this block (blue is better).

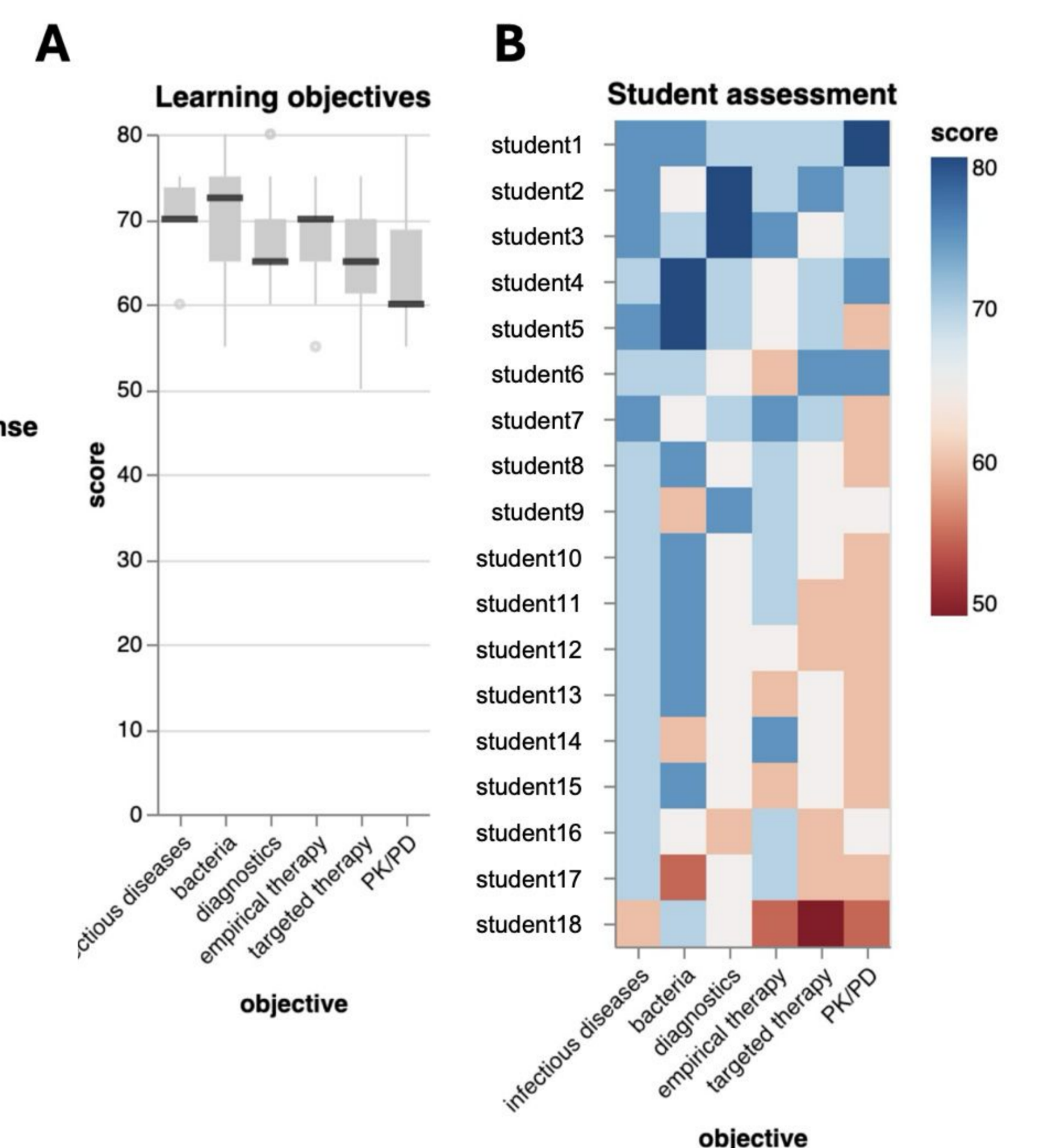


Figure 4: AI-based freeform answer reviews can reveal student learning gaps. **(A)** For each student the probability of being able to answer a new question sourced from the learning objective (“score”) was calculated. When these scores are aggregated, topics can be ranked by difficulty. Pharmacokinetics and -dynamics (PK/PD) appear to be challenging. Note that the y-axis has been truncated to 80%. **(B)** These data can also be used to identify knowledge gaps across learning topics. Individual students may then be targeted for additional learning support.

