

## Challenges in teaching interactive lectures with high student diversity using student response systems

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Interactive teaching is becoming increasingly popular in higher education, as students who engage in the learning process learn more. Student response systems - also called clickers - are an engagement tool, which promotes such interactivity as students increase their engagement in lectures. In a globalizing world, student diversity has become greater in many institutions, while publications on clickers focus on courses with similar student background. In this study, the effect of clickers on the learning climate in lectures with high student diversity is analyzed to differentiate the clicker effect.

A questionnaire was developed containing 29 questions on learning climate categorized in the seven dimensions comprehensibility, opportunity to participate, subject relevance, class participation, willingness to participate, own performance, and satisfaction. In the first session of each lecture, students were asked to describe their ideal geoscience lectures. In the following session set, effects of clickers on learning climate was compared to lectures without clicker usage. Typically three of such sets were evaluated by the students per lecture followed by the final evaluation of the whole lecture. Statistical analyses were performed using the Mann-Whitney U test and Kruskal-Wallis H test.

For each clicker session, the question difficulty was staggered from recall questions, over conceptual understanding questions, over application questions, to critical thinking questions. The clicker sessions were performed at the end of the sessions with question numbers ranging between 7 and 12 questions.

In total 174 students participated in 12 undergraduate geoscience lectures at the University of Tsukuba. In terms of student type, students were classified into degree students in the Integrated Life & Environmental Sciences program in English (with majors in geoscience, biology and agro-biological resource science) from 34 countries with 64.9%, into geoscience in the Japanese program with 14.4%, and into exchange students with 20.7%. 59.4% of the students were female and 40.6% male.

In general, sessions with clicker usage were rated better in all dimensions. Using clicker, students ( $n = 806$ ) feel more satisfied ( $U = 71746.5$ ,  $Z = -2.876$ ,  $p = 0.004$ ), and they ( $n = 805$ ) sense a higher relevance of the topics ( $U = 73455.5$ ,  $Z = -2.269$ ,  $p = 0.023$ ). In addition, they ( $n = 786$ ) think they have more possibilities to actively take part in the lecture ( $U = 69468.0$ ,  $Z = -2.446$ ,  $p = 0.014$ ), and they ( $n = 785$ ) also use this possibility significantly higher than in lectures without clicker ( $U = 69432.5$ ,  $Z = -2.403$ ,  $p = 0.016$ ).

Gender-specific differences for the initial lecture and the usage of clickers became evident. For ideal lectures, student views differed tendentially in three dimensions. For female students ( $n=82$ ), topic relevance is significantly more important ( $U = 1717.000$ ,  $Z = -1.903$ ,  $p = 0.057$ ) than for male students ( $n=52$ ). In addition, the participation of the whole class ( $U = 1733.500$ ,  $Z = -1.838$ ,  $p = 0.066$ ) as well as the own participation ( $U = 1763.500$ ,  $Z = -1.697$ ,  $p = 0.090$ ) is more important for female students. Gender differences were also shown for the usage of clickers. In sessions with clickers, female students ( $n=239$ ) rate the dimensions of comprehension ( $U = 14649.500$ ,  $Z = -2.752$ ,  $p = 0.006$ ) and course participation ( $U = 15432.500$ ,  $Z = -2.022$ ,  $p = 0.043$ ) significantly higher than males ( $n = 147$ ). In sessions

without clicker, no gender-specific differences were found.

Comparing degree students enrolled in the English and Japanese program significant differences were identified. Regarding comprehension ( $U = 5426.500$ ,  $Z = -2.415$ ,  $p = 0.016$ ) and own participation ( $U = 5761.000$ ,  $Z = -1.799$ ,  $p = 0.072$ ), the students in the English program ( $n = 235$ ) rated the lectures with clicker better than the students in the Japanese program ( $n = 58$ ). In contrast, the students in the Japanese program rated the possibility to participate ( $U = 5403.000$ ,  $Z = -2.157$ ,  $p = 0.031$ ) as well as the course participation ( $U = 5352.500$ ,  $Z = -2.251$ ,  $p = 0.024$ ) significantly higher. Exchange students were less satisfied when clickers were used, possibly due to the difficulty to answer questions correctly.

These results on the learning climate in lectures with high student diversity indicate the clickers are not a guarantor for positive effects on learning climate. Aligning question difficulty with student level is a challenging task for lectures with high student diversity.

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