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Navigating the Pedagogical Landscape: An Exploration of Machine Learning Teaching Methods

Are we laying a robust foundation for future engineers in machine learning education, or do we risk leaving them ill-equipped for the challenges of tomorrow?

Background

- ML teaching relies on lecturers' intuition and preferences;
- Lectures are predominant, familiar but not the most innovative in field of ML;
- Structured approaches lack in research on ML education;
- Exploring the gaps is key to training tomorrow's ML engineers effectively.

Objective

What are the teaching techniques documented in literature (1) and used in ML courses of Dutch universities (2), and how do two most regarded techniques from (1) and (2) compare?

Methodology

Literature review:
- teaching methods for CS and ML
- classified by Beck's taxonomy (1998)

Survey:
- 24 ML lecturers in Dutch universities
- teaching methods and tools used

Experiment:
- 13 EEMCS students
- jigsaw vs. lecture
- pre-test and post-test on k-NN knowledge
- interview at the end for opinions

Literature review

The most effective teaching methods from literature seem to be:
- mixed method, blended learning, and jigsaw (dividing the class into expert groups that teach each other).
- for ML: active learning, experiment-based approaches, live coding, and staying close to applications.

Survey results

- mixed-method approach;
- lectures, together with labs or workshops;
- projects, technological tools, and group work;
- focus on active learning;
- flipped classroom and blended learning gain traction;
- visualisations and small working examples effective in teaching complex ML topics;
- divide in how lecturers keep in touch with pedagogical practices;
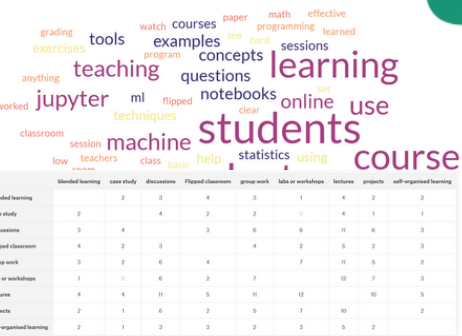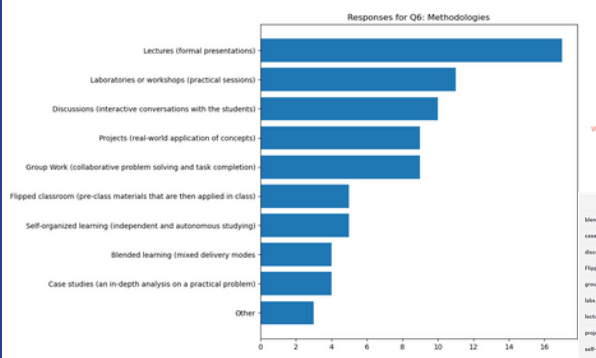
Experiment results

- jigsaw vs. lecture with k-Nearest Neighbor;
- significant improvement from pre-test to post-test;
- similar efficacy in jigsaw and lectures, no statistically significant difference with ANOVA;
- student satisfaction higher for lectures than for jigsaw might be due to the familiarity of the participants with the lecture method, or due to personal preference;
- a great variance in satisfaction and range of feedback with both teaching methods shows the importance of adapting teaching methods to accommodate a variety of learning styles;
- the results challenge the traditional reliance on lectures, advocating for a more balanced and flexible approach to teaching ML;
- limited sample size makes the experiment results less reliable.
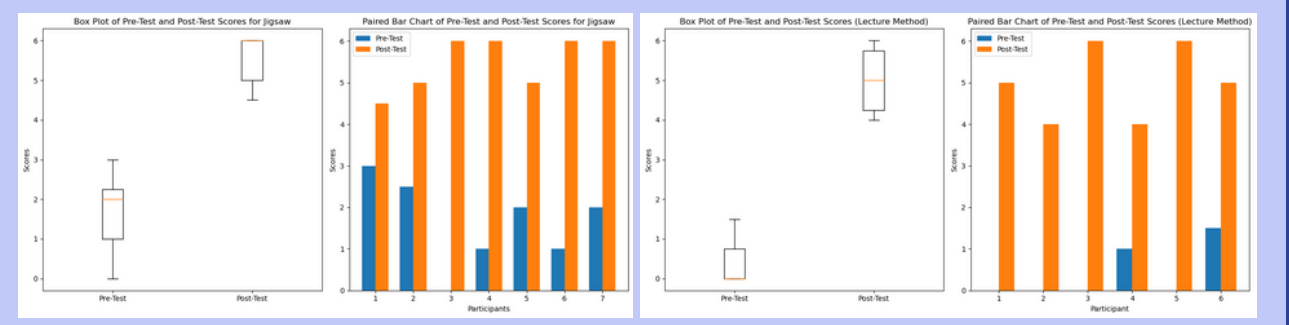
Conclusions

- effective teaching methods for ML were explored in this research;
- necessity of integrating both traditional and innovative teaching strategies, of incorporating project-based and active learning approaches;
- balanced approach incorporates technological advancements and caters to diverse learning needs;
- further research should explore the long-term impact of various teaching methods on student retention of ML concepts and their practical application, on a larger sample size.

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