

Scaffolded Learning Assignments in university Machine Learning education

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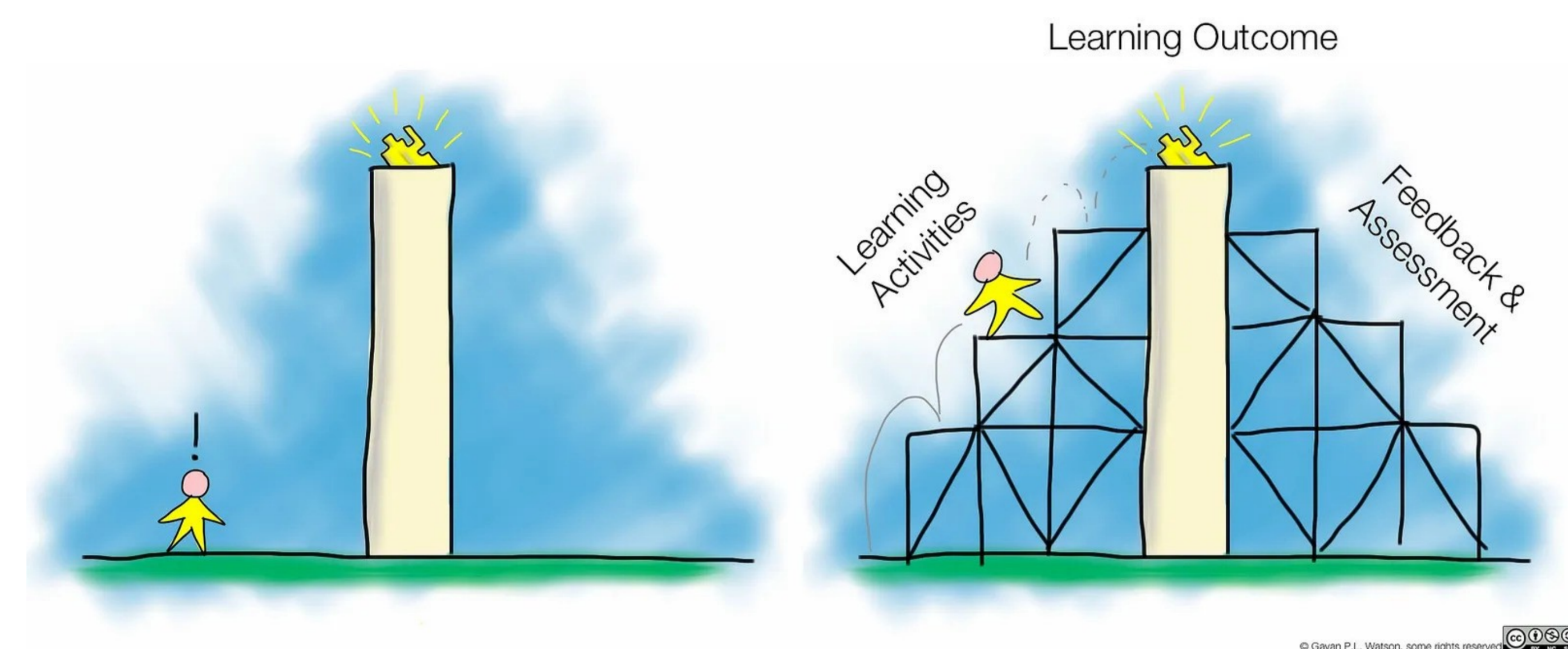
Background

“We noted that especially computer science and software engineering students tended to struggle with the adoption of an empirical mindset rather than a constructive one [1].”

- Machine Learning is becoming an increasingly large part of Computer Science curricula.
- Designing Machine Learning models requires an empirical design methodology.

Scaffolded learning is a teaching methodology where learning objectives are split up into sub-tasks by providing the student *scaffolds*, or hints, to iteratively build the understanding of the entire learning objective.

Scaffolded assignments have been shown to positively influence student learning, confidence and adaptation of design methodologies [2][3][4].



Research Question

“How do scaffolded assignments in the CSE2510 course impact **student learning, confidence, and the development of an empirical mindset?**”

Methodology

The CSE2510 course in the TU Delft Computer Science & Engineering bachelors is the first Machine Learning course in the curriculum. The aim is to survey students who have completed this course. The design of the survey is presented with respect to the three topics of interest.

- Empirical Verification:** Verify if students agree there is a difference in mindset between ML and other Software Engineering.
- Learning:** Collect and analyze data on assignment engagement, course results and perceived impact of the assignments on their grade.
- Confidence:** Execute the Instructional Materials Motivation Survey (IMMS) to determine confidence gain.
- Empirical Mindset:** Gather qualitative data on how the scaffolded assignment influence students' understanding and learning experience.

Results

- 12 out of 17 respondents agreed that Machine Learning requires a different mindset than other types of Software Engineering. Table 1 shows respondents arguments.
- No significant correlation was established between the number of assignments completed and course grade.
- IMMS results yield a Cronbach's α of 0.78. Similar to validation studies [5].
- Significant correlation was found between perceived insight gained from assignments and confidence gain from assignments (IMMS).
- Significant correlation was found between perceived impact of assignments on their grade and confidence gain from assignments.
- Students agreed that the scaffolded assignments helped them better understand the ML design process. Table 2 shows respondents arguments.
- All respondents agreed that scaffolding enhanced their learning experience by providing guidance.

Arguments	Count
Per-problem approach	6
Parameter tweaking	2
Performance evaluation	2
Experiment to solve new problems	1
None	2

Table 1. Classification of agreeing arguments regarding the differences between ML engineering and other software engineering

Arguments	Count
Experiencing the entire design process	6
Experimenting with different approaches	2
Experiencing evaluation and improvement	1
Providing context to theory	3

Table 2. Classification of agreeing arguments on how scaffolded assignments helped understand the ML design process

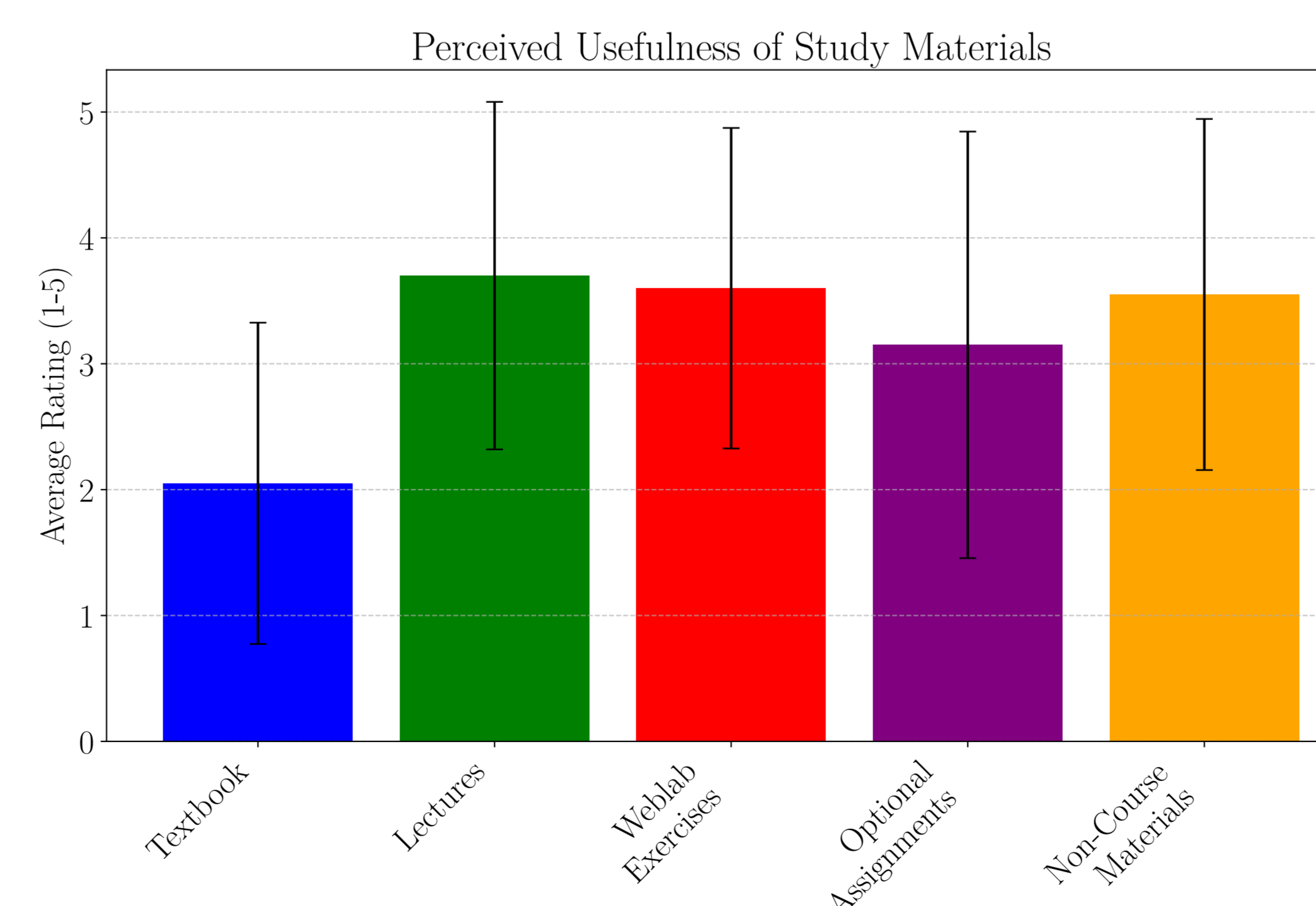


Figure 1. Reported usefulness of available study materials, on a scale of 1-5. The error bars represent the standard deviation.

Conclusion

- Students experience the different mindset needed in ML Engineering.
- No significant correlation found between scaffolded assignment engagement and grade.
- Qualitative data shows positive influence of scaffolded assignments on confidence and material understanding.

Discussion

Limitations of current study

- The study was based on a small sample size of 25 students.
- The data collected were self-reported through surveys.
- The study did not fully account for external factors such as prior knowledge, personal motivation, and external support that could influence the outcomes.

Future research

Course staff can take the following steps to further research the effects of scaffolded assignments during an edition of the course.

- Using validated instruments to measure empirical mindset [6].
- Implementation of pre- and post-course measurements.
- Constructive alignment of assignments and exam.
- Repeat application of the IMMS instrument.

References

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