

# Development of Competencies for Geotechnics using Project-Based Learning

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Abstract

In today's society engineer professionals play a crucial role in tackling challenges such as climate change or economic constraints, in order to promote economic development and increase of quality of life ensuring principles like sustainability or safety. It is fundamental to prepare the future engineers to these and future challenges. Three conditions of effective learning have been reported: active learning by doing, cooperation and teamwork in learning and learning through problem solving, essential to promote creativity and innovative capacity. Project-based learning can help to promote such skills in engineering programs as it allows recreating professional reality and relating fundamental theories and skills of an engineer. High-level thinking and sound judgment is developed through accumulated authentic professional experience by engineers. For engineering students a similar process can be triggered by a teaching environment which enables simulating and stimulating such skills. To prepare better professional and enhance students' employability Civil Engineering students of University of Aveiro, Portugal, have undertaken several modules on Geotechnics (Soil Mechanics I, Soil Mechanics II and Foundations and Retaining Structures) where a project based learning model has been used. This model was implemented using projects trying to replicate realistic situations where the students worked in teams. These group projects included open-ended realistic scenarios tackled using different tools (spread-sheets and software) and where the students applied the concepts and methods acquired during the lessons. The main goal was to help students develop soft skills and become familiar with typical numerical tools currently used in Geotechnics, while developing high order thinking and problem solving skills. For the projects students were asked to create their own spreadsheets from scratch. Students were guided into critically analysing results obtained using different approaches to increase their awareness to common misinterpretation of data generated using both spreadsheets and other software. This work presents the general structure of the modules on Geotechnics provided in the Civil Engineering course in University of Aveiro (UA), Portugal, the main characteristics of the project-based learning model implemented in the modules and the description of those projects. Students' perceptions on the added value of the project were collected using a questionnaire and are discussed. The evolution of the students' response to the model is discussed using data collected in the several modules. Although when the students attended the Foundations and Retaining Structures module most of them had attended two modules on Soil Mechanics where a similar learning model was used, initially they had negative reactions to it. Students report a severe workload; however their estimates match the expected working hours. The model has been evolving in order to optimise the learning and address the students' feedback.

Civil Engineering programme at University of Aveiro, Portugal

Integrated master:

- 5 years (10 semesters);
- 300 ECTS (European Credit Transfer System).

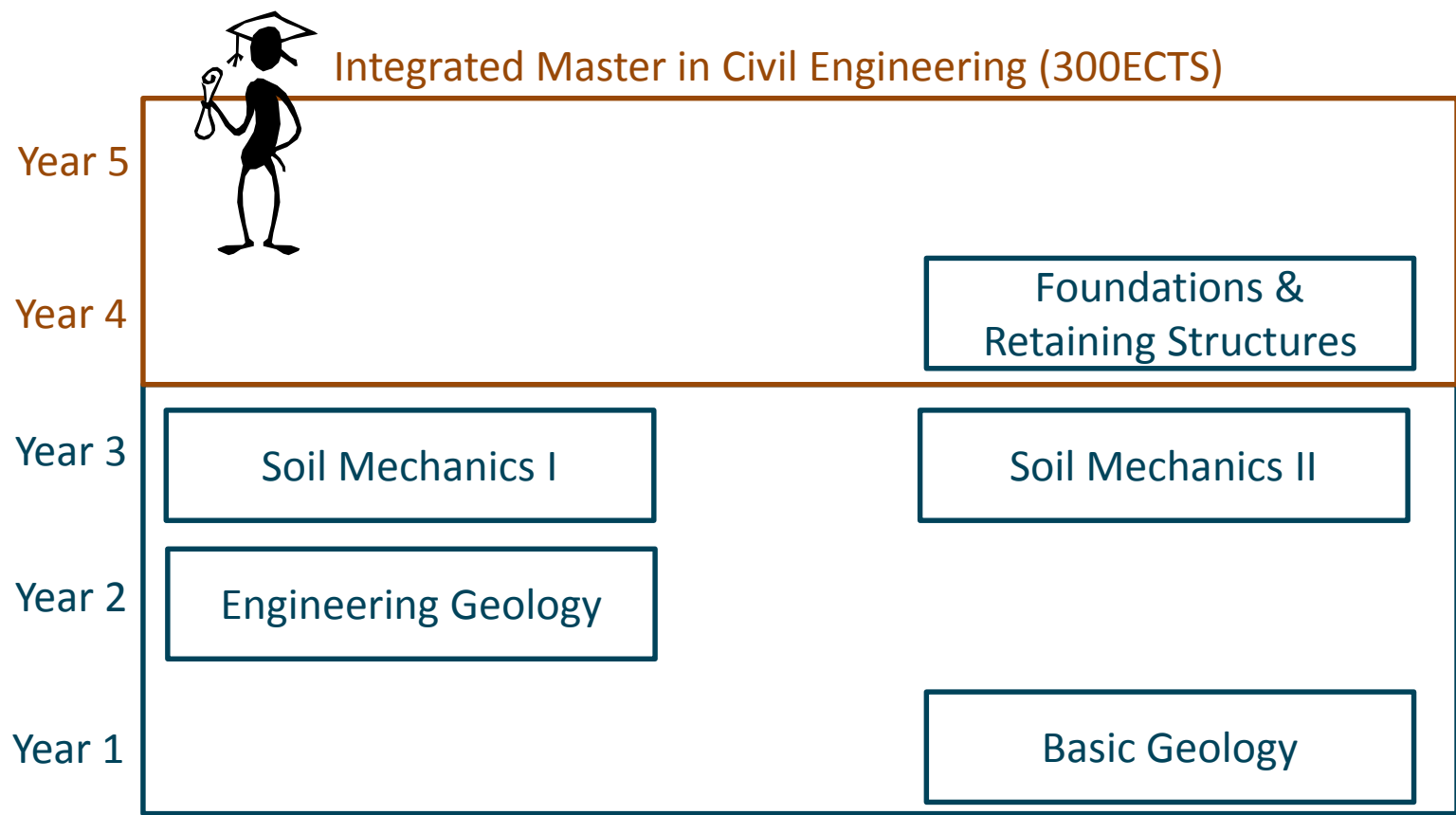


Fig.1 Compulsory modules on Geotechnics or related subjects

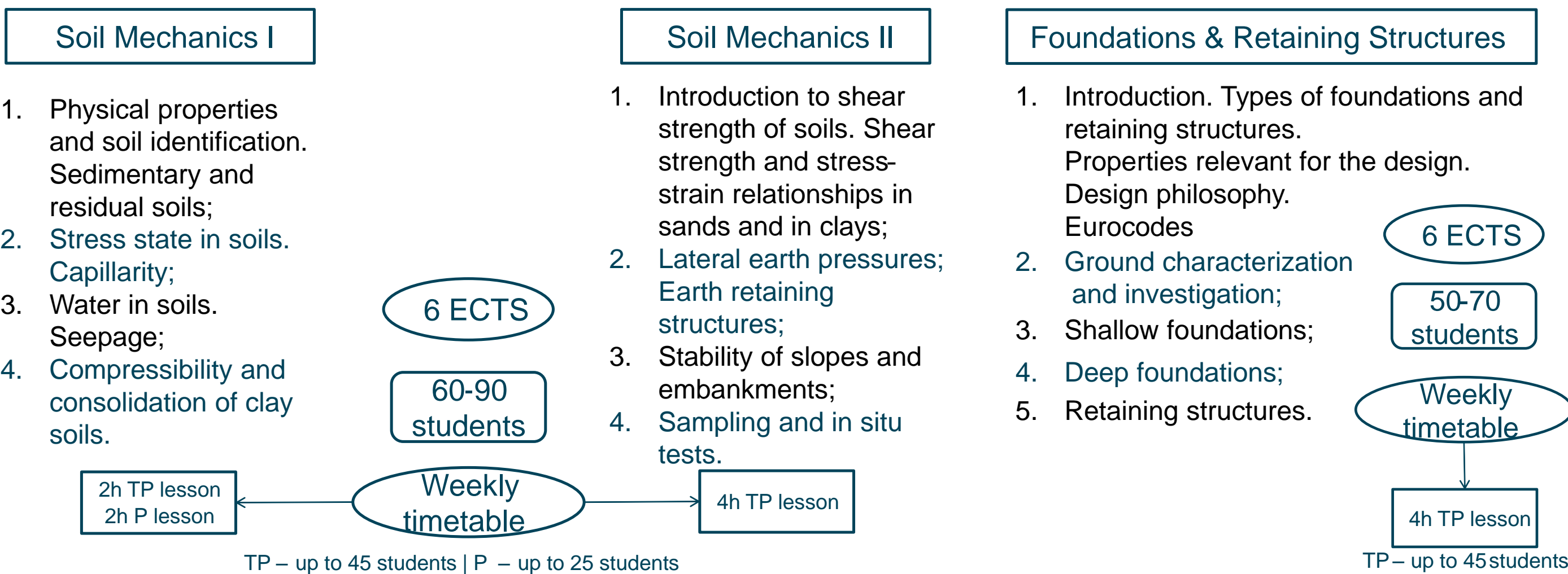
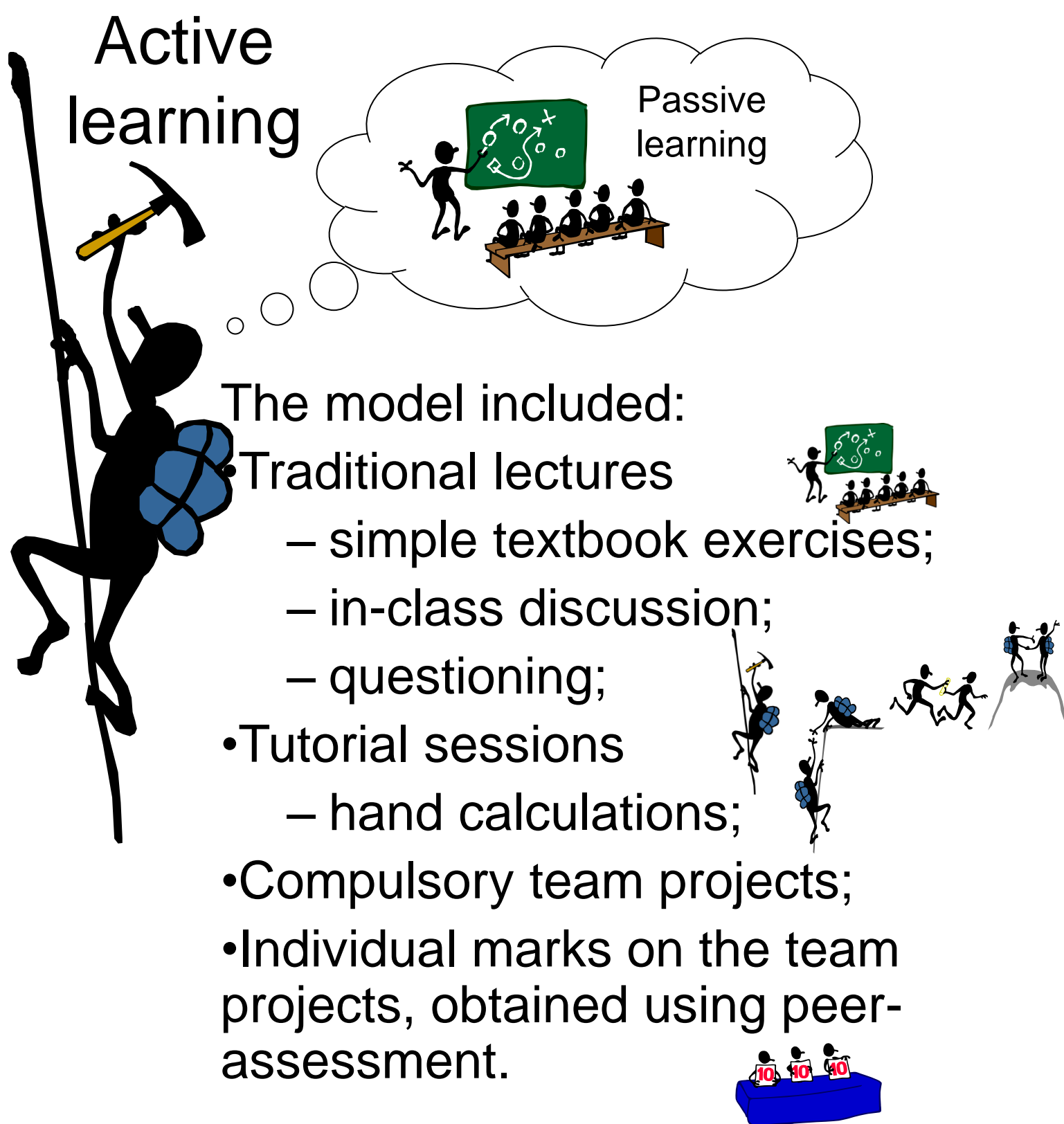


Fig.2 Syllabus and characterization of the geotechnics modules

Project-based learning model



Cooperative model

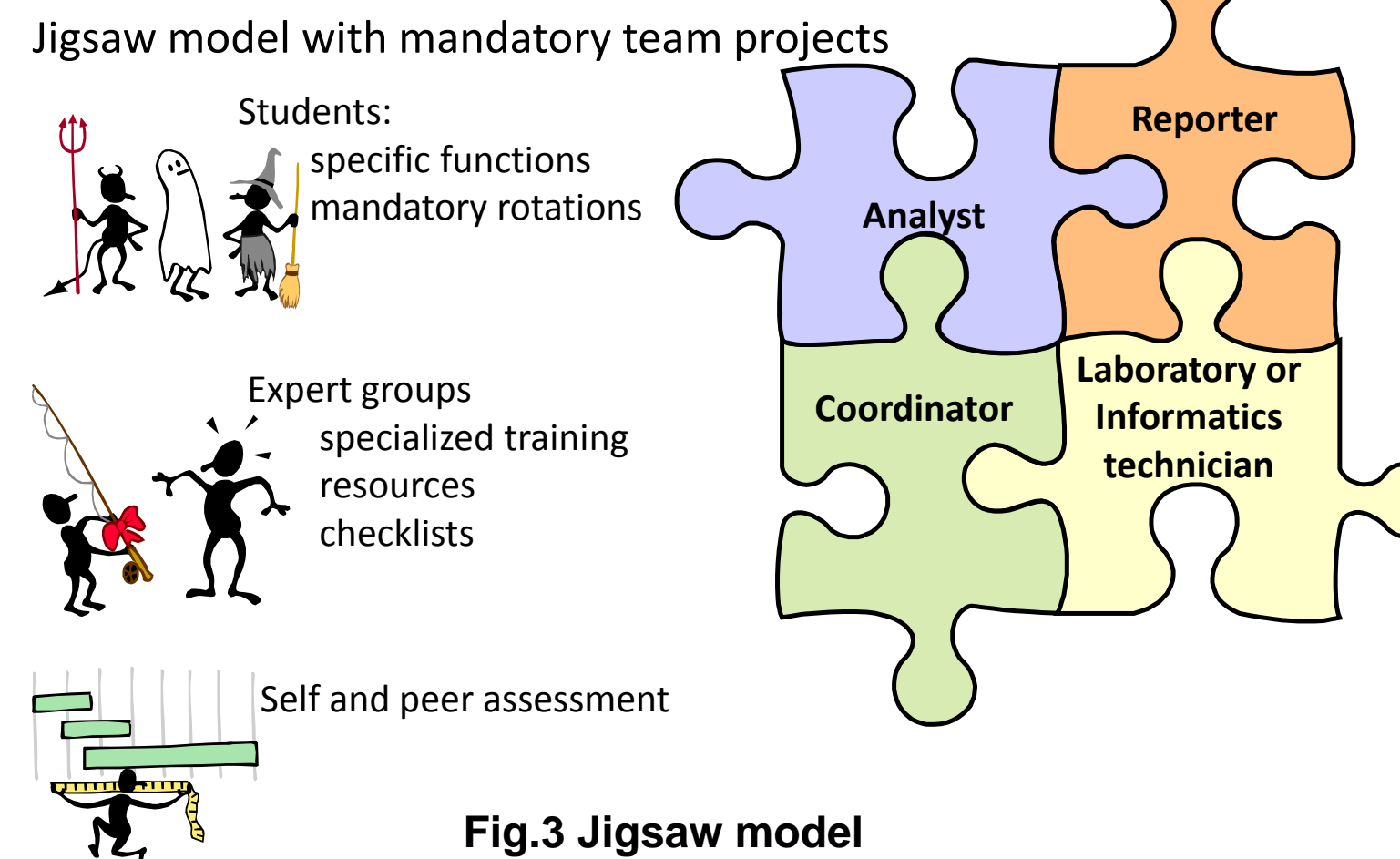
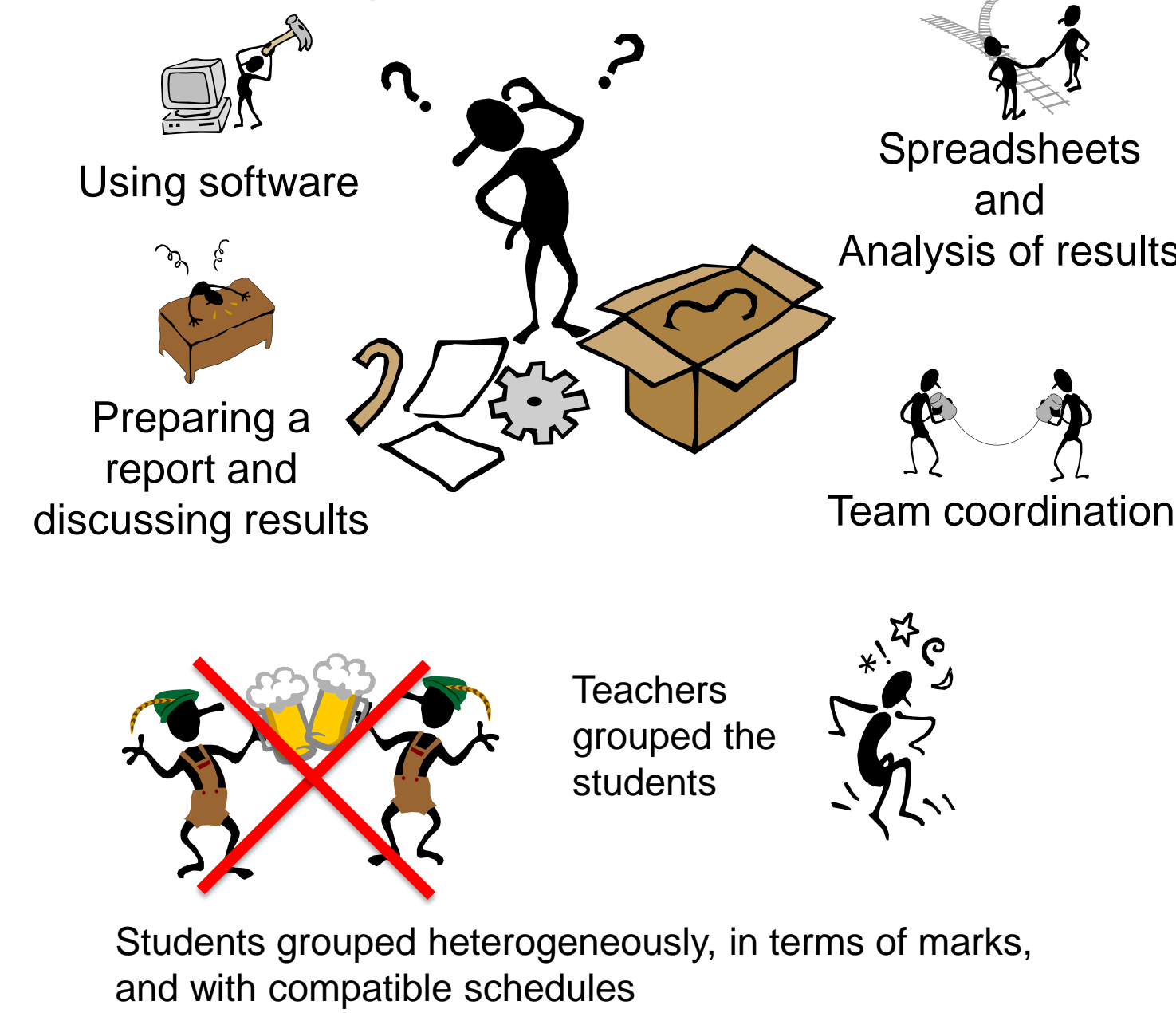
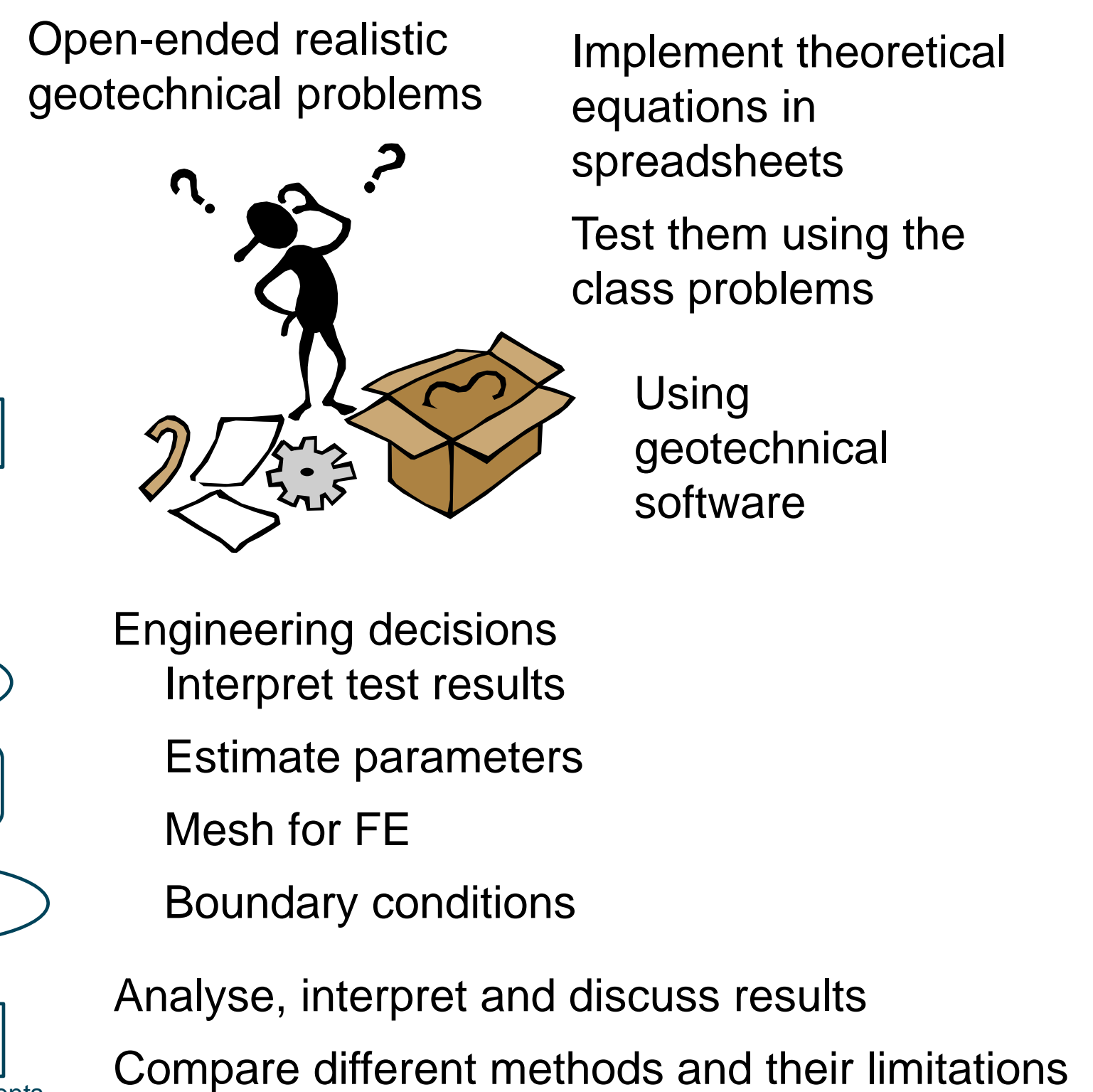


Fig.3 Jigsaw model

Team projects



Promoting problem solving and high order thinking skills



Assessment of the model

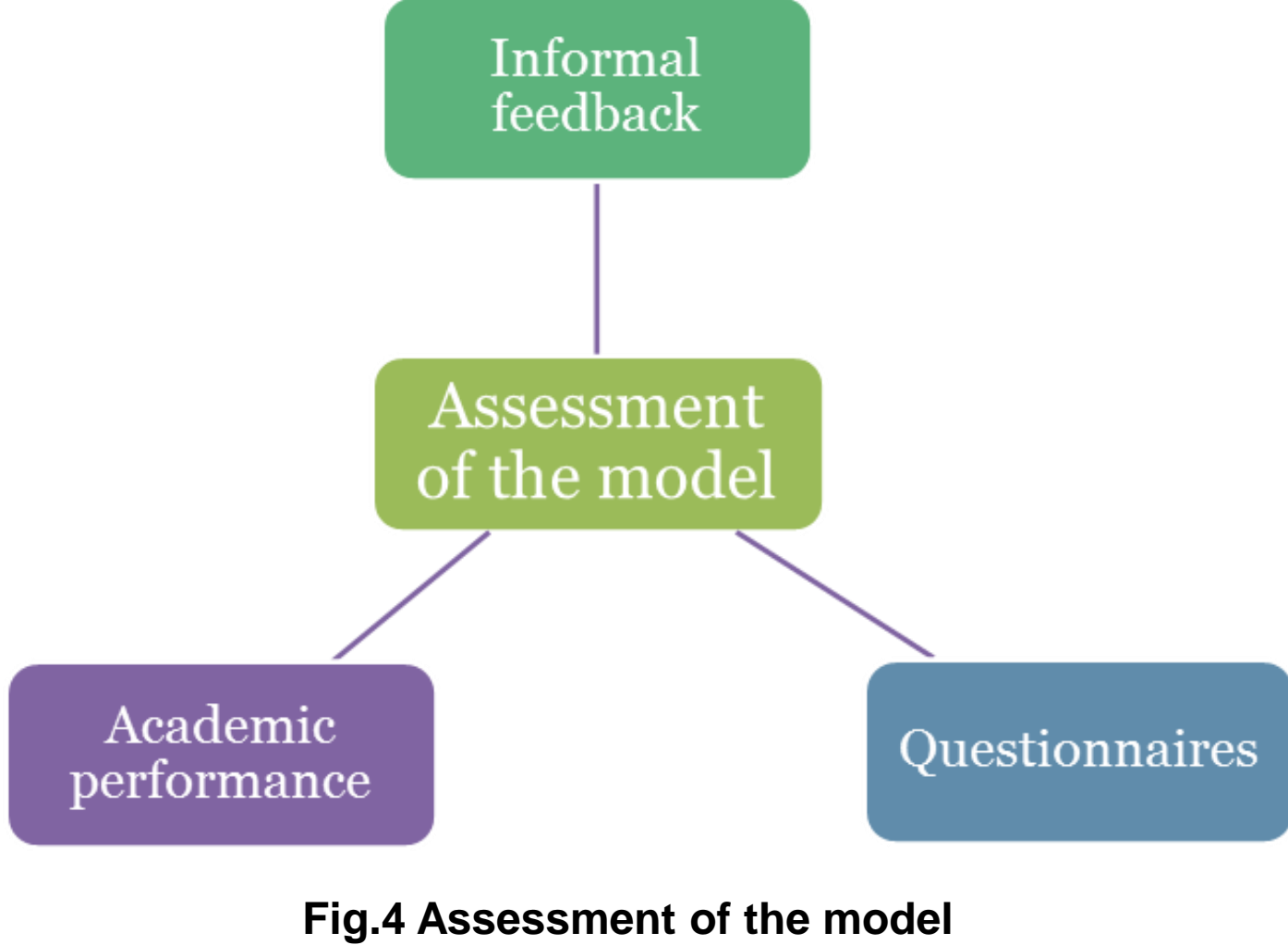


Fig.4 Assessment of the model

Conclusions

The aim of using the project-based learning model used was to promote effective learning by students. For this, different learning styles were addressed and students were challenged to adopt deeper approaches to subjects relevant for their professional or personal development. Advancing students to higher development levels was intended too. For the several modules, despite the initial reaction of rejection and suspicion students were generally successful. Their final marks are not very high but the added value of the projects is often evident for students when they tackle their M.Sc. dissertation or when they start their professional lives. Students answering the questionnaires considered the modules to be adequate and, although they report a severe working load, it matches what is expected from the module. Some issues have been raised by the students that attended the different modules where this model has been used. However, according to students' perceptions and to the overall judgement of the authors, the strategies adopted were useful and successful in promoting and facilitating the construction of knowledge and in developing competencies by students. Although students consider these approaches important for their preparation for the future professional life, it is necessary continue to show them the benefits to their professional and personal development of these student centred learning approaches. With more commitment students the model acceptance can be higher and their final results can be better.

References

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