Presentasjon/Diskusjon

Co-creating course projects in introductory Meteorology and Oceanography – enhancing and building motivation through group supervision and collaboration with former students

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Sammendrag: Small research projects aligned with a course are thought to help the students grasp theoretical concepts, apply skills that they acquired previously or during the course, and provide training in academic writing. The outcome of student projects, however, strongly depends on the effort that the students are willing to invest in their projects. We encourage students to take the lead in their own education and to learn from each other, and have tested three methods to support the students' learning: The students design their own research question, we apply group supervision to support students during the execution of the research project, and we enable exchange with former students.
By enabling students to choose a project topic of their interest, their motivation can be increased, inherently improving the learning outcome for the individual student. Group supervision facilitates learning beyond the individual projects and makes use of the individual strengths and knowledge of the students. Including more experienced students in the project development benefits both the current and former students and enables knowledge transfer across cohorts.

Nøkkelord:
Self-determined research experience, group supervision, relatedness, competence, autonomy

1 Introduction

Including practical assignments in courses is thought to support the students in their learning. Motivation for the task, however, is an important factor in determining the students' actual learning outcome of assignments. While motivation can be facilitated by external factors such as rewards (e.g. grades), self-determination theory suggests that internal motivation is created by the need for or feeling of competence, relatedness, and autonomy (Deci and Ryan, 2000). Co-creation of teaching and learning (Bovill, 2020), which describes an interactive development of education where both students and teachers are involved in designing teaching and course work, is one approach implementing these three concepts in teaching.

We implemented three co-creation practices to enhance the students' motivation and, subsequently, the learning outcome of an obligatory course assignment: (1) The students designed individual project research questions, (2) we supported the students through group supervision to both develop the project ideas further and to execute their assignments independently, (3) former students were actively involved in the development and execution of the students' projects.

In the following, we will first introduce the assignment, then we will describe how the three practices were implemented. We present the outcomes of some individual projects as well as overall observations and discuss the impacts for the student's motivation during the assignment, by relating the outcomes to the three essential components of self-determination theory, competence, relatedness, and autonomy.

2 Methods

In the course GEOF100 - *Introduction to atmosphere, ocean, and climate*, a project report is included in the course assessment, counting 30% of the final course grade. The students choose a research question, design and perform an experiment, and subsequently analyze the collected data to answer the research question. The project report resembles a scientific paper by following the IMRaD structure (Introduction, Method, Results, and Discussion). The discussion is supposed to contain a reflection of the learning outcome for the student in addition to the discussion of their results. The projects are executed individually, and each student submits his/her own report.

2.1 Letting students choose a research question

At the beginning of the semester, the teachers present an overview of the previous year's student projects and a list of the available instrumentation. The students can use the overview to find inspiration for their own project and submit a research question they want to pursue within four weeks. The students can choose an example from the provided list, but they are strongly encouraged to be creative in designing their project and developing their own research questions.

2.2 Providing feedback and further developing the research project together

It is important for the successful execution of the research projects that each project is realistic to perform within the given time and that it aligns with the knowledge and skills students gain during the course. This is achieved by group supervision, where the teacher preferably sits down with 2-3 students at a time. We allow, however, individual supervision for students who prefer working alone. The groups are preferably chosen such that the topics within the group span a wide range of topics (e.g. from oceanography and meteorology). Due to the small number of students in the specific course, the group supervision aligned well with assigning groups of friends.

During group supervision we support the students in the choice of instrument and give advice on the choice of locations where we can expect to have an interesting outcome of the project. We would like to emphasize that the students and their peers are actively included in the decision-making process and that we provide scientific reasoning for our suggestions. We do, e.g., suggest to measure spatial variability in salinity content near a river estuary rather than in a harbor or at a local bathing spot.

2.3 Engaging former students in the execution of the research project

Some research projects are similar to projects that were performed in the previous year. Instead of prohibiting access to the former students' reports, we actively encouraged an exchange between the current and former students by putting the students into contact with each other. We had two applicable student projects where, in both cases, the former students agreed to participate. The teacher did not interact further with these pairs of students, and they communicated independently.

3 Results

3.1 Choices of research questions

The degree of independence in the chosen research questions varies strongly amongst the students. Some of the chosen projects show little to no relation to any of the previously presented research questions (high degree of independence). However, most students choose to modify one of the presented research questions so that they can easily relate to the topic. Modifications include, e.g., the use of own equipment for carrying out the experiment (fishing rod, boat, buckets), the connection to a private hobby (sailing, paragliding, diving, hiking, kayaking, running, training, ...), relation to daily-life activities (doing the laundry, taking a shower), or the integration of familiar locations (their parent's home, a private cabin, etc.). Only a few students choose a research question from the list without modifying it.

In *Examplebox 1*, we provide examples of projects that were either developed independently or modified by the students. The extensive list illustrates that the students had sufficient input to creatively develop individual projects, giving them space for autonomously shaping their education. Connecting the project to previously acquired skills and knowledge acknowledges the students' competence. Enabling both autonomy and competence through tailored student projects facilitates motivation to build on and expand previous knowledge.

Suggested student project	Individual student projects
Relation between relative humidity, absolute humidity, and temperature	
How does humidity change with temperature while hiking up a mountain?	-How does humidity change with temperature while paragliding? -How does humidity change in the bathroom while I am taking a shower? -What drives changes in humidity in my local training center – the weather or the amount of people training? -How do temperature and humidity vary across different outdoor climbing spots? Does the popularity of climbing spots correlate with these conditions? -How does the humidity in my flat change while drying laundry?
Interaction of tides with fjords	
How do the tides vary inside the local fjord compared to measurements along the coast?	-How do tides vary in two different branches of the same fjord? -What type of tides can I observe near my parents' cabin?
Impact of precipitation and river runoff on ocean salinity	
-Compare the surface salinity in the local fjord before and after events of rain -Measure salinity at different locations in the local fjord	-How does salinity vary in the fjord near my grandparents' cabin – does it depend on the tides or the river runoff? -How does salinity change within a fjord? (student taking water samples while sailing in private boat)

Examplebox 1 - Suggested and modified student projects for different topics covered in the course

3.2 Group supervision in action – create relatedness amongst students

The students engaged actively in the group supervision discussions. All students commented, posed questions, or suggested a solution or an improvement to at least one of their peers' projects. Consequently, the students contributed to the development of at least two different projects (including their own one) with different research questions. In *Examplebox 2*, examples of problems and solutions that developed during the group supervision are given.

Problem: The instrument needs to float on the ocean's surface for about two weeks.
Solution: A friend of mine owns a boat, we can ask him whether we can attach the instrument to the boat or whether he knows of a suitable floating dock.

Problem: The instruments need to be placed in different training centers and preferably start measuring at the same time.
Solution: Each of us can put one of the instruments at a different location and start the measurements.

Problem: The same instrument, of which we have only one available, needs to be used for different projects. **Solution:** We can easily coordinate our measurements – and even compare them in our reports.

Examplebox 2- Problems and solutions that came up during group discussions

3.3 Knowledge transfer across cohorts

From the two groups where we encouraged exchange between this year's students and former students, we briefly outline one particularly successful example where the project quality improved noticeably from one year to another. The project aimed to quantify the strength and direction of tidal currents in a local fjord. The former student had noticed several caveats with the experimental setup while writing the project report, such as a lack of measurement accuracy and number of data points and could not make a satisfying interpretation. When the experiment was repeated in the following year, two students developed a much-improved experimental setup that allowed for higher accuracy of the measurements, increased the measurement frequency, and added a spatial dimension (variability across a bridge). The new project was very successful, and the students could interpret the results more satisfactorily. A more detailed experimental setup and improvements from one year to another due to the exchange between the students are described in detail in *Examplebox 3*. We are currently investigating how the successful collaboration was perceived by both student groups.

Measuring strength and direction of tidal surface currents in a local fjord
Improvement of measurement accuracy
(A) The former student had measured the surface velocity by measuring the time that floating objects needed to float from the upstream side to the downstream side of the bridge. This introduced large uncertainty in the distance measurement as the start and stop locations for the time measurement are very difficult to accurately locate. (B) In the following year this was improved by tethering a floating object to a marked fishing rod, such that the uncertainty of the distance covered by the floating object was drastically lowered.
Adjusting the measurement frequency to the frequency of the system
(A) In the first year, the experiment was repeated four times during the tidal cycle. While the set up was sufficient to see differences between falling and raising tide, the measurements were not sufficient to capture the entire cycle or to determine the point in time when the current reversed. (B) In the repetition of the experiment in the following year, measurements were taken every hour through the first 16 hours of the tidal cycle allowing for the interpolation of a sine curve to determine the points when the current reversed.
Increasing the complexity of the research project by adding another dimension
(B) In the second year, the students decided to measure at five different locations across the bridge to capture the spatial variability. To determine suitable locations on the bridge and to be able to explain spatial variability, the water depth below the bridge was measured with a creative set up at two-meter horizontal resolution before the start of the experiment. Based on these measurements, even the volume transport under the bridge was estimated from the measurements in the repetition of the experiment.

Examplebox 3 - Comparison of the experimental setup for the same research project in two consecutive years. The setup from the first year is marked as (A), the setup in the iteration is marked as (B).

4 Discussion and Conclusions

We applied methods from the Co-creation approach (Bovill, 2020) to individual research projects of students in an introductory climate physics course. We guided the students to find their own project question, providing the feeling of autonomy. In group supervision sessions, the students successfully co-developed and improved each other's projects, confirming their competence, creating the feeling of relatedness, and emphasizing their autonomy, as they found their own solutions. When applicable, we furthermore encouraged and enabled active exchange between former and current students, which supported all three elements of self-determination theory, relatedness, autonomy, and competence. We perceived high motivation amongst students and are currently investigating the students' perspective on the impact of inner motivation on their perceived learning outcome.

Referanser

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