Research article

Student views on active learning in the Geoscience curriculum

R. Kordts[1*], K. Daae[2], M. de Vareilles[2,3], E. Gandrud[1], A.D. Årvik[2] and M.S. Glessmer[2,4]

[1] Department of Education, University of Bergen, Norway
[2] Geophysical Institute, University of Bergen, Norway
[3] Department of Linguistic, Literary and Aesthetic Studies, University of Bergen, Norway
[4] Centre for Engineering Education, Faculty of Engineering, Lund University, Sweden

*Corresponding author. E-mail: robert.kordts@uib.no

Abstract English: Active learning is increasingly implemented in higher education, yet students' perspectives on this pedagogical approach remain diverse. This study explores geoscience students' views on active learning within a course at the University of Bergen (UiB) and in relation to their broader study program. Through longitudinal qualitative interviews with two student cohorts, we identified seven main categories related to active learning with few subcategories each: student views on specific active-learning approaches, on instructor characteristics, on assessment systems and exams, on feedback for learning, on prerequisites for active learning, and on active learning vs. other approaches. Four central conclusions were drawn. First, student views on active learning varied significantly, ranging from highly supportive to critical, expressing a diversity of views on active learning. Second, students distinguished between their opinions on active learning in theory and its practical execution, often expressing appreciation for its benefits despite challenges in adapting to new learning strategies. Third, students struggled with balancing autonomy and structured guidance, as active learning frequently disrupted their established study habits. Fourth, time played a crucial role in shaping student attitudes—initial frustration with active learning often gave way to long-term recognition of its effectiveness in fostering deeper learning. These findings

suggest that successful implementation of active learning requires addressing student expectations, providing structured support, and considering the broader curricular context. The study highlights the need for longitudinal assessments of student perspectives to fully capture the evolving nature of their experiences with active learning.

Samandrag: Aktiv læring vert i aukande grad implementert i høgare utdanning, men studentane sine syn på denne pedagogiske tilnærminga varierer. Denne studien undersøker kva geofysikkstudentar synest om aktiv læring i eit kurs ved Universitetet i Bergen (UiB) som inngår i deira studieprogram. Gjennom longitudinelle kvalitative intervju med to studentkohortar identifiserte vi sju hovudkategoriar knytt til aktiv læring med fleire underkategoriar: studentane sine syn på spesifikke aktive læringsmetodar, på instruktøren si rolle og særpreg, på vurderingsformer og eksamen, på tilbakemelding for læring, på føresetnader for aktiv læring, samt ei samanlikning mellom aktiv læring og andre tilnærmingar. Vi kom fram til fire hovudkonklusjonar. For det første varierte studentane sine syn på aktiv læring svært mykje, frå særs positive til kritiske, der kritikken som oftast vart retta mot implementeringa snarare enn konseptet i seg sjølve. For det andre skilte studentane mellom synspunkt på aktiv læring i teorien og korleis den vart gjennomført i praksis. Mange uttrykte at dei verdsette fordelene med aktiv læring, trass i utfordringar knytt til å tilpassa seg nye læringsstrategiar. For det tredje opplevde studentane utfordringar med å balansera autonomi og strukturert rettleiing, då aktiv læring ofte kom i konflikt med deira etablerte studiemetodar. For det fjerde spelte tid ei avgjerande rolle for korleis studentane sine haldningar utvikla seg—frustrasjon tidleg i kurset vart ofte erstatta av ei langsiktig forståing av aktiv læring som eit effektivt verkty for djupare læring. Desse funna tyder på at ei vellukka implementering av aktiv læring krev at studentane sine forventingar vert adressert, at strukturert støtte bør verte tilbydt, og at undervisinga vert vurdert i ein breiare fagleg kontekst. Studien framhevar behovet for longitudinelle studie av studentperspektiv for å fanga opp dei dynamiske erfaringane med aktiv læring.

Keywords:
Active learning; geoscience education; student perspective; co-creation; qualitative research

1 Introduction

Initiated and supported by educational development initiatives such as the Norwegian Centres for Excellence in Education (Norwegian abbreviation SFU), more university teaching in Norway employs active learning approaches. iEarth Center for Integrated Earth Education is one of these SFUs (iearth.no). iEarth has a particular focus on promoting activities in the field of Scholarship of Teaching and Learning (SoTL), i.e., an academic approach to learning and teaching in which instructors, often together with students, investigate student learning or teaching or related education work in order to improve student learning (cf. Hutchings & Shulman, 1999; Kordts-Freudinger & Leschke, 2020). Another important goal of iEarth is to co-create learning and teaching (e.g., Bovill, 2020), where students, teachers, and staff contribute "equally, although not necessarily in the same ways" (Cook-Sather et al., 2014, pp. 6-7) to shaping intended learning outcomes, methods, assessment, situations, etc.

This study is the result of a collaborative SoTL project conducted by the course instructors together with students and two educational developers. The project focused on students' views on active learning in Geosciences at the University of Bergen (UiB) and therefore combines SoTL with iEarth's co-creation approach. Taking the students' experiences seriously and gaining data that can support us in improving teaching, we employ a qualitative method to investigate their views on active learning through a SoTL approach. It is based on understanding educational change as requiring a curricular view, not just focusing on one specific course.

We first shed light on theoretical and empirical backgrounds, share the methods we have used, present the project's central findings, and then discuss these with respect to the consequences for research and educational practice.

2 Background

2.1 The value of active learning

Active learning can be defined as follows: "Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work" (Freeman et al., 2014, pp. 8413-8414). For us, the view of active learning encompassing a multitude of methods and approaches that lead to student engagement with the learning task (e.g., Thiele & Kordts, 2024), implies that active learning happens when students are offered a diversity of engaging learning situations. Active learning can therefore be seen as an umbrella concept of diverse methods that share this characteristic. While the discussion about the exact nature of active learning is ongoing (e.g., Lombardi et al., 2021), we here focus on established active-learning methods that have been discussed in the literature (see the Methods section).

Active learning has already been shown to affect student learning in higher education positively. For instance, the meta-analysis by Freeman et al. (2014) compared lecture-based with active learning teaching approaches in the natural sciences. They found that active learning yielded increased student performance in multiple disciplines (cf.

Deslauriers & Wieman, 2011; Hake, 1998). More specifically, active learning has also been applied and investigated in geosciences. For instance, McConnell et al. (2017) have reviewed active learning strategies for this field. By assessing the utility of eleven active learning strategies based on different criteria, they found that peer instruction, think-pair-share, and minute papers are among those with the highest utility. Darcie et al. (2024) focused on instructors' views on active learning. Their interview analysis indicates that instructors who choose to employ active learning go to great lengths to make their decision-making process visible, first and foremost, to their students, some of whom were resistant to the changes. LaDue et al. (2021) propose a model of active learning in the geosciences that differentiates cognitive, emotional, behavioral, and agentic engagement aspects. Their model indicates four dimensions to active learning, which can be reasons why views on active learning, especially by higher-education students, can be differentiated. For active learning to be effective, students must be engaged in the work required of them, both inside and outside of the classroom. Going back to LaDue et al.'s (2021) model, it can be argued that this includes several aspects. Metacognitive activities necessary for self-regulated learning, such as planning, monitoring and assessing one's own learning, could also be added here (cf. Zimmerman & Moylan, 2009). That some students have negative or differentiated views on active learning methods could indeed, in part, be due to the effects of their poor metacognition (Deslaurier et al., 2019). Other reasons to focus on student views of active learning include the role of student motivation in learning and the importance of the students' views on the curriculum. Only the students can describe and analyze the so-called experienced curriculum that can be essentially different from, e.g., the espoused (intended by curriculum designers, instructors) and enacted (implemented by instructors, tutors, etc.) curriculum levels (e.g., Pearson & Hubball, 2012). Based on this reasoning, only the students can report on the effects of teaching approaches. It thus becomes clear that it is important to assess student experiences with active learning if higher education wants to exploit its benefits.

2.2 Student views on active learning

Existing research on student views on active learning can be divided into studies done in interdisciplinary contexts vs. in the geosciences. Studies of the former type indicate that higher-education students generally have both positive and negative views on active learning methods in their education. For instance, a US study by Owens et al. (2020) found that biology students' resistance to active learning can be based on their unfamiliarity with science practices, dealing with uncertainty, and increased effort made necessary by the active learning approaches. In the Norwegian context, Thiele & Kordts (2024) found that students have differentiated views on different active learning methods and that students who already have experience with active learning appreciate them more than other students. Two studies on student views on active learning in geosciences will be summarized to indicate findings in this specific field. For instance, Welsh (2012) analyzed student comments about their views of active learning methods in teaching. This study found differences between student views based on their cohorts (third vs. fourth/fifth-year students and genders: women more positive). In a large

geoscience course that had previously been lecture-based, Huguet et al. (2020) found that changing into active learning (operationalized as pre- and post-class assignments and in-class activities as elements of flipped classroom) increased students' motivation. However, research on active learning usually focuses on one specific course or some specific teaching approaches or methods. For instance, Møller et al.'s (2023) study was conducted within the geosciences at UiB. These authors analyzed student reflection notes and group interviews (focus groups) in an active learning course focused on programming. The central category they found in the data was students' responses to uncertainty. This category had two subcategories: one about the transition to active learning, and one about a specific learning activity in the course. Based on their data, the authors speculate about the relation between active-learning courses and other courses in a study program, yet their data collection was not targeted at this issue. In addition, this study was very focused on the specific programming tasks and competencies in the course, so it is unclear to what extent their findings can be generalized to other courses, even within the same field. The following paragraph will therefore explore the value of taking a study-program focus when investigating students' views on active learning.

2.3 Importance of taking study-program level into account

Focusing only on the micro, or course, level of teaching and learning can cause relevant distortions in research findings, especially when it comes to the students' perspective. Our view is inspired by an ecosystem approach to teaching and learning within a curriculum (e.g., Ellis & Goodyear, 2019; Jackson, 2020), that implies that teaching and learning within a course should be seen as embedded into a meso-level, study-program level that determines the students' experienced curriculum (e.g., Pearson & Hubball, 2012). The study-program perspective is relevant for students' views on active learning because it is unclear to what extent changing the teaching approaches in one course will influence the students' approaches to studying in their other courses. For instance, if a single course invites students to employ a deep learning approach (e.g., surface vs. deep approach, Biggs, 1987) through active learning, while the other courses in the same study program do not, then students could react to this in a strategic manner: They could focus their efforts on the mentioned course while reducing their efforts in the other courses. This option is supported by research indicating that the students' perception of assessment seems to be one of the main determinants of student learning behavior (e.g., Scouller, 1998). However, if a larger number of courses use active learning approaches, students could adapt to this by acquiring a deep approach-to-learning habits, maybe even for a course that, by itself, does not require deep-learning approaches. This reasoning implies that the curricular context of courses in a study program with active learning plays an important role: Depending on how much the other courses employ active learning, students would have different views on active learning, among others, on the acceptance of uncertainty that might come with active learning (Møller et al., 2023). This project, therefore, focused on students' views on active learning in one individual course, in the curricular context of the other courses students took.

2.4 Research question

We set out to answer the following research question: How do Geoscience students view active learning within a specific Geoscience university course and in relation to other courses in the same study program?

3 Methods

The following paragraphs will outline how the study aimed to answer the research question. It will cover the study design, data collection, participants and data analysis.

3.1 Course context

The study was conducted at the University of Bergen's (UiB) Geoscience course, *GEOF105: Physics of the Atmosphere and Ocean* (hereafter referred to as the active-learning course, the AL course). The course was specifically targeted for developing active learning as part of a project called CoCreatingGFI, funded by the Norwegian Directorate for Higher Education. Among its active learning components, the course used asynchronous quizzes (outside of class) and synchronous classroom activities such as group discussions, group work with sketching (Daae & Glessmer, 2022; Daae, Semper & Glessmer, 2024), and innovative student guides for lab experiments (Daae et al., 2023). The course also included some traditional elements like lecturing, but these were limited and typically consisted of 15-30-minute lectures between activities. Throughout this study, several teachers were involved, and although all teachers utilized similar learning activities, there may have been some variations in the number of activities or how they were carried out. There are typically 15-40 students in the course. The students come from two different study programs and are in their third or fifth semester. The students have experienced some active learning prior to this course, but many of the learning activities were new to them (e.g., laboratory experiments and sketching).

3.2 Participants

During the first session of each semester, the instructors added interested students to a list from which participating students were later selected based on their study programs, their grades in other courses of the same study program, and gender. The course instructors contacted the selected students and asked for their interest in participating in interviews, stressing that these interviews would be done by colleagues who were not involved in teaching or assessing in the AL course.

Student Cohort 1 (six students, three women, three men), students who were enrolled in the AL course in Fall 2022, were interviewed at three points in time: at T1 in the fall semester 2022, at T2 in the spring semester 2023 (five students) and at T3 in the fall semester 2023 (four students). Student Cohort 2 (six students, three women, three men) included students who were enrolled in the AL course in the fall semester 2023. These students were interviewed at two points in time: at T3 in the fall semester 2023 and at T4

in the spring semester 2024 (five students). Each interview was reimbursed with a gift voucher worth NOK 500.

3.3 Interviews

To assess student views in detail, we collected the data through qualitative, individual face-to-face interviews with two longitudinal cohorts of students enrolled in the AL course in the fall semester 2022 (Cohort 1) and the fall semester 2023 (Cohort 2, for details see below). These were individual semi-structured interviews with questions in four thematic parts that were the same with all students: the students' view on active learning in the AL course, the student learning in the AL course and in other courses of the same study program, the assessment and exams in the AL course, and a comparison of the AL course with other courses in same study program.

The interviews were conducted by the first author, who works at the university pedagogy unit, and a student research assistant hired for the project, not enrolled in the same discipline, to ensure outsider perspectives (Mercer, 2007). The interviews were conducted face-to-face in English or Norwegian and took max. 50 minutes.

3.4 Data analysis

All interviews were transcribed verbatim (Dresing & Pehl, 2015) with the help of autotekst.no and manually revised. All quotes in Norwegian were translated to English. For coding and categorizing, we followed the guidelines for qualitative content analysis according to (Mayring, 2000). The categories that are presented as subcategories in the Results section were formed inductively by two authors, based on the material from the interviews at T1 and T2. For this, we followed Mayring's summarizing analytical strategy (Mayring, 2014), in two parallel and independent coding processes. Disagreements were resolved through discussion among the authors involved. The resulting subcategories were then grouped into more abstract categories, that are presented as main categories here. After conducting the interviews at T3 and T4, we categorized the new material deductively based on the categories that were yielded with T1 and T2, followed by revisions of the main categories as well as several subcategories.

4 Results

We found seven main categories in the interview transcripts. In the following, we will present these main categories and exemplify them with selected direct quotes from the interviews. To indicate the author of the quotes in a pseudonymized way, we indicate the student cohort by C1 (cohort 1) or C2 (Cohort 2), the semester when the interview took place by year and semester (e.g., 23s = spring 2023, 22f = fall 2022) and specify the student by a number and a letter (e.g., 1A = the first interview with student A; 3C = the third interview with student C).

4.1 Category 1: Student views on specific active learning approaches

The interviewees indicated their views on specific active learning approaches used in the AL course (see chapter 3.1 for an overview). They commented on the *Group discussions* (Category 1.1), mainly in a positive and supportive way, as indicated by the following quote: "the discussions in class, I think it [sic] helps a lot" (C1-22f-1A). *Preparation activities before lectures* (Category 1.2) were commented on both positively and critically, and the preparatory quizzes were mentioned by several students: Whereas the statement "We had one thing that was very positive, and that was quizzes [that were] approved before the lecture. [...] you're prepared, you get more in" (C1-23s-2D) indicates a more favorable view of the quizzes done before lectures, the following statement expresses criticism about the level of the quizzes and their relationship with the lecture classes: "Sometimes I think the quizzes can be a bit too ambitious about what we already know [...] sometimes you need to do a little extra work or research before the classes, so it can take a lot of time." (C1-22f-1E). *Experiments and field trips* (Category 1.3) that were part of the course, were seen as more positive: "But I like that it's a lot of practical things or practical experiments" (C1-22f-1D).

Interestingly, the students also commented on the effects these active learning approaches had on how they worked together, including their *Cooperation in class* (Category 1.4), especially with regards to the diversity of views and increased motivation: "[...] it's nice that people can share their knowledge with others, and you can hear different points of view. [...] If I'd had to sit and do everything on my own, it would have been much more boring, and I wouldn't have gotten to know the others" (C1-23f-3D). In addition to collaboration during class time, they also saw advantages of active learning for *Student cooperation outside of the classroom* (Category 1.5), as this student comments on their openness to collaboration with other students: "I've become more open to working with others and discussing topics. I often think that I'm capable of teaching myself, but it's a good idea to discuss with students. [...] I think I've become more open to it and taken more initiative to sort of discuss questions... exam questions or topics that you don't understand, yes" (C1-23f-3C).

4.2 Category 2: Student views on instructor characteristics

The second main category includes students' views on instructor characteristics that they deem to be relevant for a successful active learning experience. *Engagement and help by the instructors* (Category 2.1) were mentioned as teachers' individual characteristics, for instance when one student mentions that "the teachers were very good at explaining, and [...] well, it didn't matter if you said the wrong thing " (C2-23f-1A). *Instructors' preparation* (Category 2.2) was mentioned as important, which was mentioned, among others, when teachers were not perceived as well prepared by the students: "[...] it doesn't seem like [they] are quite so prepared for the lessons, then. I think, in order to have such an active learning lesson, you have to be prepared and know what you're going to do and what people are going to discuss" (C2-23f-1A). The importance of discussions in active learning became visible when students talked about the *Instructors' abilities to facilitate group discussions* (Category 2.3), for instance when one student criticized using discussions only so that students are active, but with unclear goals: "[...] especially at the beginning of the semester, that one lecturer, they

often asked questions that, in a way, were obvious. [...] I don't know if it was, in a way, a way for us to be active in class, but it was more like: "What [are they] really getting at? What [are they] really asking about here?"" (C2-23f-1B). Active learning, in the view of the interviewed students, also had an impact on their *Relation to the instructors* (Category 2.4), which was described as much closer compared to what they were used to: "It was, in a way, much more [...] that [...] the relationship you had with the lecturer in that subject was something completely different to what I've had before" (C1-23f-3A).

4.3 Category 3: Student views on assessment system and exams

The interviewees expressed a differentiated view on the assessment system and exams used in the AL course. This included the *Students' exam preparation* (Category 3.1) where they experienced a stronger alignment between assessment and teaching and learning activities: "I think the exam preparations happens [...] in every lecture. Because we go through [...] questions and different formulas and stuff and the quizzes were before class, [this] also prepares you for the lectures, which prepares you for [the] exam" (C1-22f-1B). This positive view was not shared by all students, some of whom are yet to experience the exam: "I think I'm actually more unsure about what the exam is going to be. [...] Right now I feel like I'm just sitting and just: Yeah, where do I start?" (C2-23f-1B). After the *Exam* (Category 3.2), students were typically more positive, again mentioning the alignment between what had been done in teaching and what had been asked in the exam: "I think it went quite well, because the exam was a lot of what we had gone through orally in class, so if you'd spent a lot of time in class, you [...] benefited from it and you [...] could recognize the tasks based on what we had discussed" (C1-23s-2A).

In addition to these specific assessment aspects, students also expressed their views on the whole of the assessment types used in the course, its *Assessment system* (Category 3.3). Their views ranged from critiques of the summative assessment type in active learning: "[...] exams are quite a traditional form of assessment, in relation to active learning" (C2-23f-1C) to positive views on the formative assessments during the course: "[...] sometimes we've worked alone and sometimes with a group along the way, and then it counts for a certain percentage of the grade. [...] I think that's been very helpful, or instructive" (C2-24s-2B). Interestingly, some students also mentioned limitations of their autonomy in how to learn, due to the number of (formative) assessment tasks: "[...] it's been a bit frustrating that you don't have time to really get to grips with the material on your own. That you constantly have to [...] come to these deadlines, [...] hand in assignments and quizzes, [...] it's been a bit of a burden maybe" (C2-23f-1A).

4.4 Category 4: Student views on feedback for learning

Although not explicitly asked for, the interviewees commented on feedback on the AL course in multiple ways. First, the *Instructor feedback* (Category 4.1), the feedback the instructors gave the students, was seen as very positive: "You got a lot of feedback, and it's nice to get feedback along the way and often" (C1-23f-3D). In addition, the interviews indicate that students can get used to receiving high-quality feedback easily and that they expect it throughout a course. The following student described how they had

received individual feedback on some assignments, but lacking the same type of feedback on other assignments: “But then there was [topic], I don't remember that I got much in the way of explanatory feedback: ‘You need to get better at this!’”(C2-24s-2E). Maybe less surprising for a course design where group work is essential, *Peer feedback* (Category 4.2) came up as a theme as well, where students again showed diversity in their views. While some supported the general idea of peer feedback, others were critical about its implementation, as indicated by the following two quotes: "It's really great that you get to see what someone else has written about the same thing [...] I actually think it's very educational, even though it might not feel like it's that necessary [...] I actually think it's quite wise" (C1-23f-3A) and "You get it from your fellow students, so it's very much like: okay, well done" (C2-24s-2E).

4.5 Category 5: Student views on advantages of active learning

The interviewees expressed advantages and positive views on active learning. First, they mentioned the *Improvement of student learning* (Category 5.1). This relates to their motivation: "[...] you become a little more engaged and interested [...] in discussing the syllabus instead of being served it. You also get to test yourself when working with the assignments" (C2-24s-2B) and the formative structure of the course: "That it helped me understand earlier in the semester, or that you're forced to understand in lectures and contribute, and that [...] you have a little more to build on when you start reading for the exam" (C1-23f-3C). Here, the long-term perspectives differed from short-term perspectives: "Even though it might be a bit, right there and then, it was a bit tiring, but afterwards it was good, because I got more out of it and understood more of the subjects [...]" (C2-24s-2E). Second, they commented on *Student participation* (Category 5.2), which was evaluated positively "I contribute a lot more in the classroom environment, and then, well, in lectures and so on, in addition to, in a way, doing more for myself, then, in a way, by reading more, then, and wanting to do better" (C1-23f-3A). This applies especially to situations when students are in doubt about their own contributions: "[...] it might be a little easier to participate in the debate in the lecture and ask about things you're not sure about" (C2-24s-2B). Third, the interviewees valued *Variation in teaching* (Category 5.3), for instance when this student stresses the diversity of working with the content: "There are a lot of different tasks like quizzes and reports and experiments and things [...] that we do [...] I think it's nice to have that variety. You get an insight or work in many different ways" (C2-23f-1C). Fourth, one specific way of employing active learning mentioned by several interviewees is the *Combination with lectures* (Category 5.4), in this instance with a suggested pedagogical logic of processing new information: "the combination of classical blackboard teaching and active learning can be [positive] but then the active learning has to come after you've been told what's important and how things are connected, so [...] the active learning may well come,[...] at the end when you have to [...] see connections that you weren't able to see before" (C1-23f-3B).

4.6 Category 6: Student views on prerequisites for active learning

The categories presented so far already included a diversity of student views on active learning approaches. It might be less surprising, then, that they also commented on

important prerequisites for successful implementation of active learning in teaching. The *Need for introduction of new content* (Category 6.1) to make active learning work was visible when students separate discussing (the active learning) from learning content: "If nobody knows anything, it's not so [effective] because I experienced that a lot in [course], because it was so new and there was so much to learn, [...] you had to discuss it before you had learned about it. And then everyone was just a bit lost" (C1-23f-3C). At the other end, after the active learning activities, students also stated a *Need for summaries* (Category 6.2) that can prioritize some content over other, asking for tools to support their meta-cognition: "It would have been nice to have a little recap like that: 'Okay, this is what we had to learn', and: 'This is what was important.' [...] You don't know what's really important, because there are so many different things" (C2-23h-1B). Related to this, they specifically expressed a *Need for written conclusions* (Category 6.3), because: "I don't think many people took notes. Because it was very much the case that you had to be a bit verbal, so it wasn't so easy to write down notes at the same time as you had to pay attention" (C1-23s-2A). As indicated by this last statement, students and instructors seemed to have differing views on the responsibilities of documenting, again bringing up meta-cognitive aspects of learning.

Questions about autonomy were discussed when students commented on the amount of *Mandatory work* (Category 6.4) to be done in the course. A student mentioned that "It's a very big subject with a lot of compulsory things, which can take time away from other subjects because of the compulsory ones. [...] you can downgrade subjects, and then they are automatically prioritized those that have mandatory things" (C1-23f-3C). This reflection clearly puts the AL course in perspective with other courses the student was enrolled in at the same time. Active learning seems to prioritize learning, compared with, for instance, lecture-based courses. On the other hand, students' views on the *Value of autonomy* (Category 6.5) were diverse. While one student supported the co-creation scheme where they negotiated the assessment criteria together with the instructors, "I actually think it works very well. We were allowed to decide for ourselves how much [an assessment would count to the final grade]" (C2-23h 1E), another criticizes that they are not competent to make this decision, following the traditional view that this is the instructors' responsibility: "we don't have any way of knowing what should have been weighted most heavily [...] I feel that it's better if the teachers take some responsibility for finding out what we should know, what should be emphasized" (C1-23f-3B).

4.7 Category 7: Student views on active learning vs. other approaches

As mentioned above, this study took a study-program level perspective on active learning by asking students to reflect on their views on the course that applied active learning versus other courses. Students compared active learning with other teaching approaches in Category 7 that consisted of four subcategories. *Workload* associated with active learning (Category 7.1) was mentioned by many students. Students experienced active learning negatively due to the increased workload, yet reflect on the value of learning more in the long run: "I remember that I was really frustrated with the course, because there was so much to do. But I was left with more of a sense of accomplishment than I have after six months [the course duration typically is 3 months]"

(C2-24s-2E). Similarly, the *Comparison to other courses* (Category 7.2) yielded a generally positive evaluation of the AL course, as indicated by this student: "[...] because of the active learning [...] I think the [subject] courses are much better than other courses, where you just sit and watch passively. [...] the pleasure of being in the lecture has been very different, or much better than just sitting and watching" (C2-23f-1B). In addition, they perceived their own motivation to learn as qualitatively different, differentiating learning from performance goals: "[subject] was more understanding-oriented than the other, which was more task- and exam-oriented" (C2-24s-2B). Yet even with all the positive aspects of active learning, they seem to be aware of their own habitual learning approaches formed by the usual way of teaching they experience: "[...] since it is so much alike in the other classes, you kind of become an expert of preparing on the way you like to prepare and then you go to class, you get the information, you know how to use that information in a good way. [...] you get quite good at learning in that way" (C1-22f-1A).

Interestingly, when talking about comparing the AL course with other courses, the physical conditions came up, including *Room and class size* (Category 7.3.). Employing active learning seems to be challenging in teaching environments that are not well suited: "[instructor of another course] tried very hard to create an active learning environment, but I think it's a bit difficult in lecture halls like that, where the distances are too long" (C1-23f-3A), and the same applies to the number of students in a course: "Maybe it helps to have courses with slightly smaller classes [...] It may not be as easy to get feedback, or to give feedback as a professor when there are 200 students" (C2-24s-2B).

Finally, the interviewees described their *Affect elicited by active learning* (Category 7.4) when they compared the AL course with other courses. While some experienced positive and activating emotional states, "I feel I'm more engaged, then, in the lectures and group classes, and [...] A desire to contribute" (C22-3f-1C), others mentioned negative, yet activating emotional states, frustration being the prime example (see the discussion about workload above): "I've become frustrated. This is because of the workload, and a bit because it's a new way of learning, which I'm perhaps not quite used to. [...] it's been a bit frustrating" (C2-23h-1B). This indicates that experiencing active learning in a course creates strong reactions in students on the background of their experiences with other teaching approaches.

5 Discussion

The following paragraphs will summarize and discuss the main findings and implications of the study, in relation to previous research, as well as discuss limitations and future directions.

5.1 Summary and discussion of findings

The interviews yielded a rich panorama of student views on active learning. The categories found in the material cover their views on specific active-learning approaches, on instructor characteristics, assessment and exam, on feedback, on

prerequisites for active learning and on active learning vs. other approaches. Four main themes became visible throughout the categories, as indicated in Figure 1.

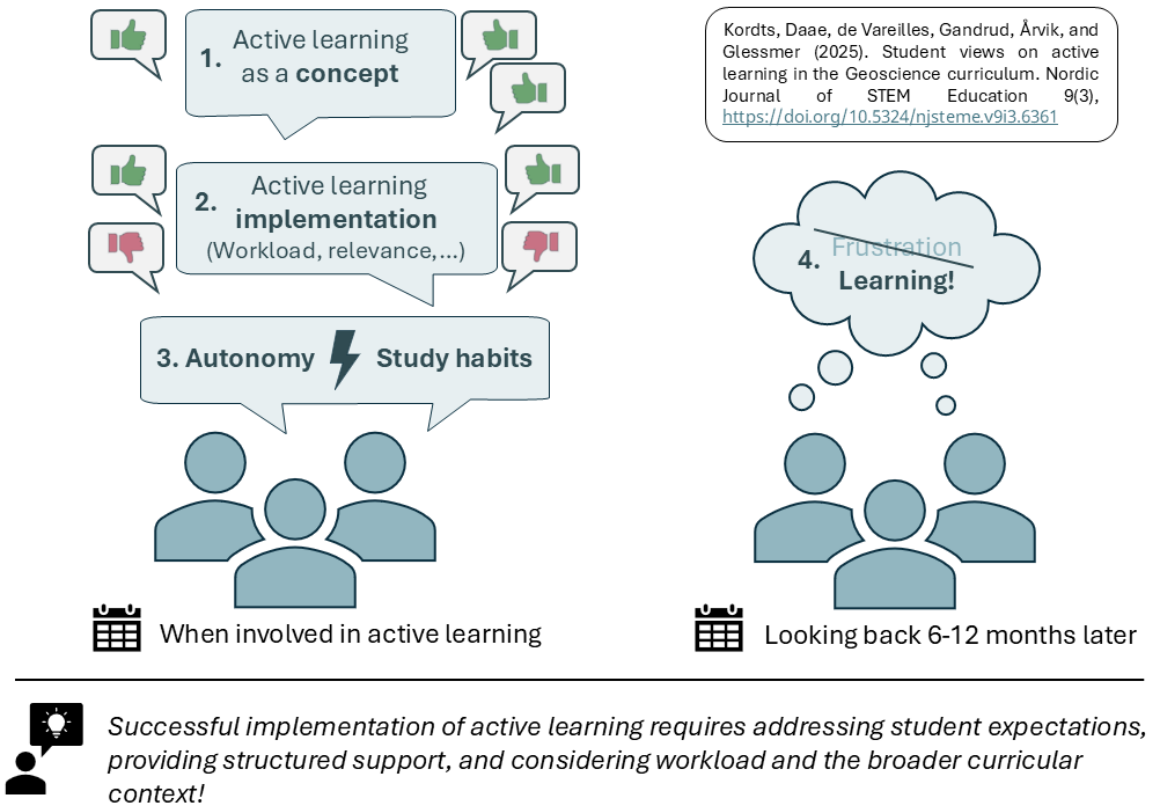

***Figure 1**. A visual summary of our four main findings: 1. Students' views on active learning vary significantly; 2. Students distinguish between active learning as a concept and successful implementation of active learning; 3. students struggle with balancing autonomy and structured guidance; and 4. student views on active learning change over time. In hindsight, they are generally more positive, reflecting on their learning.*

First, the diversity of the student views. These range from positive-supportive to quite critical. Students criticized instructors for insufficient preparation when leading discussions or for the temporal placement of active learning elements. This aligns with previous research indicating that student responses to active learning can vary significantly, often influenced by their prior experiences and expectations (Owens et al., 2020; Thiele & Kordts, 2024). It is notable that many of these critiques seemed to stem from concerns about the preconditions and implementation of active learning rather than a fundamental opposition to the approach itself. This distinction supports findings from Welsh (2012) and Møller et al. (2023), who observed that student resistance often arises from how active learning is introduced and structured rather than from the pedagogical principles underlying it.

Second, our findings indicate that students implicitly differentiated between the general concept of active learning and its concrete implementation. While their views on the specific active-learning strategies used in the course varied, their perspectives on the overarching idea of active learning were generally positive. This distinction is crucial, as prior studies have sometimes conflated students' critiques of implementations with opposition to active learning itself (Huguet et al., 2020). Our findings suggest that this differentiation should be more explicitly acknowledged in research and pedagogical

discussions, as doing so could clarify seemingly contradictory findings in the literature. The ability to differentiate between the general idea of active learning and its specific implementations could, as one reviewer remarked, be also conceptualized as a meta-cognitive trait. This study, however, does not offer data to explore this idea further. In addition, we identified a perceived friction between active learning as a concept and the workload associated with it. Students who found the workload associated with active learning too high tended to be more negative towards the implementation of active learning. This suggests that teachers need to consider the total workload of implemented active learning elements and ensure that students perceive the work relevant and worth their time spent.

Third, the interviews highlighted tensions between student autonomy and responsibility. Given that active learning often contrasts with other approaches students encounter in other courses, some students struggled with adapting their learning strategies. This aligns with research on metacognition, which suggests that students' difficulties with active learning may stem in part from their struggles with self-regulated learning (Zimmerman & Moylan, 2009). The findings further support LaDue et al.'s (2021) model, which emphasizes the role of cognitive, emotional, behavioral, and agentic engagement in active learning. By considering these dimensions, educators can better anticipate and address student challenges.

Fourth, time emerged as a critical factor in student perceptions of active learning. Interviewees noted that their views evolved over time, often shifting from frustration during the course to appreciation in retrospect. This aligns with research suggesting that active learning requires students to adjust their study habits and expectations, which can initially be challenging (Deslauriers et al., 2019). However, as students gain more experience and recognize the benefits of active engagement, their attitudes tend to become more positive. The study is silent about whether this change is linear. It could be, as one reviewer remarked, that after experiencing the positive effect of active learning, students return to their negative views when experiencing the next implementation of active learning. The study does suggest, however, that future studies on student perceptions of active learning should take a longitudinal perspective, capturing how attitudes evolve over time.

In our view, the current findings exemplify the value of employing a larger, study-program view to the question of student views. Previous research might have overlooked this aspect and therefore underestimated the value students give to active learning in general.

5.2 Implications for research

This study offers three main implications for future research and theory development. First, while students engaged with the idea of active learning, their accounts showed that the term is understood in varied ways and that perceptions depend on factors such as timing, workload, and individual conceptions of learning. Because active learning functions as an umbrella concept (Lombardi et al., 2021), future studies should specify which approaches are in focus rather than treating it as a uniform construct. Second, our findings underline the need to examine active learning at the program level. Students evaluated individual courses in relation to their wider curricular experiences, and isolated implementations were sometimes perceived as inconsistent or even

contradictory. Research that attends to programmatic coherence could therefore clarify how departmental cultures and course sequencing shape student adaptation and buy-in. Third, the results point to metacognition as a mediator of students' experiences with active learning. Future work should therefore integrate metacognitive perspectives into models of active learning and trace how such skills develop across students' trajectories. Together, these directions call for research that is more precise in its conceptualization of active learning, attentive to curricular contexts, and theoretically grounded in students' metacognitive development.

5.3 Methodological limitations

Limitations of the study include the small sample size, as the study included only a limited number of students from two cohorts at a single university. A larger sample would enhance the generalizability of the findings, allowing for a broader representation of student perspectives. However, the in-depth qualitative approach, with multiple interviews over time, provides a rich and nuanced understanding of students' experiences that might be overlooked in larger, more surface-level surveys. Future research should complement this study with larger-scale, mixed-method approaches to validate and extend its conclusions. Additionally, the local context of the study, conducted within one UiB course, may limit the transferability of findings to other institutions and educational settings. However, many of the challenges and benefits identified in this study align with existing research on active learning, suggesting that the findings may offer valuable insights for instructors and researchers beyond this specific context. Finally, the reliance on self-reported data presents another challenge. Students' reflections on their learning experiences are shaped by memory, perception, and individual interpretation, especially when it comes to experiences that happened much earlier. Future research could integrate observational data, performance metrics, or longitudinal tracking of student outcomes to complement self-reported experiences.

5.4 Implications for practice

For educational practice, the study yields a series of recommendations: First, instructors interested in applying active learning should seek to understand students' broader educational experiences (Pearson & Hubball, 2012). This requires an awareness of how different courses within a study program interact and influence students' approaches to learning. While individual instructors may focus primarily on their own courses, a more holistic, program-level approach could enhance the overall effectiveness of active learning implementation. When considering the study program, it is also necessary to evaluate the total workload of the courses students complete during each semester. Some of the interviewees indicated that courses with much active learning were prioritized over other courses to handle the total workload. If more courses implement time-consuming active learning, students will end up in a squeeze which could influence how they view active learning.

Second, this study-program focus could lead to a more aligned pedagogical approach across individual courses. While uniformity is not necessarily the goal, a more structured integration of active learning elements throughout the curriculum could help students adapt to new learning strategies more effectively. This is particularly relevant given

research on students' perceptions of assessment, which suggests that inconsistencies in teaching approaches across courses can influence learning behaviors (Scouller, 1998). By ensuring a coherent mix of pedagogical methods, educators can create a more supportive learning environment that fosters deep learning (Biggs, 1987).

Third, instructors should explicitly address student expectations and potential resistance to active learning. As our findings and previous research (Møller et al., 2023) indicate, students often struggle with uncertainty when transitioning to active learning. By acknowledging these challenges, providing clear guidance, and emphasizing the long-term benefits, instructors can help students navigate this transition more effectively. One example that became visible in our data is how students understand the value of peer discussions. As mentioned for Category 6.1, some students expressed the need to introduce new content ahead of a peer discussion. However, research indicates that peer discussions can improve learning even without this precondition (e.g., Smith et al., 2009). It might be helpful for instructors to introduce this and similar findings when they employ active learning methodologies while acknowledging the students' struggles.

Finally, when implementing active learning, instructors should balance student agency with structured guidance. While autonomy is important, students may benefit from scaffolding, such as clear summaries, structured discussions, and written conclusions (LaDue et al., 2021). In addition, instructors could work to support students so that the latter can profit more from typical teaching situations, such as lectures. Note-taking, for example (see Category 6.3) seemed to be a challenge for some students. Instructors could, e.g., be transparent about their expectations and introduce notetaking with minute papers and similar short writing exercises (e.g., Tanner, 2013). Taken together, we hope that this study supports students, instructors and researchers in their work on active learning in higher education.

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