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# Enhancing upper secondary students' engagement and learning through the INTERACT online, video-based teacher coaching intervention: Protocol for a mixed-methods cluster randomized controlled trial and process evaluation

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ABSTRACT

This protocol outlines a mixed-methods cluster randomized controlled trial (CRCT) in upper secondary schools that will investigate how video-based online coaching can support teachers' competences in teacher-student interactions (TSIs) and thereby improve student engagement and learning. The intervention will take place over a school year with at least 100 teachers and 2,000 of their students. During the implementation and one-year follow-up, we will conduct an extensive implementation and process evaluation (IPE) to understand the intervention's effects on TSI and student engagement and learning outcomes. This protocol outlines the background, design, intervention, and primary and secondary outcome measures as well as moderators.

## 1. Background

### 1.1. Significance

Despite long-term policy priority, upper secondary school noncompletion rates in Norway are higher than those of other OECD countries (OECD, 2018). Recent national statistics indicate that only 66% of students graduate with standard study progression, and 80% graduate within five years (Statistics Norway, 2021). Student engagement is a key contributor to school success, yet upper secondary students consistently and increasingly describe themselves as disengaged and bored (Bakken, 2019; Tvedt et al., 2021). A substantial body of evidence exists on the importance of high-quality teacher-student interactions (TSIs) in promoting student engagement and social and academic learning at the secondary level (Allen et al., 2013; Praetorius et al., 2018; Quin, 2017; Roorda et al., 2017). However, less is known about the role of teacher professional development (PD) in improving teachers' TSI competence.

*Abbreviations:* CLASS, Classroom Assessment Scoring System; CLASS, S - Classroom Assessment Scoring System secondary manual; CRCT, cluster randomized controlled trial; ELT, Experiential Learning Theory; GPA, grade point average; IPE, implementation and process evaluation; PD, professional development; RCT, randomized controlled trial; RQ, research question; SD, standard deviation; TSI, teacher-student interactions; TTI, Teaching through Interaction.

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TSI holds the most promise for prevention and intervention efforts seeking to improve student engagement and learning because, unlike many individual and family factors, school factors are malleable and open to improvement by the school community (Pianta, 2017; Quin, 2017). At the same time, there is large variation in the quality of TSIs between classrooms (Allen et al., 2013; Virtanen et al., 2019; Westergård et al., 2019) and a lack of research-based PD to enhance TSIs for upper secondary teachers. A meta-analysis indicates that individualized video-based coaching supports teachers' implementation of TSI skills in their classrooms (Kraft et al., 2018). Coaching teachers about TSI practices through video analyses has the potential to help them more effectively conduct TSIs as they learn to observe, analyze, and decide how to interact with students through intentional pedagogical choices.

The Teaching through Interactions (TTI) (Hamre et al., 2013; Pianta et al., 2012) theoretical framework underpinning INTERACT coaching describes TSI as involving emotional, organizational, and instructional features that are likely to contribute to students' learning. The TTI framework posits that TSIs are a central driver for student learning. For example, high-quality emotional support and classroom organization foster student engagement and learning (Gregory et al., 2017; Hamre et al., 2013). However, studies have shown that the quality of the third domain of TSI, that is, instructional support, is much lower than that of the other two domains in every country (Hamre et al., 2013; Westergård et al., 2019). This trend is problematic because teachers' instructional support is the domain through which curriculum should be converted into student academic gains (Hamre et al., 2013). Accordingly, the INTERACT coaching intervention will have a specific focus on instructional support but will also address emotional support and classroom organization.

The TTI framework draws on several theoretical perspectives within education and psychology to describe one theory of classroom practice and to explain how teachers can use their relationship with their students to enhance student development and learning (Hamre et al. 2013; Pianta et al., 2012). Drawing on systems theory (Bronfenbrenner & Morris, 1998), understanding how the context affects development through the interactions between the capacities and skills of the students and the resources available to them in various settings and that this process is dynamic is a starting point within the TTI framework (Pianta et al., 2012). Furthermore, attachment theory (Ainsworth et al., 1978; Bowlby, 1969), self-regulatory theory (Cleary & Zimmerman, 2012) and self-system theory (Cornell & Wellborn, 1991; Ryan & Deci, 2017; Skinner et al. 2009) are key theoretical perspectives contributing to this understanding of the theory of classroom practice.

Four levers producing developmental change for TSI are posited within the TTI theoretical framework underpinning the INTERACT intervention: (1) *teachers' knowledge and cognitions* related to their interaction with students, (2) availability of ongoing *relational support for teachers* themselves, (3) teachers' regular *exposure to individualized feedback* about their actual interactions with students, and (4) *a standard and valid "target" around which to focus* effort to change interaction (Pianta et al., 2012, p. 379). Previous research indicates that interventions that activate these levers in a systematic and coordinated way improve TSI and student social and academic learning (Allen et al. 2011, 2015; Kraft et al. 2018).

The effect of an intervention can be moderated by the implementation context (Fixsen et al., 2019; Humphrey et al., 2016). Accordingly, we expect that both individual teacher factors and school organization factors will affect the implementation of the INTERACT intervention and possibly the intended outcome. Teachers experiencing high levels of stress have difficulty developing high-quality interactions with their students (Sanetti et al., 2021), and teacher job satisfaction is related to teacher-student interaction quality (Dreer, 2021). School organizational factors such as leadership support, alignment with school priorities, and sufficient time affect the implementation of teacher PD (Sims et al., 2021). Furthermore, dimensions of implementation (fidelity, dosage, quality, responsiveness, program differentiation, monitoring of comparison group, adaptation) may moderate the effect of the intervention (Humphrey et al., 2016).

### *1.2. Intervention*

The INTERACT teacher coaching intervention involves the implementation of three components: (1) an online introductory module, (2) data-driven decision making, and (3) a guided video review process, as outlined below.

#### *1.2.1. Online introductory module*

This module will introduce the intervention and core components of the TTI framework. Participants will attend two online seminars at the beginning and midway through the intervention. The intervention will also provide teachers with web resources, including webinars on the core components of TTI, web articles and a video library containing short films illustrating effective TSI within the TTI dimensions, and an implementation guide. Moreover, the coaches and teachers being coached will meet in groups of 8-10 in two online workshops to share their experiences and reflect on their practices. Additionally, the teachers will attend workshops at their schools and be encouraged to reflect on their practices as part of the school's PD programs.

#### *1.2.2. Data-driven decision-making*

The classroom assessment scoring system (CLASS) observation protocol (Pianta et al., 2012), which is based on the TTI framework, will guide the selection of relevant teaching practices. An individual action plan will focus on the implementation of the core components of the new Norwegian curriculum, as guided by a specific dimension or broader domain of the TTI framework.

#### *1.2.3. Guided video review process*

At the core of the INTERACT coaching model is the premise that teachers need the opportunity to a) observe teaching practices in context and b) analyze their role in providing learning opportunities to be able to select and implement knowledge-based strategies to support student learning and development. The guided video review process is motivated by previous studies indicating that teachers

who have access to a coaching model with guided video reviews of their teaching practices show greater growth in their targeted teaching practices than those in control groups (Gregory et al., 2017).

The guided video review process is organized into seven coaching cycles (Sølvik & Vaaland, 2022). Each cycle contains six steps (Fig. 1), a preparation phase (steps 1-3) where the teacher and coach connect the recorded classroom practice to theory and research, and a dialog and further development phase (steps 4-6) drawing on the preparation phase.

Every two to three weeks throughout the academic year, teachers will video-record one of their lessons (step 1). The coach and teacher will then select short video clips from this footage for discussion in their online coaching dialog (steps 2-3). Within a strengths-based approach, these video clips will illustrate effective practices and inspire teachers to reflect on their classroom practices. The assessment of the clips (steps 2-4) begins with identifying strengths in the teacher's practices, rather than the problematic areas. The teacher then reflects on the effectiveness and ineffectiveness of the selected video clip against other experiences they have had and a shared understanding of what types of interaction lead to student engagement and learning. This strengths-based approach to coaching can help to build the teacher's self-efficacy and confidence (Bandura 1997, 2012) in applying effective TSI practices in their classrooms. The strongest source of confidence may be actually mastering TSI skills and experiencing the impact on students' engagement and learning. The teachers and coaches will view and discuss the video clips together and create an action plan to guide the implementation of improvement strategies (steps 4-6).

The theoretical underpinning of the dialog and further development phase (steps 4-6) is experiential learning theory (ELT), which offers a dynamic theory based on a learning cycle driven by the resolution of the dual dialectics of action/reflection and experience/abstraction (Kolb, 1984; Kolb & Kolb, 2009). This can be illustrated by the dialog (step 4) starting with the teacher and coach watching the identified short excerpt from the video footage together representing *concrete experiences*. These experiences are the basis for *reflective observation* when next, the teacher describes what happens and the coach supports the description using a strength-based approach. These reflections are assimilated and distilled into *abstract concept*. In INTERACT, this implies that the coach supports the teacher in reflection on TSI in the classroom grounded in the TTI theoretical framework (Hamre et al. 2013; Pianta et al., 2012) and its implications for actions. These implications, new insight, and reflections can then (steps 5-6) be transformed into specific TSI skills and actions that can be *actively tested* and serve as guides in creating new and improved classroom practices. In the following coaching cycle, the experience from testing and improving in the teacher's own classroom is picked up to further build on the teacher's experience. As such, the INTERACT-guided video review process will enrich the practice-based coaching element of focused observation and reflection/feedback by providing teachers the opportunity to observe themselves in action and identify a link between strategy implementation and student engagement and learning, which can set the stage for improved practices.

Consistent with the state-of-the-art literature, the coaching process is one in which TSI experts work in partnership with teachers to discuss classroom practices in a way that is a) individualized, including one-to-one sessions; b) intensive, involving interaction every

**Fig. 1.** The INTERACT coaching cycle.

couple of weeks; c) sustained, with coaching given over an extended period of time; d) context-specific for the teacher's classroom; and e) focused, as coaches work with teachers to engage in the deliberate practice of specific skills (Kraft et al., 2018). Internationally, the use of videos has been increasingly employed in teacher PD over the past 10 years (Gaudin & Chaliès, 2015). Paradoxically, little empirical evidence has been presented on how the use of video improves classroom practices, particularly in instructional support in upper secondary school grades.

#### *1.2.4. Coach training*

INTERACT coaches will be recruited among professionals experienced in coaching teachers and schools. The INTERACT coaches will receive a five-day training before and at the beginning of the intervention. Three days will be online, and two days will be face-to-face training. The training will cover all aspects of the coaching and the use of the online platform for coaching. Furthermore, the coaches will meet online during the intervention to exchange experiences.

### *1.3. INTERACT theory of change*

The logic model (Fig. 2) depicts the proposed pathway through which it is theorized that the INTERACT coaching intervention will affect student engagement and social and academic learning. It is proposed that the intervention will have a direct impact on student engagement through a pathway that involves increased emotional support, classroom organization, instructional support, and student engagement (primary outcomes). It is proposed that the intervention will indirectly impact students' social and academic learning outcomes (secondary outcomes) through the aforementioned four primary outcomes.

As illustrated in the logic model, the primary aim of the INTERACT intervention is to increase the quality of teachers' TSI skills and student engagement. To achieve this, and in line with the four levers of intervention posited within the TTI framework, the INTERACT intervention aims to (a) improve teachers' insight into evidence-based knowledge on high-quality TSI and how TSI can promote student engagement (Hamre et al. 2013; Pianta et al., 2012), (b) support goal-directed behaviors, that is, new ways of teaching that make use of the insight, (c) support teachers in acquiring new TSI skills and (d) embed these changes in practice in the classrooms. In a recent meta-analysis, PD interventions addressing all four purposes (insight, goal-directed behaviors, acquiring new skills, and embedding these changes in practice) were found to have the largest effect size. On average, the effect size, 0.15 standard deviations (SD), a point estimate on students' standardized test scores, was three times the size of interventions addressing three or fewer purposes (0.05 SD; Sims et al., 2021). A meta-analysis specifically addressing the effect of teacher coaching interventions (Kraft et al. 2018) found positive effect sizes on teachers' instruction (0.48 SD) and achievement (0.18 SD). Kraft and colleagues did not specifically focus on the four purposes, and it is likely to assume that the average effect size included intervention addressing both all four and fewer purposes.

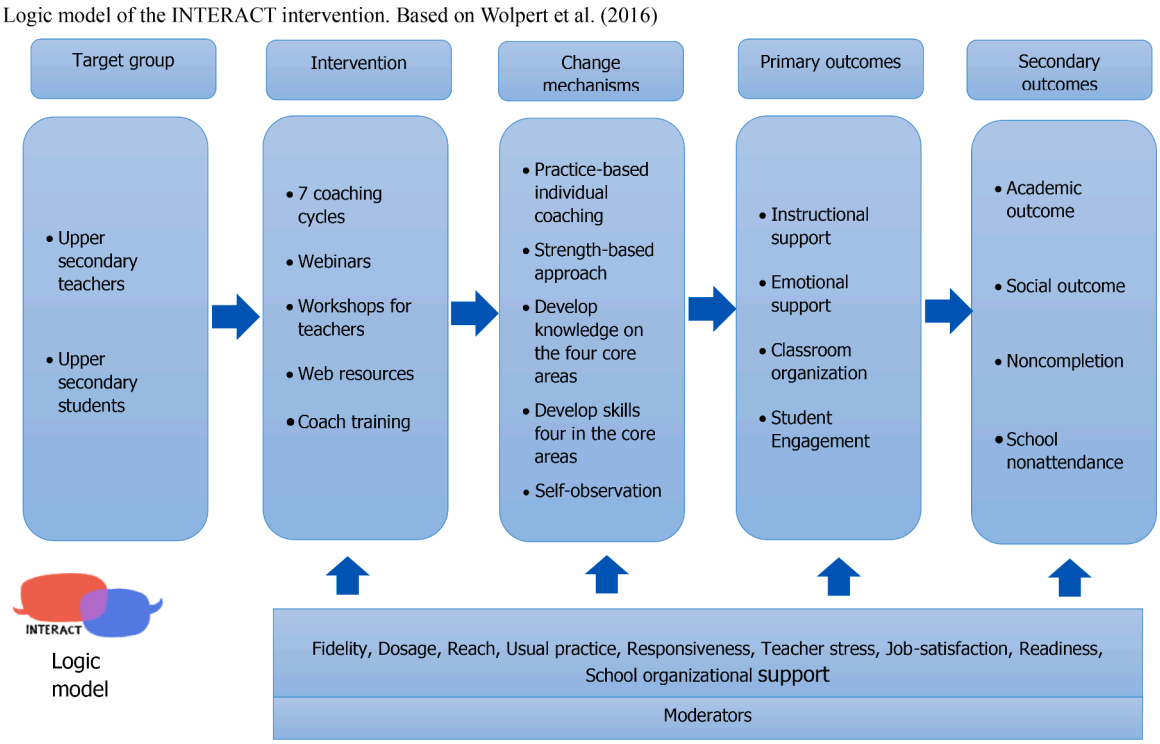


**Fig. 2.** Logic model of the INTERACT intervention. Based on Wolpert et al. (2016).

## 2. Research plan

The evaluation will consist of a mixed-methods cluster randomized controlled trial (CRCT) containing an implementation and process evaluation. The impact evaluation aims to assess whether INTERACT can improve specific outcomes for teachers and students in upper secondary education. The implementation and process evaluation aims to better understand the factors associated with implementation quality and how the implementation is associated with intervention primary and secondary outcomes.

### *2.1. Research questions and hypothesis*

The following research questions will be addressed.

#### *2.1.1. Effectiveness research questions*

Research Question (RQ)1

1a. What are INTERACT's effects, compared to business-as-usual practice, on teachers' TSI skills immediately and one year after the completion of the intervention?
1b. What are INTERACT's effects compared to business-as-usual practice on student engagement and social and academic learning outcomes immediately and one year after the completion of the intervention?

The primary outcomes are teachers' TSI skills (emotional support, classroom organization and instructional support) and student engagement (emotional, behavioral, and cognitive) because we are directly working with teachers and therefore expect this to be the greatest change. The secondary outcomes are students' academic outcomes, social outcomes (victim of bullying, discipline, mental health, mental well-being, intentions to quit, loneliness at school, peer relationships), school nonattendance, and school completion because we expect improvement in teacher TSI and student engagement to chase these changes. The outcomes will be assessed prior to the intervention, after intervention completion, and one year after the intervention is completed. Based on the theory and previous evidence, we hypothesize that intervention exposure will lead to significant improvements in teachers' TSI skills (H1a), student engagement (H1b), and social and academic learning outcomes (H1c) when compared to usual practices.

#### *2.1.2. Implementation and process evaluation research questions*

RQ2. What are the mechanisms through which INTERACT is or is not effective in supporting improvements in TSI skills and student engagement and learning?

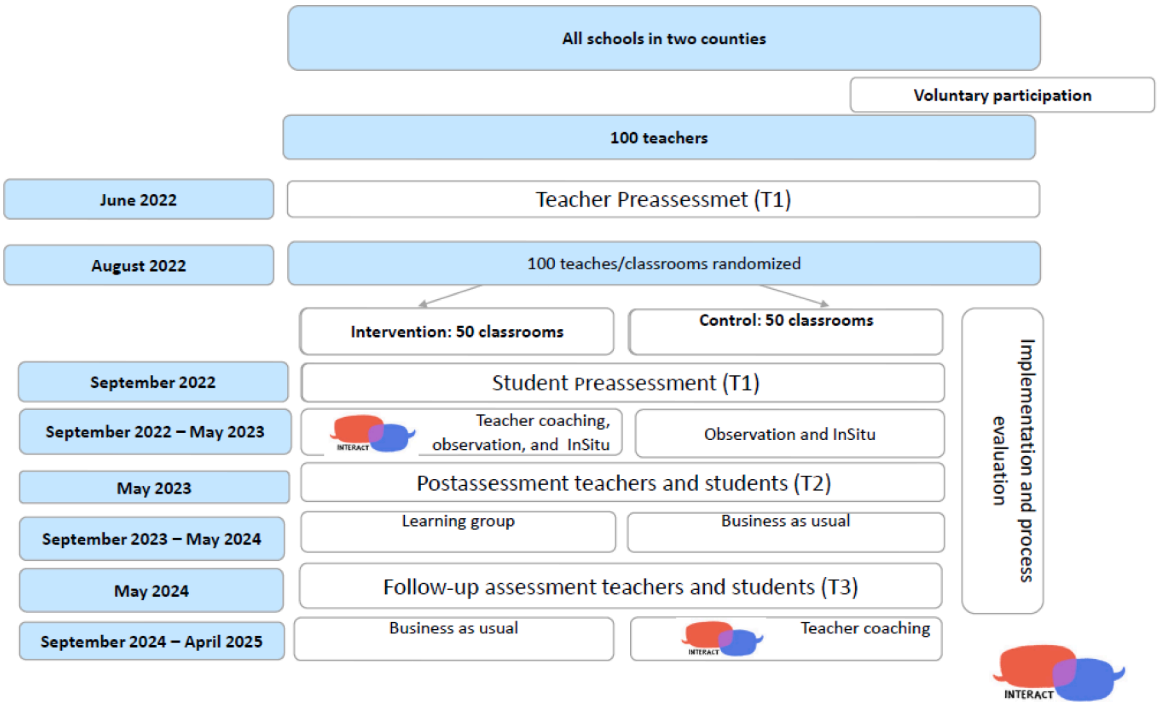


**Fig. 3.** INTERACT research design.

a To what extent does implementation follow the intervention guidelines specified, e.g., in terms of fidelity and dosage?
b What are the associations between teachers' stress, job satisfaction, and perceived school organizational factors and implementation variability (e.g., in terms of fidelity and dosage)?
c What are the associations between implementation variability and improvement in TSI skills, student engagement, and learning outcomes immediately and one year after the completion of the intervention?
d Based on profiles of implementation (e.g., fidelity, dosage, usual practice/implementer readiness) how many and what types of subgroups emerge in the sample of upper secondary classrooms?
e What is the experience of teachers and coaches in receiving/implementing INTERACT?

We predict that the intervention effects noted above will be amplified once intervention compliance (using fidelity and dosage as markers) and aspects of usual practice are considered (H2a–c).

### 2.2. Design

The evaluation is being conducted with at least 100 teachers and a class/group they are teaching in 12 publicly funded upper secondary schools across two Norwegian counties during the 2022-2024 school years. Teachers will be recruited in pairs from the same school, and in each pair, teachers will be randomized to the intervention group or the "business as usual" group. The intervention will be developed to supplement PD that highlights organizational collaboration. The teachers will attend workshops at their schools and be able to reflect on their practices in their teams as part of the schools' regular teacher PD programs. The impact evaluation consists of a CRCT with two levels (students nested within teachers/classrooms) and involves two arms, intervention and business-as-usual groups (Fig. 3).

### 2.3. Participants

The target group is teachers in upper secondary education and a classroom/group of students they are teaching. Both academic and vocational tracks will be included. Schools in two Norwegian counties and their teachers during the 2022-2024 school years are eligible to take part in the trial if:

- The schools are prepared to release teachers to prepare for and participate in the coaching intervention.
- Teachers are committed to recording their teaching of seven lessons during the 2022-2023 school year.
- Teachers assigned to an intervention group are committed to participating in a) seven coaching cycles during the 2022-2023 school year and the workshop group and b) three additional booster sessions in the 2023-2024 school year with the online workshop group.
- Schools are prepared to release administrative support for teachers in the impact evaluation.
- Schools are prepared to allow for within-school randomization and assign at least two teachers at each participating school, one for the intervention group and one for the business-as-usual group.

All teachers at schools that are taking part in the trial during the delivery year (2022-2023) are eligible to participate. We will investigate the effects of INTERACT in a mixed-methods CRCT with at least 100 participating teachers and 2,000 upper secondary students. The principal and participating teachers must sign a collaboration agreement detailing their responsibilities, which will include collecting informed consent forms as part of a larger responsibility for facilitating data collection.

### 2.4. Randomization

Teachers will be stratified by school, study program, and subject to the INTERACT intervention group or the business-as-usual group. We will use stratified randomization based on a battery of covariates, including the GPA needed for admission to the study program of the subject of the participating teacher/classes, the percentage of girls in the study program, and grade level. Half of the teachers and their classrooms/groups will be assigned to each condition. Teachers are recruited in pairs of teachers teaching the same or similar study program and subjects, with similar gender distribution, at the same grade level, and preferable at the same school (exceptions may be done for small schools with only one class within the same study program and subject, they may be paired with same/similar classrooms at another school). Within-pair randomization will be performed by a random number generator in a statistical program (SPSS). A whole number between 0 (business-as-usual) and 1 (intervention) will assign teachers and their students to one of the two arms. A balance test (ANOVA) of the randomization will be conducted based on lower secondary school GPA and preassessment student reports of engagement (emotional, behavioral, and cognitive) to establish whether the intervention and business-as-usual groups are significantly different.

We will assess teachers before randomization in June 2022 (T1) and the students before the intervention begins in September 2022 (T1). Additionally, we will assess teachers and students postintervention in May 2023 (T2) and at a one-year follow-up in May 2024 (T3). We will prepare for the possibility of a follow-up study of the longer-term effects of high-quality TSI on students' academic outcomes and dropout rates in upper secondary schools based on the data we collected.

### 2.5. Outcome measures

The selection of outcomes was guided by the logic model (Fig. 2), which was designed by the project team.

#### 2.5.1. Primary outcome measures: classroom interaction and student engagement

The three domains of classroom interaction (instructional support, classroom organization, and emotional support) will be measured using external observations, teacher reports, and student reports. Observed classroom interaction will be measured using the Classroom Assessment Scoring System-Secondary (CLASS-S; Pianta et al., 2012). In line with the procedure of CLASS-S, each of the seven recorded lessons will be divided into segments of 15–20 min, which will be scored using the CLASS-S. Scoring will be conducted by observers trained in the CLASS-S procedures (Pianta et al., 2012). Additionally, observers will be tested for interrater agreement. Interrater agreement of at least 80% will be required for scoring INTERACT recordings. The CLASS-S is validated in a Norwegian context (Westergård et al., 2019). Furthermore, the three domains will be measured at T1-T2 using complementary teacher (Ertesvåg, 2011, 2021) and student (Ertesvåg & Havik, 2021; Tvedt et al., 2021) measures for emotional support, classroom interaction, and instructional support.

Student engagement will be observed using CLASS-S after the same procedure described above. Furthermore, emotional and behavioral student engagement will be measured at T1-T3 using well-established measures (Skinner et al., 2009) previously used in the Norwegian context (Havik & Westergård, 2020; Lerang et al. resubmitted; Pettersen et al. 2022). Cognitive student engagement will be measured using a scale developed by Senko & Miles (2008). Situation-specific engagement will be measured at the end of each recorded lesson using the student versions of the InSitu measurement (Lerkkanen et al., 2012; Vasalampi et al., 2016). The InSitu student version has been translated and validated in a Norwegian setting (Pettersen et al. 2022).

Additionally, qualitative analysis of a subsample of video-recorded lessons will be conducted to further explore aspects of classroom interaction and student engagement. The selection of the subsample will be guided by quantitative observation and survey results.

#### 2.5.2. Secondary outcomes

Students' academic achievement will be measured using course grades in the subject of the recorded lessons midway through the intervention, at the end of the intervention and one year after the intervention. At baseline, most students will not yet have received grades for the subject of interest. Therefore, students will be asked to state their grade in the same subject or the most similar subject they had the previous year. In addition, they will be asked to predict their grade in the subject to measure their academic self-efficacy. Last, their lower secondary GPA (register data) will be included. Based on these measures, a baseline achievement measure will be scored,

School and course nonattendance (days and hours) and school and course completion will be measured using register data.

Students' social outcomes will be measured by self-reports at T1-T3 on being a victim of bullying (Roland & Idsøe, 2001), discipline (Vaaland et al., 2011), symptoms of anxiety and depression (Hopkins Symptom Checklist, SCL-5; Derogatis et al., 1974), previously validated in Norway by Strand et al., 2003; Tambs & Moum, 1993), mental well-being (S-WEMWBS Ringdal et al., 2018; Tennant et al., 2007), intentions to quit (Frostad et al., 2015; Tvedt et al., 2021), loneliness at school (Asher & Wheeler, 1985; Frostad et al., 2015), and peer relationships (Bru et al., 1998).

### 2.6. Covariates/moderators

#### 2.6.1. Covariates

Student outcomes will be controlled for gender, study track, socioeconomic status, and grade level.

#### 2.6.2. Teacher factors

Teacher factors that are expected to moderate the effects are job satisfaction, stress, and emotional exhaustion, as well as demographic factors such as gender, work experience as a teacher, study track, and education.

Teachers' job satisfaction is measured by a slightly modified version of the work satisfaction subscale of the Job Descriptive Index (JDI; Smith et al., 1969; Starnaman & Miller, 1992). The modified version was previously used in Norway (e.g., Ertesvåg, 2021; Munthe, 2003; Virtanen et al., 2019). The modification implies writing each item as a full sentence. Stress is measured using two subscales on stress due to workload and stress due to student behavior (Klassen, 2010). Emotional exhaustion is measured on a subscale of the Maslach Burnout Inventory (Maslach et al., 2001). The subscale has been previously used in Norwegian studies (Lerang et al., 2021; Virtanen et al., 2019)

#### 2.6.3. School organizational factors

School organizational factors will be measured using teacher reports of their school's innovation climate (Fisher & Fraser, 1991; Johnson et al., 2007), principal support (Starnaman & Miller, 1992), and two scales on collaborative activity (Ertesvåg, 2014; Lerang et al., 2021; Munthe, 2003).

#### 2.6.4. Implementation process evaluation

Moderators related to implementation are fidelity, dosage, responsiveness, reach, usual practice, quality, program differentiation, and adaptation (Humphrey et al., 2016). Measures for the eight aspects of implementation were developed for this study (Ertesvåg

et al., 2022) based on Ertesvåg et al. (2020) and Humphrey et al. (2016). Participating teachers and coaches will complete an online fidelity checklist at the end of each coaching cycle. The checklist includes a subjective measure of the extent to which the core components of the intervention are implemented. Questions will cover fidelity, dose delivered, quality, and responsiveness as key aspects of implementation. Teachers' surveys at baseline and postintervention will measure implementation aspects such as program differentiation (intervention group) and usual practice (business-as-usual group). Qualitative interviews will capture aspects of dose received and responsiveness as well as perceived barriers and facilitators of implementation and suggestions for improvement. A subsample of teachers in the intervention group and the coaches will be invited to focus group (5-6 persons in each group) interviews after the intervention. Teachers and coaches will be interviewed in separate groups. A subsample of teachers in the business-as-usual group (two focus groups, 5-6 teachers each) will be invited to focus group interviews to elaborate on reports of usual practice in the teacher survey at baseline.

### 2.7. Sample size calculations

Power calculations demonstrate that we will have adequate statistical power with 100 classrooms. Because classes rather than students will be randomized, possible cluster effects must be accounted for when power is calculated. Power was calculated using the procedures described by Hayes & Bennett (1999). We used the "Sample Size calculator for cluster randomized trials" (University of Aberdeen, 1999) to calculate power. We approximated cluster effects for our main outcomes based on previous studies (Ertesvåg & Havik, 2021; Gregory et al., 2017) and found that with a .05 level of significance, power =.80, intraclass correlations = 0.12, number of clusters = 100, average cluster size = 20, and n = 2,000, we can detect minimum effect sizes of 0.227. Hence, we should have adequate statistical power.

### 2.8. Analysis plan

The evaluation will use a mixed-methods CRCT including an implementation and process evaluation approach, drawing on data collected using observations, teacher surveys, student surveys, coach interviews, and teacher group interviews. Following the

**Table 1**
Workplan and timeline for key activities in INTERACT.

| Activity | Dates | Responsibility |
|---|---|---|
| Information to schools | June 2021-March, 2022 | Sigrun K. Ertesvåg, Grete S. Vaaland, Hilde Meringdal, Elise Breivik. |
| Revision of the INTERACT intervention and development of coach training | June 2021-March 2022 | Randi M. Sølvik, Grete S. Vaaland, Unni V. Midthassel |
| Protocol | June 2021-March 2022 | Sigrun K. Ertesvåg, Grete S. Vaaland, Marja-Kristiina Lerkkanen |
| Registration | March 2022 | Maren Stabel Tvedt, Sigrun K. Ertesvåg |
| Design of student and teacher survey | August 2021-January 2022 | Maren Stabel Tvedt, Sigrun K. Ertesvåg, Trude Havik, Øyvind Munthe Ann Kristin Kolstøl |
| Evaluation set up (ethical approval: design of consent form, etc.) | August 2021-February 2022 | Maren Stabel Tvedt, Sigrun K. Ertesvåg, Maren Stahl Lerang, Øyvind Munthe. |
| Recruitment of teachers (and classrooms) and administrative coordinator at the schools | April-May 2022 | Sigrun K. Ertesvåg, Grete S. Vaaland, Hilde Meringdal, Elise Breivik |
| Selection of online platform for coaching | March-April 2022 | Øyvind Munthe, Sigrun K. Ertesvåg, Grete S. Vaaland |
| Training the schools' administrative coordinators | May, August, November | Maren Stabel Tvedt, Øyvind Munthe, Ann Kristin Kostøl Johansen, Sigrun K. Ertesvåg |
| Collect consent from teachers | June/August | Sigrun K. Ertesvåg, Hilde Meringdal, Elise Breivik. |
| Coach training | February-December 2022 | Randi M. Sølvik, Grete S. Vaaland, Unni V. Midthassel |
| Administration of teacher pretest | June or August 2022 | Maren Stabel Tvedt, Maren Stahl Lerang, Øyvind Munthe |
| Randomization and notification of outcome | June or August 2022 | Maren Stabel Tvedt, Maren Stahl Lerang, Øyvind Munthe, Sigrun K. Ertesvåg |
| Collect consent from students | August 2022 | Øyvind Munthe, Maren Stabel Tvedt, Maren Stahl Lerang. School's administrative contact |
| Administration of student pretest | September 2022 | Maren Stabel Tvedt, Trude Havik, Øyvind Munthe |
| Intervention delivery + 7 x Observation data + 7x InSitu + Fidelity checklist | September 2022-May 2023 | Intervention delivery team, Grete S. Vaaland, Randi M. Sølvik, Maren Stahl Lerang, Gunita Mudhar. |
| Administration of teacher and student post test | May 2023 | Maren Stabel Tvedt, Maren Stahl Lerang, Øyvind Munthe |
| Implementation and process evaluation (IPE) group interview | May-June 2023 | Maren Stahl Lerang, Ingrid Skage, Randi M. Sølvik |
| Follow up intervention sessions | September 2023-May 2024 | Grete S. Vaaland, Randi M. Sølvik |
| Administration of teacher and student follow-up test | May 2024 | Maren Stabel Tvedt, Maren Stahl Lerang, Øyvind Munthe, Sigrun K. Ertesvåg |
| Data analysis and write up | August 2022-May 2025 | Sigrun K. Ertesvåg, Grete S. Vaaland and Full evaluation team |
| Intervention delivery-business as usual group | September 2024-May 2025 | Grete S. Vaaland, Randi M. Sølvik and Intervention delivery team |

recommendations of Muthén et al. (2002), the effects of the INTERACT intervention will be assessed using growth mixture modeling (GMM) within an SEM framework.

We will also investigate differential effects across performance on preintervention measures, gender, students' risk status, students' socioeconomic status, students' course of study (academic/vocational track), students' ethnic background, and the eight implementation aspects (Humphrey et al., 2016).

In addition to the effect analyses, we will analyze the association between implementation quality and teacher and student outcomes, such as the associations between intervention fidelity in INTERACT's three components and improvements in the three TSI domains, and student engagement and learning outcomes.

The responsible researchers are listed in Table 1.

#### 2.8.1. Effectiveness evaluation

The effects of the intervention will be assessed using GMM within an SEM framework. We will use multilevel analysis (students nested within teachers at the class level) in the Mplus statistical package (Muthén & Muthé, 1998-2017) to investigate intervention effects on the primary and secondary outcomes immediately and one year after the intervention and on the secondary outcome academic achievement. GMM is intended to explore subgroups that are characterized by similar within-group trajectories of change over time (Muthén et al. 2002; Wickrama et al. 2016). This approach allows us to examine the impact of the intervention on subgroups characterized by different types of growth trajectories by comparing their trajectory slopes within intervention and business-as-usual samples (Muthén et al., 2002).

The responsible researchers are listed in Table 1.

#### 2.8.2. Implementation and process evaluation

The IPE will draw on data collected from teacher surveys and teacher and coach group interviews. The IPE will explore INTERACT's theory of change and the extent to which the dimensions of implementation affect the effectiveness of the intervention and the facilitators and barriers to its implementation. Fidelity, dosage, responsiveness, program differentiation, usual practice, reach, and adaptation of the intervention's activities during implementation will be examined using pre, post- and follow-up surveys completed by the teachers. Sustainability, facilitators, and barriers to the intervention will be examined using teacher and coach group interviews and surveys at the end of the intervention school year. Teachers in the business-as-usual group will be asked to report on their practices that may be similar to INTERACT. A random subsample of intervention group teachers and business-as-usual group teachers will be invited to interview. Teachers will be interviewed in groups of 6-8 teachers, four interviews in the intervention group, and two interviews in the business-as-usual group. Coaches will be interviewed in two groups of five coaches each. With consent, group interviews will be tape-recorded in zoom and transcribed verbatim.

Teachers and coaches will complete a short intervention delivery log (web survey, fidelity checklist) at the end of each coaching session. Teachers and coaches will report on the delivery/implementation of each of the elements of the coaching session cycles, and except for the first session, teachers will report on the implementation of the plan since the last coaching session. The research staff will keep a record of attendance at both the initial training and follow-up sessions.

#### 2.8.3. Missing data

The most effective way of handling missing data is to avoid them. Extensive measures are taken to avoid missing data. For instance, each participating teacher will have administrative support at their school, organized by the project, to facilitate data collection among their students, handle any technical issues in the data collection and coaching throughout the two-year project period. Teachers will have time for the project allocated in their workplan, including time for completing the surveys, fidelity checklist, video recordings and interviews. Additionally, written and oral (in person and in films) information on the data collection is provided to inform students and teachers about the implications of participating and on practicalities in the data collection. Additionally, the county council representatives in the project and the administrative leader of the project will continuously be in contact and available for any questions from the schools and teachers. Nevertheless, different types of missing data can be expected in an RCT study (Tong et al. 2020; Gomila & Clark, 2022). In the current study, missing data may occur as a result of people not responding to the invitation to participate, usually referred to as the response rate. The measures described above are provided to increase the response rate. Second, teachers and students who sign up for participation may, for different reasons, not respond to all data sources or be unwilling to provide certain information. For instance, questions about mental health (students) or attitudes toward the inclusion of students with special needs (teachers). Third, longitudinal studies usually suffer from attrition. Teachers may drop out because of long-term sick leave or because they, for different reasons, no longer teach the class/group in question. Students may drop out because they leave the specific class/group (for another class/school), become an apprentice (as part of their secondary training) in the second year of the study, or may completely drop out of upper secondary school. Teachers' and students' reasons for dropping out of the study will be closely monitored.

For statistical analysis of data, Little's (1988) missing completely at random (MCAR) test will be applied. Depending on the results, the impact on inference is considered, and relevant statistical methods that address missing data (Tong et al. 2020) are applied. For example, for the Mplus analysis, when meeting the assumptions, the full information maximum likelihood (FIML) estimation will be used to handle missing data.

## 3. Personnel

The INTERACT study is a collaboration of the Norwegian Center for Learning Environment and Behavioral Research in Education and Møre and Romsdal County Council and the Rogaland County Council as upper secondary school owners.

### 3.1. Principal investigators

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## 4. Timeline

The workflow and timeline for the INTERACT project are presented in Table 1.

## 5. Research and professional ethics

The project is registered (nr. 210803) with the Norwegian Social Science Data Services and evaluated to be in accordance with the Norwegian Privacy Act. The ethical guidelines developed by the National Committee for Research Ethics in the Social Sciences and Humanities (NESH) will be strictly followed. Informed, written consent will be obtained from teachers and students. In addition, a film will be made in easy-to-understand language to inform students about the project, data collection and implications for participation.

A dedicated private, online, GDPR-compliant platform (IRIS Connect), accessible only by the teachers, coaches, and researchers, will be adapted to the ethical requirements of the study. The business-as-usual group will receive the potentially beneficial intervention after the intervention group has completed it, and the follow-up assessment will be conducted. Ethical aspects of the coaching process, such as the teacher-coach relationship, the impact of video recording on TSI and learning activities, and student feedback, will be addressed in the coach training. Thus, ethical PD and research guidelines will be followed (Hackling, 2014).

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## Registration

The project is registered with the Registry of Efficacy and Effectiveness Studies (REES) Registry ID: 10802.

## Declarations of Competing Interest

None.

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