



# Implementing and Evaluating Growth Mindset Pedagogy – A Study of Finnish Elementary School Teachers

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This article presents a study of five teachers at a Finnish elementary school who implemented and evaluated growth mindset pedagogy (GMP). The teachers received GMP training and conducted student interventions in their classrooms. We analyzed the impact of GMP on the teacher's pedagogical thinking and practices and found significant differences between fixed-mindset and growth-mindset teachers in the ways they internalized and applied GMP principles. The most important value of GMP was seen in its impact on emotion regulation through the normalization of hardship in learning. We discuss the dangers of a superficial understanding of growth mindsets in education.

## OPEN ACCESS

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## INTRODUCTION: MINDSET THEORY AND CURRENT TRENDS

According to Dweck's theory on implicit beliefs about the nature of basic human qualities related to learning (Dweck, 2000; Dweck, 2006), teachers and students may either have a fixed mindset (entity theory) and believe that their basic qualities are stable and unchangeable, or a growth mindset (incremental theory), meaning that such qualities are considered changeable and open to development. An extensive body of research demonstrates the impact of mindset on motivation and learning, and particularly on the resilience that learning requires (Yeager and Dweck, 2012). Much of this work focuses on the role of implicit theories in motivation and achievement, but associations between a growth mindset and both adjustment and emotional well-being in school have also been reported (King, 2012; King et al., 2012). Dweck's theory has also provided a framework for brain research, where it has been shown that students with a growth mindset recover from mistakes faster than those with a fixed mindset measured in terms of error-monitoring event-related brain potentials (ERP) (Moser et al., 2011; Schroder et al., 2017).

Nevertheless, it is possible to change mindset-related meaning systems through relatively short interventions (Dweck and Yeager, 2019). The latest and most impressive study offering more evidence of the predictive capacity of mindset-related meaning systems was conducted by Yeager et al. (2019) in the U.S. This large-scale, preregistered, nation-wide, intervention study – published in *Nature* – included 12,490 ninth-grade adolescents and reported undisputedly beneficial effects from a short online mindset intervention. Grades among lower-achieving students improved, and overall enrollment on advanced mathematics courses increased. Moreover, although the effect sizes may seem small or moderate relative to laboratory study benchmarks, they are impressive when measured against other longitudinal outcomes of real-world interventions with heterogeneous samples (Dweck and Yeager, 2019; Yeager et al., 2019).

While mindset theory is widely applied, with advocates throughout the world, it has also been criticized. For example, in contrast to Dweck's results, some empirical studies have found no

significant correlation between mindset, motivation, and achievement (e.g., Leondari and Gialamas, 2002; Robins and Pals, 2002; Dupeyrat and Mariné, 2005; Burgoyne et al., 2020; McCabe et al., 2020). Moreover, in some cases, even when the mindset effects were replicated, they seemed far weaker than in the original studies (e.g., Zhang et al., 2017a). The reasons for these unsuccessful replications and inconsistent results are not fully understood, but there are several potential causes. The first is the general shift in mindset research from laboratory to real-world settings. In addition, interventions do not necessarily affect all students equally: they are typically stronger for “high-risk” students and more moderate for others (Paunesku et al., 2015; Broda et al., 2018). Furthermore, the short interventions that have produced significant results underwent several rounds of development and testing and were very carefully matched to the target populations (Dweck and Yeager, 2019).

The atmosphere and interactions in the learning environment also mediate the results of mindset interventions (Burke and Williams, 2012; Yeager et al., 2019). It is generally known that the mindsets of children may be strongly influenced by the feedback they receive from the environment (Pomerantz and Kempner, 2013). The mindsets of teachers (Rattan et al., 2012; Canning et al., 2019; Bostwick et al., 2020) and, in turn, their feedback style (Schmidt et al., 2015; Zeeb et al., 2020) as well as parental praising styles (Gunderson et al., 2013; Park et al., 2016) also influence mindset development, motivation, and achievement among students. For these reasons, the development of “growth mindset cultures” could be considered a necessary next step to achieving more stable and effective outcomes in the research field. However, this has proved a far from simple task. For instance, Carol Dweck recently discussed observations of teachers creating a “false growth mindset,” indications of which include, for example, equating a growth mindset simply with effort and then praising effort even in the absence of progress, as well as teaching about growth and learning opportunities but failing to provide students with the necessary help (e.g., strategies) and resources (Dweck and Yeager, 2019).

In sum, recent research shows that the relationship between a growth mindset and academic achievement and motivation is complex and not thoroughly understood. In particular, the risk of oversimplified applications has become evident since the shift in focus to real-world settings. As Dweck and Yeager (2019) state:

This may sound strange to say after decades of research, but we still know far too little about how best to transmit a growth mindset to individuals, how contexts determine whether students take up and apply a new mindset, or how to help embed a growth mindset in the cultures of schools and organizations. Research into these issues is critical because we have learned that it is too easy for people to implement a growth mindset poorly (p. 481).

The current study is motivated by the acknowledged need to acquire a more nuanced understanding of the pitfalls and opportunities involved in developing growth-mindset cultures in real-world educational settings in different educational

contexts. We therefore focused our previous research on a deep case analysis of the pedagogical thinking and practices of several Finnish teachers with different mindsets, and considered the “critical points” in the practices of highly educated and experienced teachers with growth and mixed mindsets (Rissanen et al., 2018a; Rissanen et al., 2018b; Rissanen et al., 2019). On the basis of these studies and the previous literature we have identified the key aspects of “growth mindset pedagogy” in basic education. We continue this iterative process of developing the pedagogy in the present article: the study concerns five Finnish teachers with different mindsets and their experiences of learning and implementing growth mindset pedagogy.

## GROWTH MINDSET PEDAGOGY

Our conceptualization of growth mindset pedagogy (henceforth GMP) builds on the understanding that mindsets create “meaning systems.” Malleability beliefs affect performance and challenge seeking through the mediating variables of attribution<sup>1</sup>, performance-avoidance vs. learning/mastery goals<sup>2</sup>, and effort beliefs<sup>3</sup> (Dweck and Yeager, 2019). Furthermore, according to research on mindsets and self-regulation, it is also goal monitoring, and not only goal setting and goal operating, that mediates the effects of mindset on goal achievement. A fixed mindset predicts a tendency to experience negative emotions during the goal-monitoring process, as well as low expectations of future success. Such people are more likely to regard anything less than complete goal achievement as evidence of a lack of ability, and these helpless-oriented negative emotions then undermine successful achievement (Burnette et al., 2013). Thus, GMP does not target only malleability beliefs but also the different attributive styles and self-regulation processes associated with them.

According to our definition, GMP in basic education (Rissanen et al., 2019) reflects process-focused pedagogical thinking and teachers’ process- (rather than trait-) focused interpretations of the learning, behavior, and achievement of students. It is associated with the teacher’s own growth mindset and is likely to foster growth mindsets in students. We identified four educational principles as core factors of GMP. The first is to *support individual learning processes*. Instead of making quick and stereotypical interpretations of students and their qualities,

<sup>1</sup>*Attribution* refers to a process by which persons make judgements about the causes of failure or success. Successes and failures can be attributed to e.g. innate abilities or process factors.

<sup>2</sup>Having *performance-avoidance goals* means that the person is mainly concerned about avoiding performing poorly, whereas people with *learning/mastery goals* focus on the process of mastering the skill or knowledge and prioritize learning over performance. These ways of goal setting are related to responses to setbacks: *helpless-oriented* persons give up in front of failures, but *mastery-oriented* seize challenges and become eager in front of failure and see challenges as learning opportunities.

<sup>3</sup>*Effort beliefs* are about seeing effort as a positive thing that helps to grow abilities. People with high effort beliefs regard effort as necessary part of learning, whereas people with low effort beliefs consider high effort as indicator of low ability.

teachers should take time to determine the learning barriers of individual students and attribute their success and failures to process factors rather than fixed qualities. In particular, teachers should understand how students' fixed mindsets may impact self-regulation and manifest as "fixed mindset behavior," for example, as emotional reactions and helpless-behavior (Burnette et al., 2013). Thus, teaching based on individualized support and differentiation is a crucial starting point for promoting GMP in basic education.

The second principle is to *promote mastery orientation* by focusing on mastery rather than performance goals (defining success in terms of learning and improvement rather than demonstrating competence and excelling over others). Mastery orientation is also associated with challenge-seeking (Lee and Kim, 2014) and supported by placing emphasis on formative assessment and peer support. The third principle of GMP is *persistence*. Teachers with fixed mindsets tend to console students and to give up on them more easily (Rattan et al., 2012; Rissanen et al., 2018a; Rissanen et al., 2018b), whereas those with growth mindset are more persistent: they provide honest feedback and assist their students to overcome their helplessness. In this, the teacher's own growth mindset becomes increasingly relevant. Persistence demands a genuine belief in the ability of students to learn and overcome the difficulties they may currently be experiencing. However, it is not enough merely to emphasize effort: students should be taught a variety of strategies for overcome "learning pits" (Boaler, 2019). GMP addresses the importance of helping students examine and change their inner speech in the face of setbacks. Moreover, they should be provided with honest but encouraging feedback in the form of "not yet" (Ronkainen et al., 2019).

The fourth GMP principle is to support *process-focused thinking in students* by purposefully fostering their belief in the malleability of the brain and situational attributions, stressing the importance of effort as well as the positive role of challenges, mistakes, and failures in learning, offering process feedback, as well as emphasizing strategies and learning-to-learn goals. These aspects – particularly the first two – are typically at the core of mindset interventions. In our model, however, they constitute the last principle, as relying on mindset messages without persistently offering individualized support would risk turning to "false growth mindset pedagogy."

A growth mindset is often understood as a positive psychological construct (e.g., Chan et al., 2020). Positive pedagogy draws on aspects of positive psychology and attaches importance to processes that define wellness, as well as the identification and nurturing of students' character strengths (see, e.g., Chan et al., 2020; Gilman et al., 2014; Seligman, 2002). GMP aligns with many aspects of positive pedagogy, such as a focus on the holistic well-being of students and optimism. However, in our view, the GMP approach differs somewhat from the main tenets of positive pedagogy. For example, promoting student motivation by helping them become aware of their abilities and strengths as well as avoiding tasks that are overly challenging and that may trigger negative emotions (see, e.g., Ranta et al., 2020), clearly differ in focus from GMP practices. GMP is based on the idea that

persistence in the face of long-lasting problems and difficult setbacks is better promoted through learning to see difficulties as a normal part of learning and by strengthening malleability beliefs.

Furthermore, critics voice concerns that an emphasis on personal growth could reinforce and legitimize the influence of neoliberalist educational ideals (Adams et al., 2019; Chan et al., 2020), such as the pursuit of increased efficiency and individuals' responsibility to "fix themselves," as opposed to developing educational and societal systems in which individuals can thrive (see, e.g., Kohn, 2015; Webster & Rivers, 2019). In our view, supporting a belief in the human potential to change and learn does not imply succumbing to the pressures of continuous self-maximization and self-cultivation. GMP can have the potential both to bring peace to the human condition of incompleteness, and, instead of seeking motivation from ego-boosting experiences of success and achievement, to help allay ego-related concerns when they disturb learning.

## THE FINNISH CONTEXT

This study was conducted in the context of Finnish basic education – more specifically, elementary-school (grades 1–6). At this level, students are aged between seven and 13, the teaching is uniform for all, and it is generally conducted by a class teacher. Finnish class teachers, the subjects of this research, are highly educated, with a Master's degree in education (Tirri, 2014). Moreover, teacher education in Finland is research-based (Tirri, 2014; Eklund, 2014) and student teachers are educated to become researchers of their own work. During their studies, they also attend teaching practicums organized in the university's *teacher training school*. As a result, Finnish teachers are valued and trusted professionals, and teacher autonomy is also high.

As in other Nordic countries, equality and inclusiveness are central values in Finnish educational policy (Arnesen et al., 2007; Takala et al., 2009). One of the main educational principles aimed at maintaining equality is the requirement to take care of the weakest students (Tirri and Kuusisto, 2013); consequently, the strongest support is directed to those with special educational needs (Niemi, 2012). Thus, more emphasis has been placed on equality in terms of educational outcomes than on the pursuit of individual excellence (Hotulainen and Schofield, 2003). Nevertheless, since the 1990s, there has been an ever greater focus on individuality and freedom of choice, with the importance of taking every student's needs and abilities into account acknowledged in both the Finnish Constitution (731/1999) and the Basic Education Act (628/1998).

Finland's success in the Program for International Student Assessment (PISA) was notable at the beginning of the 21st century (OECD, 2004, 2011). However, PISA results since 2013 have revealed a decline in the achievements of Finnish students (Kupari et al., 2013; Leino et al., 2019). One suggested explanation for this trend is the current lack of willingness in Finnish schools to confront situations and deal with content that may be challenging or disquieting for students (Hautamäki et al., 2015). Fear of failure among Finnish students is less than the

OECD average. However, the difference between girls and boys is notable, with girls being more anxious about failure than boys (Leino et al., 2019).

Many features of the Finnish educational system align with GMP principles (Rissanen et al., 2019). The National Core Curriculum for Basic Education (Finnish National Board of Education, 2014) advocates pedagogy that meets the needs of diverse learners in inclusive settings. Accordingly, differentiated teaching is emphasized as the pedagogical basis for education. Furthermore, curriculum contents that reflect GMP principles include formative assessment, student goal-setting and self-assessment, progress assessment, the use of different learning strategies, and encouraging constructive feedback. However, aspects previously identified among Finnish teachers that run counter to the principles of GMP include trait-focused as opposed to process-focused pedagogical thinking and practices in the case of academically competent students.

Most Finnish teachers nevertheless have growth mindsets regarding student intelligence and giftedness (Laine et al., 2016, Laine et al., 2016; Ronkainen et al., 2019). However, some Finnish teachers continue to hold fixed mindsets, and such teachers are more likely to concentrate on performance-oriented strategies. Finnish students (aged from 9 to 19) also tend to have growth mindsets. Nonetheless, they perceive intelligence as more malleable than giftedness, and younger pupils (age 9–12 years) hold more fixed views about intelligence (Kuusisto et al., 2017b). There is thus a need to reinforce the development of a growth mindset in this age group.

Five class teachers from a Finnish teacher training school, all of whom also supervised teaching practicum of student teachers in their classrooms, participated in the study. These individuals were suitable subjects for this study for several reasons. First, as teachers at a university teacher training school they are required to continuously update their research-based pedagogical knowledge and are able to analyze the added value of GMP against the state-of-the-art pedagogical knowledge they already possess. Moreover, even though research has been conducted on the mindsets of students and teachers in Finland for some time, it seems that Finnish teachers remain relatively unfamiliar with the concept: at least it was unfamiliar to all the teachers involved in this study, which means that they had not developed “false growth mindset” practices either.

## DATA AND METHODS

The present study is part of the research project CoPErNicus – Changing Mindsets about Learning: Connecting Psychological, Educational and Neuroscientific Evidence, the aim of which is to investigate the views of students, teachers, and parents on learning. The project utilizes a multidisciplinary approach based on psychological, educational, and neuroscientific data. For the present study, we collaborated with Finnish class teachers ( $n = 5$ ) and explored how they adopted, implemented, and evaluated GMP. Our research questions were the following: 1) How do teachers evaluate the impact of GMP on their pedagogical thinking and practice? 2) What kind of differences

exist between the evaluations of growth mindset and fixed mindset teachers? Previous studies have explored differences in the pedagogical practice of teachers with different mindsets, but this study was designed to investigate how growth mindset and fixed mindset teachers react to GMP training and what kind of changes in their pedagogical thinking and practice they report.<sup>4</sup>

In order to be able to induce and explore teachers’ learning processes in natural settings, we regarded teachers’ active participation in the research process necessary. Our methodology draws on participatory approaches and includes many typical aspects of design-based research (DBR): the emphasis was on theory building and its practical validation, the study was situated in a real educational context, and focused on the design and testing of an intervention (see, e.g., Anderson and Shattuck, 2012; Plomp, 2007). However, participation was more limited than in many DBR approaches – the teachers did not participate in the analysis and reporting phase of the study. The extent of teachers’ participation in the research was determined partly by the time resources they could allocate for this project. Moreover, the term “intervention” has a double meaning here. This is because the five teachers involved in this study implemented a growth-mindset intervention for their students developed for grade levels 3–6 within the CoPErNicus project, while they were themselves the target of an intervention. This included 1) education about GMP and growth-mindset interventions, 2) the implementation of GMP by the teachers in their everyday work, 3) the implementation of a growth-mindset intervention by the teachers in their classrooms, and 4) guided self-reflection among the teachers. The influence of the student intervention was measured quantitatively (see below), while our approach in this article is qualitative and our focus is the way teachers implement GMP.

We assessed the mindsets of the five teachers of this study at the beginning of the research period (before the teachers received any training) using Dweck’s (2000) Implicit Theories of Intelligence Scale, which is a six-point Likert-type scale (1–3 indicating entity beliefs/a fixed mindset, and 4–6 indicating incremental beliefs/a growth mindset, e.g., *Your intelligence is something about you that you can’t change very much*). Three of the teachers (GM1  $M = 5.0$ ; GM2  $M = 5.0$ ; GM3  $M = 5.75$ ) displayed growth-mindset tendencies, whereas the mindsets of the other two (FM1  $M = 3.0$ ; FM2  $M = 2.25$ ) were more fixed. These measurements aligned with our interpretations based on the interviews and diaries, which enabled us to analyze the possible impact of the teachers’ own mindsets on implementing GMP. At the time, four (GM1, GM3, FM1 and FM2) taught classes in grade 3, and one (GM2) in grade 5. GM1 and FM2 co-taught a class. FM1 was male, while the others were female. Their teaching experience ranged from 8 to 10 years (GM1, GM3 and FM2) to approximately 20 years (FM1 and GM2). The teacher training school in which the teachers worked

<sup>4</sup>The language we use (FM teachers/GM teachers) may suggest a view of mindset as a fixed trait. We use these terms to ensure readability of text; however, they should be understood as referring to teachers who at the moment and in the context of the study express a stronger tendency towards either growth or fixed mindset.

**TABLE 1** | An overview of the lessons, topics and methods of the GMP intervention program.

| Lesson                           | Topics addressed   | Methods used   |
|----------------------------------|--|--|
| 1. Introductory lesson           | The general structure and topics of the lessons  | Instruction for using learning diaries for self-reflection during the program. Learning the basic <i>theme rhyme</i> of the intervention program. The rhyme was repeated in every following lesson, with additional and more challenging movements added each time, the purpose being to demonstrate learning processes and the effects of “training the brain.”   |
| 2. The brain is like a muscle    | The basic structure of the brain and the roles of different parts of it. The role of the limbic system and the cortex in learning. The neuroplasticity of the brain and neural processes of learning | Bringing examples of students’ own learning throughout their childhood to demonstrate the extensiveness of what their brains have already learned. Using the <i>fast to model the brain</i> , with the wrist as the stem, the thumb as the limbic system and the fingers as the cortex. Referring to the limbic system as a “lizard” that evokes emotions and becomes alarmed when a possible threat is perceived, and how this can disturb learning processes. Discussing different strategies to take responsibility of one’s emotional reactions and “calm down the lizard.” <sup>5</sup> Explaining the creation and reinforcement of neural connections during learning |
| 3. Challenges in learning        | The importance of challenges for learning. The learning pit and how to come out of it  | Discussing challenging learning situations and the accompanying emotions. Reflecting on students’ own experiences of and emotions during challenging learning situations through the metaphor of <i>the learning pit</i> (Boaler, 2019). Reflecting on strategies for getting out of the learning pit  |
| 4. Mistakes are part of learning | The important role of mistakes in the learning process. Growth mindset as a concept  | Listening to and reflecting on a children’s story about learning from mistakes. Discussing the meaning of mistakes and their important role in learning. Presenting the concept of a growth mindset. Reflecting on one’s own reactions to mistakes and challenges and reframing their meaning in the context of learning.  |
| 5. Internal speech               | Growth-mindset speech  | Practicing noticing “fixed mindset messages” in one’s internal speech and learning to change them into “growth mindset messages” (Thomaes et al., 2020) through pair discussion and drama. Students were introduced to growth-oriented inner speech with examples such as “I don’t know it yet,” “It feels hard now, but I can learn it” or “Everyone makes mistakes; it is a normal part of learning.”  |
| 6. Summative lesson              | Revisiting the topics of previous lessons  | Revisiting all the topics addressed thus far and discussing their key contents. Reflecting on the processes of learning the theme rhyme and the accompanying challenging movements.  |

was an urban school that had students from different SES backgrounds.

Contrary to some DBM studies (Anderson and Shattuck, 2012), the teachers did not participate in designing the study approach and research questions, which were designed on the basis of our previous studies. However, the teachers were involved in designing the interventions. First, they attended a one-day training event about GMP (November 2019), where teachers were educated about the growth-mindset meaning system, its implications for learning and motivation as well as the principles of GMP. Through a “learning café” method they began to develop concrete ideas for implementing GMP in their own teaching. During a second training day in January 2020, the teachers learned about the growth-mindset intervention that was designed within the CoPerNicus research group, and the materials were revised based on their feedback. The five teachers participating in this study implemented an intervention titled “I will learn!” over 3 weeks in February 2020. This GMP intervention program included six lesson plans, which are briefly presented in **Table 1**. The general purpose in the lessons was to cover different aspects of the growth-mindset meaning system. The intervention was developed utilizing

previous mindset interventions and the relevant mindset literature (e.g., Aronson et al., 2002; Dweck, 2006; Blackwell et al., 2007; Boaler, 2019). It was designed to support malleability beliefs, effort beliefs, situational attributions, coping with mistakes and challenges, and mastery orientation through developing self-reflection. The content and material were created to be suitable and effective for elementary school children within six 45-min lessons. The key teaching content included the malleability of the brain and neural processes of learning, normalizing challenges in learning, and learning new ways of overcoming difficulties. The students were encouraged to reflect on these things on a personal level throughout the intervention *via* learning diaries.

We also measured the influence of the intervention on the students quantitatively. However, given the lack of a specific experimental design for this part of our study, the quantitative results serve merely as background information and support for the qualitative observations. Eighty-five third-grade ( $n = 61$ ) and fifth-grade ( $n = 24$ ) students completed an online questionnaire before the intervention and 4 weeks after its completion. The general-intelligence mindset of the students was measured on four items based on entity theory taken from the Implicit

**TABLE 2 |** Reflection instructions.

| Guidelines for reflections during the student intervention   | Guidelines for reflections on implementing GMP  |
|--|---|
| <p>After each intervention lesson, reflect on and write about your observations. Use the following questions to support your reflective process:</p> <ul style="list-style-type: none"> <li>• What do you think worked well in the lesson? What induced challenges or confusion?</li> <li>• What reactions did students have to the content and methods of the lesson?</li> <li>• How could the lesson be further improved?</li> <li>• What should a teacher consider when planning and conducting the lessons?</li> </ul> | <p>Report on your experiences of and reflections on situations, in which you</p> <ul style="list-style-type: none"> <li>• Observed students expressing fixed or growth mindsets</li> <li>• Noticed that your own fixed or growth beliefs influenced your pedagogical practice and interaction</li> <li>• Consciously tried to act according to the principles of GMP</li> <li>• Noticed changes in students' motivation, behavior or learning that you interpreted as being linked to the intervention and/or the implementation of GMP in the classroom</li> </ul> |

Theories of Intelligence Scale (Dweck, 2000). In turn, we measured effort beliefs using five negative statements (e.g., “It doesn’t matter how hard you work – if you’re not smart, you won’t do well.”) from the questionnaire used by Blackwell (2002). The students indicated how much they agreed with each statement in the questionnaire by marking one of six circles that varied in size and ranged from “not at all” to “really a lot”; the answers were then mapped on a six-point Likert-type scale. Higher scores on the scales indicated a stronger endorsement of a growth mindset and a weaker endorsement of negative effort beliefs. The internal consistencies of the instruments were acceptable (Cronbach’s alphas from 0.73 to 0.91). A paired-samples t-test revealed statistically significant differences in the scores related to a general intelligence mindset before ( $M = 3.43$ ,  $SD = 1.38$ ) and after ( $M = 4.09$ ,  $SD = 1.47$ ) the intervention program:  $t(84) = -5.81$ ,  $p < 0.001$ . Similarly, statistically significant differences were also found between the pre-intervention ( $M = 3.96$ ,  $SD = 1.00$ ) and post-intervention ( $M = 4.16$ ,  $SD = 1.11$ ) scores for negative effort beliefs:  $t(84) = -2.36$ ,  $p = 0.02$ . These results indicate that the intervention affected the students’ general intelligence mindset and negative effort beliefs in the predicted direction. No statistically significant differences between the student groups of different teachers were found.

The data of this study includes diaries kept by teachers and teacher interviews. The teachers wrote a diary about their experiences during the student intervention in February 2020, which they sent to the research group either after every intervention session or in the middle of and after the intervention period. The original plan was also for them to write a diary about the implementation of GMP during the spring of 2020. However, following the introduction of distance teaching due to the COVID 19 pandemic, the teachers’ workload exceeded and less time-consuming data collection needed to be planned. In order to accommodate this change in teachers’ workload, we decided to withdraw the diary task and conducted semi-structured interviews with the teachers *via* video link in April 2020. Each teacher was interviewed once. The interviews lasted approximately 30 min, and they were recorded and transcribed. GM1 and FM2 had nevertheless written GMP diaries, which we used as data in addition to the interviews as well as intervention diaries written by all teachers. **Table 2** lists the instructions for teachers in their reflections on the student intervention and on implementing GMP. In addition to covering these reflection guidelines, in the interviews teachers

were asked to evaluate possible changes to their pedagogical thinking and practice during and after the intervention period as well as their perceptions of the impact and significance of GMP.

The data (diaries and interview transcripts) were analyzed by means of abductive qualitative content analysis (Timmermans and Tavory, 2012; see also; Elo and Kyngäs, 2007). The units of analysis were sentences or paragraphs in the transcribed teacher interviews and diaries that provided answers to the first research question, i.e., teachers’ evaluations of the impact of GMP on their pedagogical thinking and practice. These were formed into condensed meaning units. The CMUs were then inductively coded (but guided by the researchers’ knowledge of growth mindset theory). In the next phase, these codes were deductively categorized under the four principles of GMP in an iterative process whereby small revisions were made to the coding. The second research question was analyzed by marking which teachers’ CMUs were included under each category and then interpreting the differences that emerged between the FM and GM teachers, category by category. The CMU’s of each individual teacher were listed and short profiles written; however, the space here allows only presenting key observations from these profiles. **Table 3** presents the categories linked to GMP principles and teachers as well as sample excerpts from the CMUs. Codes per category are presented in **Supplementary Appendix Table S1**.

## RESULTS

### Self-Reported Impact of GMP on FM and GM Teachers’ Pedagogical Thinking and Practices

#### Recognizing and Supporting Students’ Individual Learning Processes

The growth mindset teachers in this study reflected on new ways of interpreting students’ learning and behavior. Their reading of reluctance among students to put in effort and to take on challenges had changed as they had learned to *recognize and overcome fixed mindset behavior* (**Table 3**) – for example, helpless-responses, freezing, and strong emotional reactions to

**TABLE 3 |** Teachers' perceptions of the impact of GMP on their pedagogical thinking and practice.

| GMP dimensions <sup>6</sup><br>Rissanen et al. (2019)              | Impact of GMP<br>on teachers' pedagogical<br>thinking and practice<br>number of CMUs                   | FM1 | FM2 | GM1 | GM2 | GM3 | Sample excerpts from<br>condensed meaning units<br>(CMUs)   |
|--|--|-----|-----|-----|-----|-----|---|
| Recognizing and supporting students' individual learning processes | A) Recognizing and overcoming fixed mindset behavior (25 CMUs)   | —   | —   | x   | x   | x   | GM1_fixed mindset shows as students' tendency only to take on easy tasks which they are sure they will manage<br>GM2_has started to think how important it is that a teacher understands the many possible reasons behind a student's tendency to give up and get stuck<br>GM3_recognising how a student with a fixed mindset compares himself to others, considers himself dumb, and cannot handle making mistakes |
|  | B) More versatile attributions (14 CMUs)   | —   | x   | x   | x   | x   | GM1_has learned to recognize many new possible reasons for why a student is not able to start working on a task<br>GM2_has begun to pay more attention to the impact of students' emotional processes for learning<br>GM3_has begun to put more effort into analysing students' learning processes<br>FM2_has begun to pay more attention to students' physiological states   |
| Promoting mastery orientation                                      | C) Encouraging challenge-seeking and providing adequate challenges (10 CMUs)                           | —   | x   | x   | —   | x   | GM1_wants to start giving high achieving students more challenging tasks<br>GM3_wants to put more effort into setting concrete learning aims also with special needs students<br>FM2_has started to tell students when they succeed easily, that it would be good to find more challenging things so that they can really learn something   |
|  | D) Avoiding comparison and emphasizing collaboration (4 CMUs)  | —   | —   | —   | —   | x   | GM3_puts more emphasis on developing students' skills to encourage each other   |
| Persistence  | E) Persistence through positive messages and encouragement (13 CMUs)                                   | x   | x   | —   | —   | —   | FM1_more effort to positively encourage students to strive<br>FM1_used to confront students more but now wants to encounter challenges in a more positive manner<br>FM2_wants to emphasize to students that they can and will learn   |
|  | F) Persistence through emotion regulation supported by normalization of hardship in learning (32 CMUs) | —   | x   | x   | x   | x   | GM1_personally significant realization has been to understand the "learning pits" and normalize them for students<br>GM2_the language of overcoming difficulties has took root in her pedagogical interaction<br>GM3_has received support for her idea that learning does not need to be easy and fun all the time<br>FM2_wants to teach her students how to endure a certain amount of discomfort in learning      |
| Fostering students' process focused thinking                       | G) Teaching about the brain and the significance of "brain exercise" for learning (9 CMUs)             | —   | —   | x   | x   | x   | GM1_emphasises that exercising the brain is necessary for learning<br>GM3_more "brain talk" in the classroom<br>GM2_reminds students of the intervention and what happens in the brain during learning, when notices that a student is giving up<br>(Continued on following page)   |

**TABLE 3 |** (Continued) Teachers' perceptions of the impact of GMP on their pedagogical thinking and practice.

| GMP dimensions <sup>6</sup><br>Rissanen et al. (2019) | Impact of GMP<br>on teachers' pedagogical<br>thinking and practice<br>number of CMUs         | FM1 | FM2 | GM1 | GM2 | GM3 | Sample excerpts from<br>condensed meaning units<br>(CMUs)  |
|---|--|-----|-----|-----|-----|-----|--|
|   | H) More process feedback (11 CMUs)   | —   | x   | x   | x   | x   | GM1_has sent students' parents instructions on how to support their children with process feedback<br>GM2_when students succeed has started to focus the feedback on how they have practiced<br>GM3_particularly with high achieving students has begun to try to shift their attention away from talent and intelligence to process factors<br>FM2_has learned to avoid "praising a person" and support growth instead  |
|   | I) Helping students to strengthen situational attributions through self-reflection (40 CMUs) | —   | x   | x   | x   | x   | GM1_increasingly guides students to observe, recognize and verbalize the factors that influence their learning processes<br>GM2_has developed the habit of asking students to reflect on and talk to the teacher about their current state of mind and how it may influence their learning<br>GM3_her students have started to refer to their lizard being active<br>FM2_in P.E. lessons there are good opportunities to reflect what emotions arise when trying something new and how that influences performance |

difficulties in learning—resulting in new ways of approaching these situations:

GM1: Getting nervous, that is what very easily shows how “the lizard takes over.” It is important how you see it now in a different way. . . . these moments of freezing and getting stuck, you learn to see them and see how they may appear in so many different ways in different students.

GM2: Really this has awoken me. . . . I was aware of a lot of it before, but now I really started to reflect on how important it is for the teacher to recognize how students freeze, sometimes there are these pits and moments of getting stuck and giving up, like what might lie behind this behavior. . . . much of this was totally new to me and I think this is something every teacher should be aware of. . . . With growth-mindset thinking I have learned how to approach these specific students. Giving up is so common these days.

By contrast, teachers with a fixed mindset failed to report similar changes. However, FM2 as well as all the GM teachers also reported developing *more versatile attributions* (Table 3) for students' learning and behavior: in particular, a sharper focus on the brain as the organ of learning had increased their likeliness of attributing students' successes and failures to the physical prerequisites of learning – for example, eating,

sleeping, and exercising. The malleability beliefs of FM2 seemed to have changed somewhat, and she reported an increased belief in students' ability to learn. The following quote demonstrates her evolving growth mindset and how it aligns with attributing the possibility to learn to suitable strategies:

FM2: This thought about the malleability of the brain, and then to have the idea that each and every one of us is able to advance in our own zone of proximal development. . . . Like more than before I think that everyone can learn if we just find the right strategies and paths for development, and, maybe through recognizing our strengths and the skill levels at the moment, we can advance further. It's like a consolidating idea, everyone is able to grow. Not everyone has the same capacities, and they don't need to have, but we support children's learning on their own levels and in their own states of development.

### Promoting Mastery Orientation

Some aspects of GMP related to the promotion of mastery orientation (e.g., an emphasis on formative assessment) are already deeply integrated into the Finnish mainstream pedagogical thinking and thus provoked little reflection or change among the teachers of this study. Nevertheless, the teachers reported some increase in *encouraging challenge-seeking and providing adequate challenges* (Table 3), which were categorized under this principle since teachers referred

<sup>6</sup>See section “Growth mindset pedagogy” in this article.



to the importance of adequate challenges as a way to maintain the focus on learning rather than on achievement or performance. However, a difference between the teachers that seemingly reflects their different mindsets was that FM2 referred mainly to “clever students” when discussing the importance of challenges, indicating her continuing trait-focus, while the GM teachers also considered challenges important either for all students or particularly for those with difficulties:

FM2: the clever ones did embrace this idea very soon. . . . and were able to reflect on this in the assignments, that we want to improve and we want challenges. . . . I think those students who need challenges, with them this idea of developing oneself stayed.

GM3: I have had this idea already before that I don't have to make things too easy for the special support students, but I can challenge them. . . . But now [with] this growth mindset thinking I have made this clearer for both myself and the students.

This finding aligns with previous results on the tendency of FM teachers to implement process-focused pedagogy for high achievers (as they believe these students have potential that can be cultivated), and GM teachers for low-achievers (because they view these students as underachievers whose potential needs to be unleashed) (Rissanen et al., 2018a; Rissanen et al., 2018b). However, process-focused pedagogy is equally important for all students – also high achievers (Rissanen et al., 2019).

Peer feedback is known to prime and modify mindsets and academic motivation (Zhang et al., 2020), and peer feedback was practiced in the intervention of this study through drama (see **Table 1**). However, only one teacher (GM3) discussed putting greater effort into developing peer relations by *avoiding comparison and emphasizing collaboration* (**Table 3**). This teacher reported improvement in the students' ability to encourage one another:

GM3: So my students have had very lovely moments, like “if you don't know how to do this YET, let me help you.” This is not totally new, but I feel there have been more of these moments this spring, so maybe (GMP has been able) to harness peers to support those who have a low understanding of themselves as learners.

In general, this teacher with the strongest growth mindset also reported the widest application of GMP.

### Persistence

There was a clear and interesting difference between the GM and FM teachers in the way they interpreted and implemented support for persistence. The FM teachers emphasized *persistence through positive messages and encouragement* (**Table 3**). For FM1, the language of positive encouragement for effort and persistence was the one thing that he mentioned as an influence of GMP:

FM1: I think we (he and his class) have absorbed new vocabulary and language and a kind of common language; like we talk about trying and pushing and encouragement and cheering, like hey, when you just keep on making an effort, you will learn.

However, this kind of extensive emphasis on effort, which reflects a lack of effort in analyzing and overcoming individual barriers to learning, was almost completely absent from the GM teachers' reflections. Instead, they discussed developing *persistence through emotion regulation supported by normalization of hardship in learning* (**Table 3**). Moreover, they felt the need to address difficulties in learning more openly and straightforwardly than is typical in positive pedagogy (which had been strongly implemented in their school, and the teachers had recently been educated about it) and reported that GMP had provided them with the necessary tools. According to the GM teachers, it was perhaps more important to recognize and address individual learning barriers before pushing for more effort. In particular, they mentioned paying attention to emotion regulation and verbalizing emotional learning processes for students – as well as for themselves. “The lizard” (see **Table 1**) had been experienced as a particularly useful tool in this:

GM1: One student had difficulties getting any text on paper in one lesson. I, “the great pedagogue,” go and grill this kid to get the work started. As a teacher, I get so irritated when it seems like the student is not even trying. Luckily, I then recognized my own emotional state and start talking to myself – calm the lizard down! Suddenly, I realize that the student's lizard is also active, but that it shows in a different way – he freezes. After realizing this, I understood that I have to help this kid to calm down. I started talking with him calmly, and little by little he relaxed, and could take my advice. . . . Situations such as these have been very difficult for me, too, I have got stuck as well and just started like, we just need to do this, we need to work, like try, try, try.

For GM2, an important part of supporting persistence by normalizing hardship was to increase students' awareness of the prevalence of being in the “learning pit” (see **Table 1**):

GM2: I developed the habit of asking, “how many of you have been in this kind of situation?” Like in arts class when somebody experienced failing, and so many hands were raised. . . . and how it may happen that you start to compare yourself with others, and feel that I am unable. . . . and how to move on from this, so many good ideas for that then came from the students. . . . And the learning pit. . . . I think many of the kids have experiences of being there, and then they recognized that “hey,” that student has also been there and so many others, too. Probably all of us are there sometimes.

Furthermore, using the phrase “not yet” (see **Table 1**) was regarded as a good tool for normalizing the incompleteness of learning processes and the need for perseverance:

GM3: For me, maybe the most significant words that I have continued using are “not yet”, like. . . we didn’t succeed with this yet, but let’s try again next time, that phrase suits me very well.

Researcher: How do students react to that?

GM3: I think these words are quite calming. By using them you want to signal to students not to worry, if we did not know how to do this today, we will continue trying tomorrow. Today, this was difficult; we need more practice. Students react to this really well; I think they feel relieved that the teacher was not angry with me if I did not know how to do this.

Altogether, the GM teachers reported that these practices had led to increased persistence and challenge-seeking among certain students. These students had previously tended to “become stuck” easily and abandon their attempts before even trying, but they had now become more courageous. Moreover, they observed increased calm and a more relaxed orientation among students who were described as having problems with emotion regulation or low self-confidence. According to the teachers, this was attributable to their improved ability to reflect on and regulate their emotional learning processes by normalizing difficulties, which led also to a reduction in competitiveness among students.

### Fostering Students’ Process-Focused Thinking

GM teachers discussed *teaching about the brain and the significance of the “brain exercise” for learning* (**Table 3**) as one GMP practice that had remained with them and through which they attempted to maintain students’ process focus. Furthermore, both they and FM2 reported paying attention to their methods of providing feedback and increasing the focus on *process feedback* (**Table 3**). The GM teachers offered rather deep reflections on verbalizing students’ learning processes in order to strengthen their malleability beliefs and process focus and overcome fixed mindset behavior, as demonstrated by GM3’s description of one student case:

GM3: Particularly when he compares himself to others and considers himself dumb, and even the smallest mistake throws him off, his lizard goes wild. . . in these moments, just last week we had several good moments, when he’s had a very negative first reaction, when we get over that and manage to start working and learning something new, so afterwards verbalizing that to him. But often we do it, like, the student sits at his desk and draws and we adults in the classroom talk when he is there and can hear us, like “it was super great what happened today; like first it was very difficult and he was reluctant but when we persistently worked and tried and tried again, how well things got going, like how could we support this

in the future, too.” Like, without making it too big a deal, making the student aware that he had got over his emotional reaction, and even though he thought at first that he was not going to learn anything, he did learn. This emotional reaction is so strong; we have to deal with that first. So, this student is one of my “I will learn” students, whom I have really designated with an exclamation mark in my mind and with whom I have made the most progress in implementing these things since the intervention.

Furthermore, all teachers except FM1 discussed *helping students to strengthen situational attributions through self-reflection* (**Table 3**) – for instance, by attempting to include moments of reflection on their current state of mind and other current situational factors in their daily practices. The teachers considered these practices successful: students had begun to seek situational instead of trait attributions, which had also led them to develop new ways of overcoming difficulties:

GM2: Just today, one boy told me, when he got a bit frustrated during the exam, that actually, I didn’t sleep that well last night. . . . And another girl, who has diabetes, when she had difficulties, she started to think that her sugar levels might be low. . . the kids have started to process these things themselves. So, they don’t blame themselves so easily for being dumb; they might think that maybe there are also some other. . . some outside factors that may explain why you don’t succeed with a task or you don’t understand. . . . And when we are in the “learning pit”, the kids. . . the students remember that now you can ask for help and maybe someone can help you to go further. These kinds of things, it was interesting to see how they started to apply in practice these things they had learned.

FM2 also reported some changes that were categorized under this GMP principle – such as returning to the idea of the learning pit and the steps for climbing out of it to encourage students’ reflection on their learning processes:

FM2: Well, we have now discussed also in other lessons that could this be about the learning pit now and in what phase we are now and how to cope. Sometimes. . . and using these slogans, like “not yet” . . . But I don’t know if it’s us or the students who have brought up these things.

However, her inability to provide detailed examples from particular situations or student cases in a similar manner to the GM teachers indicated a more superficial change.

### Evaluations of GMP: Summary

Clear differences were found in the way the teachers perceived GMP and its impact on their own professional development. FM1 reported the least changes on a personal level and had not noticed any visible changes in his students either. He saw GMP as an

“easy concept” and considered encouraging student effort as the core of GMP. Emphasis on effort without ensuring individualized support can be regarded as a reflection of a “false growth mindset” (Dweck & Yeager, 2019), and the one-dimensional practices of FM1 could be referred to as implementation of “false GMP.” The reactions of his students to GMP had been “cynical” and reluctant. FM2 regarded the ideas of GMP as novel and inspiring; however, she also found them confusing and difficult at times. In comparison to the GM teachers, she relied on a formulaic implementation of GMP and reflected less on implementing its principles creatively and situationally.

The GM teachers were able to develop further the GMP ideas taught to them in the training sessions. They all produced deep reflections on ways to use GMP to support students’ emotion regulation. Moreover, they voiced their enthusiasm for GMP and emphasized the difference between it and other pedagogical trends. For instance, while they were familiar with positive pedagogy and saw value in its principles, they regarded GMP’s ideas of the normalization of hardship in learning as unique and useful. Notably, GMP offered them tools for working particularly with students whom they had learned to identify as suffering from motivational and emotional problems related to a fixed mindset. Departing from false GMP practices, a key idea for them was to deal with emotional barriers to learning through GMP practices before pushing for more effort.

## DISCUSSION

### Limitations and Validity of the Study

There are limits to the conclusions that can be drawn from the self-reported case data of this study. Our findings should be regarded as preliminary evidence that can hopefully spur more research in different contexts and with approaches that allow larger samples. Making inferences about individual teachers’ mindsets based on their survey responses is seldom, in itself, a reliable approach; however, our collaboration and interviews with the teachers allowed us also to evaluate their mindsets qualitatively, with the resulting conclusion that their answers to the mindset scales reflected their real-life mindsets rather well. By studying a group of highly educated and experienced teachers, it was possible to draw inferences about the impact of the teachers’ mindsets on their adoption of GMP; however, the specific nature of this group limits the possibilities of generalizing the results to other kinds of teacher groups.

The validity of design-based research is based on the ability of researchers to walk the narrow line between committed enthusiasm and detached objectivity (Anderson and Shattuck, 2012). In this study, we unreservedly fostered enthusiasm and trusted that such enthusiasm would motivate the teachers for only a certain period of time, after which we would be able to identify differences between them. We have included many examples from the data to help the reader evaluate the validity of our interpretations. A critical evaluation of GMP from the experienced teachers in our study would have been valuable. However, possibly due to group dynamics in the highly enthusiastic group dominated by GM teachers, we were unable

to provoke much critical reflection. Nevertheless, we would like to emphasize that the evaluation of GMP requires different perspectives, methodological approaches, and datasets, of which the analysis of teachers’ self-reported experience reported here is only one. In the CoPErNicus project, we additionally investigate the effects of the growth mindset intervention on elementary school students by using data from surveys, learning diaries, and psychophysiological recordings in order to achieve a multifaceted and all-round understanding of the potential impact of growth mindset pedagogy.

### Discussion of the Key Results and Their Implications

Our study aimed to explore the varieties and nuances of teachers’ understanding and implementation of GMP in the real-life setting of the Finnish basic-education classroom and to analyze how teachers’ mindsets may influence their adoption and implementation of GMP. Our findings contribute to deconstructing the idea of growth mindset as a “simple concept” and provide more evidence of the significance of teachers’ mindsets. We found significant differences between fixed mindset and growth mindset teachers in the ways they internalized and applied key principles of GMP. Our previous studies have identified some tendencies similar to those observed in the present study, such as the propensity of GM teachers to practice GMP mostly for low achievers and the inclination of FM teachers to practice GMP for high achievers (Rissanen et al., 2018a; Rissanen et al., 2018b; Author et al., 2019), thus indicating the need to teach GMP for both FM and GM teachers.

These mindset-related differences can be regarded as rather logical. People are motivated to defend their implicit meaning systems, seeking evidence that supports them (e.g., FM teachers attributing the failure of high achievers to process factors but viewing the failure of low-achievers a result of innate traits) so as to preserve their sense of causal certainty. A violated implicit theory engenders anxiety, and thus it is natural to turn away from things that are likely to violate one’s core beliefs, even though they might have many positive implications (Plaks et al., 2005; Plaks et al., 2009). In our data, “turning away” aptly describes the response of FM1 to GMP. By contrast, the GM teachers’ core beliefs were not challenged; moreover, GMP influences which promoted the development of the teachers’ meaning systems into even more coherent and logical entities were welcomed with ease and enthusiasm.

In turn, the efforts of FM1 (and to some extent FM2) to adopt GMP seemed to result mainly in pedagogical practices that induced “false growth mindsets” (Dweck and Yeager, 2019; Zhang et al., 2020), for instance, praising and encouraging effort without ensuring individualized support, whereas colleagues with a growth mindset emphasized the analysis of individual (often emotional) barriers to learning. These observations have implications for teacher education: influencing teachers’ malleability beliefs (i.e., mindsets) is a prerequisite for teaching about GMP if the unwanted result of a more superficial understanding of mindsets – practices of “false growth mindset pedagogy” – is to be avoided. Training teachers to implement GMP was part of the design of this study, but the training

was not focused on changing teachers' mindsets. The results indicate, that if teachers' professional development towards GMP is to be supported, inducing self-reflective processes around their own mindset meaning systems is necessary.

People with a fixed mindset are more likely to consider less-than-perfect goal achievement an indicator of their lack of ability, which easily leads to negative emotions and a helpless response in the learning process (Burnette et al., 2013). This implies that normalizing difficulties and setbacks in learning could help promote process-focused thinking; according to the teachers in this study, this was an aspect of GMP that really made a difference for their students. These findings indicate that there is common ground between GMP and research on social emotional learning (e.g., Osher et al., 2016), which should be further explored. GMP could contribute to this field by further enhancing understanding of the relationship between students' implicit meaning systems and their emotional reactions. Furthermore, the insights of these teachers could be read as indicators of where they think the most significant learning barriers lie in their particular educational context: not in insufficient learning strategies, but in students' emotional states. In general, contextualization is a prerequisite for applying mindset theory and GMP in practice and for developing effective interventions.

We hope this study will maintain and provoke further discussion on possible misunderstandings of growth mindset theory and pedagogy. Our teachers saw the value of GMP in supporting students' well-being more broadly in life (see also King, 2012). Cultivating growth mindsets means cultivating teachers' belief in the ability of their (individual) students to learn, as well as limiting their tendency to judge and stereotype. Thus, we see the cultivation of GMP as the cultivation of teachers' ethical professionalism and their ability to promote active change in the educational system. Consequently, we reject comparisons between GMP and neo-liberal ideals emphasizing the efficiency and accountability of education (see e.g., Adams et al., 2019; Chan et al., 2020); on the contrary, we wish to develop discussion on growth mindsets and GMP that diverges from ideas of self-maximization. Critics are right to highlight the misuse of growth mindset theory in education. However, rather than rejecting the theory, it would be preferable to tackle this problem by increasing the input of researchers in the fields of teaching and teacher education in terms of exploring, developing, and critically analyzing "growth mindset teaching" and its implications. A possible future direction could be to build bridges between mindset theory and critical theories of education by widening the discussion on malleability beliefs

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from psychological constructs to the culturally and communally formed constituents of ideas of being human that shape educational values and systems and have implications for the development of educational equity.

## DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the subjects of research have consented only for the researchers of this study to see the data. Requests to access the datasets should be directed to [inkeririssanen@tuni.fi](mailto:inkeririssanen@tuni.fi).

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

All authors contributed to conception and design of the study. IR conducted teacher intervention and qualitative data gathering. IR and EK performed qualitative data analysis. IP performed quantitative data analysis. SL and IP had main responsibility of the student intervention development. IR wrote the first manuscript draft, all authors contributed to writing sections to manuscript, revised, read and approved the submitted version. KT was responsible of the holistic design of the Copernicus project this study is part of.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2021.753698/full#supplementary-material>

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