False, Limited, and Authentic Growth Mindsets in Learning: Preliminary Findings from Fourth-Grade Students in Estonia and Finland

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Abstract

This study examines whether beliefs about the malleability of intelligence manifest in growth mindset behaviour and improved math achievement among Finnish and Estonian 4th graders. The sample consists of 368 students, 184 from both countries. Results show that the two mindset-instruments being compared—one capturing the generalised implicit beliefs about the malleability of intelligence and the other, more specific mindset-related behaviours—do not assess the same latent phenomenon. In both countries, the general idea of malleability of intelligence seems to have spread among the students. However, mindset profiles show that most students in both countries demonstrate a *mixed mindset* in their behavioural preferences, indicating that widespread notions about the malleability of intelligence do not necessarily manifest in growth mindset behaviour, therefore limiting realisation of students' true potential. In line with theory, students reporting an *authentic growth mindset*, manifesting both in their words as well as behavioural preferences, demonstrated better academic achievement in math. The differences are discussed in the context of growth mindset pedagogy.

Keywords: Implicit beliefs; assessing mindsets; false growth mindset; authentic growth mindset; Finland; Estonia.

Mindsets refer to implicit beliefs that one holds about basic human qualities, such as intelligence. Dweck and Leggett (1988) have identified two meaning-making systems (or *mindsets*) that influence learning processes and motivation. *Fixed mindset* (or an entity view of intelligence) refers to implicit beliefs where intelligence is seen as stable and *growth mindset* (or an incremental view of intelligence) refers to beliefs where intelligence is regarded as malleable and changeable (Dweck, 2000). Studies show that the former leads to avoiding challenging learning opportunities, whereas the latter motivates students to enjoy difficult tasks and rebound from mistakes, helping students realise their full potential and build talent.

The present study was conducted in Finland and Estonia, two countries that demonstrate high academic achievement in the Programme for International Student Assessment (PISA) tests (Gurria, 2016; Schleicher, 2019). The aim was to examine the phenomenon of mindsets about intelligence among Finnish and Estonian 4th graders as this is the age that has been argued to witness an important shift in how internally consistent and reasonably related to other achievement-related cognitions and behaviours students' beliefs have become (Kinlaw & Kurtz-Costes, 2007).

There is a body of evidence showing that mindsets have a role to play in students' academic achievement, math achievement included (Blackwell, et al., 2007; Burnette, et al., 2013; Good, et al., 2003; Paunesku, et al., 2015). Yet, as is evident from studies with parents and teachers (Moorman & Pomerantz, 2010; Park, et al., 2016), mindsets do not always translate into achievement results directly, but rather via mediating factors such as students' academic self-efficacy, achievement goals, effort beliefs, resilience, and reactions to setbacks (e.g., Blackwell et al., 2007; Zeng, et al., 2016). Successful mindset interventions (Aronson, et al., 2002; Blackwell et al., 2007; Good, et al., 2003; Paunesku et al., 2015; Yeager, et al., 2016) as compared to those not so successful (Burnette, et al., 2018) have hence been sure to back growth mindset messages with practical knowledge about how to stretch one's abilities via effort and effective learning strategies and about putting mindset messages into practice in everyday schoolwork (Sun, 2015; 2018).

Mindset researchers have most often addressed and surveyed students at times of difficult academic transitions in middle school (Blackwell et al., 2007; Good et al., 2003), high school (Yeager, et al., 2016) or college (Aronson et al., 2002), as these transitions are universally characterised by significant drops in student motivation and subsequently also retention. Yet, mindset-milestones affecting students' learning are already evident in lower grades (Zeng, et al., 2016). Math programs are known to become increasingly abstract and therefore cognitively more demanding already during the 4th grade (Tsang, et al., 2015). As children's thinking at that age has been argued to go through an important shift in gaining consistency in achievement-related cognitions and behaviours (Kinlaw & Kurtz-Costes, 2007), associations formed at that time could leave children vulnerable to fixed mindset messages during difficult transitions in the higher grades. This might be especially true in math, the subject area claimed to communicate the strongest fixed ability messages and thinking (Boaler, 2010; Jonsson, et al., 2012). With that in mind the current study focuses on 4th grade students' mindsets, mindset-related behavioural task preferences and math performance.

Assessing the mindsetThis study sheds light on the assessment of the mindset phenomenon among young students. Several instruments have been developed to assess mindsets but the task has been challenging as mindsets represent implicit and dynamic meaning making systems. Although people tend to have a dominant mindset, studies have found domain-specificity (Kuusisto, et al., 2017b) and situational variation in the actualization of the mindsets (Rissanen, et al., 2018).

Assessing mindsets with the traditional instrument by Dweck (2000) has been shown to be relevant for predicting academic performance (Blackwell, et al., 2007; Claro, et al., 2016; see also Zhang, et al., 2017c). Still, more nuanced instruments have been found useful to estimate the associations between mindset and actual behaviour (Aus, et al., 2017a; Haimovitz & Dweck, 2016). Aus, et al. (2017a) showed that better discriminant and predictive power was achieved when teachers were asked not only about their beliefs about the malleability of intelligence but also their views on whether students need to be academically gifted and possess an inborn set of characteristics to be successful in school (Leroy, et al., 2007). Also, Haimovitz and Dweck (2016) conclude that whereas adults' self-reported mindsets are linked to their parenting or teaching practices, the mindsets of parents and educators measured with Dweck's instruments *per se* do not predict the mindsets of their children or students (e.g., Good & Dweck, 2012; Haimovitz & Dweck, 2016; Moorman & Pomerantz, 2010; Park, et al., 2016; Rattan, et al., 2012). Instead, it has become evident that mindsets reported as such may not be activated in day-to-day situations, where perhaps more automatic behavioural reactions become dominant. For example, one might know and believe that intelligence is malleable but in challenging situations fixed mindset behaviour might take over (Haimovitz & Dweck, 2016; 2017). It may be especially true for individuals holding a mixed mindset, characterised by uncertainty and endorsing neither fixed nor growth mindset statements to their fullest (Claro, et al., 2016; DeLuca, et al., 2019). It is also possible that for children and students their vague ideas about the malleability of intelligence might not necessarily manifest in growth mindset choices in their everyday study behaviour.

Previous intervention studies have shown that when children's mindsets are primed it affects their behavioural preferences, e.g., process feedback has resulted in children choosing difficult tasks over easier ones and person feedback has been shown to lead to opposite behaviour (Mueller & Dweck, 1998). However, it should be noted that these studies have utilized task-specific priming of the mindsets in artificial contexts, regardless of the dominant mindset of the students.

Items of the Dweck's (2000) original instrument were designed to study mindsets of ten-year-olds and older. However, since mindsets develop in early childhood, Gunderson et al. (2013) created a scale that small children of seven and eight years can answer. It was aimed to measure beliefs about the stability of intelligence, academic abilities, and preference for difficult and easy tasks. Park et al. (2016) refined the instrument further and utilized a six-item version of it. These studies indicate that Gunderson et al.'s (2013) scale is a valid tool to measure mindsets. Still, it seems that there is a need to develop the instrument further to improve reliability of the scale. In previous studies Dweck's (2000) and Gunderson et al.'s (2013) instruments have not been paralleled and it has not been investigated whether they truly assess the same phenomenon with the first being more abstract and the latter more behaviourally specific in nature. Therefore, combining the two measures would provide useful for tackling the more abstract as well as the concrete and behaviourally specific attributes of mindsets in students.

Finnish and Estonian educational systems as the context of the study

The present study was conducted in two countries, Finland and Estonia. Whereas Finland has enjoyed a long history of being regarded as one of the top-performing countries in education, Estonia has begun showing comparable results in the recent decade. According to the most recent PISA results in reading, mathematics and science both Finland and Estonia are considered to be leading countries in education (Gurria, 2016; Schleicher, 2019). The educational system in the two countries is quite similar; compulsory formal education consists of nine years of comprehensive school and children start school from the age of seven. In both countries primary education begins with a class-teacher system, which means that children most often study the main subjects with the same teacher during the first three to four school years. Master-level education is expected of teachers in both countries; studies in educational science cover about half of the whole teacher training study program—demonstrating more consistent structure in Finnish than in Estonian programs though—and the concept of research-based pedagogical thinking is a priority in both countries (Jakku-Sihvonen, et al., 2012). It is relevant to note that the consistency and sustainability of the quality of teacher education programs in Estonia has gone through some noteworthy interruptions due to changes in the political arena and a recognizable number of teachers in Estonia have received their education under the Soviet regime (Jakku-Sihvonen et al., 2012; Ruus & Timoštšuk, 2014). However, current teacher training curricula in Finland and in Estonia emphasize constructivist learning theories, child-centred teaching methods and individualisation of instruction.

The national basic school core curricula are also rather similar in the two countries, both in academic demands as well as in stating the importance of supporting general or transversal competencies of students (Estonian Government, 2011/2014; Finnish National Agency for Education, 2014). Both Estonian and Finnish educational policies similarly emphasize the importance of school curriculum development, which means that although both countries have specified their national core curricula, the schools are expected to adapt the curricula to the needs and possibilities of specific school contexts and to draft more individualized curricula in the framework of the national core curriculum.

Curricula in Finland and Estonia do not mention Dweck's growth mindset theory *per se* but nevertheless, both highlight a process-focused approach to learning. Recent PISA results reveal that Estonia has the highest percentage of students who reportedly believe that intelligence is malleable (Schleicher, 2019). At the same time, it seems that the Finnish *National Core Curriculum for Basic Education* is built more explicitly on the core elements of the growth mindset pedagogy than the Estonian *National Curriculum for Basic Schools* (Rissanen, et al., 2019; Estonian Government, 2011/2014; Finnish National Agency for Education, 2014). For example, teachers are expected to give process-focused feedback, to emphasize the positive role of mistakes in learning, to foster mastery orientation by comparing students' achievement with their own previous achievements not with other students' success, and to consider students' individual development (Finnish National Agency for Education 2014, pp. 47–48). At the same time, Dweck (2015, 2016) in her public statements has cautioned against a *false growth mindset* that refers to oversimplified interpretation and application of the growth mindset theory in schools indicating that both teachers and students should not only use growth mindset rhetoric but also recognise the behaviours and strategies that truly support growth and development.

In this study we investigate the mindsets and math achievement of students from Finland and Estonia – two similar, yet different countries. The present study focuses on examining 4^{th} grade students' mindsets about intelligence with Dweck's (2000) and Gunderson et al.'s (2013) scales by answering the following research questions:

1. To what extent do the two different mindset-instruments measure the same phenomenon?
2. How do Finnish and Estonian students' mindsets and behavioural preferences related to difficult and easy tasks differ?
3. How do different mindset profiles manifest in math achievement?

Data and methods

Participants

The sample consisted of 368 fourth grade students; 184 from Finland (n_{girls}= 87) and 184 from Estonia (n_{girls}= 97). Both sets of data were collected as part of other ongoing studies. School leaders and individual class-teachers in both countries were asked beforehand for their consent to participate. Also, parents of the students were asked for their written consent and the children were informed that their participation was voluntary. In both countries the students filled out electronic questionnaires during their regular school-hours. The testing was supervised by the class teachers in Finland and by researchers in Estonia.

The sample in Finland was gathered from two schools, one located in a medium socioeconomic status area and one in a low one in Helsinki (Vilkama, et al., 2014), the capital of Finland. In the seven parallel classes the average class size was 20 (min. 17, max 22). The sample in Estonia was gathered form three schools. Two of the schools were located in Tallinn, the capital city, and the third school in the outskirts of Tallinn. One of these Estonian schools has classes for which students apply and the most talented are chosen. In all eight parallel classes, the average class size was 23 (min 18, max 28).

Measures

The measures for students' mindsets and mindset-related learning behaviours were based on two instruments; Dweck's (2000) traditional 4-item measure of the fixed view of intelligence (e.g. Zhang, et al., 2017c; 4 items, α = .80) and the mindset instrument used by Gunderson et al. (2013; 18 items, α = .61) as well as Park et al. (2016; 6 items, Omega = .70).

Mindset about Intelligence

Mindset about intelligence was assessed using the traditional instrument by Dweck (2000). As data were collected as part of other ongoing studies, Dweck's items in Finland were evaluated on a scale from 1 to 6 (1= totally agree, 6= totally disagree) and in Estonia from 1 to 5 (1= totally agree, 5= totally disagree). Examples of Dweck's items: "You have a certain amount of intelligence, and you really cannot do much to change it" and "You can learn new things, but you cannot really change your basic intelligence". The higher the score, the more the student endorsed the idea of intelligence being malleable.

Disliking Easy Tasks

Disliking easy tasks was evaluated with a single item "How much would you like to solve tasks that are very easy so you can get a lot right?" from Gunderson et al.'s (2013; Park et al., 2016) instrument on a scale from 1 to 5 (1 = totally disagree, 5 = totally agree). The answers were reverse-coded so that a higher score reflected preferences theoretically linked to a growth mindset.

Liking Difficult Tasks

Liking difficult tasks was evaluated with a single item "How much would you like to solve tasks that are very hard so you can learn more?" from Gunderson et al.'s (2013; Park et al., 2016) instrument on a scale from 1 to 5 (1 = totally disagree, 5 = totally agree).

In translations, both into Finnish and Estonian, the Gunderson et al.'s word "maze" was replaced with "task" to better fit the everyday school context. Higher scores reflected preferences theoretically linked to a growth mindset.

Students' Math Achievement

Students' math achievement was examined with marks of mathematics that were obtained from students' report cards in Spring preceding the data collection in Autumn. The marks were based on teachers' evaluations of examinations and classroom activities. In Finland, fourth graders were assessed in the first school using a scale from 4 to 10 (4 fail, 5 lowest passing mark, 10 highest mark) and in the second school a 5-level scale was utilized (lowest evaluation "You have not achieved your goals yet"; highest evaluation "You have achieved your goals excellently"). The evaluation covered three different areas of mathematical skills, thus, the marks in the second school were based on the mean scores of the three verbal evaluations. In Estonia, the grading system scaled from 2 (*weak*) to 5 (*excellent*).

Analysis strategy

Statistical packages IBM SPSS Statistics 24 and Mplus version 7 were utilized.

Confirmatory factor analysis for determining the factor structure of the mindset items was conducted with Mplus 7.0 (Muthén & Muthén, 1998–2015) using a full information maximum likelihood (FIML) method as there were a small number of missing values on some of the item-level variables. The unstandardized loading for the first indicator on each factor was set to 1.0 to establish the metric of the latent variable. Based on the recommendations from Brown (2006, pp. 103–149), the factor models were checked for model fit indices as well as the interpretability, size, and statistical significance of different parameter estimates (factor loadings and factor variance estimates).

The model fit was evaluated using the χ^2 test statistic, root mean square error of approximation (RMSEA), and comparative fit index (CFI). Models are generally deemed acceptable when the χ^2 value is non-significant ($p > .05$), RMSEA has a value of .05 or less (Browne & Cudeck 1993, pp. 136–162) and CFI is .95 or above (Hu & Bentler 1999).

Latent profiles analyses (LPA) was also conducted with MPlus 7.0. Profiles were based on students' reported mindsets and their preferences for easy or difficult tasks. LPA results were evaluated by fit indicators and theoretical background. Minimum values of Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-size adjusted BIC (aBIC) were considered, along with entropy and Vuong-Lo-Mendell-Rubin Likelihood Ratio test (VLMR) values (Dziak, et al., 2019). When comparing pairs of models, a model with a smaller value of AIC, BIC and aBIC is considered better (Dziak, et al., 2019) and entropy with values approaching 1 indicate clear delineation of classes (Celeux & Soromenho 1996).

The analyses were carried out separately for the Finnish and Estonian samples as the response scale for Dweck's items differed in the two countries and the grading systems do not allow for combining the data. Scores standardized on the country level were used in all analyses.

Results

Confirmatory factor analysis on dweck's and gunderson et al.'s mindset instruments

We first tested whether the two mindset instruments can be regarded as measures of the same general phenomenon of implicit beliefs about intelligence. We used the four fixed mindset items traditionally used from Dweck's instrument. For the scale from Gunderson et al., researchers have previously found that the instrument shows better internal consistency when shortened to a 6-item format that covers two aspects: preference for easy/difficult tasks in mazes, math problems, and spelling as well as fixed ability beliefs (Park et al. 2016). We transformed the responses on each item into a standardized z-score (M = 0, SD = 1) separately for two samples and used the standardized scores to evaluate the structure of the two mind-set instruments via confirmatory factor analysis.

While testing the possible fit of a model with all 10 items (4 Dweck items and 6 Gunderson et al. items) belonging to the same latent factor, we found that the overall model fit for a 1-factor solution for the Finnish sample was poor ($\chi^2(35) = 61.44$, $p = 0.004$, RMSEA = 0.06, CFI = 0.866). All the items belonging to the Dweck scale showed standardized factor loadings that were statistically significant and higher than the suggested limit of .30 (ranging from .62 to .79), but factor loadings for the items from the Gunderson et al. scale fell under the acceptable limit of .30 (Brown, 2006) and also failed to reach statistical significance for half of the items. Model fit for a 1-factor solution for the Estonian sample was poor to acceptable ($\chi^2(35) = 48.52$, *ns*, RMSEA = 0.05, CFI = 0.927). Again, all the standardized factor loadings were statistically significant and ranging from .50 to .94 for the Dweck items but fell under the acceptable limit of .30 for all the Gunderson et al. scale items and none of the factor loadings in Gunderson et al. scale reached statistical significance.

As evident from previous analysis, the two scales could not be regarded as measuring the same latent phenomenon. Hence, we tested the possible factor structure with the two original scales forming two separate latent factors. The overall model fit for a 2-factor solution for the Finnish sample was again poor ($\chi^2(34) = 62.85$, $p = 0.002$, RMSEA = 0.07, CFI = 0.854). The latent factor comprising four items of the Dweck scale showed statistically significant variance and the standardized factor loadings of the items were statistically significant and ranged from .62 to .79. For the Gunderson et al. scale, only two factor loadings were higher than .30 (.40 and .63), but neither reached statistical significance. Model fit for a 2-factor solution for the Estonian sample was overall acceptable ($\chi^2(34) = 41.849$, *ns*, RMSEA = 0.04, CFI = 0.958). As was the case in the Finnish sample, all the standardized factor loadings for the Dweck items were statistically significant and ranged from .49 to .85. The variance of the latent factor was also statistically significant. For the Gunderson et al. scale, only two of the six factor loadings reached statistical significance and were higher than .30 (.38 and .56 for items tapping disliking easy tasks and liking difficult tasks, respectively).

As such the final model tested for both samples included 4 Dweck and 2 Gunderson et al. items forming two separate latent factors. The overall model fit for the 2-factor solution for the Finnish sample was acceptable ($\chi^2(8) = 13.95$, *ns*, RMSEA = 0.06, CFI = 0.963). The latent factor comprising four items of the Dweck scale showed statistically significant variance and the standardized factor loadings ranging from .63 to .79 were statistically significant. For the Gunderson et al. items, both factor loadings reached statistical significance at .31 and .64. Model fit for a 2-factor solution for the Estonian sample was good ($\chi^2(8) = 3.391$, *ns*, RMSEA = 0.00, CFI = 1.000). All the standardized factor loadings for the Dweck items were statistically significant and ranged from .43 to .85. The variance of the latent factor was also statistically significant. For the Gunderson et al. items, both the factor loadings reached statistical significance ($p < .05$) and were higher than .30 (.36 and .64 for disliking easy tasks and liking difficult tasks, respectively). The variance of the latent factor was not statistically significant though ($p = .32$).

All in all, confirmatory factor analysis showed that Dweck's and Gunderson et al.'s instruments do not measure the same phenomenon and Gunderson et al.'s items show strong multidimensionality. Based on preliminary results we averaged the standardized scores of the four items from the Dweck scale

(2000) to form a composite measure of a growth mindset for the Finnish (M = 0.0, SD = 0.78, range = −1.83 to 1.44; Cronbach α = .78) as well as the Estonian sample (M = 0.0, SD = 0.78, range = −2.77 to 1.52; Cronbach α = .77). Gunderson et al. scale items' statistical estimates were not acceptable though and could not be regarded as a single coherent phenomenon. The two items concerning disliking easy and liking difficult tasks showed acceptable factor loadings, but the internal reliability of the scale was too weak (Cronbach α = .33 for the Finnish and α = .39 for the Estonian sample).

As it has been argued that for some concrete constructs that are very narrowly (e.g., behaviourally) defined, single-item measures show predictive validity comparable to that of multiple-item measures (Bergkvist, 2015; Loo, 2002), we decided to use preference for easy or difficult items from the Gunderson et al.'s scale as two separate items in further analyses. The decision is theoretically backed by Mueller and Dweck's (1998) seminal findings indicating that mindsets manifest in behavioural preferences for either avoiding or approaching challenges. Finnish students reported higher levels of disliking easy tasks than Estonian students, $t(346) = 7.75$, $p < .001$, $d = 0.83$ and also liking difficult tasks, $t(345) = 3.12$, $p < .01$, $d = 0.34$.

Hence, in further analyses we will concentrate on three indices of the mindset phenomenon: mindset about intelligence (a sum score of the four items from Dweck (2000)), student's preference for easy tasks (a single item from Gunderson et al., 2013, hereafter *disliking easy tasks* since the scale was reversed for interpretational purposes), and student's preference for difficult tasks (a single item from Gunderson et al. (2013), hereafter *liking difficult tasks*).

Table 1: Descriptive statistics and bivariate correlations.

	Finnish sample ***M (SD)*** ***n* = 184**	**Estonian sample** ***M (SD)*** ***n* = 184**	1.	2.	3.	4.
1. Mindset about intelligence Dweck (2000)	3.25 (.96) (scale 1 – 6) α = .78	3.59 (.73) (scale 1 – 5) α = .77	–	.09	.13	.21**
2. Disliking easy tasks Gunderson (2013)	3.10 (1.16) [a] (scale 1 – 5)	2.19 (1.05) [a] (scale 1 – 5)	.22***	–	.24**	.17*
3. Liking difficult tasks Gunderson (2013)	3.50 (1.04) [b] (scale 1 – 5)	3.14 (1.14) [b] (scale 1 – 5)	.09	.19**	–	.25**
4. Math achievement	8.41 (1.25) (scale 5 – 10)	4.22 (.69) (scale 2 – 5)	.23***	.12	.24***	–

Notes: $p^* < .05$, $p^{**} < .01$, $p^{***} = .001$, two-tailed; correlation coefficients for the Finnish sample below the diagonaal; means that share superscripts [a] differ at $p < .001$ and superscripts [b] at $p < .01$.

Associations of Finnish and Estonian students' mindsets and task preferences with math achievement

Math achievement showed statistically significant correlations with reported mindset and liking difficult tasks for both Finnish and Estonian students, and marginally significant associations with disliking easy tasks only for the Estonian students (see Table 1). Mindset and liking difficult tasks remained significant predictors of math achievement also in multivariate regression models for both samples. The three predictors together explained ten percent of variance in math achievement in both countries (see Table 2), meaning that the same proportion of differences in math achievement in both countries can be attributed to mindset and mindset-related behaviours.

Table 2: Predictors of math achievement – multiple regression results.

	B	*SE B*	β	*t*	*p*	VIF
Finnish sample						
Mindset about intelligence	.25	.10	.20	2.53	.01	1.07
Disliking easy tasks	.02	.08	.02	.31	.76	1.09
Liking difficult tasks	.21	.08	.21	2.78	.01	1.05
Estonian sample						
Mindset about intelligence	.22	.09	.17	2.34	.02	1.02
Disliking easy tasks	.11	.08	.11	1.40	.17	1.07
Liking difficult tasks	.20	.08	.20	2.62	.01	1.08

Notes: $R^2 = 0.10$, $F(3, 166) = 5.33$, $p = .001$ (Finland); $R^2 = 0.10$, $F(3, 172) = 6.41$, $p < .001$ (Estonia)

Profiles based on students' reported mindsets and disliking easy or liking difficult tasks

In order to tap deeper into the mindset-related phenomena of individual children, a person-centred approach in the form of latent profile analysis (LPA) was utilised. Mindset profiles were created using standardised scores of the three mindset variables (see Table 1). Children with missing data on one or more variables were deleted, leaving the sample with 172 Finnish and 176 Estonian students. As children were nested within classes, LPA analyses were performed as mixture missing complex models where cluster was the students' class ID.

A latent profile model with four profiles for both samples was deemed best relying upon different statistical indicators (see Table 3). For the Finnish sample, the minimum BIC value supported the model with four profiles. However, the AIC and aBIC values did not stop decreasing. For deciding upon the best fitting model, other indices of classification quality were also inspected. Average latent class probabilities and classification probabilities for most likely latent class membership as well as entropy values supported the model with four profiles. For the Estonian sample, all indicators supported the best fit to data for the four-profile model (see Table 3).

Table 3: Fit Indicators of Latent Profile Models.

Country	No of profiles	AIC	BIC	aBIC	Entropy
Finland (*n* = 172)	2 (80,92)	1364.235	1395.710	1364.045	.652
	3 (47,89,36)	1359.435	1403.500	1359.169	.774
	4 (50,23,66,33)	**1219.958**	**1276.613**	**1219.616**	**.995**
	5 (23,50,66,16,17)	**1216.556**	**1285.801**	**1216.139**	**.962**
	6 (37,23,50,17,29,16)	1218.815	1300.650	1218.321	.875
Estonia (*n* = 176)	2 (110,66)	1392.427	1424.132	1392.464	.805
	3 (51,110,15)	1389.199	1433.586	1389.251	.812
	4 (45,53,57,21)	**1076.816**	**1133.885**	**1076.883**	**1.000**
	5 (53,55,45,2,21)	1077.378	1147.129	1077.460	.986

Notes: The numbers in brackets represent the number of individuals in each profile. AIC = Akaike information criterion; BIC = Bayesian information criterion; aBIC = sample-size-adjusted BIC.

Based on the means of the three variables and previous research on mixed mindsets (Claro, et al., 2016; DeLuca, et al., 2019; Dweck, 2015) the four profiles were named as: *false growth mindset*, *limited growth mindset 1*, *limited growth mindset 2*, and *authentic growth mindset*. Figures 1 and 2 illustrate the similarities and differences of the standardised means of the latent profiles for the Finnish and the Estonian students respectively. To examine how latent profiles in different countries differed in children's general mindset about intelligence, disliking easy tasks, and liking difficult tasks, we conducted separate one-way analysis of variance (ANOVAs).

In the Finnish sample the profiles did not differ in children's mindset about intelligence $F(3, 168) = 0.97$, *ns*, but the results indicated significant differences for disliking easy tasks, $F(3, 168) = 2.77$, $p < .05$, $\eta_p^2 = 0.05$, and liking difficult tasks, $F(3, 167) = 2033.43$, $p < .001$, $\eta_p^2 = 0.97$. Liking difficult tasks compared to liking easy tasks showed considerably stronger discriminating power between profiles in Finnish students. In the Estonian sample the profiles did not differ in children's mindset about intelligence $F(3, 172) = 0.42$, *ns*, but the results indicated significant differences for disliking easy tasks, $F(3, 172) = 5968.43$, $p < .001$, $\eta_p^2 = 0.99$ and liking difficult tasks, $F(3, 172) = 3.82$, $p < .05$, $\eta_p^2 = 0.06$. In the Estonian sample disliking easy tasks discriminated best between profiles. Results from post hoc analyses are specified in Table 4.

Table 4: Descriptive statistics of the four mindset profiles in Finnish students (z-scores).

	False growth mindset *M(SD)*	**Limited growth mindset 1** *M(SD)*	**Limited growth mindset 2** *M(SD)*	**Authentic growth mindset** *M(SD)*	***F* value**
Finland					
Number of students	23 (13.5%)	66 (38.1%)	50 (29.2%)	33 (19.3%)	
Mindset about intelligence	.02(.69)	.00(.75)	–.01(.81)	.25(.79)	*ns*
Disliking easy tasks	–.31(1.04)	–.16(.99)^{c}	.26(.80)^{c}	.15(1.18)	2.77*
Liking difficult tasks	–1.74(.45)^{a}	–.49(.00)^{a}	.48(.00)^{a}	1.44(.00)^{a}	2033.43**
Math achievement	–.42(.99)^{b}	–.19(.94)^{c}	.13(.92)	.35(1.08)^{bc}	3.811*
Estonia					
Number of students	57 (32.4%)	53 (30.1%)	45 (25.6%)	21 (11.9%)	
Mindset about intelligence	–.07(.87)	.01(.67)	.06(.83)	.12(.65)	*ns*
Disliking easy tasks	–1.13(0)^{a}	–.17(.00)^{a}	.78(.00)^{a}	1.84(.29)^{a}	5968.43**
Liking difficult tasks	–.17(1.06)^{d}	–.14(.85)^{b}	.12(.94)	.60(1.08)^{bd}	3,821*
Math achievement	–.21(.95)	.13(.99)	.11(.98)	.33(.96)	*ns*

Notes: * $p < .05$ ** $p < .001$. Means in the same row that share superscripts ^{a} differ at $p < .001$, superscripts ^{bd} at $p < .05$, and superscripts ^{c} at $p < .06$ in post hoc comparisons. Games-Howell was used when variances were not equal; in other cases, Tukey's method was used.

Profiles indicate that students generally reported having a growth mindset, i.e., believing that intelligence is malleable. However, only 19.3% of Finnish and 11.9% of Estonian students demonstrated the so-called *authentic growth mindset,* reporting behavioural preferences most in line with Dweck's theory. Students in the group that was named the *false growth mindset* (13.5% of Finnish and 32.4% of Estonian students) reported average levels of general malleability beliefs, yet this belief was not apparent in their behavioural preferences. The two profiles between the opposite ones showed average levels of aspects representing both the fixed and growth mindsets.

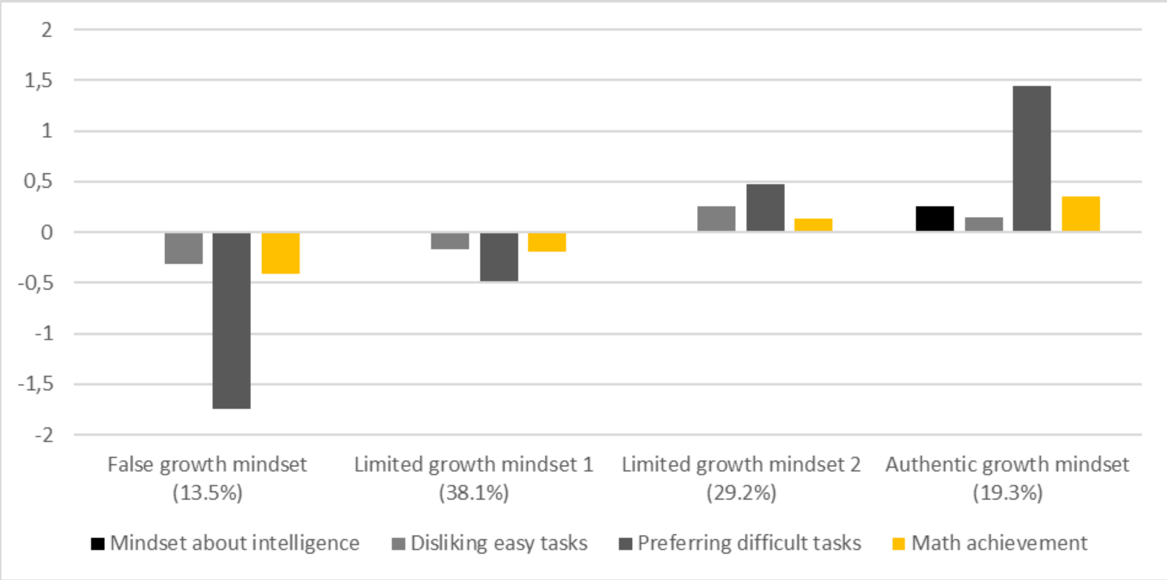

Figure 1: Finnish students' latent profiles with standardized means.

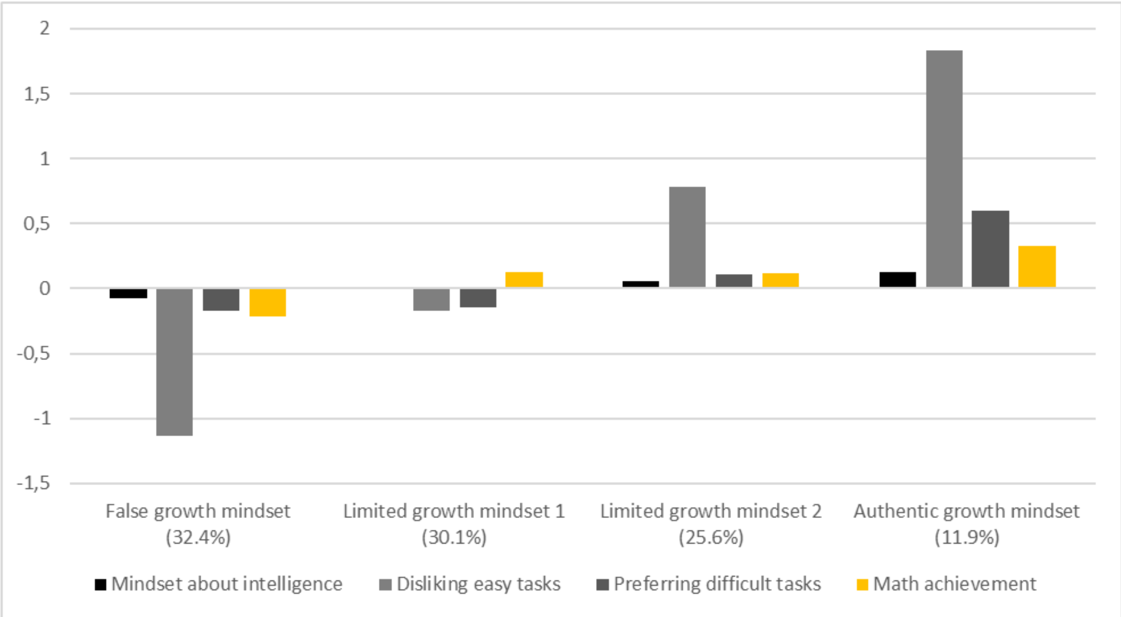

Figure 2: Estonian students' latent profiles with standardized means.

Profile differences in math achievement

In order to understand, whether and how the growth mindset profiles were related to math achievement, an analysis of variance (ANOVA) was conducted. Comparisons of the profiles revealed significant differences in math performance for the Finnish sample, $F(3, 164) = 3.81$, $p < .05$, $\eta_p^2 = 0.07$. Students with an *authentic growth mindset* had significantly higher math achievement than students who belonged to the *false growth mindset* and the *limited growth mindset 1* profiles (see Table 4). In the Estonian sample, differences in math performance for the different profiles followed the same trend as for the Finnish sample (see Figures 1 and 2), but the differences did not reach statistical significance, $F(3, 169) = 2.08$, *ns*.

Discussion

The current study examined Finnish and Estonian 4th grade students' ability beliefs or mindsets with two widely used mindset-instruments: Dweck's (2000) and Gunderson et al.'s (2013) scales. Finnish and Estonian students' mindsets and behavioural preferences as well as associations with math achievement were investigated. The sample consisted of ten-year-old students (N = 368), who were old enough to answer to Dweck's mindset instrument and young enough to be the intended target group for the Gunderson et al.'s scale.

Assessing mindsets

Results indicate that Dweck's and Gunderson et al.'s instruments do not measure the same latent phenomenon; or they at least address it from a different perspective or abstraction level. Namely, whereas Dweck's items seem to capture the generalised implicit beliefs, the Gunderson et al.'s questions about liking difficult or easy tasks target more concrete mindset-related behaviours. Those two aspects might not necessarily align with each other. Haimovitz and Dweck's (2016) findings have indicated that parents' self-reported implicit beliefs do not predict their children's mindsets, but parents' beliefs about failure that are more visible to children, have a more prominent role in shaping children's beliefs. In other words, parents' specific mindset related *behaviours* (e.g., "protecting" children from challenges) that do not always align with their self-reported mindsets seem to have a tangible impact on children in actual real-life settings and achievement situations. Similar patterns have been reported in teaching practices in school contexts (Park, et al., 2016; Rattan et al., 2012; Rissanen, et el., 2018). Results on children from the present study align with these findings—self-reported mindsets and mindset-related learning behaviours or behavioural preferences do not always align and mindset-related behaviours, not only reported mindsets need to be considered when explaining learning success.

Associations with math achievement

More specifically, based on Dweck's and Gunderson et al.'s instruments, variable-oriented regression analysis showed that math grades among both Finnish and Estonian students were significantly related to students' self-reported mindset as well as the mindset-related behavioural preference for solving difficult tasks that aid learning. Whether a student liked or disliked easy tasks, where it would be possible to get a lot of right answers was not associated with math achievement in either country. These results show that already in the 4th grade mindsets and mindset-related behavioural preferences have a role to play in students' math achievement as has been shown before, both directly and indirectly via mediating factors like self-efficacy and effort beliefs and resilience (e.g., Blackwell et al., 2007; Zeng, et al., 2016).

Mindset profiles

In order to make more specific inferences about individual patterns of mindsets and mindset-related behavioural preferences, individual-level latent profile analyses were carried out. As predicted, self-reported mindsets and mindset-related preferences about tasks offering different levels of learning potential, did not align for each individual student. Rather, four types of mindset profiles were defined showing that whereas both Finnish and Estonian 4th graders generally agree with the idea that intelligence can be developed, not all children have associated the concept of malleability of intelligence with learning behaviours that enable change on the neurobiological level. Only students with an *authentic growth mindset* seemed to be enjoying challenges and not be disheartened by task difficulty, whereas students with a *false growth mindset*, while sharing the idea of intelligence being malleable, did not report actual behaviours indicative of a growth mindset toward learning tasks. It can be speculated that although these students have a general idea of intelligence being changeable, they might not know how to actualize their growth mindset in actual learning strategies. The results illustrate discrepancies between implicit beliefs and concrete behaviour among the students. This indicates that there is a need for even more conscious efforts from teachers and parents to realise growth mindset pedagogy (Rissanen, et al., 2019) and make children explicitly aware of the learning behaviours and strategies that put growth mindset into action (Sun, 2015; 2018). Growth mindset rhetoric alone (Dweck, 2015; 2016), e.g., emphasising the malleability of intelligence and even the importance of effort might not be sufficient in bringing about true change in students' learning preferences and behaviour; skills and knowledge do not increase when learners, perhaps unknowingly, shy away from difficult tasks and instead invest valuable learning time in tasks that have already been mastered (Sun, 2015; 2018).

Mindset profiles and country-level differences

Although students from both countries appeared to fall into more or less similar profiles of *authentic*, *limited* and *false growth mindsets*, there did emerge some country-level differences. Recent PISA results tell us that when assessing student mindset with a single item "*Your intelligence is something about you that you can't change very much*", Estonia has the highest percentage of students who reportedly believe that intelligence is malleable (Schleicher, 2019); however, in our study, Finnish students reported higher levels of growth-mindset behavioural preferences. They reported more readiness for tackling difficult tasks that offer opportunities to learn and also showed less liking for solving tasks that are safe and easy. In Finland the best discriminating variable among mindset-profiles was students' preference of difficult tasks that offer most learning opportunities, whereas in Estonia, students fell into different profiles mostly based on their liking or disliking of safe and easy tasks. It is interesting to note that the Finnish national curriculum is more explicitly in line with growth mindset pedagogy than the Estonian curriculum (see Estonian Government, 2011/2014; Finnish National Agency for Education 2014; Rissanen, et al., 2019). As teacher training programmes are aligned with respective national curricula, it can be suspected that explicit growth-mindset messages in the Finnish national curriculum, such as the importance of process-focused feedback, the positive role of mistakes in learning, and fostering mastery orientation in students has had an influence on teachers' classroom practices and therefore also students' reported mindset-related behavioural preferences (e.g., Park et al., 2016).

When it comes to associations with academic achievement, the person-oriented analyses somewhat paralleled the results of the variable-oriented regression analysis. In both countries the growth mindset profiles manifested in differences in academic achievement in mathematics; *authentic growth mindset* being associated with the highest marks and false growth mindset with the lowest. Yet, differences in achievement were statistically significant only for the Finnish sample, perhaps because liking difficult tasks—which was on a variable level a better predictor of learning and achievement than disliking easy tasks—showed better discriminative power between profiles for the Finnish students. All in all, in line with theory, students with an *authentic growth mindset* prefer difficult tasks that seem to result in better learning and achievement (Dweck, 2000). Students in our sample, who exhibited a *false growth mindset* seemed to avoid challenges and also demonstrated poorer achievement. It should be noted though that the cross-sectional nature of the current study does not allow making conclusions about causality. Longitudinal research is needed to illuminate the effects of theoretically valid authentic and false growth mindsets on academic achievement and to understand whether and how the profiles might change over time. Also, the relevance of authentic and false growth mindsets could be further researched in different cultural settings and even domains characterized by different meaning systems, such as sports, the performing arts, etc..

Practical conclusions

In line with warnings from Dweck and her colleagues (Dweck, 2015; 2016; Yeager, et al., 2016) our study cautions against the oversimplified misinterpretations of the growth mindset theory that might result in the spread of detrimental growth mindset rhetoric in the schools. Educators as well as researchers should not make decisions about students' mindsets only based on students' statements about knowing and believing that intelligence is malleable. Rather, this impression should be validated with observing or inquiring about student's actual behaviours and reactions in learning situations (Yeager, et al., 2016), for example, how the child reacts to failure, chooses challenges, and interprets mistakes. Effectively promoting a growth mindset can be counterintuitive and without proper theoretical and pedagogical understanding, misapplication of research is likely to occur, as has been witnessed with the self-esteem movement's detrimental effects (Yeager, et al., 2013; Yeager &

Walton, 2011). Thus, our study results signal the need for more concrete and explicit understanding of the mindset theory and pedagogy among educators, and in teacher education programs (Rissanen, et al., 2018; 2019).

Limitations and future directions

The current study also had a few limitations. The moderate sample size and cross-sectional design of the study limit the generalizability and robustness of the conclusions as well as set apparent limits to the implications that can be drawn. The results need to be replicated with larger sample sizes and longitudinal or intervention studies to analyse the causal and temporal dynamics of the belief profiles. Although the items for behavioural preferences were situationally specific and worded behaviourally rather than as general abstractions, they were still self-report measures and the actual behaviour of children was not assessed. This should be kept in mind when interpreting the results. Also, even though single items have been shown to be adequate measures of one-dimensional and concrete constructs (see Bergkvist, 2015; Loo, 2002), more trustworthy measures for assessing mindset-related behavioural preferences are needed for future studies. It is evident from our results that assessing mindset effects in learning benefits from supplementing self-reported mindset information with data about mindset-related learning behaviours. Our results call for future comparative studies to better clarify the possible differences in students' mindsets and mindset-related learning behaviours as even seemingly similar educational systems may exhibit subtle differences in learning cultures that only become evident through in-depth analysis.

All in all, our study indicates that the authentic and false growth mindsets as phenomena deserve more attention both in research as well as educational practices.

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