The role of domain-specific growth mindset (implicit theories) at the beginning of STEM university studies: Comparing new and old measures

Malte Diederich, Verena Spatz

Technical University of Darmstadt, Physics Education Research Group, Hochschulstrasse 12, 64289 Darmstadt, Germany

E-mail: malte.diederich@physik.tu-darmstadt.de

Abstract.

Mindsets according to Dweck can have a great impact on learning and play a particularly important role when facing challenges such as transition from school to university. This study compares classic domain general (intelligence) mindset measures to a subject specific measure for STEM university studies in Germany. We conducted a questionnaire study with first year students at two survey time-points (survey 1 at the beginning and survey 2 two month into the first semester). With the data taken at the first time-point, we performed an exploratory factor analysis on 17 mindset items from different scales and formed a short subject specific scale. We checked construct validity by comparing it to four scales from the "mindset meaning system". For the domain general scale, we collected further evidence that students interpretation of the word "intelligence" impacts scale values. In the second survey, we applied the new measure and found significant correlations between a subject specific growth mindset and lower intentions to change mayor or drop out, while the domain general scale did not show significant correlations. Finally, we observe an interaction between academic self concept and mindset with no correlations in survey 1 and significant correlations in survey 2 for the subject specific scale. Based on this results we recommend using a subject specific mindset scale in this context.

1. Theoretical background

Starting university studies for a degree in the STEM poses many new challenges for students compared to school. With typically only one big exam in every lecture at the end of semester, the German university system expects a high degree of self-motivation and self-organisation from its students. Not all of them master these challenges successfully and the dropout rate in these subjects have been above average for years [1]. This is problematic given the continued high demand for graduates. A possible level of support here is on the individual-motivational level. Dresel and Grassinger [2] observed a dramatic drop in motivation for a significant proportion of students within the first semester, calling for support. Mindset theory according to Dweck [3] might offer one possible way to support students in this critical phase. Mindset is the belief that personal characteristics such as intellectual abilities can be developed (growth mindset or incremental theory) or are largely predetermined and unchangeable (fixed mindset or entity theory) [3]. These beliefs were originally referred to as implicit theories or lay theories [3]. Similar to a scientific theory, they form a framework for interpreting the meaning of everyday events and making predictions about possible effects. In contrast to a scientific theory, they are highly subjective and rarely made explicit [4]. Years of research have shown that a fixed mindset is associated with unfavorable learning reactions and attitudes (f.e. [5]). Four constructs found connected to a fixed mindset are higher negative effort beliefs (i.e. associating higher effort with lower talent), higher appearance-focused performance-avoidance goals (i.e. focusing on avoiding to look dumb), lower learning goals (i.e. focusing less on learning new things rather and more on getting good grades) and helpless responses (i.e. connecting failure to lack of talent), which have been summarized as the "mindset meaning system" [6]. Large studies (e.g. U.S. National Study of Learning Mindsets (8th grade), N=12,490 [7]; PISA 2018 N > 600,000 [8]) have also found relations between mindset and academic performance. Other studies have found null results (e.g. Czeck university applicants, N = 5653 [9], German students (11th grade) N = 463 [10]). One possible explanation lies in heterogeneity between cultures and within groups [6]. In the 2018 PISA study, correlations between mindset and test results in Germany were among the lowest together with Czeck Republic while in most countries moderate correlations were found [8], which stresses the need for further analysis. Another explanation might lie in how mindset measures are interpreted in different countries.

1.1. Defining and measuring mindset

1.1.1. Domain general mindset The most common way to measure mindset in an academic setting is with students' agreement to several statements about the malleability of intelligence measured on a 6-point likert scale (e.g. "Your intelligence is something about you that you can't change very much", single fixed mindset item used in the PISA study [8]). While some studies differentiate between growth and fixed mindset formulations (f.e. [11]), creating two separated scales, mindset has been largely considered as a one-dimensional spectrum, explaining differences with social desirability effects (f.e. [3], [12]). Other study differentiate between "My intelligence" and "Your intelligence" [13], but all items are still very similar in wording and correlations are very high (.80, [13]). Recent studies discuss the effect of individual definitions of intelligence on the scale values. Depending on their definition, students might understand items differently, threatening overall construct validity. Students that define knowledge as part of intelligence lean more towards a growth mindset on the scale ([11],[14]), which should be investigated further empirically.

1.1.2. Subject specific mindset Similar to other motivational components like academic self concept [15], mindset believes might be different depending on the specific subject. Several studies try to operationalize a subject specific mindset by replacing the word "intelligence" by a subject specific term like "chemical intelligence" ([16]) or "talent for physics" ([17], scale in our study: malleability of talent). However, problems with interpretation of these terms might persist. In the last years, our research group has developed a physics specific scale. We started by interviewing students ([18],[19]) and teachers ([20]) to identify their mindset. Rather than asking about the malleability of intelligence or talent directly, we discussed the consequences of talent and intelligence for acquiring physics skills: *Could you get a good understanding of physics, even if you are not talented? Will some people never be good in a subject, even if they try really hard and study a lot?* From these interviews, we developed two sets of items about the role of talent and effort in success, which have been tested with physics university students ([21]). In recent time, there have been similar approaches (f.e. physics [23], STEM [24]), but to our knowledge there has not been a comparison to existing measures. One can therefore come to the conclusion that although some scales have been proposed for measuring mindsets, these are constructed differently and also provide heterogeneous findings. What is missing is a systematic, empirical comparison of the scales, which also includes a consideration of the correlation of individual scales with other constructs.

2. Objectives and general approach

In this study we want to apply our physics specific scale to the STEM context and compare it to several other approaches to measure mindset. Correlations with the mindset meaning system and academic self concept are used check for construct validity. By examining different definitions of intelligence, we want to further investigate potential problems of the domain general scale. The first goal is to form a short subject specific mindset measure and to improve the way of measuring mindset in a STEM university context. The second goal is to apply this measure to investigate predictive power of mindsets for intentions to changing ones' major or even dropping out of university education. To reach these goals, a questionnaire study with two survey time-points (survey 1 at the beginning and survey 2 two month into the first semester) has been conducted. The data taken will allow to answer the following research questions:

- (Q1a) How do domain general and subject specific mindset items relate to each other?
- (Q1b) How do different mindset scales correlate to the mindset meaning system and academic self concept at the start of university studies?
- (Q1c) How do the definitions of intelligence influence the score in different mindset scales?
- (Q2) How are domain general and subject specific mindset scales correlated to academic self concept and intentions to change major or drop out two month into the first semester?

3. Survey 1 - Method

We conducted an online survey in introductory STEM courses at our university in the fall 2021 semester (local ethics committee approved) during the first week of the semester. Students participated voluntarily during lecture time. From 826 students, 21 students were excluded for answering items in an average time of less than 1,5 seconds, leading to 805 participants (28 % of all first semester students in STEM subjects at TU Darmstadt, 31 % female, 84 % in first semester). Participants come from in total 24 different STEM fields (largest groups: mechanical industrial engineering (16 %), informatics (10 %), electrical engineering (8 %), mechanical engineering, medical technology, physics, mechatronics, mathematics (each 6 %)).

3.1. Measuring instruments

The survey consisted of 17 mindset items, 20 items from four scales of the mindset meaning system and 3 items measuring subject specific academic self concept. All items were measured on a 6-point likert scale from 1 (completly disagree) to 6 (completly agree). These mindset items can be found in table 1 and will be explained in more detail here:

3.1.1. Domain General Mindset We included two fixed mindset items ("My intelligence") from a German scale [30], a growth mindset item ("My intelligence") translated from [16] and the item used in the PISA survey ("Your intelligence") [10], (I1 to I4, see table 6, $\alpha = .87$). Additionally, we included one math item (Y1), which has been recommended as a short three item scale together with two fixed "Your intelligence" items in a recent paper discussing mindset controversies by leading mindset researchers Dweck and Yeager (see appendix of [6]).

3.1.2. Malleability of talent (subject specific) We included three physics items from [20], which we adapted in wording by changing "physics talent" to "talent for my field of study" . The items are very similar in wording to the intelligence scale items ((M1 to M3, $\alpha = .69$).

3.1.3. Role of talent and effort (subject specific) We included nine physics items developed by our research group [21], which we also adapted in wording by changing "physics" to "my field of studies". Five items are about the role of talent (T1 to T5) and four items are about the role of effort (E1 to E4) in succeeding in one's field of study ($\alpha = .84$).

Table 1. Descriptive statistics. All items are likert scaled from 1 (completly disagree) to 6 (completly agree). N = 805, survey 1 the at start of the semester.

Variable	Mean	SD	% Agree	Curtosis	Skew
Malleability of intelligence (domain general)					
I1: I can learn new things, but I can't really change by intelligence.	3.02	1.16	33.4 %	-0.57	0.33
I2: I have a certain amount of intelligence, that I cannot change much.	3.11	1.20	37,0 %	-0.41	0.21
I3: With enough time and effort I think I could significantly improve my intelligence level.	4.34	1.20	79.6 %	0.21	-0.70
I4: Your intelligence is something about you that you can't change very much.	2.85	1.34	28.8 %	-0.47	0.51
Malleability of talent (subject specific)					
M1: I can learn new things, but I can't really change, how talented I am in my field of studies.	3.28	1.22	44.7 %	-0.70	0.01
M2: My talent for my field of studies is a part of me that I can't change much.	3.21	1.12	41.5 %	0.21	-0.70
M3: I have a certain amount of talent for my field of studies, and I can't do much to change it.	2.97	1.06	31.2 %	-0.42	0.04
Math item					
Y1: Being a "math person" or not is something that you really can't change. Some people are good at math and other people aren't.	3.22	1.29	44.1 %	-0.70	0.02
Role of effort and talent (subject specific)					
T1: You will never be good in my field of study, if you did not inherit a certain talent for it.	2.77	1.22	27.8 %	-0.45	0.36
T2: If you are not talented in your field of study, there is not much you can do to improve significantly.	2.28	0.96	10.7 %	0.19	0.59
T3: You need to inherit a specific talent for my field of study.	2.47	1.17	20.4 %	-0.48	0.46
T4: You either understand my field of studies or you don't.	2.54	1.22	20.2 %	-0.12	0.62
T5: I believe that some people are good in my field of studies and others will never really learn it, no matter how much they try.	2.94	1.21	30.9 %	-0.34	0.34
E1: Each of my fellow students can understand my subject in depth. You just have to do enough for it.	4.45	1.11	81.7 %	-0.04	-0.56
E2: If they really want it and make an effort, any of my fellow students can successfully study my field of studies.	4.66	1.12	85.6 %	0.25	-0.77
E3: Even if they try hard in my field of study, some of my fellow students could never understand the content in depth.	2.89	1.19	29.7 %	-0.30	0.33
E4: Even if they invest a lot of time: Not every one of my fellow students could successfully study my field of study.	3.05	1.28	38.5 %	-0.70	0.16

Italic items are incremental items (growth mindset), five bolded items used in short subject specific short scale. Note that the original items are in German. Translating some terms is difficult and might change the meaning slightly (f.e. "Begabung" - talent, "Anstrengung" - effort).

3.1.4. Mindset meaning system We included four scales found related to mindset in other studies. All scales were translated to German. For negative effort beliefs, we combined two items from [3] with a third item developed from interview material (e.g. “If you have to work very hard for your studies, you are not so gifted for it.”, $\alpha = .71$). For performance avoidance goals, we used a four item scale from [25] (e.g. “One of my goals in class is to avoid looking like I am having trouble doing the work.”, $\alpha = .81$). For learning goals, we included three items from [3]. α was not acceptable (.57), with one item loading on a different scale in EFA. Droping this item lead to an aceptable score with only two items (e.g. “It’s much more important for me to learn something in class than it is to get the best grades.”, $\alpha = .71$). For helpless response, we included 9 items from [26]. The original items were separated into two subscales (helpless response and mastery response). In our survey, both scales could not be separated into two factors and two items loaded scattered. We combined the remaining seven items into one helpless response scale by inverting the mastery response items (e.g. ”When I fail to understand something, I become discouraged to the point of wanting to give up.”, $\alpha = .73$)

3.1.5. Subject specific academic self-concept We used a three-item scale (confidence in one’s intelligence-scale) by Dweck [3] adapted to the university context by Dresel et al. [2]. As an exception, the items consisted of a pair of statements about low and high confidence on a 6-point answer scale (e.g. ”I feel pretty confident -” vs. ”I’m not very confident about my intellectual abilities, which I need in my field of studies” $\alpha = .76$).

3.1.6. Definition of intelligence After the 40 items, we asked students how they define the term intelligence by selecting up to five given statements. The statements (see table 5) were generated by comparing definitions stated by chemistry students in [14] to the definitions given by 13 German students in an interview study [19].

4. Survey 1 - Results

4.1. Q1a: How do domain general and subject specific mindset items relate to each other?

To answer the question, we conducted a exploratory factor analysis (EFA). Table 2 shows the results of MAP test and eBIC for models with different numbers of factors and the assigned eigenvalues. The values were calculated with the psych package in r. For all 17 mindset items, Kaiser-Guttman criterion and eBic suggest three factors, while MAP test suggests only two factors. The factor loadings of both models can be seen in table 3 (consult table 6 for full item names). Factor 1 includes all subject specific items, while factor 2 can be identified as the domain general items (I1 to I4). In the three factor model, the incremental items (E1 and E2) build the third factor. E3 and E4 are inverse formulations of E1 and E2 and load mixed on F1 and F3. This makes it difficult to interpret the third factor. The intelligence items all clearly load on one factor, independent from the incremental formulation (I3) or the difference between ”Your intelligence” (I4) and ”My intelligence” (I1 and I2).

When excluding the three incremental items, the eigenvalues of factor three drops to 0.91, while eBic still suggests up to 4 factors (Table 2). Looking again at the factor loadings in table 2, the malleability of talent scale (M1, M2, M3) loads mixed on both scales and cannot be separated clearly into a third factor. The math item Y1 from Yeager et al. [6] loads on the subject specific factor F1 and not on the domain general factor F2. In the STEM university context, being a ”math person” or ”being good in my field of studies” seems to be highly related.

To create clear factors, we excluded the malleability of talent scale and reduced the subject specific items down to five by dropping items with lower factor loadings and still keeping the different content facets of the scale. The resulting eight items lead to two clearly separable factors (F1 subject specific mindset and F2 domain general mindset) with a correlation of .55 (see table 2 and 3).

Table 2. Statistics summary for different factor numbers in EFA.

# of factors	17-item version			14-item version			8-item version		
	EV	**MAP**	**eBic**	**EV**	**MAP**	**eBic**	**EV**	**MAP**	**eBic**
1	6.37	0.029	1196	5.69	0.028	530	3.78	0.078	506
2	1.97	**0.016**	-244	**1.55**	**0.02**	-203	**1.38**	**0.052**	**-68**
3	**1.17**	0.019	**-379**	0.91	0.027	-215	0.67	0.092	-42
4	0.86	0.024	-370	0.86	0.036	**-223**	0.56	0.177	-12
5	0.85	0.031	-349	0.74	0.05	-178	0.52	0.333	NA

EV, Eigenvalues; MAP, Velicer's Minimum Average Partial; eBic, empirical Bayesian information criterion.

Table 3. Results of EFA for different numbers of mindset items.

	I1	I2	**I3**	I4	M1	M2	M3	Y1	T1	T2	T3	T4	T5	**E1**	**E2**	E3	E4	correl F	
17 items																		F2	F3
F1	-.01	.06	.21	.01	.36	.40	.29	.60	.55	.67	.68	.55	.74	-.59	-.49	.70	.64	.49	
F2	.88	.82	-.81	.76	.36	.24	.26	.01	.06	.00	.01	-.10	-.07	.06	-.02	-.09	-.03		
F1	.16	.31	.29	.14	.51	.65	.49	.62	.43	.49	.56	.57	.45	-.06	.06	.43	.35	.44	-.38
F2	.78	.71	-.83	.69	.27	.13	.17	-.05	.05	-.01	-.02	-.14	-.06	-.02	-.11	-.08	-.01		-.54
F3	.00	.10	.19	-.01	.04	.16	.11	-.06	-.19	-.25	-.20	-.03	-.37	.63	.66	-.33	-.37		
14 Items (poled all in fixed mindset direction)																			
F1	-.08	-.04		-.05	.33	.37	.26	.64	.57	.68	.66	.60	.75			.71	.63	-.64	
F2	.91	.90		.79	.38	.26	.29	-.01	.04	-.02	.02	-.13	-.09			-.10	-.03		
F1	.01	-.04		.05	.19	-.08	.00	.56	.53	.68	.56	.49	.78			.77	.65	.58	.66
F2	.92	.81		.80	.28	-.08	.10	-.01	.06	.03	.00	-.15	-.02			-.02	.02		.71
F3	-.09	.12		-.10	.28	.91	.50	.10	.04	-.04	.14	.15	-.09			-.15	-.06		
9 Items																			
F1	-.03	.04		-.01						.62	.56		.72			.72	.68	.55	
F2	.89	.84		.77						.06	.11		-.02			-.07	-.02		

Bolded items are incremental items (growth mindset).

4.2. Q1b: How do different mindset scales correlate to the mindset meaning system and academic self concept at the start of university studies?

Table 4 shows descriptive statistics and the correlations of the domain general and the subject specific mindset scale. Correlations to the mindset meaning system (negative effort believes, learning goals, performance avoidance goals, helpless response) are significant in the expected direction for both scales, while there are no correlations with subject specific academic self concept.

Table 4. Means, standard deviations, and correlations with confidence intervals; N = 805; survey 1 at the start of the semester.

Variable	M	SD	1	2	3	4	5	6
1. Domain General Mindset (Intelligence)	4.09	1.08						
2. Subject Specific Mindset	4.28	0.87	.42*** [.36, .48]					
3. Negative Effort Believes	2.63	0.98	-.35*** [-.41, -.29]	-.40** [-.45, -.34]				
4. Learning Goals	3.73	1.09	.14*** [.07, .21]	.18*** [.11, .25]	-.16*** [-.23, -.09]			
5. Performance Avoidance Goals	3.51	1.08	-.11** [-.18, -.04]	-.21*** [-.27, -.14]	.15*** [.08, .22]	-.21*** [-.27, -.14]		
6. Helpless Response	2.61	0.70	-.23*** [-.30, -.17]	-.21*** [-.27, -.14]	.25*** [.18, .31]	-.27*** [-.33, -.21]	.25*** [.18, .31]	
7. Subject Specific Academic Self Concept	3.84	1.04	.06 [-.01, .13]	.01 [-.06, .07]	-.02 [-.09, .04]	.06 [-.01, .13]	-.16*** [-.23, -.09]	-.34*** [-.40, -.28]

M and SD are used to represent mean and standard deviation respectively. Values in square brackets indicate the 95 % confidence interval. ** $p < .01$; *** $p < .001$.

4.3. Q1c: How do the definitions of intelligence influence the score in different mindset scales? Table 5 shows the mean values for both mindset measures depending on whether students agree or disagree with a statement about intelligence. Students could select several definitions. The group of students including knowledge and experience in their definition of intelligence score significantly towards a Growth Mindset in the domain general scale, while the group of students that define intelligence as what is measured in an IQ-test score towards a Fixed Mindset. Students that include social and emotional intelligence in their definition score more towards a Growth Mindset on both scales.

Table 5. Mean values for subject specific and domain general mindset in dependence of intelligence definition. N = 781, as some students did not fill out this part of the survey.

definition	**% Agree**	**M SuSp**	**p.adj**	**M DoGe**	**p.adj**
total		4.28		4.09	
Intelligence is the ability to think abstractly and reasonably.	68.0%	4.24	2.3	4.04	0.15
Intelligence is different in separated areas (f.e. math intelligence and speach intelligence).	69.3%	4.31	0.85	4.15	0.79
Intelligence includes knowledge and experience.	41.6%	4.35	0.31	4.53***	0.000
The word intelligence includes sozial and emotional intelligence.	55.2%	4.39***	0.000	4.30***	0.000
Intelligence is what is measured in an IQ-test.	15.9%	4.09	0.153	3.39***	0.000

M SuSp - Mean subject specific mindset; M DoGe - Mean domain general mindset; p.adj - bonferroni adjusted p value for t-tests (10 measurements), *** $p < .001$ in t-tests.

5. Survey 2 - Method

The second online survey was conducted in the same STEM classes two month into the first semester, again with voluntary participation during the lecture. 338 students (34 % female, 90 % in first semester, largest groups: mechanical engineering 19 %, physics, biology, industrial engineering, mathematics, informatics (7 - 9 %)) participated in the survey.

5.1. Measuring instruments

The survey consisted of the *domain general* (3 items, $\alpha = .89$) and the *subject specific* (5 items, $\alpha = .82$) mindset scale described in 4.1 and the *subject specific academic self concept* scale (3 items, $\alpha = .89$) from survey 1. In addition, we included two new scales, *Intentions to change major* and *Intentions to drop out* (3 items each, e.g. "At the moment I don't feel suitable for my mayor / for studying.", $\alpha = .79$ and .86, both on likert scale 1 - 6) adopted from the differentiated process model of student dropout by Bäulke et al. [27].

6. Survey 2 - Results

6.1. Confirmatory factor analysis of mindset scales

To validate the factor structure found in study 1, we performed a confirmatory factor analysis of the 8 mindset items using the lavaan package in r. A one-factor model showed poor fit (df = 20, $\chi^2 = 282.4$, rmsea = .2, srmr = .11, cfi = .79), while the proposed two-factor model showed good fit parameters (df = 19, $\chi^2 = 39.6$, rmsea = .06, srmr = .04, cfi = .98).

6.2. Q2: How are domain general and subject specific mindset scales correlated to academic self concept and intentions to change major or drop out two month into the first semester?

Pearson correlations can be found in Table 6. The subject specific mindset scale correlates significantly with lower intentions to change major or drop out. The domain general scale also correlates with lower intentions, but correlations are smaller. Also, there is a significant correlation between a subject specific growth mindset and a higher academic self concept.

Table 6. Means, standard deviations, and correlations with confidence intervals; N = 338; survey 2 two month into the first semester.

Variable	**M**	**SD**	**1**	**2**	**3**	4
1. Subject specific mindset	4.05	0.93				
2. Domain general mindset (intelligence)	3.89	1.15	.55*** [.47, .62]			
3. Subject specific academic self concept	3.85	1.19	.17** [.06, .27]	.09 [-.01, .20]		
4. Intentions to change major	2.44	0.94	-.27*** [-.37, -.17]	-.11* [-.22, -.01]	-.58*** [-.64, -.50]	
5. Intentions to drop out	2.09	0.98	-.14** [-.24, -.03]	-.06 [-.16, .05]	-.41*** [-.50, -.32]	.48*** [.39, .56]

M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95 % confidence interval. *p < .05.; ** p < .01; *** p < .001.

7. Discussion and limitations

In this study, we compared several ways to measure mindset. While small differences between growth mindset and fixed mindset formulations or the difference between ”my intelligence” and ”your intelligence” are measurable in other studies, we found the difference between a domain general mindset (intelligence) and a subject specific mindset to be more important. The malleability of talent approach by changing the word ”intelligence” to ”talent for my field of study” loaded mixed between both scales and could not be separated into a third factor.

We propose a short subject specific mindset scale (5 items) for the university STEM context. In order to reduce social desirability effects, we included only entity (fixed mindset) items. The scale is similar to the math item proposed by Yeager et al. [6], but loads to another factor in survey 1 (EFA) and survey 2 (CFA). The new scale shows the expected correlations to the mindset meaning system, which supports construct validity of the scale. In the data of survey 2, the subject specific mindset scale correlated significantly with lower intentions to change major (-.27) and drop out (-.14), while the domain-general scale did not correlate significantly. While at the start of the semester, academic self concept and mindset was independent, there was a significant correlation in survey 2 two month into the semester. There seems to be an interaction between mindset and academic self concept over the course of the semester. The direction of this interaction can only be speculated from this study and needs further research.

The main limitation of our study lies in a selection bias which should be particulary large in survey 2. We cannot generalize our findings without further studies. Furthermore, we could not differentiate between different STEM subjects. Effects for example in biology and mathematics might be different, as the level of difficulty in abstract thinking varies. Last, we only measured self reports. Correlations to test grades or the actual decision to change studies or drop out could give clearer insights.

Our study confirms that the definition of intelligence has an impact on mindset scale values. E.g., including experience in your definition shifts to a ”growth mindset”, while defining it as an IQ value leads more toward a ”fixed mindset” in the domain general scale. Both effects do not show as strongly in the subject specific scale.

While this threatens scale validity, it has to be noted that the domain general scale has been used successfully to show e.g. the relation to the mindset meaning system in many studies. In general, mindset is an implicit construct that we are trying to measure with an explicit scale - a critic that also applies to the subject specific approach. In [29], Dweck et al. describe both mindsets as two separate knowledge structures that can be triggered in certain situations. This helps explain why mindsets are both stable ([26]) and easily manipulable ([12]) at the same time. We therefore should not use a single number from a mindset scale to put students into boxes of ”fixed mindset” and ”growth mindset”. Instead, we should always keep the limitations of measurement in mind.

This being said, findings in our study support the claim that mindset does matter in a university STEM context and a subject specific scale can help to better describe the mindset of students and to detect further effects of a fixed mindset. Future research should focus on ways to support students in developing a growth mindset in such a challenging environment.

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