



Latent profile analysis of students' perception of German classroom climate: outcomes and covariates

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Abstract

Classroom climate has been considered as an important factor influencing students' learning motivation, achievement and psychological and behavioural health in schools. With the data from German National Educational Panel Study and the latent profile approach, we explored students' perception of German classroom climate including learning and social environment ($N=4643$). We also explored the outcome differences among these profiles and possible covariates related to them. The four following latent profiles differing in perceptions of German classroom climate were identified: negative, moderately negative, moderately positive and positive profiles; migration background predicted the probability of belonging to a specific profile; generally, students with a more positive perception had also higher interest, performance motivation, and achievement in reading as well as satisfaction with school life; the profiles of students in academic and vocational tracks were quite similar, but gender did not predict the profile membership probability for students in the vocational track and there was no self-concept disparity among profiles for them. These results supported individual differences in classroom perception as well as the associations of the perceptions with different outcome and background variables, which have implications for understanding students' subjective perceptions of classroom climate and early detection of, or intervention for, the groups at risk.

Keywords Covariates · Educational outcomes · German classroom climate · Latent profile analysis

Introduction

Classroom climate research has received increasing attention from researchers and educators (Dorman, 2001; Fraser, 1994; Tapola et al., 2008). It provides insight into contextual factors enhancing students' learning motivation and engagement and yields practical implications for optimizing the learning environment. However, previous literature focusing on classroom-level measurement of climate might overlook the fact that students' perceptions can vary even if they sit in the same classroom. These individual differences of perception

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might stem from individual characteristics such as their own achievement motivation, gender, or migration background (Spearman & Watt, 2013; Tapola & Niemivirta, 2008). Individual-level measurement of classroom climate perception can help with understanding how students perceive climate differently. Furthermore, the heterogeneity of perception in the population cannot be detected by the variable-centered approach used in previous studies (Rohatgi & Scherer, 2020; Schenke et al., 2017; Van Eck et al., 2017). A person-centered approach might capture the heterogeneity and be useful in identifying groups at risk. Moreover, although classroom climate has many facets (Schenke et al., 2017), the framework for measuring classroom climate in previous studies was based on either learning focused aspects such as teaching quality (Hochweber & Vieluf, 2018; Kunter & Voss, 2011) or social aspects (Hamre & Pianta, 2010; Murayama & Elliot, 2009; Reeve & Jang, 2006;). A framework including both social and learning aspects and from students' perspectives might capture their perception at the individual level more precisely. Therefore, this current study aimed at exploring student perception of classroom climate using a person-centered approach and a framework that includes both learning and social aspects of the environment. Also, samples from different school tracks in Germany were included and discussed separately.

Perception of classroom climate

The classroom climate is considered an important factor influencing students' learning motivation, engagement, and achievement (Martin & Dowson, 2009). It can be defined as learning-related attitudes, norms, and structures set by teachers (Urduan & Schoenfelder, 2006) and includes various aspects related to teaching quality, goal structure and social interactions (Hochweber & Vieluf, 2018; Murayama & Elliot, 2009; Ryan & Patrick, 2001).

Based on the self-determination theory (SDT, Deci & Ryan, 1985; Ryan & Deci, 2000), an optimal learning environment should consider students' basic needs for autonomy, competence and relatedness. Many studies have adopted the SDT framework to investigate the social interaction in the learning environment (Hardre & Reeve, 2003; Joe et al., 2017; Ryan & Patrick, 2001), because aspects such as autonomy support provided by teachers and peer relationship were considered directly related to the satisfaction of these basic needs (Joe et al., 2017) and positive social interaction in the classroom is especially important for young adolescent students given their increasing self-awareness and need for autonomy (Ryan & Patrick, 2001). Autonomy support provided by teachers can increase students' psychological well-being, learning, achievement, and positive development (Reeve, 2009) as well as engagement and motivation (Benita et al., 2014; Ciani et al., 2010). Besides, the need for relatedness can be satisfied when students build positive relationship with others in the classroom. If teachers promote cooperation, including ideas sharing, working in small groups and help-seeking or -giving procedure in their lessons, students can make progress in both academic learning and peer relationship (Roseth et al., 2008; Webb & Palincsar, 1996). If teachers promote performance goals, such as emphasizing performance or judging students' performance in comparison with others, students can develop negative relationship with others which often has a negative effect on learning (Midgley et al., 1995; Roseth et al., 2008). Therefore, autonomy support, cooperation climate and a focus on performance goal were selected as key aspects addressing social environment in classrooms in this study.

Moreover, how students perceive the teaching–learning process is also an important aspect of classroom climate, which can impact students’ need satisfaction and motivation. Goal clarity and classroom management are two dimensions of evaluating the quality of the teaching–learning process (Fauth et al., 2014; Helmke et al., 1997). If the instruction is provided in a clear and systematic way, with clear goals and tasks, students’ learning motivation and academic outcomes would be enhanced (Helmke et al., 1997). Lessons without clear goals and structures hinder students from integrating teacher-provided learning goals with their own goals and thus have been considered detrimental for self-determined learning (Seidel et al., 2005). Moreover, classroom management is another important dimension of instructional quality (Fauth, et al., 2014) and can be understood as a way of providing structure in classrooms (Nie & Lau, 2009). Students need a structured learning environment without disruption, which can only be achieved by teachers’ successful management of classrooms, including setting rules and coping with disruptions (Kunter et al., 2007). Given these findings, goal clarity and classroom management were also included in this study as important dimensions of the classroom climate.

In summary, it is only in a classroom with high instructional quality and autonomy support that students can be active learners and develop their competence; in a classroom with positive social interaction, students would feel related with each other and find meanings for their learning. Therefore classroom management, goal clarity, autonomy support, cooperative climate and performance focus were selected as key dimensions of classroom climate in the current study.

Another question related to the measurement of classroom climate is whether the class-level variables should be implemented. Students’ perception is shaped by both contextual and individual factors. Their perception and preference of classroom environment might vary because of individual differences in goals, expectations and needs (Tapola & Niemi-virta, 2008). Although classroom-level variables also contribute to the perceptions, recent studies have also shown insufficient reliability for the class-level measurement of such perceptions (Aditomo & Köhler, 2020; Miller & Murdock, 2007; Schweig, 2014). In our study we also had the same problem. Moreover, because we focused more on the subjective environment which shapes the motivation and adopted a need-based framework to assess classroom environment, we based our main analysis on the individual level with consideration of a clustered data structure.

Perception of classroom climate: outcomes and covariates

Previous literature provided evidence about the relationship between perceived climate and learning-related outcomes from a variable-centered approach. Perception of classroom climate predicted motivational variables including efficacy, self-concept, task value, goals (Dorman, 2001; Spearman & Watt, 2013), self-regulated learning behaviour (Velayutham & Aldridge, 2013), achievement or achievement growth (Sandilos et al., 2017; Seidel, 2005), and psychological and behavioural adjustment (Way et al., 2007).

In the research using a person-centered approach, the results were similar: different profiles existed and students with different profiles differed in motivation and performance (Rohatgi & Scherer, 2020; Yi & Lee, 2017), as well as problematic behaviour in schools such as chronic absence (Van Eck et al., 2017). Normally, students with more positive perceptions of the climate also had higher motivation and better outcomes (Rohatgi & Scherer, 2020; Van Eck et al., 2017). There was also evidence that students with profiles of high performance focus or low emotional support had lower achievement (Schenke et al., 2017). Therefore, in the current

study, we anticipated that students with profiles of more positive perception of classroom climate (high autonomy support, collaboration, goal clarity and classroom management, low performance focus) would have higher achievement, self-concept, learning motivation, and well-being.

Regarding the covariates, several researchers have explored possible predictors for the probability of belonging to a specific profile and found that gender and migration background can influence such probability (Rohatgi & Scherer, 2020). Gender differences in reading and in the perception of language classes have been reported in previous literature (Hajovsky et al., 2017; Hochweber & Vieluf, 2018). Besides, ethnic background or familiarity with the teaching language can influence students' perception of classroom climate: Afro-American students seem to prefer warm and demanding teachers (Sandilos et al., 2017); students with or without English as first language can differ in their perception of class climate in English-speaking countries (LeClair et al., 2009).

German educational system: students in different tracks

Most of the students in the German educational system are distributed to different school tracks at the end of fourth grade (in some states the time point is sixth grade). Some students are placed in the academic track and others in the vocational track. The educational goals, curricula and teaching concepts among different tracks are different: in the academic track, students are expected to enter the higher educational system and teachers focus on delivering content-related knowledge and improving students' academic learning ability whereas, in the vocational track, students receive more vocational training and teachers adopt a more practical pedagogic approach (Baumert et al., 2010). Therefore, the learning climate of the two tracks as well as students' perceptions can be quite distinct (Kunter & Voss, 2011; Schiepe-Tiska, 2019). Moreover, the track placement decision is mainly based on students' achievement (Schiepe-Tiska, 2019). Meanwhile, there has been evidence that perceptions of climate were more heterogeneous in classes with lower average achievement (Schenke et al., 2017). Therefore, it is meaningful to separate the analysis for the students in the two school tracks in order to capture the potential difference in heterogeneity of perceptions between tracks.

Aims

The present study aimed at answering the following research questions:

- (1) What are the characteristics of the latent profiles of students' perceptions of German classroom climate?
- (2) Do students with different profiles differ in educational outcomes (domain-specific motivation and self-concept, achievement, and life satisfaction in schools)?
- (3) Which demographic variables (gender, migration background, and social economic status) predict the probability of profile membership?
- (4) Are there differences between students in the academic and vocational tracks?

Method

Data and sample

We used data of the fourth wave of the Starting Cohort 3 (SC3) in the German National Educational Panel Study (NEPS). NEPS is a multi-cohort longitudinal study of educational development and outcomes through a life span (Blossfeld et al., 2011). The data collection procedure and instruments were controlled through the data protection unit and the participation was completely voluntary. NEPS SC3 provides a representative sample of secondary school students in Germany. We focused on students in Grade 8 (wave 4), and conducted analysis separately for students in schools with an academic focus (Gymnasium and equivalent tracks in comprehensive schools) and with a vocational focus (Hauptschule, Realschule and equivalent tracks in comprehensive schools).

A total of 2679 eighth-grade students (male = 1254, female = 1398, missing = 27) from the academic track and 1964 students (male = 1039, female = 898, missing = 36) from the vocational track were included in this analysis. Their average age was 13.37 (SD = 0.53) for the academic track and 13.66 (SD = 0.66) for the vocational track. Students' socioeconomic status (SES) of parents was indicated by the variable ISEI (International Socio-Economic Index of Occupational Status) scale from the parental questionnaire. The higher SES of the parents was used as indicator for the family SES, ranging from 10 to 90. The mean of family SES for students in the academic track was 64.3 and for students in the vocational track was 47.84. Regarding the migration background, there were 1964 native students and 484 s-generation and 75 first-generation (missing = 156) students in the academic track; there were 1277 native students and 421 s-generation and 94 first-generation (missing = 181) in the vocational track. Missing rates of the climate and outcome variables were less than 5%.

Measurement

Classroom climate

We focused on the subject German. Several scales were used to measure the climate of German classes: goal clarity, classroom management, autonomy support, cooperative climate, and performance goal focus. They were all measured with 5-point Likert-scale items ranging from 1 (not at all true) to 5 (very true). Both the goal clarity and the classroom management scale were based on an instrument from the DESI study Students' performance in German and English, Ditton, 2000; Wagner et al., 2009). The Goal clarity scale measured whether the German course has a clear structure and instructional goal and the classroom management scale denotes teachers' behaviour for classroom management. The autonomy support scale was a short form of the Learning Climate Questionnaire (LCQ; Hardre & Reeve, 2003; Williams & Deci, 1996) measuring teacher support for student autonomy. The cooperative climate scale was based on a scale measuring teachers' behaviour promoting interaction among students (Ryan & Patrick, 2001). The performance goal focus scale measured students' perception of their German teacher's behaviour of promoting performance goals. Information about the number of items, alpha reliability and examples is presented in Table 1.

Table 1 Scale information

Construct	Item number	Alpha reliability	Example	Source
<i>Instruction quality</i>				
Goal clarity	3	.80/.81	My teacher summarises the content at the end of the class	DESI study (Ditton, 2000; Wagner et al., 2009)
Classroom management	4	.83/.83	My teacher knows what happens in the classroom	DESI study (Ditton, 2000; Wagner et al., 2009)
<i>Social aspects</i>				
Autonomous	3	.82/.83	My teachers try to understand how I see things before they suggest to me how they would handle a particular situation	Learning Climate Questionnaire (Hardre & Reeve, 2003; Williams & Deci, 1996)
Cooperative climate	3	.86/.85	My teacher encourages us to share ideas with one another in class	Ryan and Patrick (2001)
Performance goal focus	3	.62/.56	My German teacher tells us how we compare to other students	Ryan and Patrick (2001)
<i>Outcomes</i>				
Self-concept	3	.79/.76	I can read quickly and comprehend texts very well	Möller and Bonerat (2007)
Intrinsic motivation	4	.87/.88	I learn in German classes, because I find the content interesting	Kunter et al. (2003)
Performance motivation	4	.85/.83	I learn because I want to get better scores than others in the exams	Schiefele et al. (2002)

Two alpha coefficients are provided, the former for the sample of academic track and the other for the non-academic track

In order to explore whether the scales can also be considered as level-two variables, the intraclass correlation coefficient ICC2 (Shrout & Fleiss, 1979) was calculated for goal clarity, classroom management, autonomy support, collaborative climate, and performance goal focus: 0.43 (academic)/0.21(non-academic), 0.65/0.50, 0.51/0.37, 0.50/0.38, 0.43/0.35. Because they were lower than the cut-off of 0.70 (Klein et al., 2000), we did not include them as class-level variables.

Outcome variables

Outcome variables included self-reported mid-year grade in German, domain specific (German related) intrinsic motivation, self-concept, performance motivation, and satisfaction with school life. Self-reported mid-year grade in German subject was considered to be an index for achievement in German subject, which was placed on a scale ranging from 1 to 6. Because the German grading system is different from the US system (1 was the highest level instead of 6), reported grades were reversed. The scales of self-concept in reading and intrinsic and performance motivation in German classes were adapted from previous research (Kunter et al., 2003; Möller & Bonerad, 2007; Schiefele et al., 2002). Self-concept in reading denoted learners' perception of competence in reading; intrinsic motivation in German classes described the content-related task-focused learning motivation whereas performance motivation referred to the extrinsic motivation in reading and learning. More information about the number of items, reliability, example and source can be seen in Table 1. Satisfaction with school life was measured with one item with a scale ranging from 0 to 10. Previous studies have shown that this one-item measure of satisfaction is reliable and valid (Diener, 2009).

Covariates

Covariates included in the current study were gender (0=male), socio-economic status (SES) of the family, and migration background (0=native, 1=second generation, 2=first generation). As was mentioned before, family SES was represented by the higher ISEI of the parents. With respect to migration background, children were 'native' if they and both of their parents were born in Germany; they were 'second generation' if at least one parent was born abroad and were 'first generation' if they themselves were born abroad.

Analysis method

The analysis was conducted with Mplus 8.0. We only focused on the single level analysis but, given the nested structure of the data, we adjusted the standard errors and the chi-square statistic through the TYPE=MIXTURE COMPLEX option combined with cluster=class IDs (Asparouhov & Muthén, 2010) in order to correct standard errors. The class ID indicated the class of the students who were taught by the same German teacher. Generally the class-level variance with the two samples was not low (ICC1 for goal clarity, classroom management, autonomy support, collaborative climate, performance goal focus for the academic track/non-academic track were: 0.15/0.08, 0.32/0.26, 0.20/0.16, 0.18/0.17, 0.14/0.15) but, because we had a relatively small sampling class size (averagely $N=9$ for the academic track and $N=7$ for the vocational track, some classes had sample size lower than 5) and the ICC2 for these variables

were not satisfying, we only corrected standard errors for the class-level at this step and think that this would be sufficient (Snijders et al., 2012; Stapleton et al., 2016). We also provided additional multi-level/group LPA in order to see if results would change.

To answer the first research question, latent profile analysis (LPA, Lubke & Muthén, 2005; Marsh et al., 2009) was conducted and the climate variables (scale means) were used as indicators for the LPA. This approach identified homogeneous groups with similar perceptions of the classroom climate. In the next step, different indices were used to compare the LPA models with 1–6 profiles. In order to make a decision on the number of profiles, different factors were considered: (1) lower log-likelihood, AIC, BIC, and aBIC values and higher entropy value (Jung & Wickrama, 2008), (2) better than the model with one less cluster as indicated by the Lo Mendell-Rubin likelihood ratio test (Nylund-Gibson & Choi, 2018), and (3) cluster size: profiles should include more than 5% participants. The latter two criteria were especially taken into consideration because it is common that information criteria decrease when the number of profiles increases (Morin & Marsh, 2015).

After identifying an optimal LPA model, we used the 3-step method (R3STEP and DU3STEP settings) recommended by Asparouhov and Muthén (2014) to investigate the effect of covariates on the classification of profiles and the differences of outcome variables among the profiles. The 3-step method estimated the latent most likely class variable and linked it with predictors or outcome variables. This method is suitable for continuous distal outcome variables and when there are no profile changes after linking the latent class variables with outcomes or predictors, which was the case in the current study. We included only one covariate or outcome variable at a time in this step.

Additional two-level latent cluster analysis was conducted with R package ‘glca’ (Kim et al., 2022) in order to check whether the profiles would change if we consider the class ID as a group variable.

Results

Descriptive analysis

Descriptive information for the climate and outcome variables can be seen in Table 2. In general, the classrooms were rated as positive learning climate: with relatively high autonomy support, cooperative climate, and good classroom management. Goal clarity and performance goal focus were rated relatively lower by students in the academic track. Multi-group confirmatory factor analysis, conducted in order to know if the two tracks can be compared on the five dimensions of learning environment, showed that the means cannot be compared for goal clarity and performance goal focus (see Table 7 of Appendix). Thus, at a more restrictive level, we cannot really compare the two tracks on the two dimensions.

Based on the results from *t*-tests in Table 2 for the other three dimensions, students in the academic track provided higher ratings of autonomy support and cooperative climate. Students from the two tracks also differed in achievement, self-concept, and performance motivation, as well as satisfaction in schools. Based on Cohen’s *d*, we can also observe that the differences in achievement and self-concept were medium to large, whereas the other differences were small.

Table 2 Descriptive information for School climate and outcome variables

Variable	Academic M (SD)	Vocational M (SD)	<i>t</i>	<i>D</i>
<i>Classroom climate</i>				
Performance goal focus	2.87 (.80)	3.18 (.87)	–	–
Autonomy support	3.38 (.97)	3.26 (.95)	4.24***	.12
Cooperative climate	3.41(.96)	3.26 (.96)	5.36***	.16
Goal clarity	2.91(.95)	3.06 (.97)	–	–
Classroom management	3.30 (.94)	3.32 (.94)	– .40	–
<i>Outcomes</i>				
German grade	4.52 (.81)	4.08 (.76)	18.79***	.56
Self-concept	3.25 (.62)	3.02 (.69)	11.14***	.35
Intrinsic motivation	2.22 (.66)	2.22 (.65)	– .02	–
Performance motivation	2.18 (.74)	2.32 (.75)	– 6.43***	.19
Satisfaction with school life	7.05 (2.21)	6.86 (2.33)	2.85**	.08

p* < .01. *p* < .001

Latent profile analysis

The results of model comparison (models with 1–6 profiles) can be seen in Table 3. For the sample in the academic track, the model with four profiles was the optimal solution based on the adopted criteria. Although models with five and six profiles had lower LL, AIC, BIC, and aBIC, and higher entropy, they were not significantly better than the 4-profile

Table 3 Relative model fit indices of latent profile models

Model	LL	Npar	AIC	BIC	aBIC	Entropy	<i>p</i> 1	<i>p</i> 2	Small profile
<i>Academic track</i>									
1 Profile	– 17,499	10	35,018	35,077	35,045	1	–	–	–
2 Profiles	– 16,327	16	32,687	32,781	32,730	0.757	.0000	.0000	0
3 Profiles	– 15,947	22	31,939	32,068	31,998	0.735	.0003	.0003	0
4 Profiles	– 15,816	28	31,688	31,853	31,764	0.722	.0001	.0001	0
5 Profiles	– 15,748	34	31,564	31,764	31,656	0.744	0.23	0.23	1
6 Profiles	– 15,699	40	31,478	31,713	31,586	0.752	.06	.07	2
<i>Vocational track</i>									
1 Profile	– 12,783	10	25,585	25,641	25,609	1	–	–	–
2 Profiles	– 11,804	16	23,641	23,730	23,679	0.749	.0000	.0000	0
3 Profiles	– 11,336	22	22,715	22,838	22,768	0.792	.0000	.0000	0
4 Profiles	– 11,200	28	22,456	22,612	22,523	0.754	.004	.005	0
5 Profiles	– 11,148	34	22,365	22,554	22,446	0.74	.040	.043	0
6 Profiles	– 11,111	40	22,302	22,524	22,397	0.796	.23	.24	1

LL Loglikelihood, *Npar* number of parameters, *AIC* Akaike’s information criterion, *BIC* Bayesian information criterion, *aBIC* sample-size adjusted Bayesian information criterion, *p*1 is the *p* value of the Vuong-Lo Mendell-Rubin Likelihood Ratio test, *p*2 is the *p* value of the Lo-Mendell-Rubin Likelihood Ratio test, profile with less than 5% participants were considered as small profile

Table 4 Mean and SD of the climate variables for the profiles

Profile	Classroom management	Goal clarity	Autonomy support	Cooperative climate	Performance goal focus
<i>Academic track</i>					
Profile 1 (N=178)	2.12 (.14)	1.60 (.08)	1.45 (.06)	1.67 (.08)	2.78 (.12)
Profile 2 (N=687)	2.82 (.07)	2.39 (.06)	2.62 (.07)	2.83 (.05)	2.83 (.05)
Profile 3 (N=1271)	3.40 (.05)	3.00 (.04)	3.67 (.05)	3.58 (.05)	2.83 (.03)
Profile 4 (N=515)	4.12 (.05)	3.82 (.06)	4.42 (.04)	4.38 (.05)	3.04 (.06)
<i>Vocational track</i>					
Profile 1 (N=180)	1.94 (.09)	1.67 (.10)	1.55 (.09)	1.67 (.10)	2.76 (.10)
Profile 2 (N=661)	2.96 (.08)	2.64 (.07)	2.78 (.11)	2.83 (.11)	3.00 (.05)
Profile 3 (N=875)	3.60 (.08)	3.36 (.09)	3.65 (.09)	3.61 (.07)	3.22 (.05)
Profile 4 (N=213)	4.40 (.07)	4.26 (.10)	4.58 (.07)	4.42 (.08)	3.94 (.04)

Invariance test between the two groups showed that scalar invariance can be held for the scales

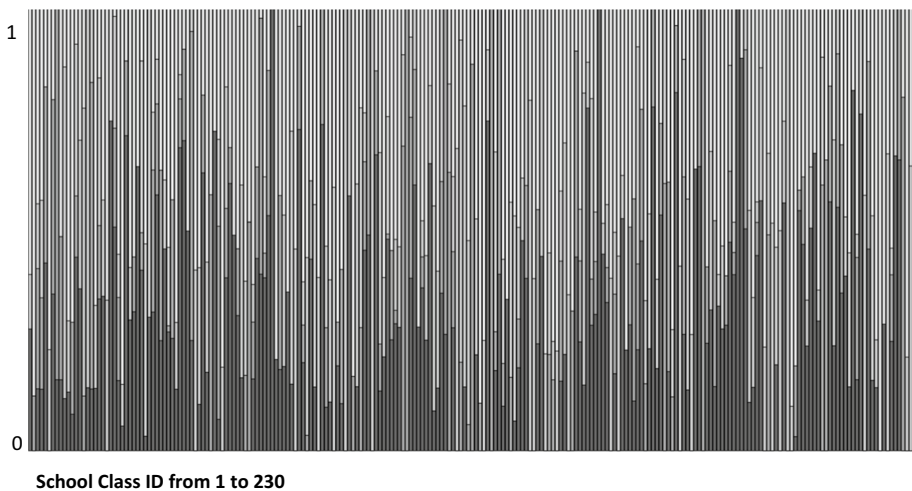


Fig. 1 Profile prevalence by school class ID based on data from academic track. *Note:* the prevalence of profile one to four is represented by bars with color black, dark grey, light grey, and white colors accordingly

solution and contained profiles with less than 5% of participants. The model with 4 profiles had satisfying indices, was significantly better than the model with 3 profiles, and did not include the extremely small profile.

For students in the vocational track, the model with 5 profiles and 4 profiles had similar indices, but the model with 5 profiles contained a profile with only 5.5% of the sample (slightly higher than the cut-off ratio) and was not significantly better if we set the cut-off for p -value at 0.01. Therefore, we chose the model with 4 profiles.

Specific information on the four profiles in both school tracks can be seen in Table 4 and Fig. 1. As it can be seen in Fig. 1, A1 (academic profile 1) and V1 (non-academic profile 1)

were quite similar: autonomy support was the lowest rated dimension (for other profiles it was goal clarity) and performance goal focus was the highest. Thus profile 1 can be named as ‘high performance stress and low autonomy support’ for both tracks. Profile 2 (A2 and V2) perceived less goal clarity and high performance goal focus and thus can be named as ‘high performance stress and low structure’ for both tracks. Because A3 and V3 were also similar, they can be described as ‘high support, low performance stress and structure’. Although the performance goal focus reported by A4 was not the lowest among profiles, it was still rated the lowest among dimensions. Thus A4 can be named as ‘highest support and low performance stress’. Because this pattern was not so obvious for V4, they can be named as ‘highest support’.

Generally the four profiles in each track had rated at least the four dimensions from low to high, whereas the same order was not observed for the rating of performance goal focus. Students from the vocational track rated performance goal focus relatively higher, and A2 and A3 did not differ too much on the performance goal focus. Goal clarity was rated lower than other dimensions except for profile 1, for whom the autonomy support was rated the lowest.

From the correlation table (Table 8 in the Appendix), we can also observe that actually the performance goal correlated weakly with other dimensions, especially for the non-academic track. However the correlations for other dimensions were quite high (equal or over 0.40).

In order to test if results would be different in a multi-level latent profile analysis with the class ID as a group variable, we did an additional analysis. The analysis excluded classes which contained fewer than 5 students ($N=2511$ and 66 classes were deleted for the academic track; $N=1722$ and 103 classes were deleted for the vocational track). The results showed that class prevalence was influenced by the group variable and that some classes were more likely to have a specific profile (Figs. 1 and 2 in Appendix). Some classes (3–5 in each track) contained only the second profile, which rated the environment as the worst. The models with the class ID as a group variable had a better fit than the

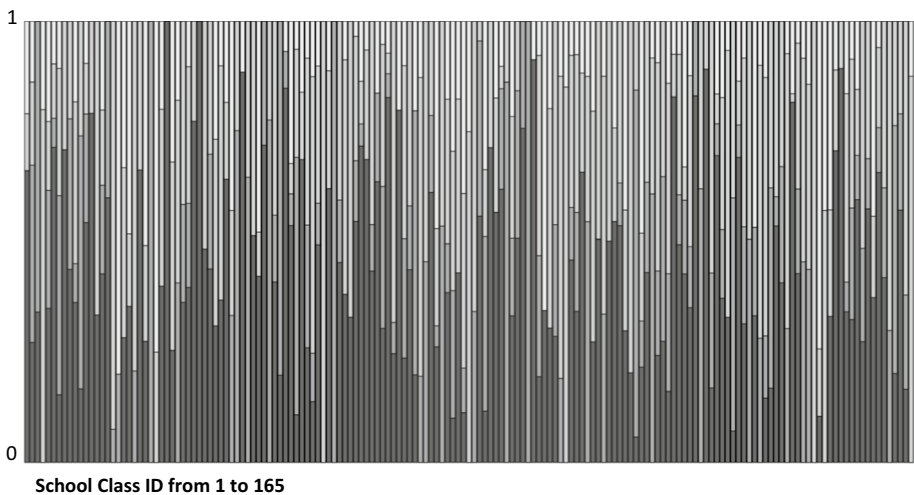


Fig. 2 Profile prevalence by school class ID based on data from vocational track. *Note:* the prevalence of profile one to four is represented by bars with color black, dark grey, light grey, and white colors accordingly

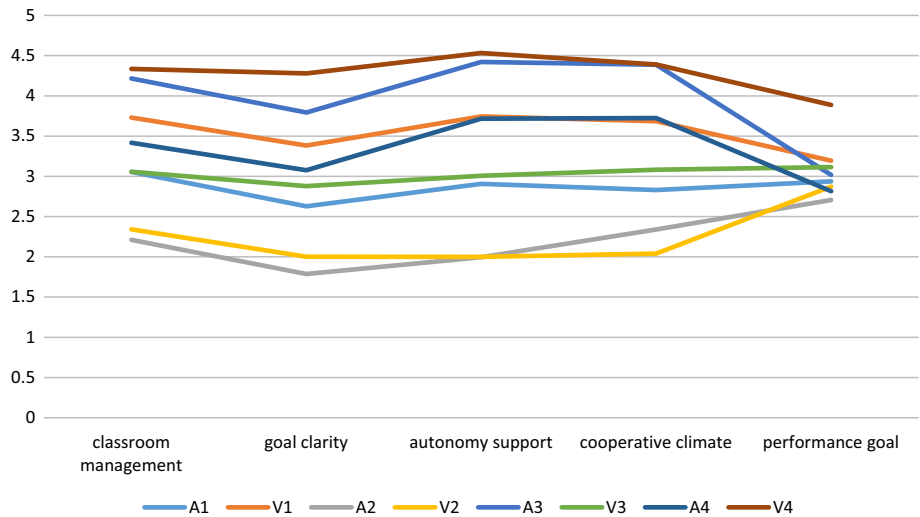


Fig. 3 Two-level Latent Profiles of Students Based on Their Perceptions of School Climate. *Note.* A1–A4 means the new first to fourth profile in the academic track using multilevel LPA, V1–V4 means the new first to fourth profile in the vocational track using multilevel LPA

Table 5 Logistic regression coefficients of covariates explaining the profile membership probability

Predictors	<i>B</i>	<i>SE</i>	<i>p</i>	OR [95%CI]
<i>Academic track</i>				
<i>Gender (0 = male)</i>				
Profile 2 vs. profile 1 (reference)	.66**	.22	.002	1.94* [1.27, 2.98]
Profile 3 vs. profile 1 (reference)	.60**	.20	.003	1.82* [1.23, 2.68]
Profile 4 vs. profile 1 (reference)	.77***	.22	.000	2.16* [1.40, 3.33]
<i>Migration background</i>				
Profile 3 vs. profile 2 (reference)	– .24	.12	.05	.79* [.62, 1.00]
<i>Vocational track</i>				
<i>Migration background</i>				
Profile 3 vs. profile 2 (reference)	– .26*	.13	.04	.77* [.60, .98]

* $p < .05$. ** $p < .01$. *** $p < .001$

models without, as was shown by the deviance analysis (p value of chi square tests were less than 0.001 for both tracks). The profiles and their characteristics were however almost the same (Fig. 3 in Appendix).

Covariates influencing the membership classification

The second RQ pertained to possible covariates of profile membership probability. The analyses, presented in detail in Table 5, showed that, in both tracks, migration background was a significant covariate, and gender was a significant covariate for students in the academic track, influencing the probability of belonging to a profile.

For students in the academic track, the probability of girls belonging to the other three profiles was higher than that of belonging to the first profile. Girls in general had more positive perceptions of the German class climate. It was also more likely that students with a migration background belonged to the second profile (higher stress and lower support) instead of the third profile (similar stress level and higher support). For students in the vocational track, the effect of migration background was the same but there was no effect of gender.

Differences in outcomes among the profiles

The third RQ was about the differences among the profiles in the outcome variables including the self-reported German grade, satisfaction with school life, and learning motivation variables in reading. Means of the outcome variables in each profile can be seen in Table 6.

German grade and self-concept

Wald-tests showed that the students with different profiles in both tracks had different German grade ($\chi^2_{\text{academic}}(3) = 25.53^{***}$; $\chi^2_{\text{vocational}}(3) = 18.52^{***}$). The more positive the class climate perceived by students, the higher achievement that they had in the last semester. After correction of the pairwise comparisons using Holm method, differences were significant for four comparisons in each track: between the A4 and each of the other three profiles, between the A1 profile and A3 profile for students in the academic track; between the V1 and V3, between V1 and V4, as well as between V2 and V3, and between V2 and V4 for students in the vocational track.

Similarly, there were also significant differences in reading self-concept among the profiles in the academic track ($\chi^2_{\text{academic}}(3) = 103.13^{***}$). For the academic track, the A3 had

Table 6 Comparison of outcome variables among profiles

Profile	Mean (SD)				
	German grade	Reading self-concept	Reading interest	Performance motivation in reading	Satisfaction with school life
<i>Academic track</i>					
Profile 1	4.30 (.08)	3.26 (.12)	1.63 (.05)	2.11 (.08)	5.32 (.26)
Profile 2	4.42 (.05)	3.39 (.14)	1.98 (.03)	2.06 (.05)	7.32 (.21)
Profile 3	4.53 (.03)	3.05 (.06)	2.25 (.03)	2.17 (.05)	6.69 (.10)
Profile 4	4.70 (.06)	3.52 (.03)	2.67 (.04)	2.35 (.06)	8.21 (.09)
χ^2	25.53***	103.13***	335.42***	29.90***	209.76***
<i>Vocational track</i>					
Profile 1	3.89 (.08)	3.02 (.07)	1.58 (.06)	2.15 (.07)	6.47 (.22)
Profile 2	3.99 (.04)	2.99 (.04)	2.04 (.03)	2.14 (.04)	6.01 (.14)
Profile 3	4.16 (.04)	3.04 (.03)	2.35 (.03)	2.34 (.04)	7.57 (.14)
Profile 4	4.18 (.06)	3.06 (.06)	2.77 (.07)	2.86 (.07)	7.19 (.29)
χ^2	18.52***	1.32	237.35***	93.20***	61.94***

* $p < .05$. ** $p < .01$. *** $p < .001$

the lowest self-concept, which was significantly lower than the A4 profile. However, the differences in self-concept among profiles were not significant for students in the vocational track.

Domain-specific intrinsic motivation and performance motivation

Students with different profiles differed in domain-specific intrinsic motivation ($\chi^2_{\text{academic}}(3) = 335.42^{***}$, $\chi^2_{\text{vocational}}(3) = 237.354^{***}$). All of the pairwise comparisons were significant even after correction. Similarly to the relationship between profile membership and self-reported German grade, the more positive was classroom climate the students reported, the higher interest they had.

Regarding performance motivation, there was also significant difference among profiles ($\chi^2_{\text{academic}}(3) = 29.90^{***}$; $\chi^2_{\text{vocational}}(3) = 93.196^{***}$). For the academic track, the A2 profile had the lowest performance motivation, significantly lower than the A4. For the vocational track, the V2 profile also had the lowest performance motivation, significantly lower than V3 and V4.

Satisfaction with school life

Students with different profiles also reported different satisfaction with school life ($\chi^2_{\text{academic}}(3) = 209.76^{***}$; $\chi^2_{\text{vocational}}(3) = 61.94^{***}$). For the academic track, all of the pairwise comparisons showed significant differences. Generally, the more positive that students rated the classroom climate, the more satisfied that they were with their school life. The only exception was the A2 profile. Students belonging to this profile had higher satisfaction than the A3 profile. For the vocational track, both V1 and V2 profiles had significantly less satisfaction with school in comparison with V3 and V4.

Discussion and conclusion

Similar to previous studies (Rohatgi & Scherer, 2020; Van Eck et al., 2017), this study revealed profiles with different levels of positive or negative perceptions. Within profiles, the climate was perceived holistically (at least for the four positive dimensions). The evaluation of instruction (Hochweber & Vieluf, 2018; Kunter & Voss, 2011) and social interactions (Hamre & Pianta, 2010; Murayama & Elliot, 2009; Reeve & Jang, 2006) were somehow related. Students in Grade 8 are at the phase between early and middle adolescence and are experiencing changes of puberty and middle-school transition (Goldstein et al., 2015; Way et al., 2007). Students' academic and social self-concepts might be related (Wentzel, 1991) and it is not unexpected that their perceptions of these two aspects of learning environment were connected. This implies that students' dissatisfaction or frustration towards one aspect can be extended to the other. Students with a negative perception of the climate perceived low quality of instruction, low autonomy support compared with others, which indicated a relatively poor subjective climate where the basic needs for autonomy, competence and relatedness cannot be satisfied (Deci & Ryan, 1985; Ryan & Deci, 2000). Consequently, they were unsatisfied with their school life, had lower interest, self-concept and achievement, which was also shown by previous studies (Dorman, 2001; Rohatgi & Scherer, 2020; Sandilos et al., 2017; Seidel et al., 2005; Spearman & Watt, 2013; Yi & Lee, 2017). They might be at risk of developing behaviour problems

such as depression or delinquency, as has been shown by Van Eck et al. (2017) and Way et al. (2007). Therefore, a comprehensive intervention including both academic and social aspects might be more efficient. Changing the situation in the most critical aspect might also bring benefit in the other.

Based on LPA, we were able to reconsider our definition of a higher or lower rating of climate perception. For example, the A4 profile rated performance focus higher than A1 profile. However it was the lowest rated dimension among all dimensions for A4 and highest rated dimension for A1. Performance focus actually had a different meaning and function for the two groups of students. If we only focus on the relationship between performance goal and achievement using a variable-centered approach without a holistic perspective on the classroom climate, we might make different conclusions. Through LPA, we also identified the characters of the group at risk (the profile with high stress and low support). It was more important to provide them with autonomy support instead of asking them to perform better. For them, it is more important to explore their own goals, make them connected with the educational or instructional goals, focus on their development and encourage them to gain control over their learning (Ryan & Deci, 2000). Additionally, communication on their perceptions of the classroom climate can also help teachers to detect their difficulties, problems and disengagement earlier.

Generally, students with more positive perception of classroom climate had higher domain-specific interest, self-concept, performance motivation, achievement and life satisfaction. There was, however, one exception in the case of self-concept: the difference in self-concept among profiles in the vocational track was not significant; one profile in each track showed the lowest self-concept among profiles although their perception was not the least positive. Self-concept might also be influenced by other factors such as reference groups of social comparison (e.g. small-fish-big-pond effect) and thus more evidence is needed to explore the relationship between students' perceptions of themselves and school climate as well as possible mediators or moderators. Moreover, there was another exception for life satisfaction for the moderately negative profile in the academic track. Students belonging to A2 had less positive perceptions of the climate but higher school life satisfaction in comparison with students belonging to A3. They had a similar perception of performance goal focus but A2 had less reported support. Considering possible higher rate of students with a migration background in A2, one speculation could be that they felt more satisfied because the learning environment has already been better than what they had experienced before. Additionally, other factors such as social comparison (Fujita & Diener, 1997), expectation and motivation in reading or German learning, as well as other contexts in school settings (eg. classroom climate in other subjects), might also have impact on their life satisfaction in schools.

Gender and migration background were associated with students' perceptions, which was consistent with previous studies (Eccles & Blumenfeld, 1985; Hajovsky et al., 2017; Hochweber & Vieluf, 2018; Rohatgi & Scherer, 2020; Sandilos et al., 2017). Girls tended to have more positive perceptions in German classes, which might be due to their higher reading interest and achievement (Logan & Johnston, 2010). Moreover, a PISA study has revealed disadvantages among children with a migration background in Germany (OECD, 2019). Considering their disadvantage in the instruction language (LeClair et al., 2009) or their (sub) culture-related preferences with respect to teacher behaviour (Thijs et al., 2012), it can be expected that they would feel lack of support in comparison with their classmates if no additional support for them was provided.

Some differences between tracks were observed, although we should bear in mind that the means of two dimensions cannot be directly compared between tracks at a more

restrictive level. Descriptively we observed that students in the non-academic track rated the performance focus of the environment relatively high. Because the school tracking system was also considered as ability grouping (Maaz et al., 2008) and students with lower achievement might hold performance-avoidance goals (Wolters, 2004), students in the vocational track might perceive more stress and competition among their peers. Besides, their similar career perspectives and potential competition make the social comparisons among them more likely to happen (Festinger, 1954). Furthermore, gender only predicted the profile membership probability of students in the academic track. In their classrooms, female students showed their interest in reading and had advantages in language learning, as was found in other studies (Logan & Johnston, 2010). For students in the vocational track where there is occupational gender segregation, female students in vocational programs with different professional focuses might face different situations which cannot be generalized.

In conclusion, this study showed that (1) there were four latent profiles of students regarding their perceptions of German classroom climate: A1/V1 (high performance stress and low autonomy support), A2/V2 (high performance stress and low structure), A3/V3 (high support, low performance stress and structure), and A4 (highest support and low performance stress)/V4 (highest support); (2) migration background and gender were covariates which can predict the probability of belonging to a specific profile; (3) generally profiles with perceptions of higher social and instructional support had higher interest, performance motivation, and achievement in reading as well as satisfaction in schools, although exceptions were observed in case of self-concept and life satisfaction; (4) the profiles of students in academic and vocational tracks were quite similar, but differences regarding the rating on performance focus, self-concept disparity among profiles, and gender effect were not yet observed.

Implications and limitations

Students' perception of learning climate was related to multiple outcomes including learning motivation, achievement and well-being. This result was in line with other findings from longitudinal studies, which indicated that the 'psychological' climate had a unidirectional influence on well-being and adjustment in schools (Way et al., 2007). Using latent profile analysis, we found something that might be ignored by variable-centered approaches (Ferguson et al., 2020). Patterns of rating on different dimensions for a specific cluster cannot be found and the characters of the group at risk might not be fully depicted through the variable-centered approach. The results contributed to the understanding of students' classroom climate perception and how they were related to outcomes and demographic variables. Social and academic aspects being closely related to each other indicated a more comprehensive framework including both aspects of learning environment is needed. The results also revealed the characters of the group at risk, who perceived high performance stress but low autonomy support. It might help to optimize our intervention plan.

From a practical aspect, our findings indicated that communications between students and teachers about students' perceptions of classroom climate can facilitate early detection of individuals at risk who could be included later in school intervention programmes. The close relationship between perceptions of instructional quality and social interactions implies that an intervention for one of the two aspects might be a stepping-stone for the other aspect. Furthermore, it would also be meaningful to help the group at risk by involving them in identifying students' own learning goals, connecting them with educational goals, and helping them to internalize the regulations and promote their autonomy.

Students' perceptions were related to gender and migration background. This implies that male students or students with a migration background might have specific needs in German classroom due to, for example, gender stereotypes, insufficient command of the language of instruction, or cultural factors. How students form their perception and influence each other within the group might be worth investigating in the future (Schenke et al., 2017). The results of this study also provide insights into differences and similarities between school tracks. Different school tracks could differ in key dimensions of instructional quality and forms of social interactions, which has not been recognized in past research. The relationship between perceptions and gender and self-concept was also not as straightforward for students in the vocational track as for those in the academic track, which might be worth exploring in the future.

Because we had a relatively low average participation rate (around 35%) within a class and did not find powerful second-level predictors, we cannot draw solid conclusions at the class level. For future study, it is necessary to have a close look at the influence of class-level predictors on students' perceptions, especially for classes dominantly with profiles with negative rating.

Because our study was cross-sectional, we cannot make causal conclusions. Because there were also no indicators of the objective classroom climate, we can only define our measurement as the 'psychological climate'. Additionally, although including class-level variables can help us identify the source of class-level variance, the scales had insufficient class-level reliability to support an analysis. Moreover, important factors such as motivational prerequisites or personal goals were not included. Future research should apply a longitudinal design, include motivational indicators, and use objective observations to better understand the role of both objective and perceived climate in the development of multiple outcomes.

Appendix

Tables 7, 8.

Table 7 Multi-group CFA results for the five dimensions of learning environment perception between two tracks

Model	$\Delta\chi^2$	CFI	Δ CFI	Level of MI
<i>Classroom management</i>				
Configural		.97		
Metric	2.50	.97	0	
Scalar	55.54***	.96	-.01	scalar
<i>Goal clarity</i>				
Configural				
Metric	1.38	1		
Scalar	8.37***	.983	-.017	metric
<i>Autonomy support</i>				
Configural				
Metric	7.30*	.999		
Scalar	3.49***	.993	-.006	scalar
<i>Cooperative climate</i>				
Configural				
Metric	3.55	1		
Scalar	69.90***	.99	-.01	scalar
<i>Performance goal focus</i>				
Configural				
Metric	2.18	1		
Scalar	46.97***	.977	-.023	metric

MI = measurement invariance. We used the widely applied criterion for large-scale analysis of checking invariance: CFI reduction not more than .01 (Cheung & Rensvold, 2002)

Table 8 Correlations among five scales of perceived environment

Variable	Correlations											
	Gender	MB	PGF	AS	CC	GC	CM	IM	PM	SC	LS	GG
Gender	1	0	-.05	.07	.07	.01	.01	.15	-.11	-.11	.06	.2
MB	.04	1	-.04	-.04	-.03	0	-.02	-.02	.06	-.08	-.05	-.11
PGF	-.06	.02	1	.03	.02	.18	.15	.13	.22	-.06	-.02	-.01
AS	.02	0	.27	1	.64	.51	.5	.36	.07	.04	.18	.15
CC	.05	.01	.23	.67	1	.5	.4	.32	.08	.04	.16	.12
GC	-.01	.05	.3	.59	.54	1	.43	.31	.12	-.01	.08	.05
CM	-.01	.01	.26	.59	.49	.5	1	.31	.08	.02	.13	.07
IM	.06	.05	.23	.42	.34	.37	.36	1	.21	.08	.11	.22
PM	-.12	.11	.31	.22	.14	.2	.15	.35	1	.01	.11	.08
SC	-.05	-.01	-.1	.04	0	-.02	.01	.05	0	1	.15	.2
LS	-.01	-.01	.02	.16	.12	.08	.14	.21	.16	.18	1	.33
GG	.19	-.09	0	.14	.11	.04	.08	.19	.08	.22	.26	1

Significant correlations were in bold. MB migration background. PGF performance goal focus. AS autonomy support. CC cooperative climate. GC goal clarity. CM classroom management. IM intrinsic motivation. PM performance motivation. SC = self-concept. LS life satisfaction. GG German grade

Outcome and covariate variables in academic (below diagonal) and non-academic (above diagonal) samples

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Data availability This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort Grade 5, <http://dx.doi.org/10.5157/NEPS:SC3:10.0.0>. The data that supports the findings of this study is available from the Leibniz Institute for Educational Trajectories (<https://www.neps-data.de/Data-Center/Data-Access>). Restrictions apply to the availability of this data, which is the reason why it cannot be provided by the authors of the study. Survey questionnaires are available on the NEPS study website (<https://www.neps-data.de/Data-Center/Data-and-Documentation>).

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