

The Composite Weight of CILS4NEPS: Joint Weighting of the German CILS4EU Sample and the Sample of Starting Cohort 4 of the German National Educational Panel Study (Wave 1)

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Technical Report referring to [DOI:10.5157/CILS4NEPS:SUF:1.0](https://doi.org/10.5157/CILS4NEPS:SUF:1.0)

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Abstract

This report documents the derivation of the joint Grade 9 weight for the pooled samples of the German panel of CILS4EU and Starting Cohort 4 (SC4) of the German National Educational Panel Study (NEPS). Both studies share the same target population: They focus on the educational pathways of Grade 9 students initially educated in different types of regular schools and special-need schools (focussing on learning disabilities) in Germany in the school year of 2010/2011. Pooled analysis of these two different cohorts requires a composite weight of Grade 9 students in the school year 2010/2011. This report details the corresponding weighting procedure. That is, the composite weight is constructed by minimizing the variance of a weighted sum of different population sizes. The weights are calibrated to population totals given in official school statistics.

1 Prequel

This report documents the derivation of the joint Grade 9 (Wave 1) weight for the pooled samples of the German panel of CILS4EU and Starting Cohort 4 (SC4) of the National Educational Panel Study (NEPS).¹ It supplements the original nonresponse and weighting reports of Steinhauer et al. (2015) giving details on the sample design together with the nonresponse adjustment of design weights and Steinhauer and Zinn (2016) giving details on wave-specific nonresponse adjustment for Waves 1 to 6 in NEPS SC4 as well as the Wave 1 report of CILS4EU (CILS4EU, 2016), respectively.

It refers to the corresponding Scientific Use File (SUF; [DOI:10.5157/CILS4NEPS:SUF:1.0](https://doi.org/10.5157/CILS4NEPS:SUF:1.0)).

2 CILS4EU German panel

CILS4EU-G focuses on the intergenerational integration of children of immigrants in Germany. The data allows analyzing the complex causal interplay between the processes of structural, social, and cultural integration

The target persons were sampled representatively in the school year 2010/2011 via a stratified multistage cluster sampling approach in all Federal States with except of Bavaria. Interviewing started in fall 2010 at age 14 with a subsequent follow up of the adolescents over the next two years. CILS4EU-G comprises 5,125 panel members, with 5,013 participants in Wave 1.

3 NEPS Starting Cohort 4

The German National Educational Panel Study (NEPS) surveys a cohort sample of Grade 9 students (Starting Cohort 4) and follows their educational pathways in the secondary level and their transition into the vocational education system into higher education program or (and finally) into the labor market.

The target persons were sampled representatively in the school year 2010/2011 via a stratified 2-stage cluster sampling approach. The first survey for ninth graders was conducted in the institutional context in fall/ winter 2010. The NEPS SC4 comprises 16,425 panel members at the age of almost 15 years, of whom 16,106 participated immediately in Wave 1. For harmonization the subgroup of panel respondents with survey data only were considered. That is, the sample size reduces to 16,375 target persons.

4 Composite Weighting of CILS4NEPS

Sampling of CILS4EU-G and NEPS SC4 was quite similar and conducted by the IEA Data Processing Center DPC. In both studies, the first stage sampling units consisted of individual schools enrolling the relevant target group. Sampling of schools was done with probability proportional to size (*pps* sampling). The measure of size of the school was the number of classes or

¹For general information on the NEPS, see Blossfeld and Roßbach, 2019; Blossfeld et al., 2011. More detailed information is available in the documentation section on the [homepage](#).

the number of students in Grade 9. Prior to sampling, schools were assigned to mutually exclusive groups: Explicit strata in CILS4EU-G were build by the proportion of students with an immigrant background in the schools, and in the NEPS SC4 by the type of school. The second stage sampling units were classes within sampled schools. Two classes were selected at random and all students within these classes were asked for participation. Both samples can be considered as being independent of each other. An overlap of schools was circumvented by the survey institute carrying out the survey (IEA) through the definition of replacement rules for sampling of schools.

Pooled analysis of these two different cohorts requires a composite weight of Grade 9 students in the school year 2010/2011. Composite weighting according to Chu et al. (1999) is a straightforward way. Without loss of generality, we use the size of the Grade 9 students population in the school year 2010/2011 as population parameter of interest for construction of the joint Grade 9 weight. Let n^N denote the sample size of NEPS SC4 and n^C the respective sample size of CILS4EU-G. The calibrated panel entry weights are denoted by w^N and w^C , respectively. That is, for NEPS SC4 we used `w_t` and for CILS4EU-G `totwghts`, although the latter is not a panel entry weight because it refers to the participants in wave 1 only. Both weights include the institutional weights already and are calibrated each by school type and Federal State. The unbiased estimates of the true population size N can now be derived as:

$$\widehat{N}^N = \sum_{i=1}^{n^N} w_i^N = 828,479 \quad \text{and} \quad \widehat{N}^C = \sum_{i=1}^{n^C} w_i^C = 828,479$$

with

$$n^N = 16,375 \quad \text{and} \quad n^C = 5,013 .$$

The unbiased estimate of N for any choice of α with $\alpha \in (0, 1)$ is then:

$$\widehat{N}_\alpha = \alpha \sum_{i=1}^{n^N} w_i^N + (1 - \alpha) \sum_{i=1}^{n^C} w_i^C .$$

The joint weight for Grade 9 students $w = [w_1, \dots, w_{N^N+N^C}]$ can be directly computed for $i = 1, \dots, N^N + N^C$ as

$$w_i = \begin{cases} \alpha w_i^N & \text{for all students } i \text{ who are part of NEPS SC4 and} \\ (1 - \alpha) w_i^C & \text{for all students } i \text{ who are part of CILS4EU-G .} \end{cases}$$

For minimizing the design effect of the weighted estimate, and hence, to avoid variance inflation because of weighting, α has to be chosen to minimize the variance of the estimated population parameter (here population size \widehat{N}_α). The variance of \widehat{N}_α is

$$\text{Var}(\widehat{N}_\alpha) = \alpha^2 \text{Var}(\widehat{N}^N) + (1 - \alpha)^2 \text{Var}(\widehat{N}^C) + 2\alpha(1 - \alpha) \text{Cov}(\widehat{N}^N, \widehat{N}^C) .$$

The corresponding derivative with respect to α gives

$$\frac{\partial \text{Var}(\widehat{N}_\alpha)}{\partial \alpha} = 2\alpha \text{Var}(\widehat{N}^N) - 2(1 - \alpha) \text{Var}(\widehat{N}^C) + 2(1 - 2\alpha) \text{Cov}(\widehat{N}^N, \widehat{N}^C) .$$

Setting this equation to zero yields the following optimal value for α , which ensures minimal variance:

$$\alpha = \frac{\text{Var}(\widehat{N}^c) - \text{Cov}(\widehat{N}^N, \widehat{N}^c)}{\text{Var}(\widehat{N}^N - \widehat{N}^c)}.$$

Please note that the selection of α is crucial and there exists no value that is optimal for all kinds of analyses. We examined two variants for the definition of α : the population size and the size of female students. Defining α this way addresses all weighted analyses with respect to the whole population. Please keep in mind that consideration of other subgroups of the Grade 9 students population may yield different optimal values for α .

Because both samples can be considered as being independent of each other, $\text{Cov}(\widehat{N}^N, \widehat{N}^c) \approx 0$ and the formula for α simplifies to

$$\alpha \simeq \frac{\text{Var}(\widehat{N}^c)}{\text{Var}(\widehat{N}^N + \widehat{N}^c)}.$$

If (approximately) $\text{Var}(\widehat{N}^N) = \frac{c}{n^N}$ and $\text{Var}(\widehat{N}^c) = \frac{c}{n^c}$ for a constant c , α further reduces to

$$\alpha \simeq \frac{n^c}{n^N + n^c}.$$

yielding the following optimal values for $\alpha = 0.2344$ and $\alpha = 0.2363$ for the population size and the size of female students, respectively. We refer to $\alpha = 0.2363$ the size of female students for further calculations.

5 Participation in Wave 1

To account for the wave-specific participation decision of students response propensity re-weighting is used to provide corresponding weights. To model binary participation decisions a generalized model with probit link function and random effect at the school level is used. The significant coefficients for the estimated models are displayed in Table 1. We can see that students from “Förderschulen” are significantly less likely to participate opposed to students from “Gymnasium”. Having missing values in age, migration background or primary language also decreases participation propensity significantly.

Table 1: Model estimating the individual participation propensities for Grade 9 students in Wave 1.

	Wave 1
(Intercept)	2.907*** (0.129)
School type: Förderschule (ref. = "Gymnasium")	−0.889*** (0.116)
School type: Hauptschule (ref. = "Gymnasium")	0.040 (0.108)
School type: Integrierte Gesamtschule/ Freie Waldorfschule (ref. = "Gymnasium")	−0.157 (0.125)
School type: Schule mit mehreren Bildungsgängen (ref. = "Gymnasium")	0.120 (0.175)
School type: Realschule (ref. = "Gymnasium")	0.025 (0.115)
Age group: younger half (ref. = "older half")	0.053 (0.058)
Age group: missing (ref. = "older half")	−1.368*** (0.317)
Migration background: missing (ref. = "no")	−0.733*** (0.100)
Migration background: yes (ref. = "no")	−0.131 (0.083)
Primary language: German (ref. = "Other")	0.0001 (0.073)
Primary language: missing (ref. = "Other")	−3.001*** (0.144)
Random effect	0.4775
Observations	21,500

Note. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

6 Summary of Weights

Various kinds of weights for students from CILS4EU-G together with NEPS SC4 are provided. Besides individual (ID_t) and institutional (ID_i) identifiers, Table 2 summarizes the different weights provided by SUF release version DOI:10.5157/CILS4NEPS:SUF:1.0. Nonresponse adjusted design weights on the individual (w_t) level are given for both cohorts jointly. For all participants in Wave 1, cross-sectional weights are provided. The general overview of variables contained in the weighting data set is accompanied by summarizing statistics of all weights provided, see Table 3.

Unstandardized and untrimmed as well as standardized and trimmed weights are provided to enable own calculations. Generally, we recommend to make use of the trimmed and standardized weights only. Trimming increases statistical efficacy by reducing the sample variance. Standardization to mean 1 and sum of the weights equaling the number of cases weighted eases the use of the weights.

Panel entry weights are calibrated to the population in Grade 9 in school year 2010/2011, with regard to school type and Federal State (Statistisches Bundesamt, 2011). After calculation of the composite weights calibration was repeated with regard to gender and school type. The corresponding population margins as well as the sample and population proportions are given in the Tables 4 to 8 in the Appendix.

Table 2: Variables included in the weighting data set for CILS4NEPS

Variable	Applies to	Content
<i>Identifier</i>		
ID_t	all targets	Identifier for target person
ID_i	all institutions	Identifier for institution
source	all	Identifier for source (CILS4EU-G/ NEPS SC4)
<i>Survey weights adjusted for nonresponse</i>		
w_t_CILS4NEPS	21388	Nonresponse adjusted joint panel entry weight for targets with panel consent (unstandardized)
w_t_CILS4NEPS_cal	21388	Calibrated nonresponse adjusted joint panel entry weight for targets with panel consent (unstandardized)
w_t1_CILS4NEPS	21119	Cross-sectional weight for targets participating in wave 1 (unstandardized)
w_t_CILS4NEPS_std	21388	Nonresponse adjusted joint panel entry weight for targets with panel consent (standardized)
w_t_CILS4NEPS_cal_std	21388	Calibrated nonresponse adjusted joint panel entry weight for targets with panel consent (standardized)
w_t1_CILS4NEPS_std	21119	Cross-sectional weight for targets participating in wave 1 (standardized)

Table 3: Summary statistics for all weights provided.

Label of weights	Min.	Lower Quart.	Median	Mean	Upper Quart.	Max.
w_t_CILS4NEPS	0.788	8.786	14.245	19.823	22.096	757.031
w_t_CILS4NEPS_cal	0.751	10.507	15.583	38.736	31.402	1508.651
w_t1_CILS4NEPS	0.763	10.637	15.751	40.041	32.421	2880.685
w_t_CILS4NEPS_std	0.042	0.471	0.764	1	1.186	4.156
w_t_CILS4NEPS_cal_std	0.025	0.343	0.509	1	1.026	5.097
w_t1_CILS4NEPS_std	0.024	0.34	0.503	1	1.035	5.104

For further information on weighting please contact statistik@lifbi.de.

Acknowledgements

This paper uses data from the National Educational Panel Study (NEPS; see Blossfeld and Roßbach, 2019). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LifBi, Germany) in cooperation with a nationwide network (NEPS Network, 2023).

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A Comparison of the distributions of the sample data and the target distributions (DESTATIS, Fachserie 11, Reihe 1)

Table 4: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to gender.

Gender	Net sample			Population	
	CILS %	NEPS %	All %	%	Total
male	51.14	50.59	50.72	51.28	424806
female	48.86	49.41	49.28	48.72	403673
Total	100	100	100	100	828479

Table 5: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to school type.

School type	Net sample			Population	
	CILS %	NEPS %	All %	%	Total
GY	19.8	32.29	29.32	34.1	282484
FS	2.42	7.19	6.05	4.19	34736
HS	30.07	23.13	24.78	18.41	152558
IG/ FW	16.33	10.37	11.79	10.19	84418
MB	4.59	7.24	6.61	7.99	66178
RS	26.79	19.78	21.45	25.12	208105
Total	100	100	100	100	828479

Note. GY - Gymnasium, FS - Förderschule, HS - Hauptschule, IG/ FW - Integrierte Gesamtschule/ Freie Waldorfschule, MB - Schule mit mehreren Bildungsgängen, RS - Realschule.

Table 6: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to Federal State.

Federal State	Net sample			Population	
	CILS %	NEPS %	All %	%	Total
Brandenburg	0.57	2.36	1.93	2.12	17594
Berlin	7.57	2.22	3.5	3.39	28081
Baden-Württemberg	18.26	15.22	15.94	14.68	121613
Bayern	0	13.62	10.38	16.75	138777
Bremen	1.8	0.65	0.93	0.76	6314
Hessen	11.75	8.87	9.56	7.6	63003
Hamburg	2.32	1.89	2	1.88	15591
Mecklenburg-Vorpommern	0.8	1.76	1.53	1.35	11178
Niedersachsen	9.39	10.87	10.52	10.77	89250
Nordrhein-Westfalen	35.57	25.65	28.02	23.87	197751
Rheinland-Pfalz	8.53	4.52	5.47	5.25	43474
Schleswig-Holstein	0.53	3.27	2.61	3.82	31622
Saarland	0.72	1.4	1.24	1.25	10341
Sachsen	0.41	3.19	2.53	2.98	24726
Sachsen-Anhalt	0.62	2.11	1.75	1.84	15209
Thüringen	1.17	2.38	2.09	1.68	13955
Total	100.01	99.98	100	99.99	828479

Table 7: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to gender and Federal State.

Gender	Federal State	Net sample			Population	
		CILS %	NEPS %	All %	%	Total
male	Brandenburg	0.33	1.23	1.01	1.1	9082
male	Berlin	4	1.13	1.81	1.74	14414
male	Baden-Württemberg	9.23	7.76	8.11	7.55	62559
male	Bayern	0	7.29	5.55	8.63	71486
male	Bremen	0.7	0.28	0.38	0.39	3261
male	Hessen	5.72	4.68	4.93	3.91	32393
male	Hamburg	1.29	0.88	0.98	0.96	7963
male	Mecklenburg-Vorpommern	0.45	0.95	0.83	0.69	5724
male	Niedersachsen	4.43	5.49	5.24	5.49	45481
male	Nordrhein-Westfalen	18.81	12.9	14.31	12.23	101323
male	Rheinland-Pfalz	4.25	1.97	2.52	2.69	22246
male	Schleswig-Holstein	0.31	1.55	1.25	1.97	16341
male	Saarland	0.41	0.71	0.64	0.64	5273
male	Sachsen	0.33	1.49	1.21	1.5	12463
male	Sachsen-Anhalt	0.18	1.17	0.93	0.93	7724
male	Thüringen	0.7	1.12	1.02	0.85	7073
female	Brandenburg	0.23	1.14	0.92	1.03	8512
female	Berlin	3.57	1.09	1.68	1.65	13667
female	Baden-Württemberg	9.03	7.46	7.84	7.13	59054
female	Bayern	0	6.34	4.83	8.12	67291
female	Bremen	1.09	0.37	0.54	0.37	3053
female	Hessen	6.03	4.19	4.63	3.69	30610
female	Hamburg	1.03	1.01	1.02	0.92	7628
female	Mecklenburg-Vorpommern	0.35	0.81	0.7	0.66	5454
female	Niedersachsen	4.96	5.38	5.28	5.28	43769
female	Nordrhein-Westfalen	16.76	12.75	13.71	11.64	96428
female	Rheinland-Pfalz	4.27	2.55	2.96	2.56	21228
female	Schleswig-Holstein	0.21	1.72	1.36	1.84	15281
female	Saarland	0.31	0.69	0.6	0.61	5068
female	Sachsen	0.08	1.7	1.32	1.48	12263
female	Sachsen-Anhalt	0.45	0.94	0.82	0.9	7485
female	Thüringen	0.47	1.26	1.07	0.83	6882
Total		99.98	100	100	99.98	828479

Table 8: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to school type and Federal State.

School type	Federal State	Net sample			Population	
		CILS %	NEPS %	All %	%	Total
GY	Brandenburg	0	0.84	0.64	0.11	870
GY	Berlin	4.04	0.77	1.55	0.12	982
GY	Baden-Württemberg	1.48	5.67	4.67	0.62	5111
GY	Bayern	0	3.87	2.94	0.51	4242
GY	Bremen	0.29	0.33	0.32	0.03	284
GY	Hessen	2.87	2.28	2.42	0.36	2943
GY	Hamburg	0.96	0.6	0.68	0.09	766
GY	Mecklenburg-Vorpommern	0	0.39	0.3	0.13	1053
GY	Niedersachsen	2.15	3.94	3.51	0.44	3664
GY	Nordrhein-Westfalen	5.56	8.26	7.61	1.03	8543
GY	Rheinland-Pfalz	1.83	1.7	1.73	0.19	1587
GY	Schleswig-Holstein	0	0.85	0.65	0.11	873
GY	Saarland	0	0.47	0.36	0.02	205
GY	Sachsen	0	1.11	0.84	0.18	1520
GY	Sachsen-Anhalt	0.62	0.45	0.49	0.15	1234
GY	Thüringen	0	0.78	0.59	0.1	859
FS	Brandenburg	0	0.38	0.29	0.89	7371
FS	Berlin	0	0.13	0.1	1.34	11118
FS	Baden-Württemberg	0.98	0.46	0.59	4.69	38848
FS	Bayern	0	0.5	0.38	5.1	42281
FS	Bremen	0	0.06	0.05	0.3	2503
FS	Hessen	0.45	0.43	0.43	2.78	23064
FS	Hamburg	0.18	0.35	0.31	0.78	6441
FS	Mecklenburg-Vorpommern	0	0.32	0.24	0.5	4141
FS	Niedersachsen	0.14	0.84	0.67	3.83	31706
FS	Nordrhein-Westfalen	0.68	2.04	1.72	7.87	65230
FS	Rheinland-Pfalz	0	0.26	0.2	1.8	14923
FS	Schleswig-Holstein	0	0.06	0.05	1.23	10180
FS	Saarland	0	0.02	0.02	0.44	3686
FS	Sachsen	0	0.68	0.52	1.18	9765
FS	Sachsen-Anhalt	0	0.35	0.27	0.69	5699
FS	Thüringen	0	0.28	0.21	0.67	5528
HS	Brandenburg	0	0	0	0	0
HS	Berlin	1.23	0.31	0.53	0.39	3215
HS	Baden-Württemberg	9.23	5.01	6.01	3.83	31732
HS	Bayern	0	5.6	4.27	5.56	46039
HS	Bremen	0	0	0	0	31
HS	Hessen	2.4	1.65	1.83	0.92	7655
HS	Hamburg	0	0	0	0	0
HS	Mecklenburg-Vorpommern	0	0	0	0	0
HS	Niedersachsen	2.5	2.78	2.71	2.02	16718
HS	Nordrhein-Westfalen	12.16	6.32	7.71	4.56	37770
HS	Rheinland-Pfalz	2.03	1.03	1.27	0.27	2272
HS	Schleswig-Holstein	0.53	0.43	0.45	0.86	7094
HS	Saarland	0	0	0	0	32
HS	Sachsen	0	0	0	0	0
HS	Sachsen-Anhalt	0	0	0	0	0
HS	Thüringen	0	0	0	0	0
IG	Brandenburg	0	0.34	0.26	0.32	2659
IG	Berlin	0.6	0.6	0.6	0.96	7976

Table 8: Comparison of the distribution of the sample data and the target distribution in the school year 2010/2011 with regard to school type and Federal State. (continued)

School type	Federal State	CILS %	NEPS %	All %	%	Total
IG	Baden-Württemberg	0	0.05	0.04	0.3	2490
IG	Bayern	0	0	0	0.12	953
IG	Bremen	0.78	0.2	0.34	0.23	1920
IG	Hessen	4.08	2.27	2.7	1.44	11952
IG	Hamburg	0.92	0.68	0.74	0.58	4793
IG	Mecklenburg-Vorpommern	0	0.22	0.17	0.12	980
IG	Niedersachsen	1.42	0.58	0.78	0.58	4778
IG	Nordrhein-Westfalen	7.8	3.4	4.45	4.11	34040
IG	Rheinland-Pfalz	0	0.17	0.13	0.61	5013
IG	Schleswig-Holstein	0	1.31	1	0.46	3816
IG	Saarland	0	0.33	0.25	0.25	2066
IG	Sachsen	0	0	0	0.01	119
IG	Sachsen-Anhalt	0	0	0	0.05	435
IG	Thüringen	0.72	0.22	0.34	0.05	428
MB	Brandenburg	0.57	0.81	0.75	0.81	6694
MB	Berlin	0	0	0	0	0
MB	Baden-Württemberg	0	0	0	0	0
MB	Bayern	0	0	0	0	0
MB	Bremen	0.72	0.06	0.22	0.19	1576
MB	Hessen	0	0	0	0	0
MB	Hamburg	0	0.26	0.2	0.43	3591
MB	Mecklenburg-Vorpommern	0.8	0.84	0.83	0.6	5004
MB	Niedersachsen	0	0	0	0	0
MB	Nordrhein-Westfalen	0	0	0	0	0
MB	Rheinland-Pfalz	0.92	0.74	0.78	2.04	16912
MB	Schleswig-Holstein	0	0.16	0.12	0	0
MB	Saarland	0.72	0.57	0.61	0.49	4098
MB	Sachsen	0.41	1.4	1.17	1.61	13322
MB	Sachsen-Anhalt	0	1.3	0.99	0.95	7841
MB	Thüringen	0.45	1.1	0.94	0.86	7140
RS	Brandenburg	0	0	0	0	0
RS	Berlin	1.7	0.41	0.72	0.58	4790
RS	Baden-Württemberg	6.58	4.02	4.63	5.24	43432
RS	Bayern	0	3.66	2.79	5.46	45262
RS	Bremen	0	0	0	0	0
RS	Hessen	1.95	2.24	2.17	2.1	17389
RS	Hamburg	0.27	0	0.07	0	0
RS	Mecklenburg-Vorpommern	0	0	0	0	0
RS	Niedersachsen	3.18	2.73	2.84	3.91	32384
RS	Nordrhein-Westfalen	9.37	5.64	6.53	6.3	52168
RS	Rheinland-Pfalz	3.75	0.62	1.37	0.33	2767
RS	Schleswig-Holstein	0	0.46	0.35	1.17	9659
RS	Saarland	0	0	0	0.03	254
RS	Sachsen	0	0	0	0	0
RS	Sachsen-Anhalt	0	0	0	0	0
RS	Thüringen	0	0	0	0	0
Total		100.02	99.99	100.01	99.98	828479

Note. GY - Gymnasium, FS - Förderschule, HS - Hauptschule, IG/ FW - Integrierte Gesamtschule/ Freie Waldorfschule, MB - Schule mit mehreren Bildungsgängen, RS - Realschule.