

Irregular Teacher Turnover and Student Academic Achievement in High Schools: A Study in the Subjects Mathematics, German, French and History

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Abstract

Teacher turnover that is not related to regular school transitions is a neglected topic of educational-psychological research. This study examines irregular teacher turnover and its effect on students' academic achievement in the subjects Mathematics, German, French and History at four high schools of the canton of Berne, Switzerland. The study is based on an administrative dataset used to track the academic achievement of N = 1789 students from more than 100 classes. The results show that irregular teacher turnovers affect every 12th class on average, whereby definitive turnovers occur more frequently than temporary ones. In all examined subjects, panel data models show that irregular teacher turnovers have a more or less pronounced negative effect on students' academic achievements. With respect to the students' gender no significant differences have been observed.

Keywords: academic achievement, gender, high school, longitudinal data analysis, teacher-student relationship, teacher turnover, teaching

1. Irregular Teacher Turnover

In the explanations of school achievement, proximal conditions have proved to be more influential than distal conditions (Fraser, Walberg, Welch, & Hattie, 1987; Wang, Haertel, & Walberg, 1993; Walberg, 2006). An important influence on student learning outcomes is instructional design and, thus, the teacher (Walberg & Paik, 2000; Seidel & Shavelson, 2007; Hattie, 2009). As Lipowsky (2006) asserted, it 'depends on the teacher'. Therefore, a change in teachers is a critical event that can have an effect on the learning outcomes of not only specific students but also the class as a whole. Normally, students experience teacher turnover during a school transition, whether it be from one grade to the next (e.g. third to fourth grade) or one school level to another (e.g. primary school to secondary school). These are the regular transitions of a school career. Although changes in school grades and levels have been examined in several empirical studies, teacher turnover has rarely been investigated; rather, the institutional effects of school transitions have been the focus.

It can be derived only indirectly that the constancy of the teacher is important for student success. Studies have shown that student achievement and self-esteem are more negatively affected during the transition from primary to secondary school if students experience several occurrences rather than only one occurrence of teacher turnover (Simmons & Blyth, 2008). School transitions are often accompanied by changes in class composition; thus, these effects cannot be attributed solely to teacher turnover. A study by Alspaugh (1998), which controlled for class transfers, found that student achievement was more negatively affected if, in addition to dealing with school and teacher transfers, the students also faced reassembled classes.

Because of the confounding institutional and individual effects, little is known about the influence of teacher turnover during regular school transitions. This situation is even more pronounced in the case of irregular teacher turnover, a change in teaching staff that is not tied to an institutionally prescribed and, thus, normative school transition. Irregular teacher turnover is unexpected because the teacher fails during an education period and has to be replaced. Such a change can be temporary or permanent. Temporary irregular teacher turnover could be the

result of educational leave, time off, pregnancy or maternity leave, military or civilian service, an accident or illness. Definitive irregular teacher turnover can be caused by a change of profession or job, a workload reduction, school organisational processes, retirement or death.

Teacher turnover can be a major influence on students' adjustment to school because of the possible variations in teachers' instructional and curricular competencies and the consequences for the teacher-student relationship (Hattie, 2009). Teacher support and students' feelings of belongingness are linked to students' academic motivation and their engagement and social-emotional wellbeing in school (Osterman, 2000; Juvonen, 2007; Eccles & Roeser, 2011). According to the self-determination theory of motivation, the sense of relatedness is one of three basic needs that affect students' behavior in school. It is of special importance for the self-regulation of learning and academic performance (Niemic & Ryan, 2009). Inadequate support from teachers or feelings of being disrespected by teachers partly account for negative attitudes toward school, and this can even lead to school alienation and dropout (Juvonen, 2007; Osterman, 2000; Teuscher & Makarova, 2018).

Given that a stable and trusting teacher-student relationship is critical for students' feelings of belongingness and wellbeing at school, an unexpected disruption of the relationship because of irregular teacher turnover can be detrimental to students. Because it is unexpected and unplanned, irregular teacher turnover represents a non-normative life event for students. This can result in greater psychological stress than regular teacher turnover, which is expected and allows for the appropriate preparation (Heckhausen & Tomasik, 2002). Irregular teacher turnover can be especially stressful for adolescents, who must transform their relationships with parents and are therefore in need of stable role models and the emotional support of trusting nonfamilial adults for navigating this age-related developmental task (Tatar, 1998a; Darling, Hamilton, & Shaver, 2003).

That irregular teacher turnover could also have positive effects in individual cases cannot be ruled out, however. Studies have shown that teachers have differing expectations of students; consequently, they treat them differently. They can have favorites and even harbor stereotypes (Brophy & Good, 1974; Osterman, 2000; Jussim & Harber, 2005). Transitions are generally associated with risks and opportunities; thus, irregular teacher turnover can be a positive experience for a student or an entire class if the teacher-student relationship or instructional quality improves with the arrival of the new teacher (Adnot, Dee, Katz & Wyckoff, 2016). *But what are the 'true' effects of irregular teacher turnover?* This question has been answered through a study in the canton of Berne Switzerland. The paper is organized as follows: Section 2 summarises the state of the research. Section 3 introduces the study focus. Section 4 explains the methodological approach, and Section 5 presents the empirical results. Section 6 discusses the findings, draws conclusions and explores the methodological and practical implications of the study.

2. An Untapped Research Field

Currently, irregular teacher turnover is not being theoretically or empirically investigated in educational science. A review of educational science, school pedagogy, didactic and educational psychological handbooks and encyclopaedias (search criterion: teacher turnover) covering the last 150 years yielded a total of 233 books and articles in German, English and French. At the beginning of the reviewed period, irregular teacher turnover was discussed relatively frequently; however, since the end of the 1950s, the issue has received very little attention in the verifiable literature. While entries on teacher turnover were occasionally found in recent English-language publications (e.g. Dejnozka & Kapel, 1982), the latest entry in a German-language reference book was found in the fourth edition of the Encyclopedia of Pedagogy (Lexikon der Pädagogik) published in 1965 (the first edition was published in 1954).

One of the last contributions on irregular teacher turnover in the German-language research literature is by Heller (1969), who dealt only marginally with the subject and did not refer to any empirical studies. Even in the English-language literature, very few recent studies have focused on the effects of irregular teacher turnover on students. Most studies have addressed the institutional effects.

Because of the high rate of young teachers leaving shortly after entering the profession, changes in teaching staff have been examined in terms of job change, i.e. teacher migration, and teacher attrition (Ingersoll, 2001; Ingersoll & Smith, 2003; Loeb, Darling-Hammond, & Luczak, 2005; Boe, Cook, & Sunderland, 2008; Borman & Dowling, 2008; Carver-Thomas & Darling-Hammond, 2017). The organisational, administrative and financial consequences of teacher turnover were the main interest of these studies. The effects on students have only been marginally explored. This was confirmed by Kloss (2013), who stated: 'Much of the research literature on teacher turnover focuses on the teacher, and why they move from one position to another, or quit the field entirely. Ignored are the perspectives of [the] students who experience this teacher turnover.' Kloss (2013) conducted one of the few recent studies on irregular teacher turnover. Twelve students from three high schools

were interviewed about their experiences with teacher turnover in music classes. The students' positive, negative or neutral responses were primarily the result of differences in the personalities and the teaching and communication styles of the previous teacher and the new teacher. The effect of teacher turnover on academic performance was not considered.

The most recent comprehensive American study on irregular teacher changes was conducted by Ronfeldt, Loeb and Wyckoff (2013). On the basis of the administrative data from more than one million fourth and fifth grade students in New York, the research team evaluated and related test scores in mathematics and English language arts to teacher data for a period of more than ten years. The results of the study were summarised as follows: 'Though there may be cases where turnover is helpful to student achievement, on average, it is harmful' (p. 18). The study design did not allow for a comparative evaluation at the class or individual level because teacher turnover was recorded for the school as a whole; therefore, the effects of teacher turnover on specific classes are unknown.

This study by Ronfeldt, Loeb and Wyckoff (2013) confirmed the findings of other studies regarding a negative image of irregular teacher turnover. Specifically, irregular teacher turnover was found to have a negative effect on academic achievement (Ingersoll, 2001; Guin, 2004; Reid, 2010; Roehl, 2010). Most of these studies, which included anecdotal evidence, have been in education economics. In an interview, the former chairman of the Federal Directors Conference of High Schools in Germany emphasised that frequent teaching staff changes would be 'at the expense of the quality of teaching' (Stein-Bastuck, 2012). The Swiss paediatrician Remo Largo even compared frequent teacher turnover to emotional abuse: 'When we look at why some classes get completely out of control, we see that a frequent reason is intensive teacher turnover' (Largo, 2008). Although teacher turnover is more often considered to be a risk rather than an opportunity for students, the effects are unclear. Therefore, this article aims to reinvigorate research into irregular teacher turnover and to provide an understanding of the negative image of the phenomenon.

3. Focus of the Study

3.1 Secondary Education in Switzerland

The main goal of this study was to examine irregular teacher turnover and its effects on high school students' long-term academic achievement. The study was conducted in the canton of Berne. In Switzerland, responsibility for education lies primarily with the 26 cantons. The compulsory school period is 11 years: from kindergarten to the lower secondary level. At the lower secondary level, pupils are taught in performance-based groups, usually on the basis of the results of the examinations at the end of primary school. In most cantons, including Berne, the transition to upper secondary level high school (Gymnasium) occurs after at least two of the three lower secondary years have been completed. Admission is based on an overall assessment, the students' grades and/or an entrance examination. The standards are high. Only approximately 20 per cent of an age cohort attends high school. About two-thirds of all young people enter apprenticeship programs in the dual-track vocational education and training (VET) system. The remaining students enrol either in entirely school-based form of education or pursue no form of post-compulsory education.

During high school, which lasts four years, there is no further institutional transition. The curriculum consists of core subjects, a main specialty and a secondary specialty. The core subjects are the first national language, the second national language, a third language, mathematics, biology, chemistry, physics, history, geography and music or the visual arts. For the students in this sample, the first national language was German, and the second national language was French. At the end of high school, the students are examined in at least five subjects. Graduation from high school facilitates direct entry into a university.

Before 2017, the first year of high school in Berne could be completed at the lower secondary level; therefore, data from only three years, i.e. six semesters, were available for exploring the research questions (cf. also Section 4.1). This study focused on mathematics, German, French and history classes. These subjects were selected according to the following two criteria: (1) Instruction had to be continual over the six semesters, and (2) the subject had to be compulsory. Only mathematics, German, French and history met these two criteria. They were taught according to the subject teacher principle: the subject was taught throughout all levels at the high school by a specific teacher. Mathematics, German and French are compulsory subjects for the Matura examination.

3.2 Research Questions

The following research questions were posed:

- 1) Occurrence, timing and type of teacher turnover: How often and at what time does irregular teacher turnover

occur in high schools? What are the reasons for irregular teacher turnover at high schools?

- 2) Effects of irregular teacher turnover on school achievement: What are the effects of irregular teacher turnover on high school student academic achievement in mathematics, German, French and history?

Because of the paucity of recent empirical studies on irregular teacher turnover, a clear position on its effects on student academic achievement could not be discerned; consequently, hypotheses were not formulated. However, the potential effects should be examined for the influence of gender. This is needed for two reasons. First, the findings of studies on school transitions have shown that males and females are differently affected by such transitions (Simmons & Blyth, 2008; Evans, Borriello, & Field, 2018). According to Blyth, Simmons and Carlton-Ford (1983, p. 106), female students' sensitivity to school changes could be attributed to the greater perceived importance of social relationships for females in the society. A study by Tatar (1998b) surveying Israeli secondary school students found that girls, more than boys, characterise significant teachers facilitating learning and relationships. It could therefore be argued that female students experience an irregular departure of a teacher as a violation of an informal agreement with that teacher. However, the possibility of students' benefitting from a change of teacher, especially the replacement of a negative teacher-student relationship with a positive one, cannot be excluded. Second, student grades are used as indicators of achievement (cf. Section 4.2). Some studies have found no effect of student gender on the correctness of a teacher's assessment of achievement; however, others have noted higher ratings, at least in specific subjects, for female students (Harlen, 2005; Buchmann, DiPrete, & McDaniel, 2008; Hannover & Kessels, 2011).

4. Method

4.1 Design and Sample

This study is part of a project that was supported by the Swiss National Science Foundation from 2013 to 2015 (Grant. no 100019_150320). Access was provided to the Evento database, which was established by the Bernese educational authority in 2005. Data on high school students and teachers were included. The study sample covered 2005 to 2013. There were 16 high schools in the canton of Berne. The four private schools and the high school in the French-speaking part of the canton were excluded because of comparability issues (e.g. different curriculum).

The data covered the beginning to the end of high school. The study used the semi-annual school reports, as well as background information, such as gender and dropout rates. The grades for each school semester were considered to be indicators for subject-specific academic achievement. Such data are collected periodically and are available for nearly all high school students. The data allowed for the association of a teacher with a specific class in order to identify possible teacher turnover. Because the Evento database was built successively, the data were not complete for all of the high schools. The requirement for inclusion in the sample was the availability of data for a minimum of two semesters.

The majority of the data covered four or more semesters (four semesters: 28.7%, five: 13.2%, six: 41.8%). Only 6.9 percent of the students were only at three semesters and 9.4 percent only at two semesters in our sample. Students with only one semester, missing grades or with a change of class during the observation period were deleted from the sample (88 cases). Classes that had experienced more than one instance of teacher turnover (8 classes) were excluded for comparability reasons. The adjusted sample comprised 1'788 high school students in 109 classes from four Bernese high schools. The average class size was 16 (SD = 4), and the average age was 16 (SD = 0.64) at the beginning of high school and 19 (SD = 0.76) at the end. Female students were 59.2 percent of the sample. This reflected the Swiss high school population, of which 57.3 percent were women, a slightly lower percentage than in the sample (Federal Statistical Office, 2016, p. 9). Because there are no normative transitions during high school in Switzerland, each teacher turnover was defined as irregular. Therefore, for the remainder of the paper, 'teacher turnover' refers to 'irregular teacher turnover'.

4.2 Dependent and Independent Variables

Dependent variable. Academic achievement in a school subject was measured by the grades recorded in the semi-annual school reports. In the Swiss school system, grades are reported on a 1-6 scale in half-point increments (1 = very poor, 4 = sufficient, 6 = excellent).

Independent variables. Teacher turnover was identified by a change in the teacher identification number (LP ID) in the Evento database at the end of each semester. Teacher turnover was identified if the LP ID for the relevant school subject changed between the first and the fifth semesters. The first instance of teacher turnover was observed in the second semester. Teacher turnover refers to a dummy variable, which was '0' for all the students in the dataset. Immediately after an occurrence of teacher turnover, this variable was '1' for the relevant students.

Every occurrence of teacher turnover in the Evento database was verified with the office of the specific school by means of a standardised survey. With the data from the high schools, the reasons for teacher turnover could also be determined. The reasons were placed into 12 categories: job changes, occupational changes, educational leave, time off, unpaid holidays, workload reductions, pregnancy or maternity leave, military or civilian service, accidents, illness, retirement, layoffs and death. An 'other' category was created for additional reasons, which were related mostly to school reorganisation (e.g. class reorganisation, functional teacher change). To control general time dependent changes or trends we included a variable indicating each of the six semesters.

4.3 Statistical Procedure

In addition to performing a descriptive analysis of the dimension and type of teacher change (*Research Question 1*), the study used inferential statistical models to estimate the effects of teacher turnover on student academic achievement (*Research Question 2*). Thus, the panel structure and the nesting of the data (class effects) were considered (Gangl, 2010). A requirement for correct statistical inference with repeated measurements is the unbiased estimation of standard errors; however, a correlation between the independent variable(s) and the error term is not essential. To fulfil the 'homoscedasticity assumption', cluster robust standard errors were used in the fixed effects panel regressions (Bruederl & Ludwig, 2015). The use of fixed effects models also made it possible to take the nesting of the data into account, the embeddedness of students in classes, by assuming that class effects were constant over time. By this assumption, the procedure demeaned the data. Thus, the estimations were based solely on the variance within an individual over time, i.e. the person-specific deviation from the individual's mean value of the referring variable at each time point. Consequently, for a student, the model could compare only the states before and after a teacher turnover if there were changes on any explanatory variable. This meant that grade changes in the model were explained only for the students experiencing teacher turnover. Time-constant unobserved or observed variables were therefore controlled in this model. Finally by including a semester variable we took the general time trend and therewith also the control group information into account. After this, all the changes were explained by the only time-varying variable: teacher turnover.

A further advantage of the described procedure was the control of self-selection effects through the quasi-experimental data structure (Gangl, 2010). For example, a negative effect of teacher turnover could be explained by lower academic achievement than that of students who did not experience teacher turnover. The results would therefore not be attributed to teacher turnover but to the non-randomised composition of the classes, which contained students in the treatment and control groups. Because the procedure compared students with the results of their own internal changes (before and after the change), the study controlled for these unwanted effects.

The last assumption of the model was related to parallel trends in the academic progress of classes with and without teacher turnover over time. Thus, in terms of the experimental design, the stimulus, i.e. teacher turnover, affected academic achievement. This could be tested only for the period before the occurrence of teacher turnover. As is shown in Figure 1, the assumption of parallel trends before teacher turnover applied to three of the four subjects: mathematics, German and history. To control for these parallel trends, the time (Semesters 1 through 6) was included as a control variable in the models. Thus, the information of the students without teacher turnover was also included. As Figure 1 indicates, there were no parallel trends in the French (students' second language) grades before the treatment. Therefore, a fixed effects individual-slope (FEIS) regression, a trend-adjusted procedure, was used for obtaining valid estimates (Bruederl & Ludwig, 2015). As a result, the semester variable, which measured time trends in the other three models, could not be estimated because it had already been included in the general trend, which was differenced out in the FEIS regression.

Furthermore, the Hausman test was used to control whether the (partly unobserved) determining factors were not fixed but random, thereby varying over time. The test always pointed to the chosen fixed effects models (Hausman, 1978). Last, the specific models, as well as the interaction models for each subject, were estimated to determine possible gender effects. All of the estimations were performed with Stata 14 software.

5. Results

The occurrence and timing of and reasons for irregular teacher turnover are reported descriptively. The effects of irregular teacher turnover on student academic achievement were determined by comparing high school students who experienced teacher turnover and those who did not.

5.1 Teacher Turnover: Occurrence, Timing and Reasons

As can be seen in Table 1, approximately every 12th class in this high school sample was affected by teacher turnover in at least one of the subjects under review. However, the results for the subjects varied considerably.

While students in the mathematics and German classes experienced 16 and 13 incidents, respectively, of teacher turnover, fewer instances were observed for the history and French classes (four and three turnover occurrences, respectively). Most incidents happened in the fifth semester. In other words, at the beginning of the last school year under review, each subject of the treatment group had been affected by at least one instance of turnover. For French, all occurrences of turnover were observed during this period. For mathematics, approximately half (9; 56%) of the occurrences were during this period, and for German, it was just more than one-third (5; 39%). For history, the highest value of teacher turnover (2; 50%) was in the first semester of the penultimate school year.

Table 1. Occurrence and time of teacher turnover by school subject

	Total	Classes				Timing of teacher turnover				
		without tt		with tt		2 nd s	3 rd s	4 th s	5 th s	6 th s
		n	%	n	%					
M	104	88	84.62	16	15.38	1 (9)	5 (78)	1 (2)	9 (158)	-
G	109	96	88.07	13	11.93	2 (12)	2 (22)	3 (31)	5 (69)	1 (12)
F	106	103	97.17	3	2.83	-	-	-	3 (46)	-
H	95	91	95.79	4	4.21	1 (13)	2 (16)	-	1 (15)	-

Note. tt = teacher turnover; M = mathematics; G = German; F = French; H = history; s = semester; Student number in parentheses.

Figure 1 shows the average high school grades, for students who experienced teacher turnover and those who did not, for each relevant subject over the study period (six semesters). Whereas the average grades in classes without teacher turnover were mainly horizontal, the average grades in classes with teacher turnover were uneven, thus suggesting that irregular teacher changes could have negative effects. In total, the average grades were 4.17–5.18. The highest average grade was 4.66 for history. This was followed by 4.61 for German, the students’ first language, and 4.51 for French, their second language. The lowest average grade, 4.41, was for mathematics.

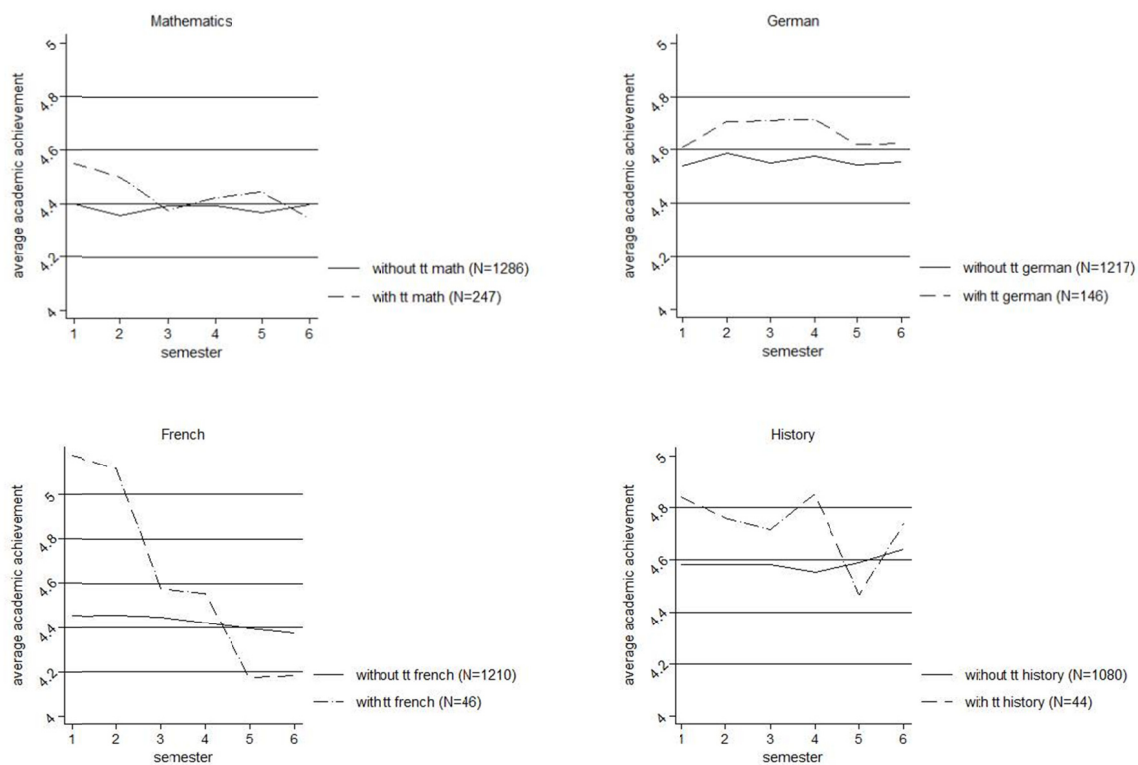


Figure 1. Average high school grades with or without teacher turnover (tt)

The reasons for teacher turnover at the high school were varied (cf. Table 2). The most common was a teacher's moving to another school (9 cases), followed by retirement (8 cases). School organisational processes ranked third (7 cases), and dismissal and pregnancy or maternity leave (2 cases each) were fourth. There was only one occurrence for each of the other reasons. Rare events, such as accidents, illness or death, military or civilian service and workload reductions, were not reasons for teacher turnover in this sample; therefore, they are not listed in Table 2.

Table 2. Reasons for teacher turnover by school subject

Reason	Maths	German	French	History	Total
Job change	3	4	2	-	9
Retirement	6	2	-	-	8
School organisational processes	3	3	1	-	7
Dismissal	2	-	-	-	2
Pregnancy or maternity leave	-	1	-	1	2
Occupational change	1	-	-	-	1
Educational leave	-	1	-	-	1
Unpaid holidays	-	1	-	-	1
Missings	1	1	-	3	5
Total	16	13	3	4	36

The analysis of the reasons for teacher turnover by school subject did not indicate a clear pattern because of the small number of cases related to French and history. However, it must be noted that the number of occurrences, 27 cases, of permanent teacher turnover (change of school, change in occupation, dismissal, retirement, school organisational processes) was significantly higher than the number of instances of temporary turnover (pregnancy or maternity leave, time off, education leave), which was only four.

5.2 Effects on Student Academic Achievement

To determine the effect of teacher turnover on school performance, fixed effects regressions were used to estimate the subject-specific models (cf. Table 3). An overall model was estimated for each subject (Model I), and only teacher turnover and the control variable time were considered. Separate models for the students and the interaction models (teacher turnover \times gender) were estimated in order to model the gender effects (Model II) (cf. Table 4).

Table 3. Effects of irregular teacher turnover on students' academic achievement: fixed-effects (within) regression

	Model I			
	Maths	German	French	History
Teacher turnover	-.03 (-.83)	-.11** (-2.95)	-.19† (-1.86)	-.14† (-1.66)
2 nd semester (1 st sem. = reference)	-.06** (-2.95)	.05** (3.38)		-.00 (-.07)
3 rd semester	-.13*** (-5.74)	-.04* (-2.28)		-.02 (-1.13)
4 th semester	-.13*** (-5.37)	-.02 (-1.16)		-.05* (-2.57)
5 th semester	-.15*** (-6.08)	-.05** (-3.07)		-.02 (-1.11)
6 th semester	-.15*** (-6.06)	-.04** (-2.62)		.03 (1.58)
(Within) R ²	.014	.019	.002	.008
F(df1, df2)	8.25***	10.5***		7.08***
Rho	.743	.689		.654
N	1533	1363	1119	1124

Note. Dependent variable: academic achievement; independent variable: teacher turnover and time. Non-standardized β -coefficients are reported; t-values in parentheses (based on panel-robust standard errors). R² = Coefficient of determination; significance level: * p < .05, ** p < .01, *** p < .001; † The coefficient is at the 10% level significant and therefore can be considered as trend (Dormann, 2013); For French the model was estimated with the FEIS-procedure which doesn't output all estimators (cf. Section 4.3).

The overall achievement of the students who had to deal with irregular teacher turnover during their high school education declined after the change in teachers (cf. Table 3). The overall model for German indicated that a change had a significant effect on grades: $-.11$ grade points ($p = .003$). In French and history, the declines of $.19$ ($p = .064$) and $.14$ ($p = .096$) points, respectively, were significant. Although not statistically significant, the same negative trend was observed for mathematics. Achievement declined $.03$ points when students experienced teacher turnover. The explanatory power of all four models (R^2 within) was $.2$ – 2.0 percent.

The estimated models (Model II) for possible gender effects are presented in Table 4. Separate estimated models for the students showed that the gender differences in the effects of an occurrence of teacher turnover in mathematics, German and history were not statistically significant (Model IIa and IIb). For mathematics, turnover had no effect ($.00$, n. s.) on the female students' performance; however, it had a negative effect ($-.11$, n. s.) on the male students' performance. In German and history, the female students' performance was somewhat worse than the male students' (Model IIa and IIb): by $-.02$ grade points in German and $-.01$ grade points in history (Model IIc). The three interaction models explained 1.4 – 2.0 percent of the average variance within a person over time (R^2 within).

No interaction model could be calculated for French because of the methodological choices, i.e. the use of the FEIS regression. To assess differences in the effects of teacher turnover on school achievement for French, the confidence intervals of the coefficients of teacher turnover for male and female students were compared. The values ranged from $-.60$ to 1.00 for the male students and $-.45$ to $-.04$ for the female students within the 95 percent probability interval. Because the interval of the female students was completely located within the interval of the male students, both estimated coefficients could still be assumed to be statistically similar. Therefore, no significant gender effect could be found for French.

Table 4. Effects of irregular teacher turnover on students' academic achievement under consideration of students' gender: fixed-effects (within) regression

	Model II		
	Models with gender differences		
	Maths	German	History
<i>Model IIa: female students</i>			
Teacher turnover	-.00 (.03)	-.07 (-1.59)	-.02 (-0.26)
<i>Modell IIb: male students</i>			
Teacher turnover	-.11 (-1.53)	-.05 (-.88)	-.01 (-.11)
<i>Modell IIc: interaction model</i>			
Teacher turnover \times sex (differential value)	-.11 (-1.29)	.02 (.26)	.01 (.10)
(Within) R^2	.017	.020	0.014
F(df1, df2)	5.38***	5.37***	5.14***
Rho	.746	.685	.652
N	1533	1363	1124

Note. Dependent variable: academic achievement; independent variable: teacher turnover, time. Non-standardized β -coefficients are reported; t-values in parentheses (based on panel-robust standard errors). R^2 = Coefficient of determination; significance level: *** $p < .001$.

6. Discussion

Teacher turnover that is not tied to a transition to a higher school grade or a different type of school, thereby having an irregular character, has long been a neglected topic in educational science research. Recent studies have been conducted mainly in the United States because of the growing number of teachers who leave after only a short period. Accordingly, education economics and organisational psychology approaches have been oriented toward teachers and the school as an institution. The effects of teacher turnover on students have not been considered. To provide the impetus for inquiry into an under-researched topic, the present study used high school administrative data to investigate the occurrence and effects of irregular teacher turnover.

6.1 Summary of Results

The findings demonstrate that irregular teacher turnover is not a rare event. In the sample, irregular teacher turnover occurred in approximately one out of 12 classes in at least one subject over the three-year observation

period. Mathematics and German were affected much more frequently than history and French. The high frequency of irregular turnover in the first semester of the last school year was striking. The most frequent reasons were retirement or a teacher's moving to another school. Organisational processes also led to irregular teacher turnover. Other events, such as a career change, time off, or educational, pregnancy or maternity leave were less frequent. Rare events, such as accidents, illness and death and workload reductions, were not reasons for teacher turnover in this sample.

The findings confirmed the results of previous studies. Irregular teacher turnover was found to have negative effects on academic achievement. For all four academic subjects reviewed, there was a decline in achievement after teacher turnover; however, not all of these effects were statistically significant. There were no gender disparities. Male and female students tended to be equally negatively affected.

The reasons for the negative effects on student academic achievement are unclear. In the Kloss study (2013), in which no academic achievement data were collected, the teacher's personality and communication and teaching styles were cited as reasons. Because the dataset used in the current study did not include teaching style or the criteria for assessing the student-teacher-relationship, this issue could not be addressed definitively. However, it can be assumed that a replacement teacher with better professional qualifications will use more effective teaching methods, which should have a positive effect on student achievement. The same should be true for a valuable student-teacher relationship. As part of a reform project in the public schools in the District of Columbia in the United States, the dismissal of 'low-performing teachers' had indeed positive effects on student achievement (Adnot et al., 2016). The effect presupposed that the replacement teachers were better qualified and more effective; however, this could not be verified in the study. The current study found that school achievement tended to deteriorate; thus, this could be an indication that the replacement teachers might have been less qualified or experienced. It has been asserted that young teachers teach less successfully than experienced teachers because of a lack of work experience (Rockoff, 2004; Harris & Sass, 2011; Henry, Fortner, & Bastian, 2012; Kini & Podolsky, 2016). This finding is supported by the difficulty in recruiting experienced teachers outside the usual yearly and semester school appointments. It could be argued that the predominant reasons for teacher departures in this study, namely dismissal, career change and, possibly, time off and school change, suggest inadequate professional qualifications. Nevertheless, teacher turnover could have led to improvements in instruction and, indirectly, school achievement only if the replacement teachers were better qualified. For the aforementioned reasons, however, this was unlikely.

6.2 Limitations

The strength of this study lies in the longitudinal dataset that allowed for the matching of the student and teacher data. It facilitated the analysis of the effects of irregular teacher turnover on student achievement in four high school subjects over three continuous years. However, because the dataset only recently included all of the Berne high schools, a selective approach had to be adopted regarding the classes reviewed. Consequently, the extent to which the results are representative of the Berne or Swiss high schools or even high schools in other countries is unclear. Because of the considerable number of classes analysed, it can be assumed that a representative sample would not have produced significantly different results. Nevertheless, the extent of and reasons for irregular teacher turnover should be explored in further studies. The same limitations apply to the differences among the school subjects reviewed in the current study. This study was limited to high schools; thus, similar studies are needed for other types of schools.

The method for measuring achievement could be debated in light of recent reservations about the reliability and validity of teacher ratings, especially the use of student grades as indicators of school achievement. It should be noted that grades that reflect a summative assessment over a specific period are more valid than individual grades (Harlen, 2005; Trapmann, Hell, Weigand, & Schuler, 2007). Nevertheless, it cannot be ruled out that the teacher who followed in each case assigned grades differently from the teacher who had left. This is likely, particularly if an experienced teacher is followed by an inexperienced teacher with less diagnostic competence (Krolak-Schwendt & Rummer, 2005; Ophuysen, 2006). Thus, the possibility that a different method of assessing student achievement would lead to somewhat different results cannot be excluded.

6.3 Practical Implications

Although the effects were slight, irregular teacher turnover tended to have a negative effect on academic achievement. The everyday discourse on school education, which tends to overestimate the effects of teacher turnover, can be relativized. Nevertheless, in a case of irregular teacher turnover, school administrators should ensure that the replacement teacher have at least the same level of qualifications and expertise as the previous teacher.

If the number of occurrences of irregular teacher turnover in the first half of the last high school year is replicated, special care must be taken in the selection of replacement teachers at the high school level. The students are required to pass a final examination; thus, their ability to earn a matriculation diploma should not be endangered by instruction from inadequately qualified teachers shortly before the examination.

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