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Laissez-faire or guidance? Effective supervision of bachelor theses

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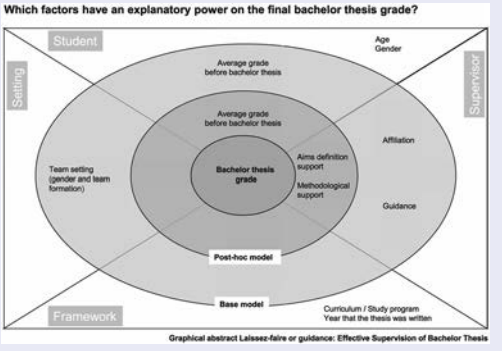
ABSTRACT

Bachelor thesis supervision involves a supporting goal and an assessment goal, requiring more guidance versus more autonomy and freedom for students, respectively. This paper tests the hypotheses that the final grade of undergraduate bachelor thesis is positively related to a supervisor's (a) guidance given to and (b) affiliation with the bachelor thesis student/project. To assess these hypotheses, undergraduate students at the FHNW School of Business have been surveyed for three years about their perception and satisfaction with bachelor thesis supervision. This data ($n = 189$) was combined with student grades before the thesis and their final thesis grades. Our results show supervision to have a measurable impact on the bachelor thesis outcome and most effective when focused on guidance related to goal definition and methodological support. In other areas supervision can, to a certain degree, follow a more laissez-faire supervision style.



Graphical abstract Laissez-faire or guidance: Effective Supervision of Bachelor Thesis

KEYWORDS

Supervision; affiliation; guidance; bachelor thesis; quantitative research

Introduction

> My supervisor guided me through the process and was interested in my topic. I've learned a lot and the outcome is convincing.
>
> I saw my supervisor once at the beginning and once after submitting the paper. I've learned a lot and the outcome is convincing.

Both the above quotes represent typical personal experiences with writing an undergraduate bachelor thesis and illustrate the contradiction that raised our curiosity and was the starting point of this study. We seek to understand how two such starkly different supervision experiences can be associated with a positive outcome, by answering two guiding research questions:

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(1) To what extent can the supervisor contribute to the outcome of a thesis?
(2) On what aspects of the thesis supervision should the supervisor focus?

To explain the observed contradiction, we assumed that not just the extent of supervision is important, but also the focus of the supervision. There could be areas where supervision is necessary and helpful, whereas in other areas supervision could be demotivating and have a negative impact on the learning experience.

We answer these questions by studying the supervision of undergraduate bachelor thesis projects at the FHNW School of Business over a three-year period. The focal bachelor thesis projects are completed individually or in teams of two students, at the end of a three-year undergraduate degree in one of four-degree programmes at the School of Business; a German language Business Administration (BA), English language International Management (IM) and German and English language versions of the Business Information and Technology (BIT) degrees, respectively.

The bachelor thesis project represents the culmination of students' studies and they are expected to take primary ownership and responsibility for managing this research project that they complete for an external client, typically a business organization. Each bachelor thesis project has a single academic supervisor that is there to offer guidance and support, as well as intervene if projects begin to go awry. Students are expected to organize the scheduling of supervision meetings and set agendas for any meetings with their supervisors. Students are also expected to professionally manage their relationship with their clients in the spirit of a consulting project.

Students complete a number of assignments individually and in groups during their degree in preparation for the bachelor thesis, as well as receiving methodological and academic writing training in a dedicated course. The work of the students on the bachelor thesis project is assessed based on the submitted final bachelor thesis project report at the end of the project and primarily assessed on the quality of the academic elements of the research, with minor aspects of the process, the independence and contribution of the students and the interaction with all involved stakeholders also included as a part of the assessment framework.

Our study proceeds as follows, we first develop a conceptual foundation for our study, which supports our hypotheses development, and then explain our research design. Our analytical approach includes both deductive and inductive elements. Exploration of the features and relations of the data and a model-building phase lead us to a final parsimonious regression model of optimal quality. After discussing our results, we conclude by drawing some key implications of our work for the supervision of bachelor theses.

Supervision and BSc thesis student performance: hypotheses development

In most European countries, the final assessment in a degree programme is a thesis (Meeus, Van Looy, and Libotton 2004), in which students individually perform a supervised piece of empirical research. This applies to Bachelor's and Master's degree programmes, whereby 'the Bachelor's thesis is in most cases a derivative of the Master's thesis' (Meeus, Van Looy, and Libotton 2004, 300). The bachelor thesis typically requires a more applied 'market research', serving as a bridge between education and the job market (Gunneng and Ahlstrand 2002), while the master thesis is on balance more 'academic' in nature. Given the prominent gatekeeping function of an undergraduate bachelor thesis at the end of the academic curriculum and its unique didactic setting, it has 'an essential role in education, irreplaceable by other means of teaching' (Han 2014, 120).

Successfully completing a bachelor thesis depends on a plethora of factors. Since a 'thesis is a far bigger project than most students will ever have undertaken before, it requires more independent study, more self-motivation' (Murray 2011, 2). At the same time writing a thesis also requires 'the development of new skills associated with the comprehension of a large volume of information, critical analysis and the development of an academic writing style. Many students need support in one or

all of these key areas' (Business et al. 2013 citied in Sharma 2017, 3). This entirely unfamiliar situation calls for a supervisor who consciously chooses an appropriate supervision role.

Yet Çetinkaya and Yılmaz (2017) diagnose a shortage of research on supervision in undergraduate programmes. This may be due to the fact that higher degrees call for an even more elaborate supervision, when compared to undergraduate thesis projects. Interestingly though Schulze and Lessing (2003) observed in their study on postgraduate supervision a general mismatch between students' aspirations and supervisors' coaching, leaving students under-supported. While Bloom et al. (2007) recommend the relationship between the supervisor and the candidate in postgraduate studies to be based on genuine care, since it is the essential component in determining degree completion. The momentum of good student–supervisor relations is underpinned by the fact that 'students commented that the relationship with their chairperson was vital to their success' (Marshall, Klocko, and Davidson 2017, 82). We argue this equally applies to bachelor theses.

Supervision approaches and quality assessment

Not only the role of the supervisor, but also the process of supervision has to be assessed with care (Wisker 2004; Wisker et al. 2008). Given the fuzzy nature of the thesis supervision process, it is not particularly obvious what supervision style is most appropriate:

> One dimension of quality in supervision may be related to a scientific perspective, for example, familiarity with the academic demands on theory and method. Other dimensions may be related to a learning perspective, referring to the pedagogic purpose of the task and to a societal perspective, mainly referring to students' employability. From the students' point of view there may also be a dimension related to a social perspective, related to the degree of service and consideration for different students' needs. Andersson and Person (2002), quoted in Holmberg (2006, 208)

Furthermore, the style and degree of supervision may vary considerably between different research fields (Egan et al. 2009). In the end, supervision would appear to be a juggling act between the supervisor's role as a coach, who regards a thesis 'as a joint responsibility and the supervisor as a trainer … , responsible for even the work climate' (Holmberg 2006, 213), as a consultant, 'i.e. a resource that the students may use if they want to' (Holmberg 2006, 213) and as a 'second mother', who takes 'responsibility for the total situation in a way similar to parenthood' (Holmberg 2006, 213).

Due to this multidimensional nature of the supervision approach, the quality of supervision is not easy to assess. Kleijn et al. (2012) suggest conceptualize it in three parts, the (1) final grade of the work, the (2) perceived supervisor's input and the (3) student's satisfaction. Student personal satisfaction is suggested as an indicator of supervision quality, because of the highly personalized nature of the supervision process. 'Student satisfaction can include satisfaction with the student's own role, satisfaction with their own rate of progress, satisfaction with their supervisor, etc.' (Kleijn et al. 2012, 928). In particular, dissatisfied students are less likely to finish their thesis (Ives and Rowley 2005). We assume that students' satisfaction with the guidance is positively related to the final thesis result, as it is considered an essential element of the student–supervisor relationship and the student–supervisor relationship is considered to be vital for the outcome of the thesis.

Grading, guidance and affiliation

Most studies conceptualize the student–supervisor relationship with a measure of the proximity of the supervision (affiliation, intimacy, supporting and so on) and a measure of guidance (direction, structuring, influence and so on) (Kleijn et al. 2012). Good supervision may enhance the quality of a thesis and lead to a higher grade by having an appropriate level of proximity and guidance, i.e. an interest in the student's progression on the one hand and the intention to influence this progression on the other (Mainhard et al. 2009; Kleijn et al. 2012). Meeus, Van Looy, and Libotton

(2004) take a notable opposite position by emphasizing the importance of independent learning: Independent learning means:

> leaving as many choices as possible up to the student … [i.e.] the subject, field of action or basic competence forming the basis of the thesis; which goal, which problem or line of questioning will be at the forefront; the personal supervisor; the number of meetings with the supervisor; when the meetings with the supervisor take place. Meeus, Van Looy, and Libotton (2004, 305)

This requirement regarding independence puts student and supervisor in a permanent 'field of tension between the demand for a clearer task description, on the one hand, and the need for autonomy … , on the other' (Holmberg 2006, 313). We develop a conceptual model of the influences on the outcome of a bachelor thesis in terms of guidance and affiliation, while controlling for other influences, see Figure 1.

This tension also refers to the fact that a thesis combines a learning goal and an assessment goal (Todd, Smith, and Bannister 2006). This makes the supervisor's role a two-fold one – supervisor *expressis verbis* and assessor, guiding the student through the research on the one hand – i.e. exercising influence on the student's activities – and assessing the quality of this research on the other. Both goals are rather vast and

> it is unclear how it can be decided to what extent a student is indeed able to do research, and to what extent the student has learned from doing the … thesis, and more importantly what the student has learned. (Kleijn et al. 2012, 927)

What is clear is that too much guidance will eventually lead to assessment problems, 'since the supervisor has also influenced that quality. This may result in the supervisor grading his or her own work, instead of the thesis of a student' (Kleijn et al. 2012, 926; Manathunga 2007).

An essential element of guidance resides in the definition of goals. There may be a consensus on some general goals to be achieved, yet the specific goals of a thesis and the responsibilities in goal-setting are always to be clarified – is it the academic department, the supervisor(s), the principal who handed in the topic (cf. chapter 4 of this topic) or maybe the student him- or herself that carries this responsibility? This point out the importance of goal alignment between all parties involved (Anderson, Day, and McLaughlin 2006; Halse and Malfroy 2010).

The discussion of coaching aspects primarily focuses on the amount of guidance and is often unspecific, in the sense that a generic feeling of the students is measured, as e.g. 'My supervisor wants me to do things his/her way' (Kleijn et al. 2012, 930). Less attention is paid to the contextual dimension of supervision – referring e.g. to the question of which coaching inputs have the greatest influence on the success of a bachelor thesis. In our analysis we will have a closer look at the different elements of guidance and if some have a stronger explanatory power for the final grade. This allows us to formulate the following hypothesis:

> H1: The final grade of the bachelor thesis is positively related to the quality of supervisor guidance.

Turning to the relational aspects of thesis supervision, Kleijn et al. (2012, 928) report 'that students who perceive more affiliation from their supervisor receive higher final grades, are more satisfied, and perceive their supervisor to have made a larger contribution to their learning'. Affiliation – which is rooted in the motivational disposition and the capacity of a supervisor (Sun 2015) – may take several forms: personal caring (Firestone and Rosenblum 1988), a sense of responsibility for the academic achievements of students (Nir 2002), an identification with students and a willingness to dedicate a considerable amount of time and effort to them (Menzies 1995). Many studies report positive effects of these relational components on student learning (Gill and Reynolds 1999; Janisch and Johnson 2003) and even on academic achievements (Housego 1999; Solomon 2007).

All aspects considered, Sun (2015, 616) concludes that 'teacher commitment is positively correlated with students' achievement'. From a student's point of view, it is the perceived supervisor's contribution to work, being related to his or her involvement and control, that is positively influencing

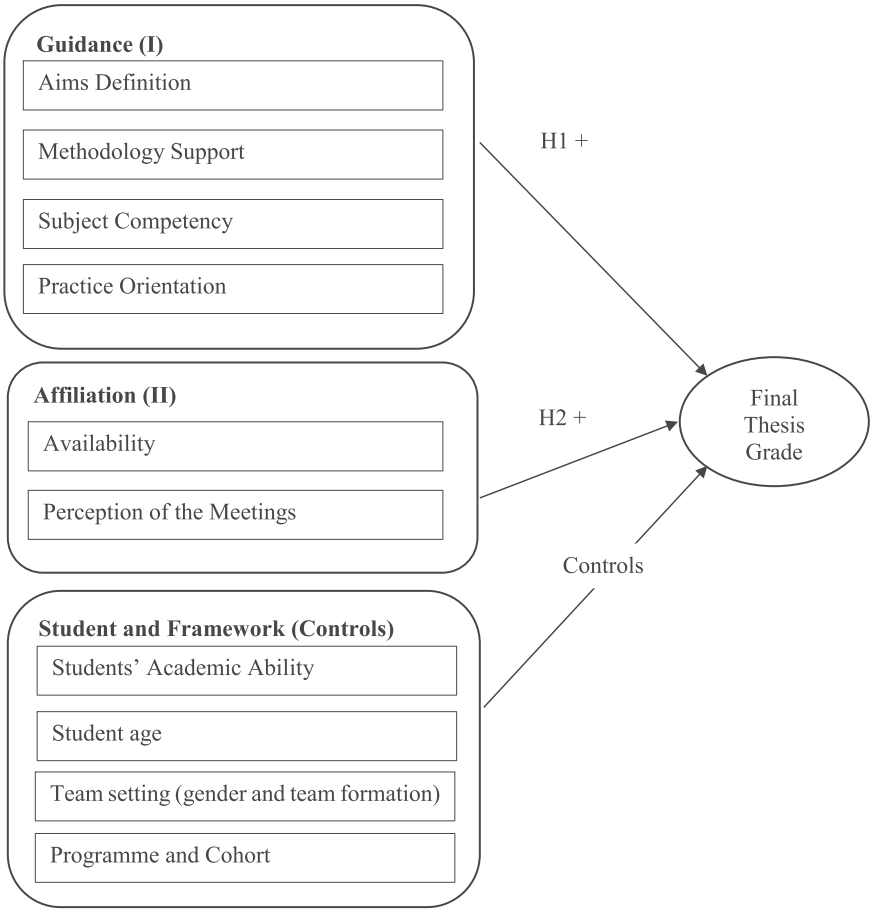

Figure 1. Conceptual model of influences on BSc thesis performance.

the learning outcome (Shuell 1988). According to Kleijn et al. (2012), the final grade largely depends upon the type and level of the supervisor–student relationship. Affiliation, i.e. the interpersonal proximity between student and supervisor and of any other stakeholder involved, produces a positive linear effect on the grade – the more affiliation, the better the grade. We assume that this is also the case for the student satisfaction with the affiliation. This suggests the following hypothesis:

H2: The final grade of the bachelor thesis is positively related to the degree of supervisor affiliation.

Methods

Study context

The focal Swiss University of Applied Sciences School of Business offers four bachelor degree programmes, Business Administration in German, Business Administration in English (International Management), Business Information Technology in both a German and English language degree. The English version of the Business Information and Technology degree programme is new and had the first graduates in 2017. Just one student of this degree programme has completed the survey in 2017. Therefore, we will consider the BIT programmes as one programme in the analysis. There were no significant pedagogical interventions or improvements on any of the degrees.

The bachelor students work on an assignment from a company or an organization for their bachelor's thesis. The assignments are business related and can include the whole range of subjects under

Business Administration or Business Information Technology degrees. Some topics are timeless, e.g. marketing concepts, cost calculations and so on, whereas other topics arise in waves, e.g. balanced scorecard, social media concepts and so on. The duration of the thesis is three to five months. Fulltime students write their thesis at the end of three years of studies, part-time students after four years of studies.

Three parties are involved in the bachelor thesis. The representative of the company or organization (client), the student or students and the supervisor. The client pays a fee, to ensure that the client has an interest in the topic and contributes to the project. The client sets the overall goal of the bachelor thesis, but specific details are negotiated between the three involved parties, with the supervisor supporting the student(s) in leading this negotiation. The experience of the supervisor in judging feasibility of the bachelor thesis is critically important in this negotiation process.

The bachelor thesis projects studied in this paper were supervised by a total of 82 supervisors that were required to hold a minimum qualification of a master degree to be able to supervise a bachelor thesis. New supervisors are given an introduction to the bachelor thesis project and documents, such as the guidelines and assessment framework, to ensure a common understanding of the projects and supervision role. The supervisor evaluates the bachelor thesis project together with the client, no further examiner is involved in the grading. In case of disagreement with the client about the grade, the supervisor has the final word to ensure an academic evaluation. Supervisors can supervise theses for all four degree programmes (BA (DE), IM (EN) and BIT (EN/DE)), but usually have a core programme for which they supervise theses. Individual and group theses are treated equally, that means that the same expectations and grading criteria are used for group and individual theses. The thesis regulations include ethical considerations in particular concerning surveys and interviews.

Sample and procedure

In the years 2014, 2015 and 2017, a satisfaction survey was administered to the bachelor students who had just finished their thesis. In 2016, the survey was not conducted due to longer holidays of the responsible person. Table 1 shows the number of observations per year in terms of survey response rates and thesis type, i.e. whether the person answering was working alone or in a team of two men, two women or man and woman.

Table 1. Overview of sample.

	Year			
	2017	2015	2014	Total
Survey responses				
Numbers of thesis	178	111	100	**389**
Responses	80	49	60	**189**
Response rate	45%	44%	60%	
Team setting and year				
Man	25	21	32	78
Woman	17	18	11	46
Two men	13	7	10	30
Two women	13	2	7	22
Man and woman	12	1	0	13
	BA	BIT	IM	Total
Team setting and study programme				
Man	18	46	14	78
Woman	22	12	12	46
Two men	12	0	18	30
Two women	10	0	12	22
Man and woman	11	0	2	13
Sum	73	58	58	189

Pooling over the three years there are 189 observations in total, where an observation refers to a student that filled in a questionnaire, with annual response rates varying between 44% and 60%. To test the legitimacy of the pooling, we use heteroscedasticity robust standard errors and include the survey year in the regression analysis. The students can decide if they want to work alone or in a team of two on their thesis. The largest group is a man working alone, with 78 theses, while the second largest group, with 46 theses, is of a woman working alone. When working in a team students prefer to work with a fellow student of the same gender, there are 30 observations of all men teams and 22 observations of all women thesis teams. Only 13 observations are of mixed-gender bachelor thesis teams, with one man and one woman. An observation in our study is a student from a team that has filled out the survey. It is possible that two students that worked together have both answered the questionnaire. They will have the same bachelor thesis grade though the individual judgement about the support of the supervisor and the satisfaction with the support may differ as well as other potential covariates like gender and age. The pairing for the bachelor thesis can be checked via the birthdate and the gender of students. In total, there is clustering for the same bachelor thesis among 13 pairs, where both students completed the satisfaction survey, corresponding to 26 of the 189 students in total.

The three curricula involved in the study are presented in Table 1. The thesis in the BIT curriculum is always an individual study and has the lowest proportion of women as students.

The survey was kept short in order to attract as many participants as possible. The survey included four groups of questions, addressing the (1) perceived supervision support at the start of the thesis project (with defining the objectives and elaborating the practical approach), (2) supervisor availability during the thesis process measured in terms of reaction time to requests, (3) student perception of the meetings (helpful, patient, motivational, convincing, correct, understanding, setting of appropriate requirements, objective), and (4) student satisfaction with the supervision process (in terms of subject-specific support of the supervising lecturer, the methodological support of the supervising lecturer, the practice orientation of the supervising lecturer, and the overall supervision experience). To understand differences in satisfaction dimensions and to avoid feedback from the bachelor thesis grade to the satisfaction variables, since the survey was carried out after the students knew their bachelor thesis grade, the overall satisfaction was not considered in the analysis. The full questionnaire can be found in the Appendix.

The survey was not anonymized, which allowed us to match responses to institutional records of students, including the average grades of the students before the thesis, student age, student gender and the final bachelor thesis grade.

Variables

The variables that are considered in the analysis are described in Table 2. Variable 1 'bachelor thesis' grade is taken from institutional records. Variables 2–7 directly correspond to questions in the questionnaire. Variable 8 meetings is derived from 8 items evaluating the meetings between students and supervisors in the questionnaire. While variables 10–16 are drawing from institutional records.

Dependent variable

The bachelor thesis grade operationalizes the success of a bachelor thesis, see Figure 1 and Table 2, the dependent variable for the study. The grading system in Switzerland is based on a scale from 1.0 to 6.0; 6.0 is the highest grade possible. A 4.0 is satisfactory or put differently a pass, while a grade of 5.0 is seen as a good result and 6.0 exceptionally good. The scale of the variable btgrade is in 10th of a full grade and thus variable btgrade has a possible range from 1 to 6 with one decimal; most students receive a final grade between 4.0 and 6.0, see Figure 2.

Table 2. Overview of variables.

	Var	Var name	Description
Dependent variable(s)			
Thesis.	1	btgrade	Final grade of the bachelor thesis
Independent variables(s)			
Guidance	2	aims	Support with the definition of specific realistic goals
	3	methods	Support with the elaboration of the practical approach
	4	sat_subject	Satisfaction with subject-specific support
	5	sat_methods	Satisfaction with methodological support
	6	sat_practice	Satisfaction with practice orientation of support
Affiliation	7	availability	In terms of reaction time
	8	meetings	Derived from meetings qualifications in the survey
	9	sat_overall	Overall satisfaction (not used in regression due to correlations)
Controls			
	10	avgrade	Average grade prior to bachelor thesis (average if working with partner)
	11	avage	Age of the student (Average age if working with partner)
	12	Team setting	Gender and group formation. 1: one man, 2: one woman, 3: two men, 4: two women, 5: man and woman
	13	Curriculum	Curriculum (BA, IM, BIT), originally 9, but aggregated to 3 later
	14	year	2014, 2015 or 2017

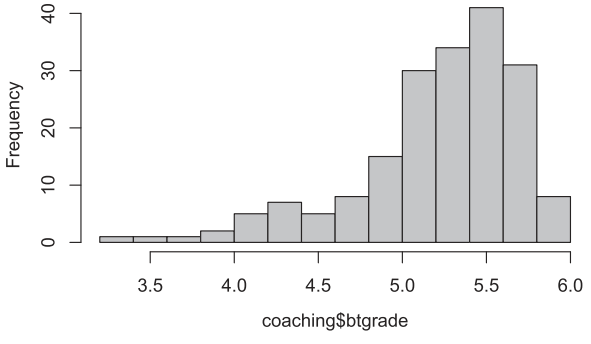

Figure 2. Histogram bachelor thesis grades.

Independent variables

Guidance is operationalized by five variables respectively measuring supervisor support with the definition of specific realistic goals, supervisor support with the elaboration of the practical approach, satisfaction of the student with subject-specific, methodological and practice orientation support, see Figure 1. A principal component analysis showed that the variables used for the construction of guidance are well aligned on the first principal component. Guidance is the mean per observation of the variables aims, methods, sat_subject, sat_methods and sat_practice. Missing values are omitted when taking the mean. Variable guidance has a range of 1–4, where 1 indicates low student satisfaction with guidance and 4 indicates high satisfaction with guidance.

Affiliation is measured by two variables, the supervisor responsiveness/availability in terms of reaction time and the student perception of the meetings. The multiple response questions on the meetings were coded from the initial dichotomies (helpful, patient, motivating, convincing, correct, understanding, reasonable) into a variable 8, meetings, by setting missing answers for a dichotomy to 0, positive answers to 1 and negative answers to −1 and, finally, summing these dichotomies. Availability is coded as a scale from 1 to 4, where 4 means the best availability. The correlation between availability and meetings is moderate (0.317) but clearly significant. Finally, affiliation is the sum of availability and meetings/4 such that the potential range of affiliation is from −1 to 6, with 6 representing the highest degree of affiliation.

Control variables

Several previous studies that have measured the value of the supervision on the outcome considered students as a uniform group (e.g. Kleijn et al. 2012; Mainhard et al. 2009). We added control variables to our model that focus on student attributes, see Figure 1. The student academic ability is measured with the average grade a student or with the average grade a pair of students achieved prior to the thesis project. We added student age as a proxy for experience. The team setting distinguishes between a man and a woman working alone and teams consisting of two men, two women or man and woman. The three degree programmes Business Administration, International Management and Business Information Technology are coded in variable curri and the year of the cohort when the bachelor thesis was written is also a recorded. Adding these controls allows us to answer the question if supervision has a measurable impact on the result with greater confidence, by more actively considering student attributes in the model.

Analysis and validity

Descriptive and inferential analysis

The analysis of the data used descriptive and exploratory methods to understand the nature of the data (Cook and Weisberg 1999). The inferential analysis was completed in two steps. First, a regression model including all covariates and the variables guidance and affiliation was established, providing a base model for the analysis. Diagnostic plots are used to find outliers and leverage points. Then a model-building process eliminated variables with low predictive power and lead to a parsimonious regression model. After the regression analysis with the constructed variables guidance and affiliation, the component variables of these two constructs were analysed in a post-hoc analysis to see whether particular constituents of guidance or affiliation could be identified as the main drivers for the success of a bachelor thesis. In both steps we adopted a model-building process, using 'all subsets' regression, leading to the identification of a parsimonious model with good explanatory power. This type of search through a large number of potential models using the Bayesian Information Criterion (BIC)[1] has good potential in finding a globally best model (Fox 2015; Stock and Watson 2007, 552–554).

Heteroscedasticity robust standard errors were used for the tests on the coefficients. A transformation of btgrade was also applied to check whether a less heteroscedastic representation would point to other variables as predictors in the base model. This was not the case (Stock and Watson 2007, 326–328).

Tests for robustness of analysis

Methodological concerns addressed in the analysis process include an evaluation of the distributions of the individual variables, linearity of the data collected, and multicollinearity (Stock and Watson 2007, 206–210). The distribution of the final grades shows left skewness, see Figure 2, with 5 bachelor theses that have been graded below 4. On the other hand, four students got the maximal grade of 6.0. The main part of the grades is concentrated between 5.0 and 5.7 with a median of 5.4.

Minor deviations of the distribution of the curricula in the sample compared with the population also occur (see Table 2). Overall, the deviations were deemed rather small and it is not necessary to adopt a weighting scheme. The satisfaction on all measured dimensions was in general high with only a few students that were dissatisfied. The distribution of the answers to question 1 on the support provided when defining specific and realistic goals of the thesis, i.e. variable aims, is shown in Figure 3. The bar charts of all other variables exhibit a similar monotone increasing pattern or at least left skewness.

The normalplot of the residuals at the base model shows some asymmetry but no clear outliers. The residual plot does not show a clear nonlinearity or outliers, but indicates decreasing variability with increasing predicted value (Stock and Watson 2007, 124). Therefore, the tests for the coefficients will use heteroschedasticity robust standard errors. Figure 4 shows the scatterplot, using the

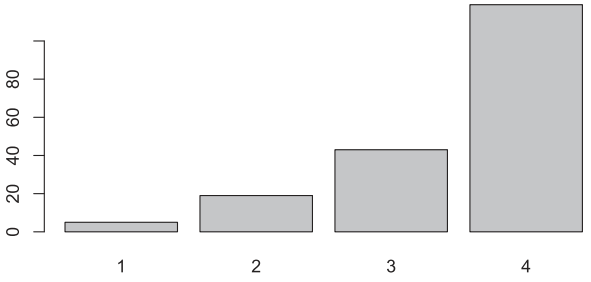

Figure 3. Histogram bar chart variable aims.

hexbinplot approach, of the dependent variable btgrade versus the variable guidance. The plot shows a rather clear and generally linear relationship but also considerable scatter and heteroscedasticity (Stock and Watson 2007, 92–96).

Students with the maximum grade of 6.0 can be rather dissatisfied with the received guidance and rate the guidance received with low 1.8 points on a scale from 1 to 4. On the other hand students with a grade of 3.8, that is just a pass, can be highly satisfied with the received guidance and rate guidance with the highest possible marks. The possible objection that giving a good bachelor thesis grade will lead automatically to students that are satisfied with the received guidance is thus not supported by the data.

Results

The results section presents and discusses the descriptive statistics and correlation results of the analysis, then presents the results of the regression analysis for the concepts guidance and affiliation and finally provides a post-hoc analysis to identify the most parsimonious model for explaining student performance in BSc thesis projects.

Descriptive statistics and correlations

The number of observations varies slightly across the models because of missing values. The final grade of the bachelor thesis (variable btgrade) has a mean of 5.264 and a standard deviation of

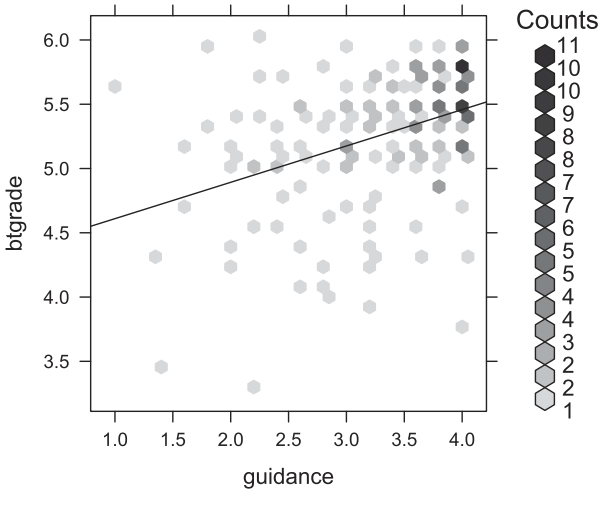

Figure 4. Hexbinplot BTGrade versus guidance.

0.496. The average grade of bachelor theses over a period of 12 years is 5.07. It seems that the students that participated in the satisfaction survey were slightly better than the average; see the distribution of the grades in Figure 2.

The correlation between the average grade of all subjects before the thesis and the bachelor thesis is visible (see Figure 5). Nevertheless, the variance is considerable and even with a rather low average grade before the thesis, a high bachelor thesis grade is possible, e.g. with an average grade of 4.57 a bachelor thesis grade of 5.9 has been achieved. On the other hand, a good average grade before the thesis does not automatically lead to a good bachelor thesis grade, e.g. with an average grade before the thesis of 5.36 students have subsequently achieved a 4.4 in their bachelor thesis.

The Spearman correlations of btgrade, guidance, and affiliation are given in Table 3. Obviously, the correlation of 0.665 between guidance and affiliation makes it difficult to distinguish between the influence of guidance and affiliation on btgrade, though the correlation of guidance with btgrade is stronger than between affiliation and btgrade.

The variables directly derived from the questionnaire and the average grade have highly significant correlations. However, the satisfaction variables are, as usual, also correlated strongly among themselves and the question of what variables are actually the most important ones must be answered by a multiple regression analysis.

Regression analysis

The full model with btgrade as the dependent variable (outcome) and with all potential independent variables (predictors)[2] yields an overall adjusted R^2 of 0.298 with 187 observations (2 observations were deleted due to missing values). Using a search through all possible subsets of the variables and the BIC criterion, all variables except avgrade, team setting, guidance and affiliation can be dropped from the model without a loss of predictive power. In the team setting, we used the largest number of observations, namely one man working alone ($n = 78$) as the base line. Then, we evaluated if the findings for the other compositions, one woman, two men, two women or man and woman together, differ from the base line. The normal plot of the residuals showed mild asymmetry, but no outliers and visible but not strong heteroscedasticity. Overall the model showed a good

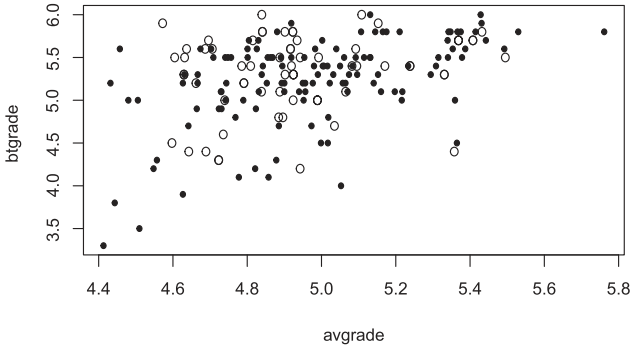

Figure 5. Bachelor thesis grade versus average grade before the bachelor thesis. Empty circles indicate pairs.

Table 3. Correlations.

	btgrade	Guidance	Affiliation
btgrade	1.000	0.414	0.319
guidance	0.414	1.000	0.665
affiliation	0.319	0.665	1.000

Table 4. Regression analysis.

	btgrade		
Predictors	Estimates	SE	*p*
(Intercept)	0.220	0.595	.712
avgrade	0.809	0.144	**<.001**
woman	0.059	0.071	.408
two men	0.026	0.102	.798
two women	0.270	0.095	**.005**
man and woman	0.258	0.146	**.079**
guidance	0.166	0.079	**.037**
affiliation	0.117	0.059	**.048**
Observations	187		
R^2/adjusted R^2	0.345/0.319		

fit with an adjusted R^2 of 0.319. The model is presented in Table 4 and is called the base model. The *t*-test for the individual variables was also carried out with heteroscedasticity robust standard errors, but since they are only marginally different from the normal *t*-tests we show the latter ones in Table 4.

The grade of the bachelor thesis is influenced by the average grade of the students prior to the thesis and as a rule of thumb academically strong students tend to write a good bachelor thesis. This is not surprising, of course, but must be taken into account in order not to overstate the influence of other variables, in particular, guidance and affiliation. Variable guidance is significant at the 5% level and adds about 0.166 to btgrade when raising guidance by 1.0 on a scale from one to four. Variable affiliation is just significant at the 5% level and adds about 0.117 to btgrade for every 1.0 increase on a scale from −1 to 6 in affiliation. Only groups composed of two women or a woman and man working together are significantly better than a single man, adding about a 0.270 or 0.258 to btgrade, respectively, see Figure 6.

To illustrate the potential influence of supervision on student performance for the bachelor thesis, a minimum and maximum impact scenario on the weakest academic student is presented. The lowest average grade before the bachelor thesis is an average grade (avgrade) of 4.413 out of 6.0 on the Swiss scale, a sound pass. Taking lowest avgrade (=4.413) and the minimal observed values for the other variables (team setting = base line (single man), guidance = 1, affiliation = 0) as a baseline, the bachelor thesis grade btgrade would be predicted as 4.123 by our model. However, a 95% prediction interval for that btgrade is [3.273, 4.971], a considerable range! A student with the minimal average grade but with a supervisor with maximal guidance (=4) and maximal affiliation (=3) would have a predicted btgrade of 4.970.with a 95% prediction interval [4.144, 5.797]. Therefore, the supervisor may, at least according to our model, have a considerable effect on the final thesis grade, this change in grade is qualitatively equivalent in the Swiss system to barely passing (4.0) and a good performance (5.0).

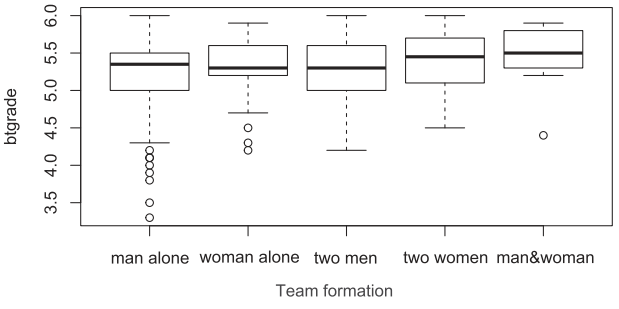

Figure 6. Boxplot BTgrade versus team setting.

Post-hoc analysis

Analysing the constituents of the two constructed variables guidance and affiliation and searching for a parsimonious model, besides avgrade only two variables remain significant: aims and sat_methods. Figure 7 shows the BIC-plot of a search over all subsets of variables.

The model with avgrade, aims and sat_methods yields an adjusted R^2 of 0.304, see Table 5. The normalplot of residuals shows some skewness but no outliers. The heteroscedasticity of residuals is visible. The model coefficients are given in Table 5, variable avgrade is highly significant and aims and sat_methods are significant.[3]

This suggests that bachelor thesis supervisors can focus their efforts on supporting students with the development of the aims of their study and on ensuring students have appropriate support with the methodological aspects of their research.

Discussion

In our literature review, we have seen the tension between the learning and assessment goal of the thesis, as a result of the learning goal asking for support and the assessment goal for more freedom (Todd, Smith, and Bannister 2006; Delamont, Parry, and Atkinson 1998; Kleijn et al. 2012). In the attempt to deal with this tension, previous researchers have made different arguments, some have stated the importance of independent learning (e.g. Meeus, Van Looy, and Libotton 2004), while others have emphasized the importance of personal caring and identification with the students (e.g. Nir 2002; Menzies 1995).

Lee (2008), Mainhard et al. (2009) and Kleijn et al. (2012) have used a model with two dimensions for the description of the student–supervisor relationship. One dimension considers the provision of guidance and direction, whereas the other dimension considered the proximity or affiliation with the topic and/or the student. This model was the basis for our hypothesis, that the bachelor thesis outcome is positively related to both the quality of guidance and to the

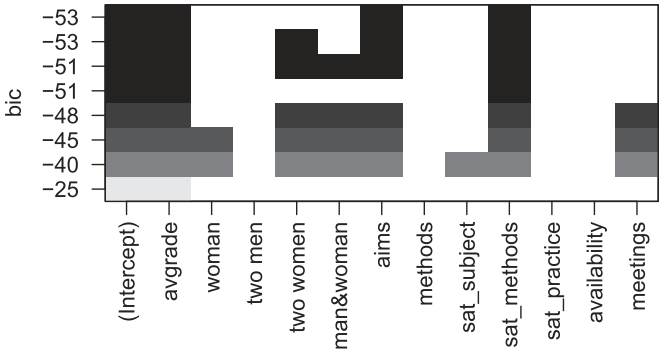

Figure 7. BIC-plot post-hoc model.

Table 5. Regression analysis for post-hoc analysis.

	btgrade			
Predictors	Estimates	SE	std. Beta	*p*
(Intercept)	0.804	0.778		.302
avgrade	0.727	0.142	0.381	**<.001**
aims	0.126	0.074	0.198	**.091**
sat methods	0.132	0.060	0.227	**.029**
Observations		186		
R^2/adjusted R^2		0.315/0.304		

degree of affiliation. We have been able to test this hypothesis thanks to the pooling of three waves of student satisfaction surveys 189 observations from students about the satisfaction with the supervision have been collected. The analysis used the achieved bachelor thesis grade as the outcome of bachelor thesis supervision.

The model-building process in our paper has considered all possible models of all available covariates. A base model including (1) the average grade before beginning the bachelor thesis, (2) the team setting (gender and team formation), (3) the guidance and (4) the affiliation as potential predictors turns out to be relatively stable and explains about a third of the variability of the final bachelor thesis grade. The inclusion of gender and team formation opened up an interesting field of future enquiry. The expectation in the literature is that in undergraduate studies women have slightly better average grades and less dispersion in the distribution of grades than their fellow male students (Barrow, Reilly, and Woodfield 2009, 592). The final bachelor thesis grades in our study provide further evidence for this pattern.

When considering a man or woman working alone on a thesis there is no significate difference in observed outcomes. Turning to findings for teams, the evidence for the impact of different gender compositions of teams are controversial. Some research has found women dominated teams to outperform teams dominated by men (Fenwick and Derrick 2001), while others have found the opposite (Rogelberg and Rumery 1996; Apesteguia, Azmat, and Ibriberri 2012). Our findings suggest that a team of a man and woman and two women teams have a favourable impact on the bachelor thesis grade, whereas two men working together seem to have a negative dynamic. Mixed-gender teams have been found to be favourable for group cohesion and team processes,

Table 6. Which factors have an impact on the bachelor thesis grade.

	Base model		Post-hoc analysis	
	Explanatory power		Explanatory power	
Variables	Yes	No	Yes	No
Guidance, including:	X			
• Support with aims definition			X	
• Support elaboration practical approach				X
• Satisfaction with subject-specific support				X
• Satisfaction with the methodological support			X	
• Satisfaction with the practice orientation				X
Affiliation, including:	X			
• Availability in terms of reaction time				X
• Perception of the meetings				X
Controls				
• Average grade before the thesis	X		X	
• Age of student		X		X
• Team setting (gender and group formation)	X			X
• Curriculum/study programme		X		X
• Year that the thesis was written		X		X
Goodness of fit	$R^2 = 0.345$; adjusted $R^2 = 0.319$		$R^2 = 0.315$; adjusted $R^2 = 0.304$	

whereas the impact on performance has remained controversial (Lee and Farh 2004; Bear and Woolley 2011). Due to the limited number of observations, e.g. only 13 observations for man and woman working together, we also do not wish or seek to interpret too much into these results and discuss them with caution.

Kleijn et al. (2012), Mainhard et al. (2009) and Hon Kam (1997) have considered the extent of guidance and affiliation and its impact on the outcome of the thesis. In our post-hoc analysis, we did not focus on the extent but on where guidance and affiliation is provided. The BIC analysis, which takes into account the variance reduction by the model, but also gives a penalty for the number of variables in the model, identified the most parsimonious model as including, (1) the average grade before the bachelor thesis, (2) the satisfaction with the support at the stage where the aims of the bachelor thesis are agreed and (3) the satisfaction with the support with the project methodology. We summarize the findings about what has an impact on the final bachelor thesis result in Table 6.

The initial base model might be seen as a summary of all available variables, as just a few variables are not included. Besides the explanatory power of the variables for the bachelor thesis grade, there might also be a relationship between them. Student attributes (controls) may influence the affiliation of the supervisor, a strong affiliation might give direction and positively influence a student's willingness to accept guidance. The post-hoc model has less variables and does potentially overstate their predictive power but on the other hand gives clearer hints where to draw attention in the supervision process.

Conclusion

We conclude by discussing the contribution of our study to the academic literature, highlight its main limitations, suggest future opportunities for research and close by drawing specific recommendations for practice.

Contribution

We provide evidence that the average grade before the bachelor thesis, the satisfaction with the support at the stage where the aims of the bachelor thesis must be defined and the satisfaction with the support in methodology is the most parsimonious explanation for BSc thesis grade achievement. Our findings suggest that guidance by the elaboration of a practical approach and satisfaction in areas such as subject-specific support, practice orientation, availability and the supervision meetings do not have an explanatory power for the quality of the thesis in our study.

Coming back to our research question: 'To what extent can the supervisor contribute to the outcome of a thesis?' We can clearly state that the supervision has a measurable impact on the bachelor thesis result. Supervision and the capacity of the student are the only predictors that are left in the most parsimonious model. The standardized beta coefficient, which measures the strength of the effect of each individual independent variable to the dependent variable, shows for the capability of the student 0.381 (average grade before the thesis) and for the support of the supervisor with the aims definition 0.198 and for the methodological support 0.227. These findings suggest that the supervision and the capability of the student have a comparable importance. Potentially, supervision can explain up to almost one grade of bachelor thesis grade.

Many authors have already stated that the student–supervisor relationship is important e.g. Lee (2008) or Bloom et al. (2007). We included controls such as the capacity of the student in terms of average grades before the bachelor thesis and we were not sure if supervision would still have an explanatory power for the bachelor thesis grade. It still has and we are surprised of the extent of the explanatory power. Therefore, our quantitative findings allow us to confirm the previous studies that were often conducted with a qualitative approach or without control variables (e.g. Marshall, Klocko, and Davidson 2017; Kleijn et al. 2012).

Limitations

One limitation of our study is that the student knew their bachelor thesis grade when filling in the questionnaire. This may have had an influence on the satisfaction evaluation by the student. However, filling in the questionnaire after the bachelor thesis but before the publication of the grade may also influence the satisfaction evaluation when a student wants to avoid a negative impact on the bachelor thesis grade. Of course, the information of the survey would not have been disclosed to the supervisors but this may not have avoided such an effect fully.

A further problem is the high correlation among the satisfaction ratings. The satisfaction with the definition of the aims and the satisfaction with the support in methodology may be seen as proxy variables for the other satisfaction ratings. And, in fact, the overall satisfaction would be the strongest, but the least informative, predictor and thus has been left out of the models. Still the modelling process clearly pointed to these two variables as the most important satisfaction variables.

Opportunities for future research

We see two natural continuations of our research. One approach would go deeper. What do the students actually need when it comes to the aims definition and the methodological support? What does a supervisor need to know if he or she would like to give valuable inputs in these two areas? The other approach would go broader. Are there other elements that have a predictive power, e.g. the type of topic or the engagement of the client?

Practical implications

The practical implications of our study are related to how supervisors should approach the supervision of bachelor theses. Our findings provide specific recommendations for where to place the emphasis in supervision. We found evidence that effective supervision should focus on two elements:

(1) The support at the beginning of the thesis, when the aims of the bachelor thesis are defined.
(2) The support of students in the methodology by the supervisor.

Both elements have an almost equal weight in predictive power of the bachelor thesis grade. It might be that these two elements are overweighed due to the reduction of variables and the concept of affiliation and guidance should not be neglected.

The role of the supervisor, e.g. Holmberg (2006, 213) and the nature of the supervision is often discussed. Whereas some authors emphasize the importance of independent learning, e.g. Meeus, Van Looy, and Libotton (2004) others state the importance of the identification with the topic and student and willingness to invest time and effort in the supervision, e.g. Menzies (1995) or Nir (2002). Our findings could allow a balanced supervision. It suggests guidance where it has an impact and, to a certain degree, laissez-faire and independent learning in other areas.

Our findings suggest that a convincing bachelor thesis outcome with a supervisor that appears once at the beginning and then give his feedback after the work is completed can only have two explanations: Either the supervisor gives both great support with the aims definition and the methodology in a very short time or he, she has a good student.

Notes

1. BIC uses a penalty for the number of parameters in the model in addition to the residual sum of squares.
2. The model contains avgrade, year, curriculum, avage, composits, guidance and affiliation.
3. Note that the heteroscedasticity robust standard errors are larger and corresponding *p*-values are larger for aims and sat_methods but significant at the 5% level.

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Appendix. Questionnaire

1 As and when required the supervising lecturer supported you				
	I agree	I partly agree	I partly disagree	I disagree
with the definition of specific, realistic goals				
with the elaboration of a practical approach				
2 How do you assess the availability of the supervising lecturer				
O very good (reaction time: Ø two working days)				
O good (reaction time: Ø three working days)				
O sufficient (reaction time: Ø four working days)				
O insufficient (reaction time: Ø more tHan four working days)				
3 How do you characterize the meetings with your supervising lecturer? (multiple choice possible)				
O helpful			O not very helpful	
O patient			O not very patient	
O motivational			O not very motivational	
O convincing			O not very convincing	
O correct			O incorrect	
O understanding			O not very understanding	
O setting of appropriate requirements			O setting of not very appropriate requirements	
O objective			O biased	
O further: … … ….				
4 How satisfied are you with the following aspects?				
	Very satisfied	Satisfied	Rather not satisfied	Not satisfied
with the subject-specific support of the supervising lecturer				
with the methodological support of the supervising lecturer				
with the practice orientation of the supervising lecturer				
with the overall satisfaction				