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How Does Supervision Shape Student Thesis Outcomes? Expanding the Theory and Measurement of Supervision and Its Impact

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ABSTRACT

For many students, writing a thesis is the final and pivotal step in their university education and their success matters for students themselves, but also universities and society overall. Despite involving large numbers of students, supervision at the undergraduate level is an understudied field of research in comparison to doctoral supervision. This article aims to advance the pedagogical literature on supervision, where the vast majority of prior contributions are qualitative case studies. We investigate what kind of supervision generates the best outcomes for undergraduate students writing their theses. Using a survey on thesis supervision answered by 251 bachelor and master level students, we assess how five dimensions of supervision (support, control, content, process and format) are related to four key outcomes (thesis quality, completion on time, deep learning and scientific curiosity). Our findings show that different types of supervision promote different outcomes. For instance, supervision focused on control is associated with higher thesis quality and more scientific curiosity, whereas supervision focused on support is associated with completion on time, but also with less scientific curiosity. Taken together, the article demonstrates the importance of a holistic approach to thesis supervision, and provides both theoretical and empirical additions of value to existing research.

Introduction

The purpose of this article is to identify the central ingredients in successful thesis supervision, and more broadly the costs and benefits of different types of supervision for both supervisors and students. To this end, we present a theoretical framework that expands the conceptualization of supervision and thesis outcomes in relation to prior literature. We then assess the components in this framework using an original survey answered by 251 bachelor and master students at a political science department in Sweden.

Our study represents several advances in relation to prior research in the field. Whereas the literature on supervisory styles primarily has focused on the relational

dimension of supervision; i.e. the degrees of support and control provided by the supervisor (Mainhard et al. 2009; de Kleijn et al. 2012),[1] we theorize and assess two additional dimensions; the content dimension, i.e. extent of attention paid to key scientific thesis content, and the process dimension, i.e. to what extent the supervisor invests in enhancing the student's research and writing process (see also Reguant, Martínez-Olmo, and Contreras-Higuera 2018). Moreover, our framework expands the conceptualization and measurement of thesis outcomes in relation to the prior literature (cf. de Kleijn et al. 2012). In addition to final grades and completion on time, the student's scientific curiosity and sense of deep learning are included as central outcomes.

From the university's perspective, the quality of the final thesis as well as completion on time are key outcomes, and from the perspective of the student, the experience of deeper learning as well as scientific curiosity are important for their long-term development. At the societal level, therefore, an evaluation of the impact of supervision needs to consider the full breadth of these outcomes. The research question pursued is: *How do different dimensions of supervision influence student outcomes such as final grade, completion on time, scientific curiosity and deep learning?*

Empirically, we focus on supervision at the master and bachelor levels, since undergraduate supervision is much less studied in existing research than PhD supervision (Roberts and Seaman 2018, 28; Harwood and Petrić 2020, 68; Strebel et al. 2021, 868). Given the much larger group of students that are affected by supervision at the undergraduate level than at the PhD level, this oversight in the literature is problematic. It is not a given that patterns in PhD supervision, which happens over multiple years, are repeated for undergraduate supervision which is more limited in time. We also collect and analyze data from a department where the supervisor is not involved in the assessment and grading, providing a unique methodological advantage. This allows us to use the final grade as a relatively pure measure of thesis quality, and an important confounder present in previous studies can be avoided (see e.g. de Kleijn et al. 2012). Our findings are still relevant to contexts where the supervisor is involved in the grading, although studying such environments would pose methodological challenges. Moreover, we provide a quantitative study, whereas much of the literature on supervision is based on qualitative case studies where correlational hypotheses are rarely investigated (see e.g. Harwood and Petrić 2020; Zackariasson 2018; Gatfield 2005; Dysthe, Samara, and Westrheim 2006; Acker, Hill, and Black 1994). Taken together our theoretical and empirical additions should provide valuable contributions to the field.

Our article has grown out of an interest in supervision in general, and a concern about the varying quality of supervision students seem to receive, as well as the varying efforts supervisors seem to put into supervision. The varying efforts and choices made by supervisors are not without explanations, as we know that a lot of the supervision work is unpaid (Larsson and Hansson 2011, 1), the workload for many university teachers is demanding (Watts and Robertson 2011, 44), and that the supervisors' choice to devote more time than what they get paid for may be gendered (Lindgren 2018). However, there are strong reasons to suspect that supervisory styles make a difference for student outcomes (see e.g. Brydon and Flynn 2014; Roberts and Seaman 2018; Drennan and Clarke 2009; de Kleijn et al. 2012; Todd, Smith, and Bannister 2006) and given the limited number of hours available for supervision, we should aim to use them in the most productive fashion. This may also help supervisors and students reduce stress and anxiety.

The article is organized as follows: We first discuss the current literature on supervision. Secondly, we define dimensions of supervision and student outcomes. Following that, we describe our data and the specifics of the supervision context that we have studied. This is followed by the empirical analysis and our conclusions. Findings reveal specific dilemmas and tradeoffs in supervision, impacting key student outcomes (final grade, completion on time, scientific curiosity, and sense of deep learning) and how they relate to supervisors' choices about how to allocate their time and effort. Supervision *control* is crucial for higher grades and scientific curiosity, but conflicts with fostering student independence. Increased supervisor *support* enhances the likelihood of students completing their thesis on time, but diminishes scientific curiosity. The *format* of supervision also makes a difference, with written feedback promoting scientific curiosity. Finally, supervision focused on research *content* promotes deep learning for the student. Overall, we see that different aspects of how we supervise promote different outcomes that are important both for the student and for the university.

Previous research and theoretical framework

Much work has been devoted to the supervision of doctoral students (see among others Anderson, Day, and McLaughlin 2006; Gruzdev, Terentev, and Dzhafarova 2020; Halbert 2015; Halse 2011; Holmberg 2006; Kreber and Wealer 2023; Manathunga 2007; Marnewick 2023; Wilkin, Khosa, and Burch 2023; Hatemi and McDermott 2024). Yet, it is not a given that lessons from doctoral supervision apply to undergraduate supervision, as there are large differences between these experiences. In this article, we study how supervision impacts student outcomes at the much less studied bachelor and master levels, where the literature so far contains important but mostly piecemeal insights and observations (Roberts and Seaman 2018), and few large-scale and systematic analyses (for an exception, see de Kleijn et al. 2012). In this section, we discuss dimensions of supervision, before turning to how to think about student outcomes.

There are multiple roles that supervisors can take on, and there have been numerous attempts to sort them (Harwood and Petrić 2020, 68; Dysthe, Samara, and Westrheim 2006; Lee 2008; Strebel et al. 2021, 868; see also Johansson and Yerrabati 2017, for a review of this literature). In order to empirically examine the multi-faceted nature of supervision up close, we develop a framework of supervision, which takes several different components of supervision into account.

A central point of reference for our article is the study by de Kleijn et al. (2012), that uses quantitative data to assess the importance of supervision for three types of student outcomes at the master level; final grade, perceived supervisor contribution to learning, and student satisfaction. While de Kleijn et al.'s work is an inspiration to us, we expand on their study in several ways, related to the conceptualization and measurement of both supervision and student outcomes. In contrast to de Kleijn et al., we distinguish between two different learning outcomes; scientific curiosity and deep learning, and we examine completion on time, in addition to final grade. Unlike de Kleijn et al., we avoid confounding the final grade with other aspects of the supervisor's role vis-à-vis the student, since our data comes from a department where the grade is determined by a different teacher than the supervisor, based on an independent assessment. Moreover, we

conceptualize and measure additional components of supervision; in addition to control and support, we also consider the extent to which supervisors' focus on key scientific thesis *content*, the student's work *process* and the *format* of the supervision, i.e. how much written feedback the student receives.

Importantly, we agree with de Kleijn et al., as they note that more large-n studies are needed to identify causal links and best practices in thesis supervision (de Kleijn et al. 2012, 929). We hope to contribute to a further empirical investigation of this. Below we present our theoretical framework as a whole, before discussing the dimensions of supervision and student outcomes further.

Theoretical framework

As argued above, dimensions of supervision and student thesis outcomes have been defined and measured somewhat narrowly in the prior literature, and a key aim of this article is to expand the theory and empirical measurement of these important phenomena. Figure 1 shows the theoretical framework that we use as our point of departure, where supervision varies across five dimensions: emotional support, control, process-focus, content-focus and format. Student outcomes are conceptualized in terms of thesis quality, completion on time, deep learning and scientific curiosity.

Dimensions of supervision: Control, support, content, process, and format

Two relational dimensions of supervision, *support* and *control*, have been analyzed in several prior empirical studies under various labels (see e.g. Mainhard et al. 2009;
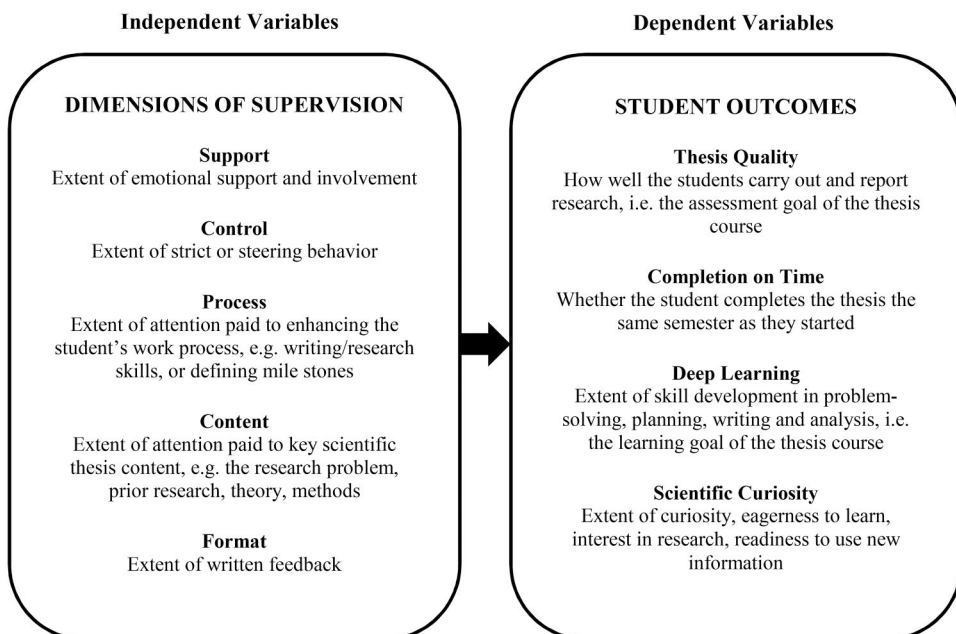

Independent Variables

DIMENSIONS OF SUPERVISION

Support
Extent of emotional support and involvement

Control
Extent of strict or steering behavior

Process
Extent of attention paid to enhancing the student's work process, e.g. writing/research skills, or defining mile stones

Content
Extent of attention paid to key scientific thesis content, e.g. the research problem, prior research, theory, methods

Format
Extent of written feedback

Dependent Variables

STUDENT OUTCOMES

Thesis Quality
How well the students carry out and report research, i.e. the assessment goal of the thesis course

Completion on Time
Whether the student completes the thesis the same semester as they started

Deep Learning
Extent of skill development in problem-solving, planning, writing and analysis, i.e. the learning goal of the thesis course

Scientific Curiosity
Extent of curiosity, eagerness to learn, interest in research, readiness to use new information

Figure 1. Theoretical framework of supervision and student thesis outcomes.

de Kleijn et al. 2012). The support dimension concerns supervisors' degree of emotional involvement in their students and their projects, whereas the control dimension concerns the extent to which supervisors steer the project (and ultimately decrease the independence of the supervisee). Overall, supervisors who are perceived to show more leadership or are strict are seen as exerting higher degrees of control, whereas supervisors who are perceived as more helpful, friendly, and understanding are seen as showing more support.

Whereas these two relational aspects of supervision and their consequences for student outcomes have been evaluated in prior research, less attention has been devoted to the *format* of the supervision, or the supervisor's degree of involvement in the key *scientific content* of the thesis and in the student's work *process*. The importance of these other components of supervision is a subject well worth exploring further. A large number of handbooks and practical advice on academic writing are available to students when they start to work on their theses, with a broad focus on content and the work process. This suggests that a supervisor's focus on content and process also may impact student thesis outcomes (see also Reguant, Martínez-Olmo, and Contreras-Higuera 2018). We argue that a student's work process is likely to be improved if supervisors invest in transferring skills that experienced researchers use to plan their time, set up milestones, organize the research process, and the like, but there is little systematic evidence in this area. Moreover, it is well-known that 'many students find it difficult to manage their time well, and as a result, they appreciate having timetables and deadlines set for them, as it helps them to distribute the workload and motivates them' (Del Río, Díaz-Vázquez, and Maside Sanfiz 2018, 160; see also Todd, Smith, and Bannister 2006, 168). Thus, we argue that supervision with a focus on process is likely to help students complete their theses on time. Reflecting on their work process in this manner may also help students achieve other goals related to deep learning.

With regards to supervision focused on content, a study undertaken by Todd, Bannister, and Clegg (2004) showed that the supervisor provided essential help in defining a thesis topic (considered a particularly critical moment), in selecting the appropriate methodology and in structuring the thesis. We define a content-focused supervision as one where significant attention is paid to the central scientific content of the thesis, e.g. the research problem, prior literature and methodological standards of excellence within a field. Engaging with such aspects, we argue, is especially likely to shape the quality of the thesis as a research product. It could also spark more interest for research and thereby foster scientific curiosity, since content-focused supervision may help the student position the thesis closer to the relevant research front, and get a sense of what it means to produce new knowledge.

We also know from previous research that the format of supervision can be important, especially the usage of written (rather than just oral) feedback, both because it increases student engagement and because it more clearly communicates the supervisor's opinions, suggestions, and critique (see e.g. Can and Walker 2014; East, Bitchener, and Basturkmen 2012). We therefore also investigate whether the format, defined as the use of written feedback, makes a difference for student thesis outcomes.

We intend to find out to what extent and how the degree of control, support, content, and process focus, as well as format impact student thesis outcomes.

Student thesis outcomes

Other studies of supervisory styles have often focused on students' satisfaction with the supervision they receive as a key outcome (see among others Del Río, Díaz-Vázquez, and Maside Sanfiz 2018; de Kleijn et al. 2012). We argue that such an outcome variable is at risk of being too similar to independent variables that reflect various aspects of the supervision received. We focus instead on four different outcome variables, which we argue are more important and relevant both from the perspective of the student and the universities where the students are located.

A central outcome is the *quality of the thesis* itself, as reflected in the grade, since the course goal is to enable students to write high-quality theses, and grades should reveal how well 'the students […] are able to carry out and report research' (de Kleijn et al. 2012, 927). The final grade should ideally reflect the thesis's alignment with the course examination criteria and its demonstration of the taught research skills. We argue that the grade assigned to the thesis is a good indicator of its quality. In the specific department where this study was conducted, the supervisors are not involved in the grading process, eliminating any potential bias they may introduce. In many contexts, supervisors are involved in the grading (see e.g. de Kleijn et al. 2012), making it difficult to use the grade as a measure of student outcomes that can be clearly separated from factors related to the supervisor, and the supervision received. Our data thus allow us to get a purer measure of the association between dimensions of supervision and the quality of the thesis.

From the university's perspective, *completion on time* may matter just as much as the quality of the final thesis. Completion on time may be seen as a reflection of the quality of a program as a whole. As the thesis component reflects the epitome of the program, completing it is particularly central in testing whether the students have been prepared enough to finish their studies. Lower completion rates induce costs for universities, but it also matters for society at large, as well as the student, if it takes longer to finalize a degree and enter the job market (Geven, Skopek, and Triventi 2018; Scott, Bailey, and Kienzl 2006; Scott 2009; Karunaratne, Hansson, and Aghaee 2019; Flores, Park, and Baker 2017; Giani, Attewell, and Walling 2019, 515). Delays in completing a degree may also increase mental health costs for students. We therefore consider completion on time to be a central student outcome. Overall, we know that the non-completion rate at the bachelor level in Sweden was 35% in 2004, numbers which reflect the trend in OECD countries in general (Larsson and Hansson 2011, 1), and the trend in the US specifically, where 37% of the 2010 cohort did not complete their undergraduate degrees within six years (Giani, Attewell, and Walling 2019, 514).

Crucially, we also argue that there are other and less frequently studied student thesis outcomes which should be considered when evaluating what kind of supervision is the most beneficial, namely *deep learning* and *scientific curiosity*. While the final thesis reflects a large portion of what a student has learned over the course of writing the thesis, the typical student learns more than what is reflected in the written product. Challenges faced during the thesis writing process as well as the final examination, may lead to other kinds of learning for the student, which we think are important to consider. We refer to this as deep learning. At the core, this is about mastering knowledge creation, a 'skill [that] is becoming more important as the future work most likely will

require a higher capacity in updating the knowledge and acquiring updated or new knowledge is in constant demand' (Larsson and Hansson 2011, 1).

While they do not measure this outcome, de Kleijn et al. talk about this as a 'learning goal,' i.e. that 'the students should learn about doing research' (de Kleijn et al. 2012, 927). This kind of deep learning is thus forward-looking, as it is about whether or not the thesis work has deepened the students' problem-solving skills, analytical skills, and ability to plan their work. It is about becoming familiar with the norms of how to produce knowledge, becoming part of a 'community of practice,' namely the knowledge production community, and feeling at ease with how to do research (Dysthe, Samara, and Westrheim 2006, 302-3).

Thus, here we connect to the well-known differentiation between *surface learning* on the one hand, and *deep learning* on the other, where deep learning is about critical thinking, integrating new and old knowledge, and where the student constructs meaning beyond the requirements of the course (Filius et al. 2018, 115; see also Biggs 1999; Marton and Säljö 1976). Thus, while *the quality of the thesis* is perhaps best described as the assessment goal of the thesis course, *deep learning* is best described as the learning goal of the thesis course. Both of these outcomes are important outcomes that should be evaluated.

We also target another forward-looking outcome: the degree to which the thesis work leads to an increase in the student's *scientific curiosity*. This kind of outcome is important in terms of sprouting new researchers and new knowledge. Scientific curiosity also matters for how we as citizens respond to the news, and important policy debates, such as that relating to climate change (Kahan et al. 2012). It 'fosters cognitive, social, emotional, spiritual, and physical development over the lifespan by stimulating exploratory behavior' and helps individuals adapt to new circumstances (Reio et al. 2006, 117; for more on the centrality of curiosity, see also Weible and Zimmerman 2016). Scientific curiosity, therefore, is a central student outcome that needs to be considered as well. Thus, we also need to ask ourselves how to create educational systems and supervise thesis projects that encourage inquisitiveness.

Taken together, we identify four student outcomes that are important both for the students themselves, but also for the university and society, namely: completion on time, final grade, deep learning and scientific curiosity. We argue that all five components of supervision need to be evaluated in relation to the four different student outcomes, as some of the components are completely new to the field, and some of the outcomes are expansions on previous work.

Data and methods

Our empirical analysis covers students who registered for a thesis course at the Department of Government, Uppsala University in the period 2017 to 2021, at the bachelor level (15 ECTS[2]/ten weeks of full-time studies) or at the master level (30 ECTS/20 weeks of full-time studies).[3] This sample covers a range of thesis types: quantitative and qualitative studies, interview based, document studies, or involving fieldwork. This student group and the types of theses are likely to speak to supervision needs and demands in other contexts as well. The thesis course designs, and whether a thesis is

required, vary across universities and academic programs in most countries. While this study was conducted in Sweden, in programs where the thesis course is obligatory for all students wanting to complete their degree, the supervision choices and impacts studied are relevant in many contexts across the globe, as supervision and thesis writing are common educational practices.

In the department studied, the supervisor has 11 hours for supervision with a bachelor student, and 16 hours with a master student, covering meetings and reading drafts of the thesis. Besides support from the supervisor, there are a number of non-compulsory components in the thesis course, such as library resources and lectures that support the students' work process. The thesis is assessed through a group seminar, where another student acts as the discussant and one member of faculty (the examiner) chairs the meeting and determines the grade. If the examiner is unsure about the grading, a second reader can be assigned after the seminar, but the supervisor has no role in the grading. Overall, there were no significant pedagogical changes done to any of the degrees during our period of investigation. For more details about the supervision context, see the Supplementary Appendix.

Our target group was contacted via e-mail and asked to complete a self-administered digital questionnaire. The survey was fielded for three weeks in February 2022, with three reminders. In the end, 251 individuals answered the survey, giving us a response rate of 21.6% (251/1163).[4] Compared to previous studies, our sample is relatively large (cf. de Kleijn et al. 2012, 930-1; Strebel et al. 2021).

A comparison between the composition of our final sample of respondents and the whole student group that we tried to reach reveals that overall, our sample has a somewhat larger share of students with high grades, and includes slightly more women and older students than the student population as a whole (see the Supplementary Appendix, Table A1, which demonstrates that while there is some bias in the data it is not extreme).

Dependent variables—measures of thesis outcomes

In line with our theoretical framework, four central thesis outcomes are measured in the student survey. Details on how variables are measured can also be found in the Supplementary Appendix. *Final grade* is measured in terms of the four possible grades given: fail, pass after completing revisions, pass and pass with distinction, 0–3.

Completion on time is measured in terms of whether the student completed the thesis in the same semester as they started their work or not. The planned amount of time is half a semester for a bachelor thesis, and one semester for a master thesis.

Deep learning is measured using an index based on four survey items, in part based on items on skill development as used by Marsh, Rowe Kenneth, and Martin (2002, 323), and answered on a five-point scale (from 'Strongly disagree' to 'Strongly agree'): 1) My thesis project further developed my problem-solving skills; 2) My thesis project taught me to develop my ideas and present them in my written work; 3) My thesis project sharpened my analytical skills; and 4) My thesis project helped me to develop my ability to plan my own work. The resulting index variable reflects mean responses across the four variables, and runs from 1 to 5.

Scientific curiosity is measured using an index based on five survey items, in part based on measures used by Marsh, Rowe Kenneth, and Martin (2002, 323) to tap what they term 'skill development', and the SCILE scale as developed by Weible and Zimmerman (2016, 1250). These existing measures were adjusted to the same format, and two original items were developed (2 and 5 below). The five items were answered on the same scale as above, in response to the following statements: As a result of my thesis project 1) … I feel confident about tackling unfamiliar problems; 2) … I feel more curious; 3) … I more often apply new information to an existing problem to see if that helps; 4) … I try more often to learn as much as I can in new situations, and 5) … I am more interested in research. The resulting index variable reflects mean responses across the five items, and runs from 1 to 5.

Independent variables—measures of supervision

Our independent variables capture students' perceptions of the supervision they received: relational qualities in terms of the emphasis that the supervisor placed on *control* on the one hand and *support* on the other, as well as the emphasis placed on *content* and *process*, and finally the *format* of the supervision.

We rely on a selection of items from the QSDI survey (Mainhard et al. 2009) to measure the relational dimensions of supervision, in terms of the degrees of *control* and *support* that supervisors provide. The selected items reflect the eight sub-dimensions of control and support elaborated in the QSDI framework (see the Supplementary Appendix). Whereas the original survey contains four to six items per subdimension, we are only able to make room for one carefully selected survey item per subdimension. In our case, four items were combined into an index that reflects the degree of *support* provided by the supervisor, all answered on a five-point scale (from 'Strongly disagree' to 'Strongly agree'): 1) My supervisor supported me; 2) My supervisor listened to me; 3) My supervisor was dissatisfied about my progress; 4) My supervisor was impatient toward me. The support index reflects a respondent's mean response across all four items, where a more supportive and listening, and less dissatisfied and impatient type of supervision yields higher values (scale from 1 to 5).

The four remaining items taken from the QSDI were combined into an index that reflects the degree of *control* exerted by the supervisor, again answered on a five-point scale (from 'Strongly disagree' to 'Strongly agree'): 1) My supervisor gave me clear guidance; 2) My supervisor demanded a lot from me; 3) My supervisor allowed me to make my own decisions; 4) My supervisor was unclear during our conversations. The control index reflects a respondent's mean response across all four items, where more controlling supervision yields higher values (scale from 1 to 5). See the Supplementary Appendix for an overview of all items contained in each index.

Another set of survey items were designed to tap the degree to which supervisors invest in improving the student's work *process*. Survey items relating to the degree of process focus were included following the question: How much attention would you say your supervisor devoted to different aspects of the thesis work process? Five types of process skills that supervisors potentially could focus on were then listed, namely: 1) How to create a time plan and deadlines; 2) How to divide goals into smaller tasks; 3)

How to improve the writing process; 4) How to work to obtain a quick overview of previous research; and 5) How to develop strategies to move forward when you feel stuck. The same response scale is used here as in the previous question, to assess the extent to which their supervisor focused on enhancing process-related skills. On this basis, we constructed a process index that reflects a respondent's mean response across all five variables (1 to 5).

In order to measure what amount of attention supervisors devoted to the *content* of the thesis, we asked to what extent the supervisor was involved in handling the following: 1) Formulating the research problem and research question; 2) Previous research; 3) Theory and analytical tools; 4) Methods, material and research design; 5) Analysis and results. The question reads: How much attention did your supervisor devote to the following aspects of the thesis? Answers were given on a response scale with the end points 'None at all' and 'A lot.' Based on these items, we constructed a content index, that is recoded to run from 1 to 5 and reflects a respondent's mean response across all content-related variables.

Finally, we measure the *format* of the supervision using a variable that reflects how often the supervisor provided written feedback, on a five-point scale from 1 'Never' to 5 'Every time').

Control variables

Our analysis includes a number of central control variables based on both new ideas and previous research (see among others Strebel et al. 2021). A first set of control variables measure the respondents' capacity or previous experience, and could influence both the supervision experience and the different thesis outcomes that we investigate. We include a number of student characteristics: *Age, Gender, Parents' education* (based on the parent with the highest educational level, measured as university or not) and *Foreign background* (based on the birth place of the respondent as well as their parents, since discrimination on both grounds may influence both the quality of the supervision received and various student learning outcomes), and finally, *Methods course grade* (i.e. what grade the student received on their most recent methods course, as an indication of the student's skill level prior to the start of the thesis course).

Second, we measure behavioral student characteristics: *Work/studies on the side* (reflecting to what degree the student was working or taking other courses while writing the thesis), as well as *Help from other than supervisor* (an additive index reflecting how many others helped the respondent based on a list that mentioned fellow students, friends and parents, as well as the university's statistics experts, language experts and librarians).

Third, we include variables that reflect characteristics of the thesis written by the student, again a factor that could shape both supervision and student outcomes: *Bachelor or master thesis, Quantitative* (whether quantitative methods were applied or not), and *Primary data* (whether primary data was collected or not).

Finally, we control for supervisor characteristics other than dimensions of supervision: *Supervisor gender* (female supervisor or not), and the *number of supervision meetings* (this has been re-scaled for master students, to the total number of meetings

divided by two, in order to make bachelor and master students comparable). For descriptive statistics of all variables, see the Supplementary Appendix, Table A6.

Results

In this section we present our results, starting with a scrutiny of how different dimensions of supervision impact students' final thesis grades, in Table 1 (Model 1). While this dependent variable only has four different values, we use OLS regression (and not

Table 1. Final models, regression analysis of the relation between dimensions of supervision and student thesis outcomes.

	Grade (Model 1)	Completion on Time (Model 2)	Deep Learning (Model 3)	Scientific Curiosity (Model 4)
Dimensions of Supervision				
Support (index)	−0.01	0.13**	0.08	−0.19*
	(0.09)	(0.05)	(0.09)	(0.10)
Control (index)	0.21*	0.06	0.08	0.45***
	(0.12)	(0.07)	(0.12)	(0.14)
Process focus (index)	−0.01	−0.00	−0.07	−0.07
	(0.07)	(0.04)	(0.07)	(0.08)
Content focus (index)	0.15	−0.01	0.24**	0.07
	(0.11)	(0.06)	(0.11)	(0.12)
Format (written feedback)	−0.01	−0.01	0.07	0.12**
	(0.05)	(0.03)	(0.05)	(0.06)
Student Characteristics				
Age	−0.01	−0.03***	0.00	0.03*
	(0.02)	(0.01)	(0.02)	(0.02)
Gender	−0.11	−0.06	0.06	0.00
	(0.12)	(0.07)	(0.12)	(0.14)
Foreign background	−0.20*	−0.09	0.16	0.22*
	(0.12)	(0.07)	(0.12)	(0.13)
Parents' education (university)	−0.21	−0.10	−0.12	−0.09
	(0.14)	(0.08)	(0.14)	(0.16)
Methods course grade	0.37***	0.02	−0.07	0.03
	(0.11)	(0.06)	(0.10)	(0.12)
Help from other than supervisor (index)	0.06	−0.02	0.14**	−0.01
	(0.06)	(0.04)	(0.06)	(0.07)
Work/studies on the side	−0.08	−0.18***	−0.20***	−0.21***
	(0.06)	(0.03)	(0.06)	(0.06)
Thesis Type				
Bachelor or master (master)	0.01	−0.12	0.06	−0.08
	(0.14)	(0.08)	(0.14)	(0.16)
Quantitative	0.10**	0.04	0.11**	0.06
	(0.05)	(0.03)	(0.05)	(0.05)
Primary data	0.24**	−0.06	0.08	0.19
	(0.11)	(0.06)	(0.11)	(0.13)
Supervisor-Related Variables				
Supervisor's gender	−0.09	0.08	−0.13	−0.10
	(0.11)	(0.06)	(0.11)	(0.13)
No of meetings	−0.01	−0.06***	0.01	−0.02
	(0.03)	(0.02)	(0.03)	(0.03)
_cons	1.06*	1.43***	2.41***	1.65**
	(0.63)	(0.36)	(0.64)	(0.73)
Observations	177	186	184	180
Adj. R^2	0.190	0.277	0.188	0.133

Standard errors within parentheses.
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

ordered multinomial logit regression), following recent econometric trends. We include controls for various student characteristics (background, methods skills), behavioral characteristics (help from others and work/studies on the side), thesis characteristics (bachelor or master, type of data, etc.) and additional supervisor characteristics. See the Supplementary Appendix for full model specifications.

With respect to grades, Model 1 suggests that a high degree of control from the supervisor is positively associated with higher grades ($p < 0.10$). We would like to note that this result is not entirely unproblematic, since introducing more control in supervision conflicts with the idea that the thesis should be an independent piece of work that develops the student's own research skills. Besides control, none of the other supervision variables appear to shape the final thesis grade. These results are robust to several other model specifications (see the Supplementary Appendix, Table A7).

While the coefficient for content-focused supervision is systematically reported as positive in all model specifications with grade as a dependent variable (see the Supplementary Appendix), it is not statistically significant in any of them. We find this result to be rather surprising given that prior research suggests that the supervisor has a crucial role to play in helping the student with initial choices relating to the topic and basic design of the thesis project (cf Todd, Bannister, and Clegg 2004). Our expectation was that greater supervisor engagement with these aspects, and key scientific thesis content such as the literature review or methods section, would shape the thesis quality rather decisively. We can also note that, unsurprisingly, the student's grade in a previous methods course is a good predictor of the final thesis grade.

Turning our focus to whether the student completes their thesis on time, we can see from Model 2, that the more support the supervisor provides, the more likely the student is to complete on time. That is, the more the supervisor expresses encouragement and listens, as well as avoids negative signals such as dissatisfaction and impatience, the more likely the student is to finish on time. Again, this result is statistically significant ($p < 0.05$) and robust across alternative model specifications (see the Supplementary Appendix, Table A8). None of the other supervision variables seem to influence the probability that the student finishes on time. We can also note that students who either work or study while writing their thesis are less likely to finish on time ($p < 0.01$). Across all outcomes except grade, this variable appears detrimental.

Turning to the outcome of deep learning, Model 3 indicates that another supervision variable is of importance, namely the amount of attention the supervisor devotes to the scientific content of the thesis (content-focus). The more attention the supervisor pays to scientific content such as the research question, the literature review, the analysis etc., the more deep learning is reported by the student ($p < 0.05$). Again, this result is robust across model specifications (see the Supplementary Appendix, Table A9). None of the other supervision variables appear to be associated with deep learning. Notably, however, the more the student also seeks help and discusses their thesis with other people besides the supervisor, the more they also seem to experience deep learning ($p < 0.05$).

Finally, we turn to Model 4, which scrutinizes scientific curiosity. We find that three of our supervision variables are significantly associated with levels of scientific curiosity. First, and interestingly, we note that the more support the supervisor expresses, the less

scientific curiosity the student experiences ($p < 0.10$). Secondly, the more control the supervisor exerts, and the more the student receives written feedback, the more scientific curiosity the student experiences ($p < 0.01$ and $p < 0.05$, respectively). Again, all these results are robust to alternative model specifications (see the Supplementary Appendix, Table A10). At the same time, and as noted before, supervisor control is a factor that must be carefully balanced, given that it runs counter to the key goal of independent analysis and skill development, that are of key importance both for the students and society.

Across all models, a process focus in supervision fails to predict student thesis outcomes. Since our process-focus variable is new to the field, this result nevertheless represents an important first step in the assessment of whether supervisor advice relating to the research and writing process makes a difference for any of the outcomes we are investigating. Our data is collected at a department where process focus in supervision seems to be rare, but it remains to be investigated whether this pattern and lack of predictive power travels to other contexts.

Overall, our results suggest that different aspects of supervision are more important for specific outcomes. Hence, what kind of supervision should be employed, depends a lot on what kind of outcomes we want to promote. In some cases, there may also be tradeoffs. For example, more supportive supervision may help the student complete on time, but may also fail to encourage scientific curiosity. This outcome could be attributed to a pattern where students who struggle to finish their thesis receive more supportive supervision, while also being less interested in science to begin with. We would argue that several of these results and complex relationships deserve continued attention in future research on supervision.

Conclusions

Supervisors have limited time and resources, and thesis outcomes are important for students, universities as well as for society. Thus, it is essential to develop our knowledge of what kind of supervision is correlated with key outcomes such as completion on time, thesis quality, deep learning, and scientific curiosity. This article empirically tests which type of supervision benefits various student thesis outcomes.

Given our analysis, we want to end by highlighting a few findings: 1) If the supervisor is more focused on control in their supervision, this is significantly associated with higher grades. 2) The more supportive and encouraging the supervisor is, the more likely it is that the student finishes on time. 3) Deep learning in the student seems to be mainly related to supervision that focuses on key scientific content. 4) The more control the supervisor exerts over the student and the more often the student receives written feedback, the more scientific curiosity this seems to instill in the student. And finally, 5) the more support the supervisor expresses, the *less* scientific curiosity the student experiences. Overall, we see that different aspects of how we supervise promote different important outcomes.

While supervisor control has several benefits, it is also in conflict with the idea that the thesis should be an independent piece of work. Continued work could attempt to disentangle different dimensions of supervisor control, and explore which of them are

most compatible with student skill development and independence, work that might benefit from inspiration from other fields. Another concern, given the correlational nature of our analysis, is reverse causality. Supervisors may tailor their supervisory practices to the student they encounter. For instance, the correlation between support and completion on time may be driven by a pattern where supervisors become more impatient and likely to express dissatisfaction when the student fails to make progress. As student characteristics may also shape supervision strategies, more work should be done to establish causal relationships between supervision and student thesis outcomes, preferably using experimental methods. Since our analysis relies on self-reported data from the students, we cannot completely rule out response bias. Finally, like prior works in the field, our study is based on data from one specific context, and broader comparisons are currently missing in the field. To find out if the patterns that we discovered are valid across country contexts, but also across disciplines—and most importantly for students from diverse backgrounds—comparative work should be a priority. It remains an open question to what extent universal guidelines for supervision can be developed.

To advance the research frontier on these accounts, we need clear and encompassing theoretical tools. One of the major contributions of this study is that we broaden the conceptualization and measurement of both supervision and student outcomes. Our measures capture new dimensions of supervision (content and process) but also classic ones (control and support), as well as a breadth of outcomes. From a university perspective, the quality of the final product as well as the completion rate are key outcomes, and from the perspective of the student and society, deep learning as well as scientific curiosity are absolutely vital qualities.

Ethics approval

The Swedish Ethical Review Authority reviewed the data collection and deemed that no approval was necessary as no intervention on a research person or other intervention would come into question in the project, nor any treatment of sensitive personal data (2021-06534-01).

Author contributions

The two authors have shared all aspects of the work with this manuscript equally.

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The authors report there are no competing interests to declare.

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Notes

1. There are interesting parallels with the management literature on leadership styles (see e.g. Udin et al. 2019; Lyons and Schneider 2009; Bons and Fiedler 1976; Blake and Mouton 1964).
2. European Credit Transfer System.
3. The expectation is that a master thesis should be written within one semester (20 weeks), and a bachelor thesis within 10 weeks; and the respective length is 12–14,000 words and 10–12,000 words.
4. As a point of comparison, a student barometer sent out to 32,000 students at Uppsala University in 2018 had a response rate of 28%, but this survey targeted active students, and it is thus likely to be a group that is more motivated to respond.

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Data availability statement

The data that support the findings of this study are openly available upon request, and available online at https://doi.org/10.6084/m9.figshare.27301698.v1.

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