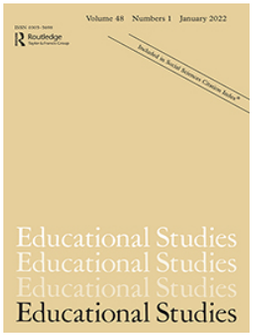

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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ceds20

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To cite this article: Wilfried Admiraal, Lysanne Post, Liesbeth Kester, Monika Louws & Ditte Lockhorst (2022): Learning labs in a secondary school in the Netherlands: Effects of teachers' autonomy support on student learning motivation and achievement, Educational Studies, DOI: 10.1080/03055698.2021.2023473

To link to this article: https://doi.org/10.1080/03055698.2021.2023473

EDUCATIONAL STUDIES
https://doi.org/10.1080/03055698.2021.2023473

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Learning labs in a secondary school in the Netherlands: Effects of teachers' autonomy support on student learning motivation and achievement

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ABSTRACT

Autonomy-supportive activities are understood to promote students' autonomous forms of learning motivation, educational outcomes and well-being. In the current study, two learning labs in one Dutch secondary school have been studied. In these learning labs - each lasting one entire school year- students' autonomy during their learning process have been supported by organisational, procedural and cognitive autonomy support activities. Effects on students' learning motivation and their achievement have been examined. In one learning lab, indicated as the one with the most autonomy-supportive classroom climate, students show relatively high scores on intrinsic motivation for learning and high achievements. In the other learning lab, no effects have been found on students' learning motivation and achievement. The extent to which student were allowed to set the task sequence is found to be an autonomy-supportive activity that positively affected both learning motivational and achievement most. Implications for practice and research are discussed.

ARTICLE HISTORY
Received 10 August 2020
Accepted 23 December 2021

KEYWORDS
Learning lab; autonomy support; learning motivation; achievement; tablets; secondary education

Introduction

The Self-determination theory (SDT) provides a broad framework to understand the relationship between students' learning climate, learning motivation, achievement and well-being. Despite a large knowledge base on this relationship, many current educational policies and practices are not based on substantial evidence on the importance of students' autonomy for their learning motivation and achievement (Ryan and Deci 2020). In the Netherlands, educational policies started to mark the significance of autonomy and autonomy support in both primary and secondary education, although educational practices lag behind (Onderwijsraad 2014). Teachers are expected to focus not only on all kinds of subject-related goals, but also on pedagogical goals. Students not only have to acquire maths and language skills and knowledge about other school

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subjects, they also have to learn to make autonomous choices and to take responsibility for their choices. Student autonomy should not only be understood as an important learning goal in schools; a sense of autonomy has a positive influence on students' educational outcomes and well-being as well. For example, Vansteenkiste et al. (2005) established that students who experience autonomy in the choices they make during their learning process are more concentrated and less distracted during learning, can better plan their learning process, process the learning content more deeply and take more responsibility for their learning process. Yet which autonomy-supportive activities have benefits for students' motivation and learning is still unknown. Reeve and Cheon (2021) distinguish seven core autonomy-supportive teaching activities: Take the students' perspective, Invite students to pursue their interest, Present learning activities in need-satisfying ways, Provide explanatory rationales, Acknowledge negative feelings, Rely on invitational language and Display patience. Yet these teaching activities refer to teachers' instructional behaviour. In the current study, two learning labs have been implemented and evaluated to contribute to insights how students' autonomy can be supported at a more general teaching level to improve students' motivation and learning in secondary education.

Autonomy support in secondary education

Two main motivational classroom climates can be distinguished that either promote or counteract students' motivation for learning (Reeve and Cheon 2021). *Autonomy-supportive classroom climate* refers to "ways to nurture, support and increase students' inner endorsement of their classroom activity" (Reeve and Jang 2006, 210). By contrast, in a *controlling motivational climate*, teachers pay little attention to their students' inner motivational resources and encourage students to adopt expected behaviour by using incentives, more directive language, and controlling modes of communication (Bennett, Ng-Knight, and Hayes 2017; Reeve and Jang 2006). Various theoretical perspectives have been used to examine student motivation and engagement, such as Expectancy-value theory (Eccles and Wigfield 2020), Achievement goal theory (Urdan and Kaplan 2020), and Self-determination theory (SDT; Deci and Ryan 2000; Ryan and Deci 2020). In the latter, the concepts of autonomy, autonomous forms of motivation and autonomy support are core features of views on the motivation of students for learning and school. SDT is a motivational theory that states that satisfying basic psychological needs of 1) feelings of autonomy 2) feelings of involvement and 3) feelings of competence, helps learners to develop optimally and feel satisfied. The more these basic needs are satisfied, the more students are intrinsically motivated for their actions. Students are likely to perceive teachers and the classroom climate as autonomy-supportive when teachers provide choices and opportunities for self-expression, explain why learning activities are important and minimise pressure and control (Reeve and Cheon 2021). The idea is to help students to connect their sense of self to the activity, so that they can do it with a sense of ownership and volition, rather than feeling controlled and coerced by their teachers or parents.

According to research testing the SDT in various settings, satisfaction of the three basic psychological needs predicts educational and well-being outcomes by affecting students' motivation (Early et al. 2016; Guay and Vallerand 1996; Tian, Chen, and Huebner 2014; Yu

et al. 2016). Many studies (e.g. Hagger et al. 2003, 2015; Hardre and Reeve 2003; Reeve et al. 2004; Su and Reeve 2011) have shown that teachers' autonomy support is related to students' autonomous regulation, perceived competence and achievement. In their study of 15 high-school mathematics classrooms, Ciani et al. (2010) found that teachers' autonomy support even counteract potential negative implications of emphasising performance in the classroom. When autonomy support was high, students reported high mastery goals (i.e. the intrinsic motivation to learn and acquire knowledge and skills), regardless of the teacher's emphasis on performance. This finding is confirmed in a study of Madjar, Nave, and Hen (2013), who found a positive relationship of teachers' autonomy support with students' master goal orientation and a negative relationship with a performance approach. The authors also report reversed relationships of teachers' compelling behaviour.

Teachers' autonomy support refers to a group of activities that encourage student intrinsic motivation by offering students meaningful choices, attempting to understand their perspectives, providing them with personally meaningful rationales for task engagement, encouraging their input in decision making processes, and giving them opportunities for self-initiated behaviour (Assor, Kaplan, and Roth 2002; Cheon et al. 2019; Ryan and Deci 2020). Although some studies indicate that the positive effects of autonomy support on students' motivation, engagement and learning fade away after some time, Wei et al. (2020) found long-term effects of teachers' autonomy support, especially for young children. Assor, Kaplan, and Roth (2002) found that of three types of teachers' autonomy support providing choice (e.g. allowing students to choose how to do their work in class) and fostering understanding and interest (e.g. explaining why it is important to study certain topics) were positively related with students' affective and cognitive engagement with learning, whereas allowing criticism (e.g. listening to students ideas and opinions) did not show a significant relationship with these student outcomes. Benefits of autonomy-supportive teaching have been confirmed in previous literature reviews (e.g. Teixeira et al. 2020; Vasconcellos et al. 2020) establishing positive correlations between autonomy-supporting teaching and students' affective and cognitive learning outcomes, such as engagement, learning and psychological well-being.

Stefanou et al. (2004) focus on ways teachers encourage student decision making and ownership and distinguish three ways teachers' autonomy support manifests in the classroom: organisational autonomy support, procedural autonomy support and cognitive autonomy support. *Organizational autonomy support* encourages student ownership of environment and includes teacher behaviour that offers students opportunities for choice over environmental procedures. Students are given opportunities to choose group members, seating arrangements and evaluation procedures, take responsibility of due dates for assignments and participate in creating and implementing classroom rules. *Procedural autonomy support* encourages student ownership of form, which means that students are given opportunities to choose materials to use in class projects, media to present ideas and the way competence will be demonstrated, display work in an individual manner and discuss their wants. Finally, *cognitive autonomy support* encourages student ownership of learning and includes teacher behaviour such as asking students to

justify or argue for their point, asking students to generate their own problem solving strategies, asking students to evaluate their own and others' solutions or ideas and stimulate students to debate ideas freely.

In order to inform teaching practice of autonomy support more insight is needed about the effects of teachers' autonomy-supportive activities and how secondary school students perceive these autonomy-supportive activities of their teachers. This study focuses on teachers' autonomy support in two learning labs in one secondary school in the Netherlands. The following research questions direct the study:

(1) What is the effect of a learning lab's autonomy support on students' motivation for learning?
(2) What is the effect of a learning lab's autonomy support on student achievement?
(3) Which autonomy-supportive activities in a learning lab are related to students' motivation for learning?
(4) Which autonomy-supportive activities in a learning lab are related to student achievement?

Method

Research design and participants

Data have been collected about an intervention with two learning labs with mobile technology in one secondary school in the Netherlands. The research design has been set up with an experimental condition (the intervention with learning lab; 3 groups with 70 Grade-7 students; 27 females) and a control condition (3 groups with 53 Grade-8 students; 27 females). Students of the control condition were from the same school, but from another year group. The learning lab interventions (one for the school subjects Dutch language, English language and Maths, called Compulsory, and one for the school subjects Calculation, Biology, Social Sciences and Visual Arts, called Electives, see description below) lasted one complete school year. The research was carried out following the guidelines for research ethics and integrity of <name removed for review>, which was principle responsible for the research project.

Data

Students completed an online questionnaire twice: at the beginning of the school year and at the end. With this questionnaire their Perceived autonomy support and Motivation for learning have been measured. In addition, they completed a school-based ability test at the beginning of the school year. Their school report scores for all relevant school subjects were gathered from the school monitoring system. These two data sources are used to measure Student achievement. Information about the implementation of both learning labs has been gathered at the end of the school year in two ways. First, six teachers completed a checklist with open items about the implementation of each learning lab. Secondly, students completed a second online questionnaire about Autonomy-supportive activities.

Perceived autonomy support

At both pre-test and post-test, *Perceived autonomy support* has been measured with eight items (with Cronbach's α = 0.693), based on Belmont et al. (1988). Previous study of autonomy-supportive interventions in 31 secondary schools (Kester et al. 2018) confirms the construct validity of this perceived autonomy scale. Each item was scored on a 5-point Likert type scale with 1 = "does not apply at all" to 5 = "applies to a large extent". Example items are "My teacher explains why attending school is important for me" and "My teacher gives me a lot of freedom to decide how I do my school work". The change in student scores on *Perceived autonomy support* between time1 and time 2 was used as a fidelity check to check the main aim of the implementation of the learning lab: the higher the increase, the more student perceive teachers supported their autonomy. Descriptive statistics are presented in Table 1.

Autonomy-supportive activities

At time 2, students from the experimental condition also completed items on their evaluation of the learning lab intervention. Students reported on their perception of frequency of 14 autonomy-supportive activities, that can be clustered in the three ways how teacher autonomy support manifest in class (cf., Stefanou et al. 2004). Organizational autonomy support refers to Planning (the extent to which students plan their own work), Tasks (the extent to which they are allowed to choose their tasks), Sequence (the extent to which they are allowed to set the sequence of completing tasks), Ability level (the extent to which they are allowed to decide for the difficulty level of the tasks they work with), Pacing (the extent to which they work following their own pace), and Reviewing (the extent to which they are allowed to decide when they take an exam). Procedural autonomy support includes Work place (the extent to which they are allowed to choose the place where they would like to work), Sources (the extent to which they are allowed to select sources they used for completing their work), Task completion (the extent to which they are allowed to choose the way they completed their work), Using books (the extent to which they use books) and Using iPad (the extent to which they to use their iPad). Cognitive autonomy support refers to Learning goals (the extent to which students discuss their learning goals with their teacher), Learning outcomes (the extent to which they discuss the learning outcomes with their teacher), and Teacher support needed (the extent to which they discuss with the teacher the support they need for learning). All these items were scored on a 5-point Likert type scale referring to frequency, with 1 = never; 2 = 1–2 times per month; 3 = 1 time per week; 4 = more than 1 time per week; 5 = each lesson. The item on Reviewing was scored on a 3-point Likert type scale with 1 = no, 2 = sometimes and 3 = yes. In addition, one item was answered about how satisfied students were with the particular autonomy-supportive activities (and asking an additional short explanation). This item was scored on a 10-point scale, with 10 as highest score. The descriptive statistics are summarised in Table 1.

Students' learning motivation

At both pre-test and post-test, students' motivation for learning was measured with a Dutch translation of the 16-items questionnaire Situational Motivation Scale (SIMS, Guay, Vallerand, and Blanchard 2000). In a previous study of 31 secondary schools (Kester et al. 2018), the structure of the questionnaire with four motivation scales has

Table 1. Means of teachers' autonomy support and time 2 evaluations with standard deviations (SD) within brackets.

	Compulsory M (SD)	Electives M (SD)
Perceived autonomy support		
Time 1	3.54 (0.55)	3.59 (0.47)
Time 2	3.75 (0.41)	3.52 (0.41)
Autonomy supportive activities (Time 2)		
Planning	2.88 (1.20)	1.71 (0.90)
Tasks	4.10 (1.24)	3.05 (1.43)
Sequence	3.90 (1.48)	3.19 (1.40)
Ability level	3.82 (1.32)	2.76 (1.34)
Pacing	4.42 (1.08)	3.62 (1.43)
Reviewing[1]	2.03 (0.80)	1.95 (0.69)
Work place	4.18 (1.08)	3.52 (1.44)
Sources	4.00 (1.22)	2.95 (1.40)
Task completion	3.58 (1.24)	2.38 (1.28)
Using books	4.35 (0.74)	3.90 (1.17)
Using iPad	4.80 (0.41)	4.30 (0.92)
Learning goals	2.88 (1.24)	2.14 (0.96)
Learning outcomes	2.77 (1.42)	2.33 (1.28)
Teacher support needed	3.20 (1.31)	2.38 (1.20)
Satisfaction		
Autonomy supportive activities	7.95 (1.01)	6.70 (1.17)

Note. [1] measured on a 3-point Likert type scale. For Perceived autonomy support at least 90 (Compulsory, time 1), 71 (Electives, time 1), 65 (Compulsory, time 2) or 46 (Electives, time 2) valid scores. For Autonomy supportive activities and satisfaction with autonomy supportive activities at least 40 (Compulsory) or 20 (Electives) valid scores, respectively.

been confirmed. Each item has been adapted to focus on the particular combination of school subjects relevant for the current study. Each item was scored on a 5-point Likert type scale with 1 = does not apply at all to 5 = applies to a large extent. Four types of learning motivation with four items each have been distinguished. *Intrinsic motivation* refers the extent to which students are motivated for school because of the pleasure and satisfaction this gives them. Example items are "I do my best for these school subjects, because I think these are interesting" and "I do my best for these school subjects, because it feels good to work on these". *Identified motivation* refers to the extent to which students "internalized" former external goals and reasons, resulting in the extent to which students think their efforts are their choice or are important. Example items are "I do my best for these school subjects for my own good" and "I do my best for these school subjects, because it is an important activity for me". *External motivation* refers to the extent to which students work for school to receive benefits or to avoid negative consequences. Example items are "I do my best for these school subjects, because it is expected from me to do so" and "I do my best for these school subjects, because I think I have to do it". *A-motivation* refers to the extent to which students are not aware why they work for school and how they can influence their own work. Example items are "I do not see what these school subjects bring me" and "I do work on these school subjects, but I cannot see it is worth the effort". The reliability and validity of the scales are established in the original study of Guay, Vallerand, and Blanchard (2000). The satisfying reliability is confirmed at the post-test in the current study with Cronbach's α of 0.86 (Intrinsic motivation), 0.85 (Identified motivation), 0.62 (External motivation) and 0.77 (A-motivation). The descriptive statistics are summarised in Table 2.

Table 2. Means and standard deviation (SD) of pre-test and post-test scores on students' learning motivation.

	Compulsory	Electives	Control
	M (SD) N = 39	M (SD) N = 20	M (SD) N = 26
Pre-test			
Intrinsic motivation	3.35 (0.83)	3.23 (0.56)	2.96 (0.48)
Identified motivation	3.63 (0.70)	3.21 (0.70)	3.30 (0.71)
External motivation	3.15 (0.75)	2.73 (0.74)	3.33 (0.63)
A-motivation	2.47 (0.57)	2.63 (0.58)	2.60 (0.64)
Post-test			
Intrinsic motivation	3.58 (0.67)	2.62 (0.60)	2.70 (0.88)
Identified motivation	3.66 (0.72)	2.70 (0.75)	3.33 (0.88)
External motivation	3.32 (0.55)	3.38 (0.70)	3.70 (0.80)
A-motivation	2.47 (0.62)	3.25 (0.80)	2.54 (0.86)

Student achievement

Student achievement has been measured in two ways. Pre-test scores are based on a school-based ability test (with scoring range 1–100) that was administered at the beginning of the school year. Post-test scores are based on the school reports of a combination of school subjects of period 4, which is the final period of the school year. This combination is based on the school subjects that are part of the two interventions with learning labs. For Compulsory learning lab, the grades for the school subjects Dutch language, English language and Maths have been averaged; for Electives learning lab, the grades for the school subjects Calculation, Biology, Social Sciences and Visual Arts have been averaged. The descriptive statistics are summarised in Table 3.

Learning lab interventions

All three groups of Grade-7 students attended a learning lab with an individual learning approach in seven school subjects (Dutch language, English language, Calculation, Maths, Biology, Social Sciences and Visual Arts). Each school subject is taught by one teacher for each of the three groups (Compulsory, Electives and control condition). In each session of each of the three groups one teacher was involved at the time, but all seven teachers taught in both conditions: three teachers taught the Compulsory learning lab, four teachers taught in the Electives learning lab and all seven teachers taught in the control condition. Both learning labs have been setup by two teachers who instructed their colleagues about the aim of the learning labs. In-between teachers meetings were organised to share evaluations and plans for the learning labs.

In the learning labs, students were taught with a combination of plenary instruction and independent work. During independent work, students had the autonomy to choose which tasks they would work on. The teachers divided students into three ability levels for each school subject. For each ability group, the teacher organised a week planning of what students can work on. All students worked with iPads and teachers prepared the materials for each week and made these available by an app iTunes U. In addition to time spent on learning a particular school subject, students collaborated in multidisciplinary projects at their own ability level.

Table 3. Pre-test and post-test scores (means and standard deviations (SD)) on student achievement.

	Compulsory	Electives	Control
	M (SD) N = 40	M (SD) N = 23	M (SD) N = 50
Pre-test			
School ability test	92.85 (6.12)	97.57 (6.66)	87.34 (10.55)
Post-test			
Compulsory subjects scores	7.01 (0.69)	n.a.	6.60 (0.83)
Electives subjects scores	n.a.	6.75 (0.40)	6.71 (0.63)

Note. n.a. = not applicable. Post-test scores were based on relevant school reports with grades 1–10; pre-test scores were based on a school-based ability test (with scores 1–100).

For the school subject Dutch language, English language and Maths – which are compulsory school subjects in the Dutch school system- students could choose each lesson on which school subject they would work. They could also choose the testing time for each school subject, within a period determined by the teacher. The other four school subjects – which are electives dependent on the school profile- were scheduled by the teacher. Data about the first learning lab intervention (labelled Compulsory) has been collected in two Grade 7 groups (N = 45; 16 females); data about the second learning lab intervention (labelled Electives) was collected in one Grade 7 group (N = 25; 11 females). Three Grade-8 student groups formed the control condition, which also used iPads. The main difference with the experimental student groups in the learning labs contained relatively more plenary instruction and less differentiating in ability in the control condition. In Table 1 data on the teachers' autonomy support for the experimental and control condition is summarised.

The change in perceived Autonomy support from time 1 to time 2 differs per learning lab. For Compulsory, a significant difference in change in perceived autonomy support has been found between students from the learning lab condition and control condition ($F(1,59) = 13.62$; $p = 0.001$; $\eta^2 = 0.193$), with an increase for students from the learning lab and a decrease for the students from the control condition. For Electives, no significant difference in change in Autonomy support between the experimental and control condition has been found ($F(1,42) = 3.62$; $p = 0.064$).

With respect to the Autonomy-supportive activities the mean scores of Table 1 suggest that both learning lab interventions have focused on Procedural autonomy support, such as the extent to which students are allowed to choose the place where they would like to work (Workplace), the extent to which students are allowed to select sources they used for completing their work (Sources), and the extent to which they use books and iPads (Using books and Using iPad). Students perceive the other two types of autonomy support to a lesser extent. Independent t-tests between both the scores of both learning lab interventions show 10 significant differences with respect of the evaluation of Autonomy-supportive activities between both learning lab interventions, with higher scores for Compulsory. Students of the learning lab of Compulsory generally show higher frequency scores for making their own planning ($t(59) = 3.88$; $p < 0.001$), choosing their own tasks ($t(59) = 2.99$; $p = 0.004$), choosing the difficulty level of tasks (($t(59) = 2.98$; $p = 0.004$), working at their own pace ($t(59) = 2.47$; $p = 0$ .017), choosing their own work place ($t(59) = 1.99$; $p = 0.05$), choosing the information sources for task completion ($t(59) = 3.03$; $p = 0.004$), choosing the way tasks were completed ($t(59) = 3.53$; $p = 0.001$), discussing learning goals with teachers ($t(59) = 2.35$; $p = 0.022$),

discussing learning needs with the teacher ($t(59) = 2.39$; $p = 0.020$), and using their Ipad ($t(22.73) = 2.31$; $p = 0.030$), compared to the frequency scores for students from the learning lab Electives.

In terms of student satisfaction with the learning lab interventions, students indicate that they are significantly more satisfied with the learning lab Compulsory than with Electives ($t(58) = 4.28$; $p < 0.001$). In their explanations of the satisfaction question for both learning lab interventions, students report that they particularly liked the freedom of making choices and working independently. The negative points mentioned relate to several issues: some activities that were not allowed during working independently (ranging from listening to music to asking questions), the large amount of work, and a limited number of work places outside the classroom.

Analyses

Independent samples t-tests show no differences between both learning lab groups and the control condition with respect to the pre-test scores on the four scales of learning motivation, except for extrinsic motivation ($t(71) = 3.088$; $p = 0.003$), with higher scores of the students in the control condition than in the Electives learning lab group. Both learning lab groups did differ significantly from students in the control condition on pre-test achievement scores, with lower scores for the control condition ($t(80.913) = 3.098$; $p = 0.003$ for the Compulsory group and ($t(71) = 4.165$; $p < 0.001$ for the Electives group). Pre-test scores on learning motivation and achievement have been included in the analyses as co-variates.

To answer research question 1, multivariate analyses of covariance have been performed, per learning lab intervention, with both conditions as factor and the four scales of students' learning motivation as dependent variables. Pre-test motivation scores are used a covariates.

To answer research question 2, univariate analyses of covariance have been performed, per learning lab intervention, with both conditions as factor and student achievement as dependent variable. Pre-test ability scores are used as covariates.

To answer research questions 3 and 4, regression analyses have been performed on the data from students from the experimental condition only, for each learning lab intervention separately. Each type of motivation for learning (research question 3) or achievement (research question 4) have been inserted as dependent variable, either the relevant motivation variable or the ability-test scores as covariate, and the 14 autonomy-supportive activities as predictors.

Findings

Effects on students' learning motivation

In Table 2, the pre- and post-test scores for the four motivation variables are summarised. The results of the multivariate analysis of covariance for the learning labs Compulsory and Electives show a significant difference between the Compulsory learning lab condition and the control condition (Wilk's λ $(4,56) = 4.32$; $p = 0.004$; $\eta^2 = 0.24$) and between the Electives learning lab condition and the control condition (Wilk's λ $(4,37) = 4.22$; $p = 0.006$;

$\eta^2 = 0.31$), after controlling for all motivation pre-test scores. Yet the between-subject effects are different for each learning lab. For the learning lab Compulsory, students from the learning lab show significant higher scores on Intrinsic motivation compared to students from the control condition (($F(1,64) = 17.703$; $p < 0.001$; $\eta^2 = 0.21$); no significance differences are observed for the other three motivation variables. For the learning lab Electives, students from the learning lab show significant higher scores on External motivation (($F(1,45) = 4.658$; $p < 0.037$; $\eta^2 = 0.10$) as well as A-motivation (($F(1,45) = 6.863$; $p < 0.012$; $\eta^2 = 0.15$), compared to students from the control condition; no significant differences are observed for the other two motivation variables.

Effects on student achievement

In Table 3, the pre- and post-test scores for student achievement are summarised. The results of the analyses of covariance for the learning labs are mixed, with a positive effect for Compulsory and a zero-effect for Electives. For the learning lab Compulsory, students from the learning lab outperform the students from the control condition, after controlling for the pre-test scores ($F(2,112) = 6.791$; $p = 0.010$; $\eta^2 = 0.06$). For the learning lab Electives, no significant difference in performance has been observed between students of both conditions, after controlling for the pre-test scores ($F(2,112) = 2.100$; $p = 0.150$).

Relationship between teachers' autonomy support and learning motivation

In Table 4, the results of the regression analyses with the four types of learning motivation as dependent variables have been summarised for both learning labs. As none of the 14 autonomy-supportive activities show a significant relationship with Identified motivation for the Compulsory condition and with External motivation for the Electives condition, the results with respect to these learning motivation variables are not included in the table.

From Table 4, it is clear that Sequence (the extent to which students can determine the sequence of their work) shows a positive relationship with intrinsic motivation and a significant negative relationship with A-motivation for both learning labs. In addition, Tasks (the extent to which students are allowed to choose their tasks) shows a positive relationship with the autonomous forms of motivation (Intrinsic and Identified) and a negative relationship with A-motivation for the learning lab Electives; no significant relationships for this autonomy-supportive activity have been found for the Compulsory learning lab. Sequence and Task can be understood as organisational autonomy support. In both learning labs, the use of books (Using books) shows a positive relationship with A-motivation, which means the more students used books in addition to their iPads, the less motivated they were for learning. For the learning lab Electives, a number of autonomy-supportive activities show either a positive or a negative relationship with A-motivation. This means some activities students perceive as demotivating (i.e. the extent to which they are allowed to choose the place where they would like to work the extent to which they work following their own pace (Pacing), (Work place) the extent to which they are allowed to choose the way they completed their work (Task completion), and the extent to which they discuss with the teacher the support they need for learning (Teacher support needed).

Table 4. Results of the regression analysis with learning motivation.

	Compulsory			Electives		
	Intrinsic B (SE; sr^2)	External B (SE; sr^2)	A- B (SE; sr^2)	Intrinsic B (SE; sr^2)	Identified B (SE; sr^2)	A- B (SE; sr^2)
Covariate	0.19 (0.16)	0.02 (0.13)	0.34 (0.19)	**1.39 (0.35; 0.85)**	**1.03 (0.28; 0.81)**	0.59 (0.24)
Autonomy supportive activities						
Planning	0.17 (0.10)	0.04 (0.09)	**−0.19 (0.10; 0.17)**	0.53 (0.23)	0.65 (0.26)	0.09 (0.28)
Tasks	−0.21 (0.17)	−0.20 (0.16)	0.30 (0.15)	**0.90 (0.25; 0.81)**	**0.79 (0.23; 0.81)**	**−0.92 (0.18; 0.90)**
Sequence	**0.35 (0.12; 0.28)**	0.04 (0.11)	**−0.27 (0.10; 0.25)**	**0.55 (0.13; 0.86)**	0.12 (0.13)	**−0.29 (0.09; 0.76)**
Ability level	−0.13 (0.09)	−0.14 (0.08)	0.14 (0.07)	0.19 (0.30)	0.21 (0.36)	**−0.17 (0.32; 0.90)**
Pacing	−0.11 (0.15)	**0.40 (0.14; 0.28)**	0.03 (0.12)	−0.37 (0.14)	−0.12 (0.18)	**0.93 (0.13; 0.94)**
Reviewing[1]	−0.10 (0.15)	−0.11 (0.13)	0.22 (0.12)	0.39 (0.24)	−0.10 (0.23)	−0.08 (0.18)
Work place	0.10 (0.18)	0.18 (0.16)	−0.23 (0.15)	−0.64 (0.39)	−0.69 (0.47)	**2.66 (0.39; 0.94)**
Sources	0.08 (0.12)	−0.14 (0.11)	−0.17 (0.10)	0.23 (0.38)	0.34 (0.46)	**−2.01 (0.38; 0.90)**
Task completion	−0.15 (0.12)	−0.18 (0.11)	0.12 (0.10)	−0.84 (0.36)	−0.56 (0.43)	**1.96 (0.34; 0.92)**
Using books	0.12 (0.17)	−0.12 (0.17)	**0.29 (0.14; 0.17)**	0.02(0.28)	0.05 (0.36)	**1.3 (0.28; 0.88)**
Using iPad	−0.11 (0.28)	0.13 (0.26)	0.29 (0.27)	0.02 (0.21)	0.35 (0.24)	−0.11 (0.19)
Learning goals	0.12 (0.09)	0.06 (0.09)	**0.17 (0.08; 0.18)**	0.06 (0.26)	−0.15 (0.32)	**−1.38 (0.29; 0.88)**
Learning outcomes	−0.08 (0.11)	−0.15 (0.09)	−0.07 (0.08)	0.82 (0.58)	0.81 (0.71)	**−3.69 (0.59; 0.92)**
Teacher support needed	0.16 (0.10)	−0.02 (0.09)	−0.17 (0.09)	−0.65 (0.24)	−0.64 (0.25)	**1.15 (0.20; 0.92)**
Model summary						
R^2	0.41	0.13	0.52	0.69	0.72	0.85
F (df)	2.67 (15, 21); p = 0.02	1.35 (15, 21); p = 0.26	3.56 (15, 21); p = 0.004	3.67 (15, 3); p = 0.16	4.15 (15, 3); p = 0.13	7.70 (15, 3); p = 0.06

Note. SE = standard error; sr^2 = squared semi-partial correlation. Only motivation scales with at least one significant effect are included. Significant effects are printed bold.

Table 5. Results of the regression analysis with student achievement.

	Compulsory		Electives	
	B (SE)	sr^2	B (SE)	sr^2
Covariate				
Pre-test ability score	−0.01 (0.02)		0.00 (0.01)	
Autonomy supportive activities				
Planning	−0.03 (0.09)		−0.06 (0.06)	
Tasks	0.12 (0.12)		0.13 (0.08)	
Sequence	**0.18 (0.09)**	**0.08**	**0.12 (0.06)**	**0.07**
Ability level	−0.03 (0.09)		0.05 (0.06)	
Pacing	−0.10 (0.11)		−0.08 (0.08)	
Reviewing[1]	0.07 (0.14)		0.07 (0.10)	
Work place	−0.00 (0.13)		−0.03 (0.08)	
Sources	0.02 (0.10)		0.03 (0.07)	
Task completion	−0.10 (0.11)		−0.04 (0.07)	
Using books	−0.02 (0.13)		−0.04 (0.09)	
Using iPad	0.14 (0.16)		−0.03 (0.10)	
Learning goals	−0.05 (0.09)		0.04 (0.06)	
Learning outcomes	0.16 (0.09)		**0.19 (0.06)**	**0.14**
Teacher support needed	−0.02 (0.09)		−0.03 (0.06)	
Model summary				
R^2	0.26		0.43	
F (df)	0.93 (15, 39); p = 0.54		1.94 (15, 39); p = 0.049	

Note. SE = standard error; sr^2 = squared semi-partial correlation. Significant effects are printed bold.

Relationship between teachers' autonomy support and student achievement

In Table 5, we have summarised the results of the regression analyses for both learning labs, with student achievement as dependent variable, the ability-test score as co-variate and the 14 autonomy-supportive activities as predictors.

From Table 5, it is clear that only three activities to support students' autonomy are significantly (and positively) related to student achievement, after controlling for pre-test scores. For the learning lab Compulsory, the extent to which students were allowed to set the sequence of completing tasks (Sequencing) is positively related to student achievement, which means that the more students indicate they had the freedom to choose the sequence of tasks, the higher their school report scores (B = 0.18, SE = 0.09; sr^2 = 0.08). For the learning lab Electives, Sequencing and Learning outcomes are positively related to student achievement, which means that the more students indicate they had the freedom to choose the sequence of the task (B = 0.12, SE = 0.06 sr^2 = 0.07) and the more they discussed learning outcomes with their teacher (B = 0.19, SE = 0.06; sr^2 = 0.14), the higher their school report scores.

Discussion and Conclusion

Autonomy support in secondary schools can be a way to empower students to take control of their learning. Our expectation was that the more learners can direct their own learning experiences -including path, pace and instructional approach-, the more they learn what they need to learn and what they want to learn. In a quasi-experimental design, questionnaire data and exam records have been gathered about the implementation and evaluation of two learning lab interventions in one secondary school in the

Netherlands. The aim of the learning labs was to provide students with opportunities to regulate their own learning and support their autonomy in order to personalise their learning and make it more worthwhile.

In one of the two learning labs (Compulsory), students report that they were supported in their autonomy to make their own choices in their learning process. Students had the freedom to choose each lesson on which school subject they would work on, how they work on it and when they would like to take a test. This means students had autonomy over all components of instruction (pacing, time, sequence, practice and review), which mainly refers to organisational and procedural autonomy support as distinguished by Stefanou et al. (2004). This learning lab also shows positive effects on students' intrinsic motivation for learning and on their achievement. The second learning lab (Electives) had a similar set up as the first one, with other teachers and school subjects. The main difference with the first learning lab was a lower level of autonomy support provided by the teachers: teachers scheduled the tasks students could work on, the pace of this work and when students were tested. In addition, teachers provided more instruction at the expense of individual student work. In this second learning lab, autonomy support included lower levels of organisational, procedural and cognitive autonomy support (see Stefanou et al. 2004, for these three types of autonomy support), compared to the first learning lab intervention. For the second learning lab no effects have been found on student achievement and even small negative effects have been found with respect to learning motivation: students show higher scores on External motivation and A-motivation, compared to the control condition.

For both learning labs, various relationships have been found between the perceived autonomy-supportive activities, on the one hand, and learning motivation and achievement, on the other hand. Sequencing -the extent to which students are allowed to set the sequence of completing tasks- is positively related to both autonomous forms of motivation for learning and student achievement in both learning labs. In the second lab, most other autonomy-supportive activities show different relationships with learning motivation, either positive or negative. This means that some of the autonomy-supportive activities were perceived as demotivating and others as motivating. A reason for these differential outcomes might be that some of the autonomy-supportive activities were not perceived as autonomy support by the students, with lower scores in the Electives learning lab, in particular. Relatively low scores on autonomy-supportive activities in the Electives learning lab refer to the extent to which students discussed with the teacher the support they need for learning (Teacher support needed), the extent to which students were allowed to choose the way they completed their work (Task completion) and the extent to which students plan their work (Planning). In addition, a significant difference has been found in increase in perceived autonomy support between Compulsory learning lab and the control condition, but not between Electives learning lab and control condition. Combined with the a possibly more controlling role of the teachers in the second learning lab, some of the autonomy-supportive activities might have been evaluated as teacher pressure instead of autonomy support. Therefore, learning lab Compulsory could probably best be identified as an autonomy-supportive learning climate, and learning lab Electives as a combination of an autonomy-supportive and controlling classroom climate (Reeve and Cheon 2021).

Autonomy-supportive activities

Although previous literature reviews of autonomy-supportive teaching (e.g. Teixeira et al. 2020; Vasconcellos et al. 2020) established beneficial effects, the mixed findings of the current study confirm the conclusions of Sorgenfrei and Smolnik (2016) in their review of empirical research on learner motivation and achievement. In their conceptual model of the relationship between learner control interventions and learner achievement, they emphasise the – mediating- role of *perceived* learner control as well as the differential influences on this relationship of both learner characteristics and teaching approach. In the current study, the first learning lab, which shows significant positive effects on student motivation and achievement, also shows a relatively large increase in autonomy support as perceived by the students. In this learning lab, students could choose each lesson the school subject they would work on. In the other learning lab, no increase in perceived autonomy support can be reported. This second learning lab offered lower levels of learner control. The mixed findings with respect to learning motivation and achievement suggest that not all teaching approaches that are directed to supporting student autonomy might be equally effective. These findings are also in line with the review studies of Karich, Burn, and Maki (2014) and Niemiec, Sikorski, and Walberg (1996), who reported many near zero-effects of autonomy-supportive interventions on student achievement. Although Reeve and Cheon (2021) distinguish seven core autonomy-supportive teaching behaviours based on previous studies on the beneficial effects of the separate teaching activities, they do not provide empirical evidence of their model.

Learner characteristics as well as teaching approach with various selections or combinations of autonomy-supportive activities might have a differential effect on student achievement. The differential effects of learning characteristics is also shown by Graça, Calheiros, and Barata (2013), who found an interaction effect of students' autonomy and the level of autonomy support provided: students with high feelings of autonomy recognised the legitimacy of teachers less in a context with low autonomy support, compared to other students. The possible differential effect of the teacher and of teaching approaches in supporting student autonomy is in line with the findings from Bennett, Ng-Knight, and Hayes (2017), who found differences in autonomy support between teachers and teaching assistants, with more positive outcomes for teachers. Yet Chatzisarantis et al. (2019) found more positive effects of equal autonomy support (a balance of personal and classmates' autonomy support) on educational outcomes and students' well-being, compared to favourable (personal over classmates) or unfavourable (classmates over personal) autonomy support. These findings could mean differentiating autonomy support based on, for example, the expected need of students, might be less effective than providing autonomy support equally for all students.

Limitations and directions for future research

Differences between autonomy-supportive activities, students, and teaching approaches might explain the mixed findings of the current study. A first limitation we should address is the small sample size, which led to low power of our statistical tests and therefore does not allow robust interpretations. A second limitation of the

current study is the composition of the control condition, which functioned as the reference group in this study. These students were from the same school, but another year group. Although we use pre-test scores on learning motivation and achievement in our analyses, Grade-7 and Grade-8 students might differ in other aspects than learning motivation and achievement, such as learning preferences and attitudes towards schooling and teachers.

A third limitation refers to the limited variety of data that have been collected with student questionnaires and school administration. No data have been collected during the school year, such as class observations, completed tasks of the students or logs from the learning environments. This kind of data could have provided a deeper insight in the implementation and evaluation of the learning lab interventions and autonomy-supportive activities. In addition, with more data on student characteristics and teaching approaches, more advanced analyses might also be possible to, for example, examine the moderating role of student characteristics (cf., Graça, Calheiros, and Barata 2013) and teacher characteristics (cf., Bennett, Ng-Knight, and Hayes 2017) on the effects of autonomy-supportive activities on students' learning motivation and learning outcomes. Also, larger sample sizes will make it possible to examine the mediating role of learning motivation between autonomy support and student achievement, following other studies on autonomy support (cf., Zhou, Ntoumanis, and Thogersen-Ntoumani 2019). Although we realise that more elaborated data collection and more advanced statistical analyses require large research efforts, in this way future research on autonomy support, learning motivation and achievement can further contribute to understanding of effectiveness of teachers' autonomy support.

Implications for teaching

This study on effects of perceived autonomy support on students' learning motivation and achievement in two learning labs has contributed to our understanding how to support student autonomy in secondary education. Although the findings are mixed, it seems that a comprehensive approach of autonomy support, with organisational, procedural and cognitive autonomy-supportive activities, result in an increase in students' perceived autonomy support as well as their autonomous forms of learning motivation and achievement. Organizational autonomy-supportive teaching, in particular, seems to be beneficial for students' motivation for learning. Teachers who allow their students to plan their work, to choose their own tasks, to set the sequence of completing these tasks, and to follow their own pace support not only the autonomy of their students, but also their motivation for learning and -consequently- positive learning outcomes. Future research can further this understanding by examining other ways and levels of autonomy support, beyond the freedom to do tasks at your own pace and ability level.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author [WA]. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Dutch Foundation for Scientific Research (NWO), department of Educational Research (NRO), grant number 405-15-823.

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