Effects of Students' Autonomy Support on their Self-Regulated Learning Strategies: Three Field Experiments in Secondary Education

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Article Info	Abstract
	Providing students with autonomy over their learning process can support the development of their self-regulation skills. This study aimed to examine the effects of autonomy-support interventions on students' self-regulated learning strategies. The participants were 432 students from three secondary schools in the Netherlands. In each school, a one-year field experiment was performed, in which teachers and students shared control over learning processes. At the start and end of the school year, students from both the experimental and control conditions completed a questionnaire on perceived autonomy support and self-regulation strategies used. Univariate analyses of covariance were performed to examine the effects of the interventions on perceived autonomy support and the use of self-regulated learning strategies. The intervention with the highest amount of student control showed positive effects on self-regulated learning strategies 'task orientation', 'planning', and 'process evaluation', although it did show a small decrease in perceived autonomy support. The other two interventions showed an increase in perceived autonomy support and a positive trend in 'monitoring'. The field experiments suggest that different ways of supporting student autonomy can yield different effects on students' self-regulated learning strategies. The tentative conclusion is that a focus on student control is the most effective.

Introduction

The use of adequate self-regulated learning strategies has positive effects on students' cognitive achievement in primary (Dignath et al., 2008), secondary (Dignath & Büttner, 2008), and higher education (Sitzmann & Ely, 2011). Interventions aimed at supporting students' self-regulated learning are shown to be effective in improving achievement (Jansen et al., 2019; Xu et al., 2023). Interventions to foster students' self-regulated learning include cognitive-behavior modification programs as well as directly teaching self-regulated learning strategies, including cognitive and metacognitive strategies. More recently, interventions have been conducted in regular classroom settings with tasks that emphasize learners' responsibility and independence during their learning process (Boekaerts & Corno, 2005): The more students experience control over the regulation of their learning process, the more they are expected to develop their self-regulated learning strategies. Previous studies in secondary education confirmed this positive relationship between autonomy support and students' self-regulated learning, but how autonomy support was provided and which roles teachers and students had in supporting this were not

clear (Schuitema et al., 2012). Yet Long and Aleven (2017) did not find any positive effects of student autonomy on cognitive strategies or self-regulated learning strategies. These authors suggest a shared-control model (i.e., control over aspects of the learning process shared by both students and teachers) would be more effective for self-regulation. More information is needed on how and when student autonomy can support the development of students' self-regulated learning strategies. Therefore, the aim of the current study is to contribute insights into the relationship between student, teacher, and shared control, and students' perceived autonomy support and their self-regulated learning strategies.

Self-Regulated Learning and Student Autonomy

Self-regulated learning can be defined as ¨an active, self-directed process whereby students monitor and evaluate their cognition, motivation, affect, behavior, and environment to achieve their goals¨ (Boekaerts, 1996; Efklides, 2011; Efklides et al., 2002; Zimmerman, 2000). Various models of self-regulated learning have been used, of which the ones based on the social cognitive theory of Bandura (1986) can be understood as the most prominent ones in the educational domain (Kesuma et al., 2020; Paris & Paris, 2001; Puustinen & Pulkkinen, 2011). In one of these models, the one of Zimmerman (2000) distinguished three cyclical phases of self-regulated learning, that is, forethought, performance or volitional control, and self-reflection. The first phase refers to cognitive activities that precede students' efforts to act, such as task orientation and planning (Forethought). The second phase refers to activities that occur during students' learning, such as attention focusing and self-observation (Performance and volitional control). The third phase influences a student's response to the learning experience, such as self-evaluation, and occurs after the performance (Self-reflection).

To improve their use of self-regulated learning strategies, Zimmerman and Kitsantas (2005) argue that students should go through four sequential levels, namely, observation, emulation, self-control, and self-regulation. At the observation level, students learn by watching a model and listening to verbal instructions. At the emulation level, students practice their skills and receive feedback that helps them correct potential errors. At the self-control level, students set goals and self-monitor their performance. At the self-regulation level, students can use self-regulation skills in various learning tasks. Teachers can support students to go through this sequential process either directly by teaching self-regulated learning strategies or indirectly by setting up tasks that enable students to practice observation, emulation, self-control, and ultimately self-regulation.

Essentially, two ways of developing self-regulated learning can be distinguished: directly teaching self-regulated learning strategies through, for example, direct instruction or tasks, and indirectly through using learning tasks that require self-regulating learning (Graesser & McNamara, 2010). With regard to teaching practices concerning self-regulated learning strategies, an observational study by Kistner et al. (2010) shows that teachers mostly teach strategies in an implicit way, whereas explicitly teaching self-regulation is rare, either by teaching strategies directly or using learning tasks that support self-regulation. Only explicit strategy instruction was found to be associated with an increase in student performance. These findings are confirmed in a later qualitative study (Dignath & Büttner, 2018), but also in a quantitative study by Van de Kamp et al. (2016). Other authors (Schuster et al., 2020) took this explicit strategy instruction a bit further. These authors examined the effects of hybrid

training that simultaneously instructed multiple aspects of self-regulated learning, which included the planning, monitoring, and evaluation of both similar and different tasks. This hybrid training approach that used both general metacognitive strategies and task-specific cognitive and motivational strategies was most effective compared to a control condition in which single aspects of self-regulated learning were trained. Results showed that students in the hybrid training condition outperformed their peers in the control condition in applying self-regulated learning strategies to both similar and different tasks.

A study by Van Loon et al. (2020) shows that primary school teachers taught more cognitive strategies instead of metacognitive strategies, and their teaching was mostly teacher-centered instead of student-centered. Yet, student-centered instructions (i.e., providing students autonomy to regulate their own learning) led to students' re-study and monitoring of their learning process. The authors conclude that it is not the content of instructions teachers give that matters for students' self-regulated learning, but whether instructions enable students' autonomy to regulate their own learning. Admiraal et al. (2019) confirm the finding that teachers in primary schools do not support the autonomy of their students to make decisions concerning their learning process. Domen et al. (2020) have also found that secondary school teachers mainly structure their students' learning in a controlling way instead of an autonomy-supportive way. The dominant role of teachers is confirmed in a study by Mouratidis et al. (2022) who conclude that teachers play a key role in enhancing the autonomous motivation of all students, including those who already seem to be motivated.

This brings us to the more indirect ways in which teachers can support self-regulated learning through the arrangement of supportive learning environments with, for example, prompts (Berthold et al., 2007; Schwonke et al., 2013), feed-forward (Taminiau , 2013), and feedback during the learning process (see for an overview (Dignath et al., 2008). Granting student control, in which students can direct their own learning experiences may enhance their intrinsic motivation for learning (Shyu & Brown,1992; Zimmerman, 2000). Student control can refer to the sequence of instructional materials, the pacing of learning tasks, and the choice of instructional approach (Niemiec, 1996). Granting students a greater share in decision-making in class, might promote their internal motivation for schooling and encourage them to employ self-regulated learning strategies. If teachers adopt a teacher-control style, students will tend to avoid self-regulated learning strategies (Eshel & Kohavi, 2006). As a result of sharing classroom decision-making, students will learn how to better use their self-regulated learning strategies in the future. Yet whether students' self-regulated learning subsequently leads to better achievement is not confirmed in a review study by Jansen et al. (2019).

Literature shows ambiguous findings about the effects of giving students control over their learning. Small effects of student control have been found on students' motivation and learning behavior (Corbalan et al., 2006; Karich et al., 2014) and on achievement (Zimmerman & Kitsantas, 2014). A meta-analysis of 18 studies by Karich et al. (2014) found, consistent with a previous literature review of Niemiec et al. (1996), near-zero effects on achievement for the pacing of learning tasks, the sequence of learning materials and the choice of instructional approach. Thus, giving students control over any aspect of their learning process does not seem to be an advantage. In addition, just providing students control over existing learning tasks does not mean that students will regulate their learning more (Azevedo et al., 2008); students need some guidance or practice on how to regulate their own

learning (Jansen et al., 2019).

This Study

To sum up, research on the effectiveness of direct (through the teacher) and indirect (through the learning environment) support to develop self-regulated learning strategies yields mixed results. However, direct instruction by a teacher that is explicit and student-centered targets multiple aspects of self-regulated learning simultaneously and allows for learner autonomy seems to be most promising. In addition, indirect support in a learning environment that allows for learner autonomy (i.e., learner control) seems to be most promising if the learning environment is part of a comprehensive program and the teacher exerts control as well. In this study, we focus on learning environments in which students and teachers share control over the learning process (i.e., shared control), supporting students' autonomy to make decisions in how they approach their learning process. The study aims to contribute to our understanding of the interventions that help students develop their self-regulated learning strategies. The research question of this study can be formulated as follows:

> What is the effect of shared-controlled learning environments that support students' autonomy in their learning process on students' perceived autonomy support and their self-regulated learning strategies?

Method

Research Design and Participants

This study reports on three field experiments to collect data in a real class setting. In these quasi-experimental experiments with a pre-test and post-test control group design, data have been collected about three learning environments in three secondary schools in the Netherlands. These schools participated, together with some 30 other secondary schools in the Netherlands, in a research and development project on how technology can be used effectively and efficiently in teaching. These schools were the only ones that focused on shared control interventions and students' self-regulation. Teachers from each school who were interested in experimenting with shared control in their teaching were asked to join the project with at least one of their classes. The three schools are labeled with a pseudonym: Bayshore Secondary School, Blue River Secondary School, and Martin Luther King Secondary School. The research design differed per school due to practical constraints. In Martin Luther King School, a control cohort group design was used with a control condition from the same school but another year group. For Bayshore School and Blue River School, a pre-test and post-test control group design has been used with a control condition with students from the same school and same year group. Information about the participants is summarized in Table 1.

Bayshore School and Martin Luther King School are medium-sized schools (with about 1,000 students). The latter provides all levels of secondary education (pre-vocation to pre-university level), the former only general secondary and pre-university education. Blue River School is a large secondary school with about 2,500 students offering all tracks of secondary education. All three schools are located in medium-sized cities (with about 100,000 inhabitants). The research was carried out following the guidelines for research ethics and integrity of Utrecht University in the Netherlands, which was responsible for the research project. These guidelines include

requirements about asking for consent, data handling, and reporting. Active consent to participate was provided by the teachers and students' parents based on collecting data that was directly related to the evaluation of the interventions. This means that it was not allowed to collect background information on the students, such as age and gender.

Table 1. Number of Participants

	Experimental condition		Control condition	
	Male	Female	Male	Female
Bayshore School(n= 214)				
Grade 7	11	16		
Grade 8	21	13		
Grade 9	24	8		
Grade 7-9			63	58
Blue River School (n= 95)				
Grade 9	6	3	18	16
Grade 11	4	7	16	25
Martin Luther King School (n= 123)				
Grade 7	43	27		
Grade 8			26	27

Note. Specific grades of students from the control condition of Bayshore School were not collected due to practical reasons.

Shared-Control Interventions

Three shared-control interventions in three secondary schools have been implemented and evaluated. For each intervention, shared control has been implemented across five aspects: 1) pacing, 2) sequencing, 3) time allotment, 4) choice of practice items, and 5) choice of review items (Niemiec et al., 1996). Pacing indicates how quickly learning tasks are presented to the learner. Sequencing refers to how instruction and learning tasks are ordered. Time allotment refers to the amount of time learners have to complete their learning tasks. Practicing indicates the type and number of learning tasks learners use to practice, and Reviewing refers to the items that are used as a check for learners' understanding. All three interventions took one complete school year. In Table 2, the interventions are summarized.

In Bayshore Secondary School, students in the lower grades could sign up for a master class to work individually or in small groups on projects in addition to the regular curriculum. After a short introduction to procedures and deadlines by the teacher, students chose to work on projects on one of the themes that the teacher had provided. They were fully responsible for their own work, and the teachers only guided the learning and work processes. When students decided that they had completed their project, they asked the teachers' permission to work on the next one. This means students had control over the first four aspects of the program and shared control with their teachers over the fifth aspect (see Table 2). The control condition followed the regular curriculum without this

master class.

Table 2. Learning Environments that Support Teacher, Student, and Shared Control

	Bayshore	Blue River	Martin Luther King
Pacing	**Student control** - Students individually or collaboratively-controlled pacing	**Student control** – Students individually controlled pacing by compressing for one school subject two school years into one	**Student control** - Students individually controlled the pacing of their work
Sequencing	**Student control** - Students individually decided the themes they would work on	**Teacher control** - Students followed a compressed learning route with a similar sequence as the regular curriculum	**Student control** - During independent work students could choose the sequence of the task they worked on
Time allotment	**Student control** - Students individually or collaboratively decided for and monitored the time they invested	**Shared control** - Students individually worked supervised by a teacher and attended some classes at a higher level	**Student control** - Students could choose the time they worked on various school subjects within the time frame of the learning lab
Practicing	**Student control** - Students could work on themes they wanted; these themes were not linked to one particular school subject	**Shared control** - Students decided for practicing items from a list provided by the teacher supervisor	**Teacher control** - Teachers decided on the ability level students worked at and made a plan for each ability group
Reviewing	**Shared control** - Students could decide the way they want to complete a project. Teachers reviewed task completion and decided on the start of a new project	**Shared control** - Students decided on the accelerating levels and review items from a list provided by the teacher supervisor	**Shared control** - Students could choose to test within the time frame provided by the teachers

In Blue River Secondary School, students in the pre-final school year could sign up for a trajectory to accelerate their learning route toward the final school exam for one school subject. Students decided to practice and review items from a list and worked on them both individually and under the supervision of a teacher. In some cases, students could choose to attend a teacher-led class at a higher ability level. At this school, students shared control

with their teacher over all aspects of the program except 'sequencing' which was set by the teacher (see Table 2). Students in the control condition attended the regular curriculum.

In Martin Luther King Secondary School, a learning lab with mobile technology was set up, lasting one complete school year. In the learning lab, students received plenary instruction from the teacher and carried out independent work. During the latter, students could choose which tasks they wanted to work on. For each school subject, students were divided into three ability levels. Students followed a week's planning set up by the teachers for each ability group. All students worked with iPads, and teachers made the materials available through the iTunes U app. In addition, students of a similar ability level collaborated on a multidisciplinary project.

Prior to each lesson, students chose the school subject they would work on. For each school subject, they could also choose reviewing, within a period determined by the teacher. At this school, students controlled three aspects of the program, while two aspects were either shared or controlled by their teacher (see Table 2). Students in the control condition attended the regular curriculum.

Measures

At the beginning and the end of the school year, students completed an online questionnaire, measuring their perceived autonomy support and self-regulated learning strategies. The questionnaire items are presented in the Appendix.

Perceived Autonomy Support

At both pre-test and post-test, 'perceived autonomy support' has been measured with eight items, based on the study of Belmont et al. (1988). Each item was scored on a 5-point Likert-type scale with 1= 'does not apply at all' and 5= 'applies to a large extent', with negative items recoded. Example items and reliabilities for each intervention separately are presented in Table 3. Descriptive statistics are included in Tables 4 (Bayshore School), 5 (Blue River School), and 6 (Martin Luther King School).

Self-Regulated Learning Strategies

At both pre-test and post-test, students' self-regulated learning strategies were measured with 32 items from the questionnaire of Vandevelde et al. (2013). Each item was scored on a 5-point Likert-type scale with 1= 'never' and 5= 'always', with negative items recoded. Following the three phases of the model of Zimmerman (2000), six aspects of self-regulated learning have been measured, two for each phase: task orientation – the extent to which students think about how to complete a task, planning – the extent to which students plan their school work, perseverance – the extent to which students keep going on with their school work, monitoring –the extent to which students assess that they are able to regulate their learning process, product evaluation – the extent to which students evaluate their work completed, and process evaluation – the extent to which students evaluate the way they completed their school work.

Task orientation and planning are self-regulated learning strategies *prior* to a task; Perseverance and monitoring take place *during* execution of the task; and Product evaluation and process evaluation are strategies performed *after* completion of a task. Example items and reliability for the pre-test and post-test in each school are presented in Table 3. Descriptive statistics are included in Table 4 (Bayshore), 5 (Blue River), and 6 (Martin Luther King).

Table 3. Measures of Perceived Autonomy Support and Self-Regulated Learning Strategies (Variable Name, Number of Items, Example Item, and Cronbach's α Pre-Test/ Post-Test)

Variable	Number of items	Example item	Ba	Bl	MLK
Autonomy support	8	My teacher gives me a lot of freedom to decide how I do my schoolwork.	0.79/ 0.77	0.66/ 0.84	0.82/ 0.75
Task orientation	6	Before I start my schoolwork, I read the instructions carefully.	0.82/ 0.84	0.80/ 0.78	0.71/ 0.86
Planning	4	Before I start my schoolwork, I decide what to do first and what later.	0.71/ 0.70	0.84/ 0.78	0.68/ 0.83
Perseverance	6	Even if I would rather do other things, I make myself start my schoolwork.	0.88/ 0.87	0.92/ 0.90	0.85/ 0.89
Monitoring	9	I am good at changing my strategy when it doesn't work out during my schoolwork.	0.83/ 0.81	0.87/ 0.85	0.84/ 0.88
Product evaluation	3	After finishing my schoolwork, I go over my answers again.	0.80/ 0.82	0.79/ 0.78	0.84/ 0.86
Process evaluation	4	After finishing my schoolwork, I ask myself: 'Have I done it the right way?'	0.88/ 0.88	0.81/ 0.85	0.83/ 0.90

Note. Ba= Bayshore; Bl= Blue River; MLK= Martin Luther King

Analyses

Preliminary t-tests showed that students in the experimental and control conditions differed in their pre-test scores. Moreover, in Bayshore School and Martin Luther King School, a relatively large group of students who completed the pre-test questionnaire did not complete the post-test. Therefore, pre-test scores were included in the analyses to answer the research question. Separate univariate analyses of covariance have been performed with the post-test score of perceived autonomy support or one of the relevant self-regulated learning scales as the dependent variable, the condition as a factor, and the relevant pre-test score as a covariate. Significance levels for the analyses concerning self-regulated learning activities have been corrected for multiple comparisons using the Bonferroni-Holm correction method ($p< (\alpha/(m+1-k)$, with m= number of analyses (in this case 6) and k= order of p-value sorted from the lowest to the highest; (Holm, 1979). The significance level was set at 5%, but trends (with a significant level of 10%) are reported as well because of the conservative correction for multiple comparisons. Effect sizes are indicated by explained variance (η^2, see Cohen (1988) for small ($\eta^2= 0.01$), medium ($\eta^2= 0.06$), and large ($\eta^2= 0.14$) effect sizes). We have tested normality, homoscedasticity, and multicollinearity, and all assumptions of univariate analysis of covariance have been met.

Findings

Bayshore Secondary School

The descriptive statistics are summarized in Table 4. Students from the experimental condition show significantly lower scores on perceived autonomy support than students from the control condition, after controlling for the pre-test scores for perceived autonomy support ($F(1,127)= 6.254$; $p= 0.014$; $\eta^2= 0.05$). Students from both conditions show a small, non-significant decrease from the pre-test to the post-test (for the experimental condition: $t(59)= 1.340$; $p= 0.186$; for the control condition: $t(67)= 1.030$; $p= 0.307$).

Table 4. Means (M) and Standard Deviations (SD) for Perceived Autonomy Support and Self-Regulated Learning Strategies (Bayshore Secondary School)

	Experimental condition		Control condition	
	Pre-test	Post-test	Pre-test	Post-test
	M (SD)	M (SD)	M (SD)	M (SD)
Perceived autonomy support				
Autonomy support	**3.70 (0.60)**	**3.61 (0.60)**	**3.08 (0.48)**	**3.03 (0.47)**
Self-regulated learning strategies				
Task orientation	**3.49 (0.77)**	**3.38 (0.85)**	**2.98 (0.66)**	**2.53 (0.75)**
Planning	*3.46 (0.80)*	*3.54 (0.70)*	*3.26 (0.71)*	*3.14 (0.80)*
Perseverance	3.60 (0.76)	3.41 (0.71)	3.36 (0.60)	3.22 (0.66)
Monitoring	3.56 (0.75)	3.54 (0.65)	3.44 (0.50)	3.32 (0.51)
Product evaluation	3.65 (0.89)	3.52 (0.95)	3.12 (0.77)	2.91 (0.93)
Process evaluation	**3.47 (0.92)**	**3.41 (0.94)**	**2.57 (0.98)**	**2.33 (0.91)**

Note. Significant effects (corrected $\alpha= 0.05$) are printed in bold. Trends (corrected $\alpha= 0.10$) are printed in italics.

With respect to students' self-regulated learning strategies, the separate univariate analyses of covariance show that students from the experimental condition, compared to students from the control condition, reported higher scores on task orientation ($F(1,127)= 16.437$; $p< 0.001$; $\eta^2= 0.12$) and process evaluation ($F(1,122)= 12.288$; $p= 0.001$; $\eta^2= 0.09$), after controlling for the relevant pre-test scores. For both self-regulated learning strategies, scores in both conditions decreased after one year, but scores in the experimental condition decreased less (for task orientation: $t(59)= 1.408$; $p= 0.164$; for process evaluation: $t(54)= 0.590$; $p=- 0.558$) than in the control condition (for task orientation: $t(67)= 6.898$; $p< 0.001$; for process evaluation: $t(67)= 2.850$; $p= 0.006$). The univariate analysis of covariance shows a trend in difference between students from the experimental and control condition with respect to planning ($F(1,127)= 6.114$; $p= 0.015$; $\eta^2= 0.05$) with a non-significant increase for students from the experimental condition ($t(59)= -0.648$; $p= 0.520$) and a non-significant decrease for students from the control condition ($t(67)= 1.372$; $p= 0.175$). These effects can be interpreted as moderate to large effects (see Cohen, 1988).

No significant difference between the experimental and control conditions has been found for monitoring ($F(1,123)= 3.338$; $p= 0.070$), perseverance ($F(1,124)= 0.221$; $p=0.639$), and product evaluation ($F(1,123)= 3.624$;

p= 0.059). A large group of some 80 students, equally spread over both conditions, failed to complete the post-test questionnaire, and their scores were not included in the analyses.

Blue River Secondary School

The descriptive statistics are summarized in Table 5. Students from the experimental condition show significantly higher scores on perceived autonomy support than students from the control condition, after controlling for the pre-test scores for perceived autonomy support ($F(1,72)= 6.595$; $p= 0.012$; $\eta^2= 0.09$). Students from the experimental condition showed a non-significant increase ($t(11)= -1.725$; $p= 0.112$) and students from the control condition did not change ($t(60)= 0.514$; $p= 0.609$).

With respect to students' self-regulated learning strategies, none of the univariate analyses of covariance shows a significant difference between both conditions: task orientation ($F(1,71)= 4.580$; $p= 0.036$), planning ($F(1,11)= 3.6110$; $p= 0.082$), perseverance ($F(1,69)= 1.358$; $p=0.248$), monitoring ($F(1,68)= 6.132$; $p= 0.016$), product evaluation ($F(1,68)= 2.117$; $p= 0.150$) and process evaluation ($F(1,68)= 5.203$; $p= 0.026$). The difference between the experimental and control condition with respect to monitoring can be understood as a trend, with students from the experimental condition showing a non-significant increase in scores $t(14)=-1.533$; $p= 0.153$) and students from the control group showing a non-significant decrease in scores ($t(54)= 0.931$; $p= 0.356$).

Table 5. Means (M) and Standard Deviations (SD) for Perceived Autonomy Support and Self-Regulated Learning Strategies (Blue River Secondary School)

	Experimental condition		Control condition	
	Pre-test	Post-test	Pre-test	Post-test
	M (SD)	M (SD)	M (SD)	M (SD)
Perceived autonomy support				
Autonomy support	**3.39 (0.67)**	**3.71 (0.79)**	**3.11 (0.50)**	**3.08 (0.61)**
Self-regulated learning strategies				
Task orientation	3.25 (0.55)	3.24 (0.71)	2.96 (0.86)	2.70 (0.71)
Planning	3.02 (0.86)	3.27 (0.94)	3.17 (0.96)	3.06 (0.75)
Perseverance	3.43 (0.80)	3.39 (0.84)	3.11 (0.89)	3.03 (0.68)
Monitoring	*3.21 (0.56)*	*3.47 (0.61)*	*3.17 (0.74)*	*3.11 (0.60)*
Product evaluation	3.17 (0.77)	3.95 (0.56)	3.11 (0.79)	3.17 (0.93)
Process evaluation	2.93 (0.80)	3.11 (1.00)	2.69 (0.90)	2.73 (0.72)

Note. Significant effects (corrected $\alpha= 0.05$) are printed in bold. Trends (corrected $\alpha= 0.10$) are printed in italics.

Martin Luther King School

The descriptive statistics are summarized in Table 6. Students from the experimental condition show significantly higher scores on perceived autonomy support than students from the control condition, after controlling for the pre-test scores for perceived autonomy support ($F(1,59)= 6.517$; $p= 0.013$; $\eta^2= 0.10$). Students from the

experimental condition show a small, non-significant increase (t(36)= -0.981; p= 0.333); students from the control condition show a small, non-significant increase as well (t(22)= -0.483; p= 0.634).

With respect to self-regulated learning strategies, none of the univariate analyses of covariance show a significant difference between both conditions. However, one trend can be observed with respect to monitoring (F(1,61)= 6.480; p= 0.014; η²= 0.10) with a significant increase for students in the experimental condition (t(37)= 0.713; p= 0.483) and a non-significant decrease for students in the control condition (t(23)= -2.452; p= 0.019). This trend can be interpreted as a moderate to large effect (see Cohen, 1988). No significant difference between the experimental and control conditions has been found for task orientation (F(1,62)= 2.351; p= 0.130), planning (F(1,62)= 1.635; p= 0.206), perseverance (F(1,61)= 2.361; p= 0.130), product evaluation (F(1,60)= 4.520; p= 0.038), and for process evaluation (F(1,60)= 0.137; p= 0.712). A relatively large group of about 20 students from the control condition did not complete the post-test. They are excluded from the analyses.

Table 6. Means (M) and Standard Deviations (SD) for Perceived Autonomy Support and Self-Regulated Learning Strategies (Martin Luther King Secondary School)

	Experimental Condition		Control Condition	
	Pre-test	Post-test	Pre-test	Post-test
	M (SD)	M (SD)	M (SD)	M (SD)
Perceived autonomy support				
Autonomy support	**3.85 (0.69)**	**3.95 (0.47)**	**3.41 (0.74)**	**3.51 (0.60)**
Self-regulated learning strategies				
Task orientation	3.21 (0.65)	3.29 (0.57)	3.08 (0.60)	2.97 (0.85)
Planning	3.39 (0.69)	3.43 (0.64)	3.32 (0.56)	3.24 (0.76)
Perseverance	3.71 (0.75)	3.55 (0.62)	3.30 (0.67)	3.08 (0.79)
Monitoring	*3.30 (0.62)*	*3.50 (0.62)*	*3.23 (0.72)*	*3.13 (0.59)*
Product evaluation	3.74 (0.93)	3.88 (0.85)	3.32 (1.04)	3.39 (0.70
Process evaluation	3.11 (0.87)	2.99 (0.88)	3.03 (0.80)	2.91 (0.80)

Note. Significant effects (corrected α= 0.05) are printed in bold. Trends (corrected α= 0.10) are printed in italics.

Discussion and Conclusion

In this field experiment, three interventions with learning environments meant to support students' autonomy have been implemented and evaluated. These interventions were adaptations of regular classroom settings to support students' autonomy in classroom decision-making and created a more shared-controlled learning environment. The three interventions differed in the way this shared control was implemented. The intervention at the Blue River School focused on shared control for most aspects of the program design, except pacing (student control) and sequencing (teacher control). Under the intensive guidance of their teacher, students were allowed to follow individual learning trajectories, thereby creating their own learning route toward the final exam. This intervention led to a significantly positive effect on students' perceived autonomy support but had a small effect on monitoring (i.e., during the task) only. These results resemble the outcomes of the study of Eshel and Kohavi (2003) partly

confirming the importance of shared control for self-regulated learning.

The interventions at Bayshore School and Martin Luther King School focused less on shared control, but more on student control (Bayshore School) or a combination of student and teacher control (Martin Luther King School) over the program design aspects. At these schools, additional teaching formats and learning opportunities were included in regular teaching. The intervention at Bayshore School showed the most positive effects on self-regulated learning strategies (i.e. task orientation and planning as strategies before the task, and process evaluation as a strategy after the task). The intervention at Martin Luther King School showed a small increase in monitoring only. Yet both interventions had a significant effect on students' perceived autonomy support. These findings might imply that the implementation of student control helped students develop their self-regulated learning strategies before and after the task, whereas shared and teacher control over students' learning processes might be less effective for the development of students' self-regulated learning. Yet this conclusion can only be a tentative one, as differences in the context of the intervention examined as well as unexpected deviations from the planned implementation and data collection might give additional explanations. These limitations will be discussed later.

Fit with Learning Environment, Target Group, and Context

As mentioned above, the three interventions differed in content, target groups, and the context in which they were carried out. The one at Bayshore School included a master class in which students could work on a project in addition to the regular curriculum. Most probably, this attracted not only intrinsically motivated students but also students who prefer autonomy to make decisions in their learning process; the pre-test score of the experiment condition on perceived autonomy was relatively high. Carrying out a project outside the regular curriculum requires self-regulated learning, such as setting up a project, planning the approach, and reflecting on what one did. This underlines the conclusions of Xu et al.(2023) to focus teaching more on the preparatory phase of students' self-regulation.

In the Blue River School interventions, students could choose and set up their own learning path to accelerate the final exam within one year. Most probably, this attracted high-performing and engaged students, as this trajectory requires extra effort and good achievements in the particular school subject. This individual learning path required some teacher control in sequencing, in particular, to guide students to the final exam in the particular school subject. Emphasizing student control too much could be detrimental to students' progress towards the exam. In this intervention, students experienced support for their autonomy and a small increase in their monitoring strategies.

In Martin Luther King School, the curriculum of some school subjects was taught in a working lab, with project work alternated with plenary instructions and individual practice. To support an approach that was adapted to individual needs and preferences, iPads were used for students to work on. Students who had chosen the particular school subjects were obliged to follow this way of working. Students in both conditions (i.e., both cohorts) had relatively high pre-test scores on perceived autonomy support, which might mean teaching in this school is in general already quite supportive of students' autonomy. A change to a learning lab, like in this intervention, might

therefore not be a large change in how students perceive their autonomy and their ideas of having control over their learning process.

Importance of Learning to Self-Regulate

In general, the learning environments in the three schools designed to support students' autonomy did not impact the students' self-regulated learning strategy development to a great extent. In all significant effects, students in the control condition showed lower scores on self-regulated learning strategies at the post-test than at the pre-test. These two findings (a relatively low number of significant effects on self-regulated learning strategies and a decrease in student scores in the control conditions instead of an increase in the experimental conditions) might indicate that students in the experimental conditions did not go through the four sequential levels of self-regulated learning strategy development distinguished by Zimmerman and Kitsantas (2005).

Guiding students through the levels of observation, emulation, and self-control could have helped students benefit more from the learning environments that induced shared control. Teaching students to regulate their own learning means more than just providing enough possibilities to control their path, pace, and instructional approach. Either teaching self-regulated learning strategies directly or designing a learning environment that gradually shifts from teacher control via shared control to student control to support students' self-regulated learning strategies could be valuable additions. Schuster et al. (2020) already showed that training near and far metacognitive strategies can be an effective way to induce students' self-regulated learning strategies.

Self-Regulated Learning and Achievement

The current study focused on the effects of autonomy support and students' self-regulated learning strategies, showing a limited number of effects. Eshel and Kohavi (2003) mention positive effects of perceived student control on students' self-regulation skills: the higher the perceived student control and the lower the teacher control, the higher the scores on self-reported use of self-regulation learning strategies. They also mention that student achievement was highest when both perceived student control and teacher control were high. The authors explain this finding by indicating that school learning often requires students to perform tasks that are not intrinsically motivating for them. Therefore, students and a teacher sharing control over learning in class is most likely to result in higher academic achievement as it combines the benefits of both student and teacher control. This could mean that what is optimal with respect to students' self-regulated learning strategies could be less optimal for students' achievement.

Admiraal et al. (2020) explored a similar learning environment that supports student control in a secondary school and examined the effects on students' achievement. They found mixed results. In one school subject, student control led to higher student achievement; in two other school subjects, it led to even lower achievement scores compared to the control condition that attended the regular curriculum. Their conclusion was that teachers did not provide enough guidance on students' self-regulated learning processes, which led to insufficient support of students' cognitive learning in a school subject.

Limitations and Directions for Future Research

A strength of the current field experiment is its ecological validity. Experiments have been carried out in real classes as part of the regular curriculum and daily teaching practices in school. The interventions on shared control were designed by teachers and were planned to be carried out anyway, with or without being part of the current study. But this high ecological validity comes with a price, as the researchers' influence on the research approach was limited. The sampling of teacher and student participants was not random, and in two interventions, students could choose to participate in either the experimental or the control condition. From a learners' perspective, it is a good thing that students can attend the teaching they prefer, but from a researchers' perspective, it might have led to a selection effect of students for the experimental condition. We have corrected for pre-test scores in our analyses, but we could not correct for a potential selection effect. Yet another issue of the current field experiment was the low motivation of teachers and students to participate in the study at both Bayshore School and Martin Luther King School, given the relatively high number of students who did not complete the post-test questionnaire. The main reason for this was that the teacher forgot or did not want to administer the second questionnaire, so entire classes were left out. This means that the lower completion rate of the second questionnaire probably did not lead to biased findings at the student level.

A second limitation of the current study is the small sample size, which allowed us to perform analyses with only the main variables. Possible analyses of interaction effects, moderator analyses, or inclusion of relevant other co-variates, such as students' age, gender, grade, school subject, or educational level, were not possible. Moreover, the researchers were not allowed to collect background information on the students. Future research might follow up with this kind of moderator analysis, as shared control might not work the same for all groups of students.A third limitation is the lack of detailed process information. The shared control interventions took one school year, which makes it hard to collect specific information about the activities of both students and teachers that relate to the implementation of the interventions. In another study, Admiraal et al. (2020) collected information on students' perceptions of specific autonomy-supportive activities that were carried out during the school year. Yet the one-time measurement of these perceptions only provided a general idea of which elements of the learning environment were perceived as autonomy-supportive. Additional classroom observations, interviews, and logbooks might help to better understand how the interventions have been carried out in terms of teacher and student activities and can provide additional insights into the effects of these interventions.

Concluding Remarks

Self-regulated learning strategies are crucial for students at all levels of education. These can support students in finding their way into learning in school and directing their learning process. Student control over instructional decisions and curriculum elements can provide students with experiences with self-regulation of their learning process. The current field experiments suggest that different ways of supporting shared control (i.e., control shared by students and teachers) yield different effects on the development of students' self-regulated learning strategies. A tentative conclusion is that *student* control works best for secondary school students' self-regulated learning strategies. But there is still a lot to discover. Which combination of student autonomy and teacher's direct guidance

in secondary education is most effective, and for what? Teachers might be needed to guide and supervise the self-controlled learning trajectories of their students, at least when self-regulated learning strategies must still be learned. Teacher support and guidance can decrease when the quality of student self-regulation strategies increases. Yet it requires a different role for the teachers, with less control over students' learning processes and more teaching that is responsive to students' needs and abilities.

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Appendix. Questionnaire Items

Autonomy support

1 My teacher gives me a lot of freedom to decide how I do my schoolwork.

2 My teacher listens to my ideas.

3 My teacher always says what I have to do during lessons.

4 My teacher gives me only little freedom to decide how I do my schoolwork.

5 My teacher listens to my opinions.

6 My teacher explains how I can use the things I learn in school.

7 My teacher often criticizes my work in class.

8 My teacher explains why it is important what I learn in school.

Task orientation

1 Before I start my schoolwork, I read the instructions carefully.

2 Before I start my schoolwork, I ask myself: 'What is it about? What do I already know about it?'

3 Before I start my schoolwork, I ask myself: 'Do I know what kind of a task this is?

4 If I get a task similar to one I have already done, I ask myself: 'How did I approach it last time? Was that a good approach?'

5 Before I start my schoolwork, I ask myself: 'What do I feel about this task (fun, difficult, interesting, ...)?'

6 Before I start my schoolwork, I ask myself: 'Will I succeed?'

Planning

1 Before I start my schoolwork, I decide what to do first and what later.

2 If I find my schoolwork difficult, I allow more time for it.

3 If I have to do a large assignment, I start some days before, and every day I do a piece of it.

4 Before I start my schoolwork, I think about how much time I will need.

Perseverance

1 Even if I would rather do other things, I make myself start my schoolwork.

2 Even if my schoolwork is difficult or boring, I do my best.

3 Even if I would rather do other things, I finish my schoolwork.

4 I carry on until I finish my schoolwork.

5 During my schoolwork, I work attentively and don't take my mind off it.

6 If I am distracted while doing my schoolwork, I immediately try to continue working.

Monitoring

I'm good at …

1 … changing my strategy when it doesn't work out during my schoolwork.

2 … thinking at first about how I will approach my schoolwork.

3 … planning the timing of my schoolwork before I start making it.

4 … working with consistent attention during my schoolwork.

5 … knowing what is important and less important when studying.

6 … pointing out the information that is important when studying.

7 … connecting new things to what I already know.

8 … making a scheme or mind map when studying.

9 … checking my schoolwork by myself.

Product evaluation

After finishing my schoolwork…

1 … I go over my answers again.

2 … I check that I haven't forgotten anything.

3 … I check if I have done everything that was asked for.

Process evaluation

After finishing my schoolwork…

1 … I ask myself: 'Have I done it the right way?'

2 … I ask myself: 'Will I use a similar approach next time, or should I choose a different approach?'

3 … I ask myself: 'Did that way of doing it worked well?'

4 … I ask myself: 'How did I feel about it? (fun, difficult, boring, interesting, ...)?'