Effectiveness of a Lesson Study Intervention on Teacher Behaviour and Student Motivation in Physical Education Lessons

Lars Borghouts[1], l.borghouts@fontys.nl, ORCID: 0000-0001-6899-0555

Menno Slingerland[1], m.slingerland@fontys.nl, ORCID: 0000-0001-6985-9356

Gwen Weeldenburg[1], g.weeldenburg@fontys.nl, ORCID 0000-0002-9707-1352

Bregje van Dijk-van Eijk[1], bregje.vandijk@han.nl

Sara Laurijssens[1], saralaurijssens@hotmail.com

Teun Remmers[1], t.remmers@fontys.nl, ORCID 0000-0002-5921-7509

Leen Haerens[2], leen.haerens@ugent.be, ORCID: 0000-0001-5715-9520

[1] Fontys University of Applied Sciences
School of Sport Studies
Theo Koomenlaan 3
5644 HZ Eindhoven
The Netherlands

[2] Ghent University
Faculty of Medicine and Health Sciences
Department of Movement and Sports Sciences
Watersportlaan 2
9000 Ghent
Belgium

Corresponding author:

Dr. Lars Borghouts
Email: l.borghouts@fontys.nl
Phone: +31(0)8850 73259

Abstract

Background There is a strong need for evidence based, effective continuous professional development (CPD) for physical education teachers. This need includes CPD aimed at impacting student motivation. Existing CPD on teachers' motivating style often takes the form of singular events such as a workshop or training session. Research shows that in general, this only has a small impact on teacher behaviour and the effects on student motivation have not received much attention. Lesson study is a popular and more extensive form of CPD in which teachers collaborate on lesson planning, delivery and evaluation, based on predetermined goals for student learning. It has been suggested that this approach could enhance the effectiveness of CPD, but few studies have actually examined this at the level of teacher behaviour and student outcomes, especially in physical education.

Aim The present study aims to contribute to the knowledge base of effective CPD within physical education. It investigated whether a lesson study follow-up to a traditional workshop approach would increase the effectiveness of a CPD program on motivating teacher behaviour, student-perceived motivational climate and student motivation for physical education lessons, from the perspectives of Achievement Goal Theory and Self-Determination Theory.

Methods Ten secondary school PE-departments were included in the workshop + lesson study intervention group (LS), whilst nine served as a control group that received a workshop only (WS). A total of 52 PE teachers (33 LS, 19 WS) and their 612 students (334 LS, 278 WS) participated in the study. Measurements were taken two weeks prior to the start of the CPD program (pre-test), and again two to three weeks after the CPD had ended (post-test). Two teachers per school were randomly chosen for pre and post measurements in their games-lessons. Lessons were video-recorded and observed using previously validated observation instruments measuring autonomy support, structure, relatedness support, mastery

climate and performance climate. Students completed questionnaires on their motivational regulation, basic needs satisfaction and achievement goal orientation during both pre and post measurements.

Results In terms of observed teacher behaviours, there was a significant, large increase in teachers' provision of autonomy-support and a trend for a medium increase in teachers' provision of structure from pre to post in both conditions, whereas teachers' employment of a performance climate decreased in both groups. There was, however, no significant difference in effect between both conditions. At the student level, there was a small but significant decrease in students' performance approach orientation (PAp), with PAp decreasing more in LS than WS. Changes for all other student-derived variables from pre to post were negligible.

Conclusion Researcher observations showed that both CPD approaches, the workshop followed up with lesson study and the stand-alone workshop, were equally effective in positively altering the motivating behaviour of PE teachers. However, there was no substantial impact on student-perceived motivational climate and student motivation. Therefore, in the manner enacted in the present study, lesson study cannot be recommended as an effective and efficient form of CPD.

Keywords:

physical education, lesson study, continuing professional development, motivation

Introduction

According to Guskey (Guskey 2000), teacher professional development can be defined as "processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so that they might in turn, improve the learning of students" (p. 16). Professional development is usually subdivided into Initial Teacher Education (ITE) and Continuing Professional Development (CPD) (Maher and Fitzgerald, 2020). ITE can be defined as a period of development during which an individual acquires a level of competence necessary in order to start operating as an autonomous professional; CPD can be defined as education for teachers to maintain or expand knowledge and skills. Several review studies on CPD have concluded that there is a dearth of studies examining its effects at the level of teaching behaviour and student outcomes (Roesken-Winter, Hoyles, and Blömeke 2015; van Veen, Zwart, and Meirink 2012). In contrast, there is a wide body of literature on CPD in PE in general (Patton and Parker 2014), as well as on teachers' implementation of specific pedagogical models such as Cooperative Learning (Goodyear and Casey 2015) or Sport Education (Hastie et al. 2015). Yet, in relation to CPD on PE teachers' motivating behaviours and student motivation far less evidence is available. Students' motivation is considered a key outcome of the health-based physical education model (Haerens et al. 2011), and more generally for students to become self-directed and lifelong learners (Ryan and Deci 2017). Attempts have been made to gain more insight into the motivational behaviour of PE teachers through lesson observations (Haerens et al. 2013; Smith et al. 2015), and to support this behaviour by developing continuous professional development (CPD) activities aimed at optimising the motivational impact of teaching (Slingerland et al. 2017; Cheon, Reeve, and Moon 2012). These CPD activities usually take the form of singular events such as a workshop or training session. Although the actual effectiveness of this approach on teacher learning has been proven (Makopoulou et al. 2019), effect sizes are relatively low, suggesting

that such CPD programs would probably have a small impact on teachers' motivating behaviours. Overall, it has been suggested that there is a lack of proof for substantial CPD-effectiveness in the entire field of PE and there is a need to more effectively support PE teachers throughout their career (Armour, Makopoulou, and Chambers 2012). In the present study, we explored the effectiveness of a specific CPD approach (i.e., lesson study), on teacher behaviour and student motivation in PE lessons. But before exploring the theme of effective modes of CPD further, it is imperative to provide some brief background on motivational theory.

Motivational Theory in PE

Currently, Achievement Goal Theory (AGT) (Elliot and Church 1997; Nicholls 1984) and Self-Determination Theory (SDT) (Ryan and Deci 2017) are the dominant theories for studying students' motivation in the field of physical education (PE). In recent years, motivational research has started to integrate AGT and SDT (Vansteenkiste et al. 2014; Milton et al. 2018; García-González et al. 2019). According to Vansteenkiste (2014), the goals of a behaviour (defined by AGT) can be considered the 'what' in motivation, whilst the underlying reasons for a behaviour (defined by SDT) constitute the 'why'.

According to AGT, goals can be either mastery or performance oriented. The 2 x 2 achievement goal framework (Elliot and Church 1997) states that individuals can be motivated to either approach or avoid these types of goals. *Mastery approach goals* (MAp) focus on mastering a task and on self-improvement. In contrast, *mastery avoidance goals* (MAv) are aimed at the avoidance of task-defined or self-defined failure. *Performance approach goals* (PAp) are characterized by a desire to outperform others, whereas *performance avoidance goals* (PAv) refer to a desire to avoid performing worse than others. PE teachers can have an impact on students' goal orientations by establishing a mastery (or

task oriented) or a performance (or ego oriented) climate during their lessons (Barkoukis et al. 2007). Research suggests that, compared to a performance class climate, a mastery class climate results in more autonomous forms of student motivation (Cox and Williams 2008). Effective CPD on motivating teaching would thus result in teachers' installation of a mastery climate and students' adoption of mastery approach goals.

According to SDT, *autonomous motivation* is largely self-determined. An example of this would be if students are actively involved during a PE lesson because they perceive it as enjoyable (i.e. intrinsic motivation) or perceive it as beneficial to their sporting abilities or health (i.e. identified regulation). In contrast, *controlled motivation* is less self-determined, for example if students participate in an activity to avoid punishment by the teacher (i.e. external regulation), or because they would feel guilty if they did not participate (i.e. introjected regulation) (Ryan and Deci 2017). Finally, if students choose not to (actively) partake in the PE-lesson for reasons such as a lack of valuation of the activity, or low feelings of self-efficacy, this is referred to as *amotivation*. Autonomous motivation is considered the 'preferable type' of motivation in PE, since studies have shown that it is associated with more beneficial cognitive, affective and behavioural outcomes than controlled motivation (Ntoumanis and Standage 2009).

SDT states that the type of motivation is impacted by the degree of both the satisfaction and frustration of the basic psychological needs for autonomy, competence and relatedness (Ryan and Deci 2017). Autonomy refers to the perception of volition, choice, and being ones' self. Competence refers to feelings of effectiveness and ability to succeed, whilst relatedness refers to feelings of trust, care, and mutual positive valuation with both teacher and classmates. Satisfaction of these needs by the social environment is associated with autonomous motivation, whilst needs frustration predicts controlled motivation and amotivation (Haerens

et al. 2015). Need satisfaction and need frustration are believed to stand in an asymmetrical relation to each other, meaning that the absence of need satisfaction does not necessarily imply the presence of need frustration, whereas the presence of need frustration does denote the absence of need satisfaction (Vansteenkiste, Ryan, and Soenens 2020).
From the perspective of SDT, effective CPD would therefore result in greater need satisfaction and autonomous motivation in the students.

Effective CPD

Scientific reviews suggest that CPD is most effective when teachers actively engage in collaborative, explorative learning (van Veen, Zwart, and Meirink 2012), especially if it regards the analysis of problems and the construction of solutions for everyday teaching practice. Importantly, teachers should experience ownership; that is, they should be involved in determining the goals and contents of the professional development (Roesken-Winter, Hoyles, and Blömeke 2015). Other factors that have been suggested to enhance the effectiveness of CPD activities include CPD being aimed at the teaching and learning process in a specific subject (instead of education in general), the CPD activities being based on a clear 'theory of improvement' about how teacher learning is impacted, and a substantial amount of time being invested by the teachers involved (Guskey and Yoon 2009; van Veen, Zwart, and Meirink 2012; Roesken-Winter, Hoyles, and Blömeke 2015).

A form of CPD that includes most, if not all, of these features, is *lesson study*. Lesson study originally stems from Japan, where it has been practiced for over a century and regarded as the default mode for ongoing teacher learning (Dudley 2015). It attracted interest from outside Japan when it was suggested to be responsible for the leading position of Japanese mathematics education in international rankings (Stigler and Hiebert 1999). Lesson study is

now considered one of the fastest growing modes of CPD in the world (van Veen, Zwart, and Meirink 2012; Dudley 2015). At its core, lesson study is a vehicle for teachers to innovate and improve their school subject by collaborating on lesson planning and delivery, based on predetermined goals for student learning. The teachers involved study the learning processes of their students through an iterative process of designing and evaluating lessons together (see Figure 1).

In spite of the attention lesson study has attracted in recent years from teachers, school administrators and scholars, few researchers have aimed to measure its actual effectiveness in terms of teacher practices and student outcomes (Cheung and Wong 2014). This is surprising, since these are the areas that lesson study is often believed to discern itself from more traditional forms of CPD, through its emphasis on practical experimentation and student-centredness. Numerous studies outside the context of PE have examined the quality of teachers' experiences during the lesson study process, its impact on teachers' learning and content knowledge learning or studied the adaptation of lesson study to different contexts (e.g. (Verhoef et al. 2014; Halvorsen and Kesler Lund 2013). But with one notable exception (Lewis and Perry 2017), the few studies that did examine the effect of lesson study on actual teacher behaviour and student outcomes, were very small-scaled and methodologically ill-equipped for determining quantitative intervention effects.

Research on lesson study situated in PE is very limited, and described (pre-service) teachers' perceptions of and experiences with the use of this approach (Cluphf, Lux, and Scott 2012; Lamb and Aldous 2016; Sato et al. 2020). Taken together these qualitative studies suggest that lesson study might be able to support (pre-service) teachers' reflective practice. As far as we are aware, however, there are no studies to date within PE that have studied the effectivity of lesson study at the level of teacher behaviour or student outcomes.

The Present Study

We have established that there is a need for evidence based, effective CPD for PE teachers and that this need includes CPD aimed at impacting student motivation. Although a few studies have described (pre-service) teachers' perceptions of and experiences with the use of lesson study as CPD within PE, there are no published records of investigations into its actual effectiveness. Therefore, the present study aimed to investigate the effectiveness of lesson study in supporting PE teachers to adopt a more motivating style to the benefits of their students. We hypothesized that a workshop on motivational climate followed up by lesson study, would boost the effects of the 'usual practice' of a stand-alone workshop. Specifically, we studied the impact of the workshop only versus workshop + lesson study approach on observed motivating teacher behaviour, student-perceived motivational climate and student motivation for PE.

[Insert figure 1]

Methods

Context

There is no national curriculum for PE in the Netherlands. Instead, PE goals are expressed in a set of broadly defined achievement goals (5–9 depending on the educational track). Examples of these are: 'Students are able to participate in at least two activities within the domains of gymnastics, athletics, dance and self-defence' and 'Students can make a well-informed choice from physical activity opportunities in contemporary society, based on insights into their own possibilities and preferences'. In general, all lessons are movement-based and take place in an indoor sports hall or on an outside field. PE in the Netherlands is

almost exclusively mixed gender grouped and is mandatory within all types of secondary school education. Typically, secondary school students participate in two lessons (of 50-60 minutes) of compulsory PE per week throughout the school year.

Participants

The study was approved by the university research ethics committee.

Secondary education PE-departments were invited to participate in the study using the university's professional network (emails, personal communication, presentation at meetings). We included a total of nineteen departments from as many schools, from different cities throughout the southern half of the Netherlands. Ten schools were included in the lesson study intervention group (LS), nine served as a control group that received a workshop only (WS). In these schools 52 PE teachers (33 LS, 19 WS) provided their informed consent to participate. Their mean age (±SD) was 34 (±8,4), 36 were male and 16 were female. On average, they had 11 (±6) years of experience teaching PE.

At the outset of the study, we had intended to assign schools randomly to either lesson study intervention or 'workshop only' control group. During the recruitment phase however, several schools indicated that they would only be interested to participate if they could be involved in the lesson study intervention, whilst others indicated that time investment prevented them from participating unless they would be included in the 'workshop only' control group. This forced us to change to a 'semi-randomised allocation' approach in which schools were in part recruited to the group of their preference, to be able to reach an acceptable sample size.

From each school, two classes were chosen for measurements based on convenience sampling (availability of teacher and researcher). Students from these classes and their parents were approached via an information letter that explained the goals and procedures of the study and given the opportunity to decline participation. A total of 612 students (334 LS, 278 WS)

taught by 38 different teachers, completed questionnaires during both pre and post measurements. 335 were Male, 277 Female. 80% of students participated in leisure time sport at least once per week. The majority of participating students (95%) were in the lowest three year-groups of secondary school; their mean age was 14 (±1,2) years.

Procedures

Measures were taken two weeks prior to the workshop (pre-test), and again two to three weeks after the workshop (WS group) or the final lesson study session (LS group) (post-test). Two teachers per school were randomly chosen for measurements taking place in two of their games-lessons, in different classes. To ensure ecological validity, they were instructed to prepare and teach their games-lessons at their own discretion, with no lesson plans or guidelines provided. PE teachers in The Netherlands normally have a large autonomy in selecting which games to teach. In practice, most teach modified (i.e., simplified) forms of invasion games (e.g., basketball), net and wall games (e.g., volleyball), striking and fielding games (e.g., baseball) and target games (e.g., disc golf). Measurements consisted of audio-visual recordings of the lessons using GoPro Hero 5 Session action cameras (GoPro Inc., San Mateo, Cal, USA) and of student questionnaires. A researcher administered the questionnaires (see measurements). It was communicated to the students that there were no wrong answers and that students' responses would be treated confidentially. It took students 10-15 min at the end of the PE lesson to complete the questionnaires.

All PE teachers followed one three hour-workshop. This workshop took place at three different moments, to make sure that every teacher could attend, and was organised in a sports hall at the university. Teachers from the same school participated together. The general outline of the workshop is provided in the Supplemental Material A. It provided a mix of motivational theory applied to teaching games, physically active practices that applied the

theory, and opportunities for the participating teachers to interact with other teachers on how to translate the presented ideas into their own school practices. To support the process and application in practice afterwards, teachers were presented with a university-developed evidence-based 'need-support toolbox' consisting of three laminated cards that each contained one of three broad categories derived from AGT and SDT: Every student should (1) experience a sense of achievement; (2) perceive to be engaged in meaningful activities; (3) feel actively involved in the lesson. For every category, four practical instructional strategies were explained in the toolbox for PE teachers to use in their lessons, based on the strategies used in the workshop. For example, for the category 'Every student should experience a sense of achievement', one of the four instructional strategies was 'Avoid students perceiving pressure to perform' with the following tips: a) communicate expectations at the start of the unit or lesson that are achievable for all students, b) avoid situations in which students have to demonstrate skills in front of large groups of peers c) do not, verbally or non-verbally, punish students for making mistakes. Upon completion of the workshop the 'workshop only' group was encouraged to implement the acquired skills and knowledge into their daily PE practice without any further support, while the lesson study intervention group engaged in lesson study starting within two weeks after the workshop.

In line with lesson study guidelines (Dudley 2015), lesson study groups consisted of three to six PE teachers. The lesson study intervention groups were each allocated to one of six trained lesson study facilitators, who visited the teachers at their school for three or four lesson study meetings, over a course of four to eight weeks, depending on schedules and availability of the PE teachers. These sessions generally lasted between 90-120 minutes and followed a similar agenda in all schools. A general overview of the proceedings is provided in Supplemental Material B. Live observation of the research lessons by colleagues proved difficult in the

majority of schools due to constraints in teachers' time schedules. Each LS group was therefore provided with two action cameras, to capture the research lesson on video.

Data Collection

The present paper was part of a larger study and reports the quantitative measurements on teacher behaviour and student outcomes. Qualitative data on the participating teachers' views on the feasibility of lesson study as CPD, on perceived teacher learning and organizational support, are reported in a separate paper (Slingerland et al., 2021).

Teacher behaviour

A total of 31 pairs of complete and usable pre-post lesson recordings were made, i.e. 62 lessons in total (30 LS, 32 WS). The duration of the video recordings ranged from ~45 to ~75 min depending on the schools' habitual planning of PE lessons. GoPro Hero 5 Session action cameras were used for recording. One camera was always placed on the chest of the PE teacher with a dedicated chest harness and one or two cameras were set up to overview the gymnasium or field, depending on its size. Custom software, constructed by the research group, allowed observers to afterwards view the multiple video angles simultaneously. An observation instrument was applied that consisted of 30 items and combined two previously validated methods (Haerens et al. 2013; Smith et al. 2015). The former (Haerens et al. 2013) is based on Self Determination Theory and consists of 23 items to measure the three constructs autonomy support, provision of structure and relatedness support. In the instrument a discrimination is furthermore made between the provision of structure by the teacher at the beginning (e.g. instructions) and during the lesson (e.g. guidance and feedback). The latter, was the AGT-subscale of the MMCOS (Smith et al. 2015), a seven-item instrument aimed at observing the extent to which a teacher establishes a mastery climate versus a performance

climate. All items described specific teacher behaviour and were scored as 'How often is said behaviour observed in a lesson' on a scale 0 (never) - 1 (sometimes) - 2 (often) - 3 (always). Mean scores were calculated for each construct for further statistical analyses. Five researchers practiced coding two lesson recordings independently, discussed scores and interpretations, coded a new lesson and then re-discussed. For analysis, each lesson was scored by two researchers independently and scores were averaged.

Student-perceived motivational climate and student motivation

The student questionnaire comprised of four existing, validated questionnaires based on SDT and AGT. All items were scored on a five-point Likert scale ranging from 1 (totally disagree) to 5 ('totally agree'). The items were preceded by nine questions regarding personal and school characteristics (e.g. age, sex, school type, leisure time sport participation). 612 students returned valid questionnaires in both pre- and post-measurement (333 LS, 279 WS).

Motivational regulation. Students' motivational regulations regarding the preceding PE lesson, were assessed by using a brief version of the Behavioural Regulations in Physical Education Questionnaire (BRPEQ) (Aelterman et al. 2012). The BRPEQ was reduced from 20 to 12 items on the basis of the factor analyses by Aelterman et al. (Aelterman et al. 2012) and De Meester et al. (De Meester et al. 2014). The introductory stem '*In the preceding PE lesson…*' was followed by 4 items each reflecting autonomous motivation, controlled motivation and amotivation.

Psychological need satisfaction and frustration. Students' perceived psychological need satisfaction and frustration during the PE-lesson, were assessed by a brief version (18 instead of 24 items) of the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) (Chen et al. 2014). The stem '*In the preceding PE lesson…*' was followed by items probing the satisfaction of autonomy (3 items), competence (3 items) and relatedness (3 items), and

the frustration of autonomy (3 items), competence (3 items) and relatedness (3 items). This shortened version was validated in previous research (Weeldenburg et al. 2020).

Achievement goal orientation. Students' achievement goal orientation during the preceding PE lesson was assessed by the 2x2 Achievement Goal in Physical Education Questionnaire (2x2 AGPEQ) (Wang, Biddle, and Elliot 2007). This questionnaire measures students' orientation towards MAp-goals, MAv-goals, PAp-goals and PAv-goals by three items each.

Perceived mastery and performance climate. Students' perceived teacher-initiated motivational climate during the PE-lesson was measured by the Motivational Climate Scale for Youth Sports (MCSYS) (Smith, Cumming, and Smoll 2008). Wording was slightly adapted to the PE context. It consists of 12 items measuring the perception of a teacher-created mastery climate versus a performance climate.

Mean scores were calculated for each construct of the questionnaires for further statistical analyses.

Statistical Analyses

Given the nested structure of the data, we relied on multilevel regression modelling, using MLwiN version 2.31. For the observational data, a three-level structure was composed with measurement occasion nested within teacher within school. For the student data, a four-level structure was used with measurement occasion nested within student, within class and within school. First, baseline variance components models (Rasbash et al. 2017) or intercept-only models (Hox, Moerbeek, and Van de Schoot 2017) were estimated to determine the variance in teaching behaviours at each of these levels (i.e. Model 0; Table 1 and 3). In a second step, we added time to the model to examine changes in the outcomes from pre to post across both groups (Model 1, Table 2 and 4). In a third step, condition and time by condition interaction effects were added (Model 2; Table 2 and 4), with significant time by condition interaction

effects indicating that changes over time were different according to the condition teachers (Table 2) or students (Table 4) were in. After initial analyses revealed there was no significant variance at the school or teacher level (see Results), effect sizes (d) were calculated using the approach recommended by Morris (Morris 2008). Effect sizes of 0,2 are considered small, around 0,5 medium, and above 0,8 large (Cohen 2013).

Results

Teacher Behaviour

As for the observed teaching behaviours (see Table 1), the random part of the variance component model reveals that there was no significant variance at the school (all χ^2<1.29; p>.26) or teacher level (all χ^2<2.93, p>.09). This indicates that there is no between schools or teacher-difference in the occurrence of the examined behaviours. Most of the variance in the examined teaching behaviours was situated at the measurement occasion level (pre vs. post). In terms of the main analyses, Table 2 shows that there was a significant, large increase in teachers' autonomy-support and a trend for a medium increase in teachers' provision of structure from pre to post in both conditions, whereas the degree to which teachers employed a performance climate decreased from pre to post in both groups, with a medium effect size. There was no significant interaction between the two conditions.

[Insert table 1 & 2]

Student-Perceived Motivational Climate and Student Motivation

As for the student reports (see Table 3), most variance was situated at the measurement occasion (pre vs. post) and student level. Variance at the class level was significant for controlled motivation, autonomy satisfaction, performance and mastery climate indicating significant between class differences in these outcomes. Significant between school differences were found for MAp and relatedness frustration only. For all other variables, variance at the school level was insignificant. As shown in Table 4, student reports indicated that MAp, PAp, PAv and mastery climate perception decreased over time, while increases in controlled motivation (trend), amotivation, autonomy frustration (trend) and relatedness frustration were found. However, the effect size was small for PAp, and negligible for all other variables. In relation to the main research question, only one significant time by condition interaction effect was found, revealing that PAp decreased more in the lesson study

intervention when compared to the 'workshop only' control group. The effect size for this was negligible to small.

[Insert Table 3 & 4]

Discussion

The present study aimed to measure the effects of lesson study, as a form of CPD, on motivating teacher behaviour, student-perceived motivational climate and student motivation. The observed changes in teachers' behaviour over time in both conditions can be deemed positive. Yet, we were unable to confirm our hypothesis that the effects of following up a workshop on motivational climate with lesson study, would be superior to the effects of a stand-alone workshop. Not only were the effects on teacher behaviour indiscernible between groups, we found negligible effect sizes on all student outcomes over time, as well as between groups. One exception to this was a small but significant decrease in students' performance approach orientation for both groups combined. This finding seems coherent with the observed decrease in performance climate.

The general lack of additional effect of lesson study might indicate a ceiling effect reached after the workshop. The effectiveness of stand-alone workshops has been questioned in the literature (Roesken-Winter, Hoyles, and Blömeke 2015), yet the workshop provided in the present study contained several aspects that have been deemed essential for effective CPD (Guskey and Yoon 2009; van Veen, Zwart, and Meirink 2012). For example, it had a focus on pedagogical content knowledge, and teachers were actively involved in a collaborative construction of instructional strategies. It has also been suggested that, for CPD activities to be effective, its contents should not be determined for, but by them (Roesken-Winter, Hoyles, and Blömeke 2015). Although participants were not actually determining the content of the

workshop, all teachers participated voluntarily in our study. This ensured a high probability of them at least being interested to learn about its theme, in comparison to, for example, workshops provided top-down and initiated by school administrators. In that regard, it might be questioned to what extent the workshop provided was representative of 'usual practice'. On the other hand, it should be noted that the effect of lesson study on actual teacher and student outcomes has seldomly been quantitatively studied. The single larger-scale intervention study that did, found only a small effect of lesson study on teacher knowledge and a moderate effect on students' knowledge (Lewis and Perry, 2017). Therefore, although it has been speculated that lesson study might be superior to other forms of CPD, our results might simply indicate that as implemented in the current study, lesson study did not live up to the high expectations regarding its effectiveness.

Given that the lesson study intervention consumed considerably more teacher-time than the control condition, and was equally effective, it might be concluded that lesson study is less efficient than a high-quality, stand-alone workshop. Moreover, effects at the student level were largely negligible for both conditions. Student learning outcomes can be considered the most critical level for evaluating effectiveness of CPD (Guskey 2000), and therefore our research might be taken to indicate that lesson study is largely ineffective (as was a stand-alone workshop). However, we would like to give into consideration that the efficiency and effectiveness of CPD most likely also depends on its content focus. It is remarkable that the majority of lesson-study literature is situated in the exact sciences, with an emphasis on mathematics (Dudley 2015). In many instances, it is aimed at developing teaching strategies for concrete and focussed learning outcomes such as understanding 3D figures or Pythagoras' theorem (Yang 2009). In this respect, our objective of enhancing the motivational climate in games lessons may have been too broad and elusive to fully exploit the potential of

lesson study. Whether the impact of our intervention at student level, or indeed the effect of lesson study compared to a stand-alone workshop, would have been different if we would have targeted, for example, an isolated motor skill, is open to further study. It is conceivable that the implementation of a specific, well-defined instructional strategy within PE, or the comparison of different instructional strategies, would lend itself well to the iterative and explorative nature of the lesson study-approach. One could for example imagine that a PE-department striving to implement video-assisted feedback in athletics lessons, or to apply formative assessment strategies, could benefit from experimenting with this approach, within the span of a few lessons.

After the rapid dissemination of lesson study outside of Japan in the last two decades, it has been noted that the approach has been adapted in various ways to local contexts and cultures, and discussion has arisen regarding its defining characteristics (Elliott 2019). According to Takayashi and McDougal (Takahashi and McDougal 2016), the key features of lesson study from an effectivity perspective are:

- Participants engage in lesson study to build expertise and learn something new, not simply to refine a certain lesson.
- The lesson study is part of a highly structured, school-wide or district-wide process.
- It includes significant time spent on the study of teaching materials.
- It is done over several weeks, rather than just a few hours.
- Knowledgeable others contribute insights during the post-lesson discussion and during planning as well.

We would argue that the lesson study intervention in the present study complies with most, if not all, of these characteristics. Nevertheless, although it was highly structured, it is debatable whether our research study counts as a ‘school-wide process’, with only PE-departments

involved. Also, although participants were prompted to study teaching materials, the separately published data from focus groups with the PE departments in the LS group showed that not much self-directed deepening of knowledge took place (Slingerland et al., *in press*). Only occasionally did teachers consult additional materials for reference or inspiration; they relied largely on the 'need-support toolbox' provided. Therefore, although lesson study was of marginal added value in the present study, it is important to note that the variance in the enactment of the approach in practice, might very well impact its effectiveness.

Strengths and Limitations

As far as we are aware, the present study is the first controlled trial into the effectiveness of lesson study in school PE. Outside of PE, larger-sized controlled trials are also very limited. Therefore, we believe this study adds valuable new insights to the knowledge base of CPD in general, and lesson study in particular. Furthermore, by evaluating impact not just on observable teacher behaviour, but also on student motivation and student perceived motivational climate from the perspective of both AGT and SDT, we were able to provide a comprehensive view that is uncommon in motivational research in PE. It has been noted that a large segment of the previously developed interventions aimed to optimise PE teachers' motivation style, only targeted autonomy-support and that many of those studies used self-reports rather than direct observation to measure the impact on teacher behaviour (Raabe et al., 2019). The lessons learned from our study provide suggestions for the more effective translation of lesson study from 'exact sciences' (e.g., mathematics) to PE. Also, it shows that exploration of the application of lesson study in different contexts might be an interesting avenue for further study.

Nonetheless, the present study has several limitations that we would like to address. Firstly, as described in the methods section, we were unable to fully randomise the allocation of schools

to the lesson study vs. 'workshop only' groups. This may have caused a selection bias, with unknown impact on the outcomes. Secondly, although teachers were asked to carry out their lessons as planned during observation, and researchers were not present during the filmed lessons, we cannot exclude the possibility that this may have caused reactivity, with teachers and/or students modifying their behaviour in response to their awareness of being observed. Thirdly, although the 2x2 AGT framework is still very prominent in educational psychology (Bardach et al. 2020), some researchers have advanced to a 3x2 approach (Elliot, Murayama, and Pekrun 2011). The application of this framework might have provided us with additional insights. Lastly, post-measurements took place two weeks after the final CPD-activity in both groups. Therefore, we do not know to what extent the changes reported endured after this follow-up period, or whether further increases or decreases will have occurred over time.

Conclusion

We hypothesized that a workshop on motivational climate followed up by lesson study, would boost the effects of the 'usual practice' of a stand-alone workshop. In contrast to our expectations, findings based on observations revealed that a singular workshop was already effective in positively altering the motivating behaviour of PE teachers. This stand-alone workshop approach was even equally effective as a workshop followed up with a more extensive lesson study approach. The impact of both types of CPD on student-perceived motivational climate and student motivation for PE lessons though, was negligible. Therefore, in the manner enacted in the present study, lesson study cannot be recommended as an effective and efficient form of CPD to enhance teachers' motivating behaviours. There is a need to search for more effective ways to positively impact student motivation in PE through CPD. This could include examining lesson study targeted to specific motivational instructional strategies in relation to one specific lesson topic, or alternative lesson study

approaches to the one applied in the present study. In addition, it would be of interest to explore whether more elaborate ‘community of practice’-based strategies to CPD would exert larger effects.

Acknowledgement

The authors would like to thank Esther Donkers-Verhoeven and Harm van den Bergh for their assistance in data collection and lesson study facilitation.

This study was supported by SIA grant RAAK.PUB03.027.

References

Aelterman, N., M. Vansteenkiste, H. Van Keer, L. Van den Berghe, J. De Meyer, and L. Haerens. 2012. "Students' objectively measured physical activity levels and engagement as a function of between-class and between-student differences in motivation toward physical education." *Journal of Sport and Exercise Psychology* 34:457-80.

Armour, K., K. Makopoulou, and F. Chambers. 2012. "Progression in physical education teachers' career-long professional learning." *European Physical Education Review* 18 (1):62-77. doi: 10.1177/1356336X11430651.

Bardach, L., S. Oczlon, J. Pietschnig, and M. Lüftenegger. 2020. "Has achievement goal theory been right? A meta-analysis of the relation between goal structures and personal achievement goals." *Journal of Educational Psychology* 112 (6):1197-220.

Barkoukis, V., C. Thogersen-Ntoumani, N. Ntoumanis, and N. Nikitaras. 2007. "Achievement goals in physical education: Examining the predictive ability of five different dimensions of motivational climate." *European Physical Education Review* 13 (3):267-85. doi: 10.1177/1356336X07081794.

Chen, B., M. Vansteenkiste, W. Beyers, L. Boone, E. L. Deci, J. Van der Kaap-Deeder, B. Duriez, et al. 2014. "Basic psychological need satisfaction, need frustration, and need strength across four cultures." *Motivation and Emotion* 39 (2):216-36. doi: 10.1007/s11031-014-9450-1.

Cheon, S. H., J. Reeve, and I. S. Moon. 2012. "Experimentally based, longitudinally designed, teacher-focused intervention to help physical education teachers be more autonomy supportive toward their students." *Journal of Sport and Exercise Psychology* 34 (3):365-96.

Cheung, W. M., and W. Y. Wong. 2014. "Does Lesson Study work?" *International Journal for Lesson and Learning Studies* 3 (2):137-49. doi: 10.1108/IJLLS-05-2013-0024.

Cluphf, D., K. Lux, and V. Scott. 2012. "Investigating PETE Majors' Perceptions of Lesson Study as a Capstone Experience." *The Physical Educator* 69:228-47.

Cohen, J. 2013. *Statistical power analysis for the behavioral sciences*: Academic press.

Cox, A., and L. Williams. 2008. "The roles of perceived teacher support, motivational climate, and psychological need satisfaction in students' physical education motivation." *Journal of Sport and Exercise Psychology*.

De Meester, A., N. Aelterman, G. Cardon, I. De Bourdeaudhuij, and L. Haerens. 2014. "Extracurricular school-based sports as a motivating vehicle for sports participation in youth: a cross-sectional study." *International journal of behavioral nutrition and physical activity* 11 (1):48.

Dudley, P. 2015. *Lesson Study*. Oxon (GB): Routledge.

Elliot, A. J., and M. A. Church. 1997. "A Hierarchical Model of Approach and Avoidance Achievement Motivation." *Journal of personality and social psychology* 72 (1):218-32.

Elliot, A. J., K. Murayama, and R. Pekrun. 2011. "A 3× 2 achievement goal model." *Journal of Educational Psychology* 103 (3):632.

Elliott, J. 2019. "What is Lesson Study?" *European Journal of Education* 54 (2):175-88.

García-González, L., J. Sevil-Serrano, A. Abós, N. Aelterman, and L. Haerens. 2019. "The role of task and ego-oriented climate in explaining students' bright and dark motivational experiences in Physical Education." *Physical Education and Sport Pedagogy* 24 (4):344-58. doi: 10.1080/17408989.2019.1592145.

Goodyear, V. A., and A. Casey. 2015. "Innovation with change: Developing a community of practice to help teachers move beyond the 'honeymoon'of pedagogical renovation." *Physical Education and Sport Pedagogy* 20 (2):186-203.

Guskey, T. R. 2000. "Evaluating professional development." In, 1-13. Thousand Oaks (Cal): Corwin Press.

Guskey, T. R., and K. S. Yoon. 2009. "What works in professional development." *Phi Delta Kappan*.

Haerens, L., N. Aelterman, L. Van den Berghe, J. De Meyer, B. Soenens, and M. Vansteenkiste. 2013. "Observing physical education teachers' need-supportive interactions in classroom settings." *Journal of sport & exercise psychology* 35 (1):3-17.

Haerens, L., N. Aelterman, M. Vansteenkiste, B. Soenens, and S. Van Petegem. 2015. "Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation." *Psychology of sport and exercise* 16 (P3):26-36. doi: 10.1016/j.psychsport.2014.08.013.

Haerens, L., D. Kirk, G. Cardon, and I. De Bourdeaudhuij. 2011. "Toward the Development of a Pedagogical Model for Health-Based Physical Education." *Quest* (63):321-38.

Halvorsen, A-L, and A. Kesler Lund. 2013. "Lesson Study and History Education." *The Social Studies* 104 (3):123-9. doi: 10.1080/00377996.2012.698326.

Hastie, P. A., A. MacPhail, A. Calderón, and O. A. Sinelnikov. 2015. "Promoting professional learning through ongoing and interactive support: Three cases within physical education." *Professional Development in Education* 41 (3):452-66.

Hox, J. J., M. Moerbeek, and R. Van de Schoot. 2017. *Multilevel analysis: Techniques and applications*: Routledge.

Lamb, P., and D. Aldous. 2016. "Exploring the relationship between reflexivity and reflective practice through lesson study within initial teacher education." *International Journal for Lesson and Learning Studies* 5 (2):99-115.

Lewis, C., and R. Perry. 2017. "Lesson Study to Scale Up Research-Based Knowledge: A Randomized, Controlled Trial of Fractions Learning." *Journal for research in mathematics education* 48 (3):261-99.

Maher, A. J., & Fitzgerald, H. (2020). Initial teacher education and continuing professional development: the perspectives of special school physical education teachers. *Curriculum Studies in Health and Physical Education*, *11*(1), 18-33.

Makopoulou, K., R. D. Neville, N. Ntoumanis, and G. Thomas. 2019. "An investigation into the effects of short-course professional development on teachers' and teaching assistants' self-efficacy." *Professional Development in Education*:1-16.

Milton, D., P. R. Appleton, A. Bryant, and J. L. Duda. 2018. "Initial Validation of the Teacher-Created Empowering and Disempowering Motivational Climate Questionnaire in Physical Education." *Journal of Teaching in Physical Education* 37 (4):340-51. doi: 10.1123/jtpe.2018-0119.

Morris, S. B. 2008. "Estimating Effect Sizes From Pretest-Posttest-Control Group Designs." *Organizational Research Methods* 11 (2):364-86. doi: 10.1177/1094428106291059.

Nicholls, J. G. 1984. "Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance." *Psychological review* 91 (3):328.

Ntoumanis, N., Barkoukis, V., and Thøgersen-Ntoumani, C. (2009). Developmental trajectories of motivation in physical education: Course, demographic differences, and antecedents. *Journal of Educational Psychology*, *101*(3), 717.

Ntoumanis, N., and M. Standage. 2009. "Motivation in physical education classes: A self-determination theory perspective." *Theory and Research in Education* 7 (2):194-202. doi: 10.1177/1477878509104324.

Patton, K., and M. Parker. 2014. "Moving from 'things to do on Monday'to student learning: physical education professional development facilitators' views of success." *Physical Education and Sport Pedagogy* 19 (1):60-75.

Raabe, J., Schmidt, K., Carl, J., & Höner, O. (2019). The effectiveness of autonomy support interventions with physical education teachers and youth sport coaches: a systematic review. *Journal of Sport and Exercise Psychology*, 41(6), 345-355.

Rasbash, J., F. Steele, W. J. Browne, and H. Goldstein. 2017. "A user's guide to MLwiN, v3.00." *Centre for Multilevel Modelling, University of Bristol*.

Roesken-Winter, B., C. Hoyles, and S. Blömeke. 2015. "Evidence-based CPD: Scaling up sustainable interventions." *ZDM Mathematics Education* 47 (1):1-12. doi: 10.1007/s11858-015-0682-7.

Ryan, R. M., and E. L. Deci. 2017. *Self-determination theory: Basic psychological needs in motivation, development, and wellness*: Guilford Publications.

Sato, T., E. Tsuda, D. Ellison, and S. R. Hodge. 2020. "Japanese elementary teachers' professional development experiences in physical education lesson studies." *Physical Education and Sport Pedagogy* 25 (2):137-53.

Slingerland, M., L. Borghouts, S. Laurijssens, B. van Dijk-van Eijk, T. Remmers, G. Weeldenburg. 2021. "Teachers' perceptions of a lesson study intervention as professional development in physical education." *European Physical Education Review*. DOI: 10.1177/1356336X21997858

Slingerland, M., L. Borghouts, L. Jans, G. Weeldenburg, G. Van Dokkum, S. Vos, and L. Haerens.

Smith, N., D. Tessier, Y. Tzioumakis, E. Quested, P. Appleton, P. Sarrazin, A. Papaioannou, and J L Duda. 2015. "Development and Validation of the Multidimensional Motivational Climate Observation System." *Journal of Sport and Exercise Psychology* 37 (1):4-22. doi: 10.1123/jsep.2014-0059.

Smith, R. E., S. P. Cumming, and F. L. Smoll. 2008. "Development and Validation of the Motivational Climate Scale for Youth Sports." *Journal of Applied Sport Psychology* 20 (1):116-36. doi: 10.1080/10413200701790558.

Stigler, J. W., and J. Hiebert. 1999. "Beyond reform: Japan's approach to the improvement of classroom teaching." *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*:103-28.

Takahashi, A., and T. McDougal. 2016. "Collaborative lesson research: Maximizing the impact of lesson study." *ZDM* 48 (4):513-26.

van Veen, K., R. Zwart, and J. Meirink. 2012. "What makes teacher professional development effective? A literature review." In *Teacher learning that matters; International perspectives*, edited by M. Kooy and K. van Veen, 3-21. London: Routledge.

Vansteenkiste, M., W. Lens, A. J. Elliot, B. Soenens, and A. Mouratidis. 2014. "Moving the Achievement Goal Approach One Step Forward: Toward a Systematic Examination of the Autonomous and Controlled Reasons Underlying Achievement Goals." *Educational Psychologist* 49 (3):153-74. doi: 10.1080/00461520.2014.928598.

Vansteenkiste, M., R. M. Ryan, and B. Soenens. 2020. "Basic psychological need theory: Advancements, critical themes, and future directions." *Motivation and Emotion*. doi: 10.1007/s11031-019-09818-1.

Verhoef, N., D. Tall, F. Coenders, and D. van Smaalen. 2014. "The complexities of a lesson study in a Dutch situation: mathematics teacher learning." *International Journal of Science and Mathematics Education* 12 (4):859-81. doi: 10.1007/s10763-013-9436-6.

Wang, C. K. J., S. J. H. Biddle, and A. J. Elliot. 2007. "The 2× 2 achievement goal framework in a physical education context." *Psychology of sport and exercise* 8 (2):147-68.

Weeldenburg, G., L. B. Borghouts, M. Slingerland, and S. Vos. 2020. "Similar but different: Profiling secondary school students based on their perceived motivational climate and psychological need-based experiences in physical education." *PLoS One* 15 (2):e0228859. doi: 10.1371/journal.pone.0228859.

Yang, Y. 2009. "How a Chinese teacher improved classroom teaching in Teaching Research Group: A case study on Pythagoras theorem teaching in Shanghai." *ZDM* 41 (3):279-96.

Figure 1. The lesson study cycle in this study (adapted from Stepanek et al., 2007)

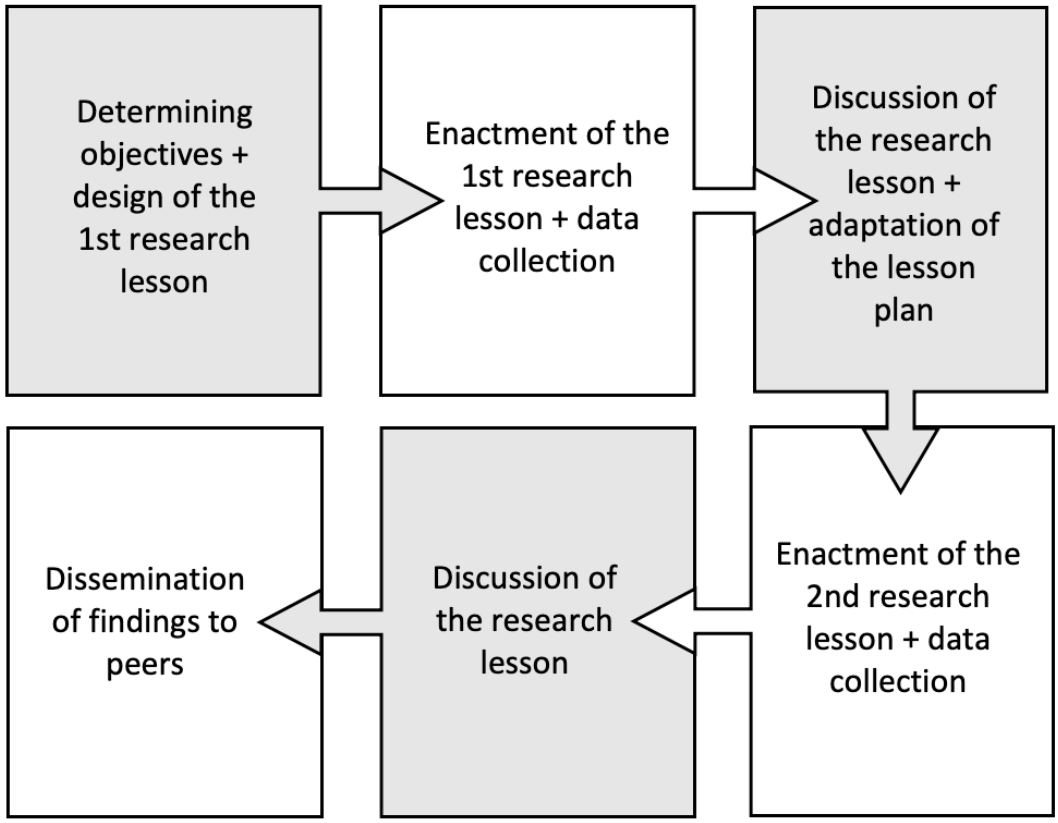

Table 1. Baseline variance components models (i.e. Model 0) for observed teacher behaviour. Observation scoring scale was 0 (never) - 1 (sometimes) - 2 (often) - 3 (always).

Model 0	Autonomy support	Structure before	Structure during	Structure total	Relatedness support	Mastery climate	Performance climate
Fixed part							
β0 (SE)	1.32(.07)	1.43(.06)	1.76(.05)	1.53(.04)	1.85(.04)	1.16(.07)	.42(.04)
Random part							
School (N=17)	.04(.03)	.02(.03)	.00(.00)	.01(.01)	.00(.00)	.04(.03)	.05(.01)
Teacher (N=31)	.00(.00)	.04(.03)	.00(.00)	.03(.02)	.04(.02)	.02(.03)	.00(.00)
Occasion (N=2)	0.21(0.04)***	.09(.02)***	.13(.03)***	.07(.02)***	.08(.02)***	.12(.03)***	.08(.02)***
-2loglikelihood	**85.96**	**51.19**	**50.31**	**23.81**	**43.34**	**63.83**	**22.79**

***p<.001,

Table 2. Changes in teacher behaviours across time (Model 1) and over time according to condition (Model 2). Observation scoring scale was 0 (never) - 1 (sometimes) - 2 (often) - 3 (always).

	Model 1				**Model 2**							
	Total sample				**Lesson study**		**Workshop only**					
	Pre	*Post*	*Time*	*Effect size*	*Pre*	*Post*	*Pre*	*Post*	*Time*	*Condition*	*Time* Condition*	*Effect size*
	β0 (SE)	β0 (SE)	β1 (SE)	d	β0 (SE)	β0 (SE)	β0 (SE)	β0 (SE)	β1 (SE)	β2 (SE)	β3 (SE)	d
Autonomy support	1.17(.09)	1.47(.09)	.30(.10)**	0,86	1.17(.13)	1.56(.13)	1.17(.12)	1.39(.12)	.22(.14)	-.00(.18)	.17(.20)	0.34
Structure before	1.76(.07)	1.75(.07)	-.01(.09)	-0,04	1.81(.09)	1.70(.09)	1.73(.09)	1.79(.09)	.07(.13)	.08(.13)	-.17(.18)	-0.47
Structure during	1.37(.07)	1.50(.07)	.13(.07)(*)	0,48	1.34(.10)	1.43(.10)	1.40(.10)	1.56(.10)	-.16(.10)	-.05(.14)	-.07(.14)	-0.17
Structure total	1.50 (.06)	1.55 (.06)	.05(.07)	0,22	1.52(.08)	1.52(.08)	1.49(.08)	1.58(.08)	.10(.10)	.03 (.11)	-.10(.14)	-0.28
Relatedness support	1.84 (.06)	1.85(.06)	.01(.07)	0,04	1.88(.09)	1.81(.09)	1.81(.09)	1.89(.09)	.08(.10)	.07(.13)	-.14(.15)	-0.41
Mastery climate	1.16(.08)	1.16(.08)	-.00(.09)	0	1.14(.11)	1.09(.12)	1.17(.11)	1.22(.11)	.05(.12)	-.02(.16)	-.11(.18)	-0.22
Performance climate	.49(.05)	.35(.05)	-.14(.07)*	-0,72	.45(.08)	.36(.08)	.53(.07)	.35(.07)	-.18(.10)	-.08(.11)	.09(.14)	0.30

**$p<.01$, *$p<.05$, (*) $p\leq.08$

Table 3. Baseline variance components models (i.e. Model 0) for student reported outcomes. Questionnaire scale ranged from 1 (totally disagree) to 5 ('totally agree').

Model 0	Mastery approach	Mastery avoidance	Performance approach	Performance avoidance	Autonomous motivation	Controlled motivation	Amotivation	
Fixed part								
β0 (SE)	3.60(0.06)	2.09(.05)	2.38(.04)	2.73(.04)	3.50(.05)	2.02(.05)	2.05(.05)	
Random part								
School (N=18)	.05(.02)*	.02(.02)	.00(.00)	.01(.01)	.03(.02)	.01(.02)	.02(.02)	
Class (N=36)	.02(.02)	.02(.02)	.01(.01)	.01(.02)	.02(.02)	.05(.02)*	.02(.02)	
Student (N=612)	.27(.03)***	.30(.03)***	.46(.04)***	.34(.03)***	.31(.03)***	.18(.02)***	.36(.04)***	
Occasion (N=2)	.31(.02)***	.37(.02)***	.38(.02)***	.34(.02)***	.35(.02)***	.28(002)***	.40(.02)***	
-2loglikelihood	2674.85	2864.18	3059.60	2842.24	2842.03	2468.55	2981.51	
	Autonomy satisfaction	Competence satisfaction	Relatedness satisfaction	Autonomy frustration	Competence frustration	Relatedness frustration	Mastery climate perception	Performance climate perception
Fixed part								
β0 (SE)	3.39(.06)	3.55(.04)	3.63(.05)	2.07(.05)	1.98(.05)	1.79(.06)	3.96(0.05)	1.83 (.05)
Random part								
School (N=18)	.02(.02)	.01(.01)	0.01(.02)	.02(.02)	.01(.02)	.05(.02)*	0.00(0.00)	.02(.02)
Class (N=36)	.04(.02)(*)	.01(.01)	0.03(.02)	.03(.02)	.02(.02)	.01(.01)	0.04(0.01)**	.05(.02)*
Student (N=612)	.20(.03)***	.27(.03)***	0.22(.03)***	.23(.03)***	.32(.03)***	.20(.02)***	0.15(0.02)***	.20(.02)***
Occasion (N=2)	.37(.02)***	.33(.02)***	0.35(.02)***	.41(.02)***	.31(.02)***	.29(0.02)***	0.23(0.01)***	.20(.01)***
-2loglikelihood	2750.91	2708.52	2723.94	2863.20	2738.34	2532.92	2196.36	2230.38

***p<.001,**p<.01, p<.05**,** (*)p<.08

Table 4. Changes in student outcomes across time (Model 1) and over time according to condition (Model 2). Questionnaire scale ranged from 1 (totally disagree) to 5 ('totally agree').

	Model 1				**Model 2**							
	Total sample				**Lesson study**		**Workshop only**					
	Pre	Post	Time	*Effect size*	Pre	Post	Pre	Post	Time	Condition	Time* Condition	*Effect size*
	β0 (SE)	β0 (SE)	β1 (SE)	d	β0 (SE)	β0 (SE)	β0 (SE)	β0 (SE)	β1 (SE)	β2 (SE)	β3 (SE)	d
Mastery approach	3.65(.06)	3.56(.06)	-.09(.03)**	-0,08	3.66(.09)	3.53(.09)	3.63 (.10)	3.60(.10)	-.03(.05)	.03(.13)	-.10(.06)	-.06
Mastery avoidance	2.10(.06)	2.07(.06)	-.03 (.04)	-0,03	2.05(.07)	2.03(.07)	2.16 (.08)	2.12 (.08)	-.04(.05)	-.11(.11)	.03(.07)	.02
Performance approach	2.47(.04)	2.29(.04)	-.18(.04)***	-0,25	2.45(.06)	2.20(.06)	2.49(.06)	2.39(.06)	-.10(.05)*	-.04(.08)	-.15(.07)**	-.14
Performance avoidance	2.78(.05)	2.69(.05)	-.09(.03)**	-0,1	2.78(.06)	2.66(.06)	2.77(.07)	2.71(.07)	-.06(.07)	.02(.09)	-.06(.07)	-.05
Mastery climate perception	4.01(.04)	3.91(.04)	-.10(.03)***	-0,14	3.99(.06)	3.90(.06)	4.04(.06)	3.92(.06)	-.12(.04)**	-.05(.08)	.03(.05)	0
Performance climate perception	1.82(.06)	1.85(.06)	.02(.03)	0,03	1.74(.07)	1.74(.07)	1.92(.07)	1.97(.07)	.05(.04)	-.19(.10)(*)	-.05(.05)	-.04
Autonomous motivation	3.52(.06)	3.47(.06)	-.05(.03)	-0,05	3.48(.07)	3.42(.07)	3.58(.08)	3.55(.08)	.-.03(.05)	-.09(.11)	-.04(.07)	-.02
Controlled motivation	1.99(.06)	2.05(.06)	.06(.03)(*)	-0,03	1.94(.07)	1.98(.07)	2.05(.08)	2.13(.08)	.07(.05)	-.11(.11)	-.03(.06)	-.03
Amotivation	.1.99(.06)	2.10(.06)	.12(.03)***	0,05	1.96(.08)	2.12(.08)	2.02(.09)	2.08(.09)	.06(.05)	-.06(.12)	.10(.07)	.07
Autonomy satisfaction	3.38(.06)	3.40(.06)	.02(.04)	0,02	3.35(.08)	3.39(.08)	3.42(.09)	3.42(.09)	.01(.05)	-.07(.12)	.03(.07)	.03

Competence satisfaction	3.57(.05)	3.53(.05)	-.04(.03)	-0,04	3.55(.06)	3.53(.06)	3.60(.07)	3.54(.07)	-.06(.05)	-.05(.09)	.04(.07)	.04
Relatedness satisfaction	3.65(.05)	3.61(.05)	-.04(.03)	-0,04	3.70(.07)	3.64(.07)	3.59(.07)	3.58(.07)	-.00(.05)	.12(.10)	-.06(.07)	-.04
Autonomy frustration	2.04(.06)	2.11(.06)	.07(.04)(*)	0,06	1.98(.07)	2.07(.07)	2.11(.08)	2.15(.08)	.04(.05)	-.14(.11)	.05(.07)	.04
Competence frustration	1.96(.05)	1.99(.05)	.03(.03)	0,03	1.90(.06)	1.93(.06)	2.03(.07)	2.06(.07)	.03(.05)	-.13(.09)	.00(.06)	0
Relatedness frustration	1.74(.06)	1.84(.06)	.11(.03)***	0,09	1.65(.08)	1.79(.08)	1.84(.09)	1.91(.09)	.07(.05)	-.19(.12)	.07(.06)	.05

***p<.001,**p<.01, *p<.05, (*) $p\leq$.08