

Where to go and how to get there: Goal clarification, process feedback and students' need satisfaction and frustration from lesson to lesson

Christa Krijgsman^{a,b,*}, Tim Mainhard^a, Jan van Tartwijk^a, Lars Borghouts^c,
Maarten Vansteenkiste^d, Nathalie Aelterman^d, Leen Haerens^b

^a Department of Education, Utrecht University, Heidelberglaan 1, 3508, TC Utrecht, the Netherlands

^b Department of Movement and Sport Sciences, Ghent University, Watersportlaan 2, 9000, Ghent, Belgium

^c School of Sport Studies, Fontys University of Applied Sciences, Theo Koomenlaan 3, 5644, HZ Eindhoven, the Netherlands

^d Department of Developmental, Personality and Social Psychology, Ghent University, Watersportlaan 2, 9000, Ghent, Belgium

ARTICLE INFO

Keywords:

Intra-individual variability
Formative assessment
Psychological needs
Self-determination theory
Motivation

ABSTRACT

This study investigated to what degree lesson-to-lesson variability in teachers' goal clarification and process feedback explains variability in secondary students' motivational correlates. Students ($N = 570$, 24 classes) completed questionnaires at six occasions. Multilevel regression analyses showed that relations between perceived process feedback and experienced need satisfaction (i.e., competence, autonomy and relatedness) were conditional on perceived goal clarification. No such interaction effects between process feedback and goal clarification were found for need frustration (i.e., experiencing failure, feeling pushed to achieve goals, feeling rejected). In general, when students perceived more process feedback or goal clarification, students experienced more competence, autonomy and relatedness satisfaction. Yet, when perceiving very high levels of process feedback, additional benefits of goal clarification were no longer present (and vice versa). In lessons in which students perceived goals to be less clear, they experienced more need frustration. No associations were found between process feedback and need frustration.

1. Introduction

Goal clarification and process feedback are strategies that teachers can use to structure students' learning activities (Hattie & Timperley, 2007; Jang, Reeve, & Deci, 2010; Locke & Latham, 1990; Sadler, 1989; Vansteenkiste et al., 2012). From a motivational perspective (Deci & Ryan, 2000; Ryan & Deci, 2017), it is suggested that motivational (Haerens et al., 2018) and learning gains (Van den Berghe, Vansteenkiste, Cardon, Kirk, & Haerens, 2014) will be obtained because in well-structured learning environments, when goals and process feedback are provided, students' basic psychological need for competence (i.e., feelings of effectiveness) gets satisfied (Mouratidis, Vansteenkiste, Michou, & Lens, 2013). Also, students might feel more in charge of their learning process (i.e., autonomy satisfaction) and they might experience a more positive classroom atmosphere (i.e., relatedness satisfaction).

According to the assessment literature (Hattie & Timperley, 2007; Sadler, 1989; Wiliam, 2011) not only motivational gains, but also

learning gains will be obtained when teachers structure the learning environment through goal clarification and process feedback (Hattie & Timperley, 2007). Sadler (1989) argues that goal clarification and process feedback are necessary conditions which must be satisfied simultaneously (in one and the same lesson) so that students experience them as one 'greater whole' as to establish optimal conditions for ongoing learning (Hattie & Timperley, 2007; Locke & Latham, 1990). While studies have empirically investigated how goal clarification and process feedback jointly relate to students' learning and performance (e.g., Hall, Weinberg, & Jackson, 1987; Schunk & Swartz, 1993), no such studies are available in relation to students' motivation (but see Schunk & Swartz, 1993). To understand the way goal clarification and process feedback work together, the current study investigated their joint association with motivational correlates.

Existing investigations of motivational correlates of goal clarification and process feedback have predominantly relied on cross-sectional data (e.g., Levesque, Zuehlke, Stanek, & Ryan, 2004; Pat-El, Tillema, & Van Koppen, 2012), only allowing for an investigation of inter-

* Corresponding author. Heidelberglaan 1, 3508, TC Utrecht, the Netherlands.

E-mail addresses: c.a.krijgsman@uu.nl (C. Krijgsman), m.t.mainhard@uu.nl (T. Mainhard), j.vantartwijk@uu.nl (J. van Tartwijk), l.borghouts@fontys.nl (L. Borghouts), Maarten.Vansteenkiste@UGent.be (M. Vansteenkiste), Nathalie.Aelterman@UGent.be (N. Aelterman), Leen.Haerens@UGent.be (L. Haerens).

<https://doi.org/10.1016/j.learninstruc.2018.12.005>

Received 14 May 2018; Received in revised form 17 December 2018; Accepted 21 December 2018

0959-4752/ © 2018 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

individual differences between students. However, during the past decade, scholars have increasingly shown that the strategies teachers rely on (Mainhard, Brekelmans, & Wubbels, 2011; Shute, 2008), students' motivation (Martin et al., 2015), and accordingly students' need-based experiences (Krijgsman et al., 2017; Van der Kaap-Deeder, Vansteenkiste, Soenens, & Mabbe, 2017) can vary substantially from one moment to another (Bartholomew et al., 2018; Ketonen, Dietrich, Moeller, Salmela-Aro, & Lonka, 2018) and from lesson to lesson (Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008). To be able to investigate this *intra*-individual variability, we used a repeated measures design encompassing six lessons.

1.1. Goal clarification and process feedback from an assessment for learning perspective

The importance of clarifying goals and providing process feedback for student learning has been widely acknowledged (Hattie & Timperley, 2007; Locke & Latham, 1990; Moeller, Theiler, & Wu, 2012; Sadler, 1989; Shute, 2008). Both teaching strategies are proposed as essential in the framework of assessment for learning (AFL; Wiliam, 2011; Wiliam & Thompson, 2008). AFL is defined as “the process of seeking and interpreting evidence for use by learners and their teachers to decide where they are in their learning, where they need to go and how best to get there” (Broadfoot et al., 2002, pp. 2–3). By communicating clear, specific and transparent goals (i.e., goal clarification or also more in general referred to as goal specificity; Hattie & Timperley, 2007; Sadler, 1989; Wirth, Künsting, & Leutner, 2009), teachers provide the necessary information for students to decide where to direct their learning to. If students understand the goals of the lesson, they can become more self-regulated, because they are able to evaluate their current performance in relation to the desired goal (Andrade & Du, 2005; Moeller et al., 2012; Winstone, Nash, Parker, & Rowntree, 2017). Process feedback (or more in general, formative feedback; for an overview see Shute, 2008) provides students with concrete suggestions on how to improve (Butler & Winne, 1995; Harks, Rakoczy, Hattie, Besser, & Klieme, 2014; Hattie & Timperley, 2007; Peterson & Earl Irving, 2008). Past research has indicated that the most motivating and effective types of process feedback should include elements of both verification (i.e., the judgement of whether an answer is correct) and elaboration (i.e., the informational aspect of the message, providing relevant cues to guide the learner towards improvement) (for overviews see Kulhavy & Stock, 1989; Shute, 2008). Furthermore, regarding timing and specificity of feedback, findings are mixed and a more differentiated view is recommended (e.g., Mathan & Koedinger, 2005; Shute, 2008).

In practice, goals are often clarified at the beginning of a lesson and presented to the whole group at once (Haerens et al., 2013; Reeve, 2015), whereas process feedback is usually presented as information to an individual learner during the exercises (Haerens et al., 2013; Reeve, 2015; Shute, 2008). Moreover, some practices, such as the use of rubrics (Andrade, Du, & Mycek, 2010), inherently involve both goal clarification and process feedback, as they include concrete indications for students on *where to go* and *how to take the next step* (Panadero & Jonsson, 2013).

1.2. Goal clarification and process feedback from a motivational perspective

Congruent with the existing literature on AFL, studies starting from self-determination theory (SDT; Deci & Ryan, 2000) consider goal clarification (i.e., clarifying) and process feedback (i.e., guiding) as components of teacher structure (Aelterman et al., 2018; Jang et al., 2010), which is crucial to foster students' motivation and learning (Vansteenkiste et al., 2012). Goal clarification and process feedback are thought to positively relate to the satisfaction of students' need for competence (Aelterman et al., 2018; Mouratidis et al., 2013). When students experience that their teachers set clear goals (Kunter, Baumert,

& Köller, 2007) and provide process feedback (Levesque et al., 2004; Pat-El et al., 2012), teachers help students to expand their capabilities hereby fostering their feelings of competence (Mouratidis et al., 2013). Because students' understanding of the goals of a lesson may also enable them to evaluate where they are in their learning trajectory and process feedback provides them with concrete information on how to improve, students may also be more likely to take ownership of their learning process (i.e., autonomy satisfaction; Butler & Winne, 1995; Carpentier & Mageau, 2016). Also, in a classroom atmosphere in which students feel effective and have ownership over their learning, a more positive and caring atmosphere may be created which satisfies students' need for relatedness (i.e., relatedness satisfaction; Pat-El et al., 2012).

Relatively few studies have linked the specific strategies of goal clarification and process feedback to students' need-based experiences. In the studies that are available, setting clear goals has been found to relate positively to students' need satisfaction (Haerens et al., 2018; Kunter et al., 2007; Mouratidis et al., 2013; Pat-El et al., 2012). Similar associations have been reported for the provision of process feedback (Carpentier & Mageau, 2016; Levesque et al., 2004; Pat-El et al., 2012). To our knowledge, no studies so far (but see Haerens et al., 2018) have included measures of the frustration of the need for competence (i.e., feelings of inferiority or failure), autonomy (i.e., feelings of pressure) and relatedness (i.e. feelings of alienation (Vansteenkiste & Ryan, 2013). Insight in goals might potentially be negatively associated to feelings of incapability of reaching those goals (i.e., competence frustration) and to feelings of pressure to reach up to the goals (i.e., autonomy frustration). Haerens and colleagues (2018) explored the role of goals in relation to need frustration. Yet, in their research, no such assumptions were confirmed. Further, although researchers have alluded to an interplay between goal clarification and process feedback (Sadler, 1989), it has not been empirically studied whether the association between process feedback and students' need-based experiences may, for example, be conditional on the level to which goals have been clarified.

On the one hand, the combination of high levels of goal clarification and process feedback may be related to large positive effects on students' competence. On the other hand, it is also possible that when the goals of a lesson are unclear, students depend more on the process feedback, such that its presence becomes of greater value for students feelings of competence (e.g., Butler & Winne, 1995; Narciss, 2013; Zimmerman, 2008).

Equally and in relation to the need for autonomy, it is possible that the process feedback provided by the teacher may become more meaningful when the goals of the lessons are clearer, such that the presence of both in one lesson would be most beneficial. On the other hand, if no information is provided about the lesson goals, the process feedback provided by the teacher may become more important for students' initiative taking (i.e., autonomy).

As for students' need frustration, it may be possible that when receiving a lot of process feedback without having a clear understanding of the goal that needs to be achieved, process feedback may be linked to feelings of failure (i.e., competence frustration). Along similar lines, students may feel pushed to live up to the feedback provided by the teacher (i.e., autonomy frustration), if they do not understand the goals of the lessons (Vansteenkiste & Ryan, 2013). Since SDT proposes that the three basic needs are interdependent (Ryan & Deci, 2017), relatedness frustration will probably fluctuate in a similar fashion as competence and autonomy frustration. Investigating need frustration is important, as they have shown to yield unique relations with maladaptive educational outcomes such as amotivation and ill-being (Haerens, Aelterman, Vansteenkiste, Soenens, & Van Petegem, 2015; Vansteenkiste & Ryan, 2013).

1.3. Research goal

The aim of the present study was to understand how student-

perceived goal clarification and process feedback are associated with students' experiences of need satisfaction and frustration. We chose physical education (PE) as a context for our study, because in PE, teachers have the opportunity to provide specific process feedback (Haerens et al., 2013) since students' performance is directly visible for them. In the current study, we focused on the within rather than between student-level associations, because we expected teaching strategies and students' needs to vary between lessons (Krijgsman et al., 2017; Mainhard et al., 2011). Consequently, we chose a longitudinal design with six repeated measures. The study was guided by the following research question:

To what degree can lesson-to-lesson variability in students' perceptions of teachers' goal clarification and process feedback explain students' lesson-specific experiences of competence, autonomy and relatedness satisfaction and frustration?

Based on previous research among adolescents, we expected substantial percentages (approximately between 40% and 60%) of intra-individual variance for perceived goal clarification, process feedback, need satisfaction and frustration (cf. Krijgsman et al., 2017; Mainhard et al., 2011; Van der Kaap-Deeder et al., 2017).

We further expected that variability in perceived goal clarification and process feedback would explain variability in students' experiences of need satisfaction and frustration on a lesson to lesson basis. Overall, we expected positive associations with need satisfaction (e.g., Pat-El et al., 2012) and no relations (Haerens et al., 2018) or negative relations with need frustration. More specifically, because perceived goal clarification and process feedback may both independently and in combination be related to student learning (Hattie & Timperley, 2007; Sadler, 1989) and need-based experiences (Mouratidis et al., 2013), we explored in what way both strategies interact with one another in relation to students' experiences of need satisfaction and frustration. Given the lack of previous work in this area, we considered this a more exploratory part in the analyses.

While addressing the research question at the intra-individual level (i.e., within students from lesson-to-lesson), we took stable processes at the inter-individual (i.e., between students) and group or teacher level into account (Tsai et al., 2008). Particularly, some students might generally receive more goal clarification or process feedback than others or some students may more easily pick up explanations about goals or process feedback due to their familiarity with the subject of the lesson or their social background (Hay & Penney, 2009). Similarly, there may be stable differences between teachers regarding how clear they are in their communication of goals and process feedback (Hay & Macdonald, 2008). Note that, although interesting, such issues were not considered as central to our aim (i.e., to investigate intra-individual variability in perceived goal clarification, process feedback and students' needs).

2. Methods

2.1. Participants

Our convenience sample consisted of 570 students ($n = 284$ boys; 49.8%, $M_{\text{age}} = 13.76$; $SD_{\text{age}} = 1.32$; range 11–18 years in wave 1) clustered in 24 PE classes and teachers from eleven secondary education schools in The Netherlands. The number of participants ranged from twelve to 32 students per class ($M = 23.75$). Students were enrolled in the seventh ($n = 168$; 29.5%; $M_{\text{age}} = 12.32$; $SD_{\text{age}} = 0.61$ in wave 1), eighth ($n = 149$; 26.1%; $M_{\text{age}} = 13.53$; $SD_{\text{age}} = 0.59$ in wave 1), ninth ($n = 182$; 31.9%; $M_{\text{age}} = 14.64$; $SD_{\text{age}} = 0.66$ in wave 1) or tenth grade ($n = 71$; 12.5%; $M_{\text{age}} = 15.65$; $SD_{\text{age}} = 0.80$ in wave 1) of secondary education. It was communicated that participation was voluntary. Out of 623 students in the selected participating classes, 53 (8.51% students did not agree to participate. The Ethical Committee of [blinded for review] approved the study protocol.

2.2. Procedure

Participants were recruited by inviting PE teachers from the network of the research team to participate in the study with one of their PE classes. Teachers were asked to plan and deliver their lessons as they would normally do. Students were asked to complete a paper-and-pencil questionnaire on six different occasions directly after the lesson. The six measurement occasions took place directly after the second last and last PE lesson of three series of lessons on three different topics. The lesson topics were categorised in five domains (i.e., gymnastics, ball-games, track and field, dancing, and self-defence), which are all customary domain categories in Dutch PE curricula. Data were collected in lessons with different lesson-topics, because PE teachers typically deliver a series of three to five lessons on one and the same topic (e.g., five gymnastics lessons) and we aimed for six measures per student. Topics were divided as followed over the measured lessons: 20.3% gymnastics, 37% ball-games, 26.2% track and field, 8.2% dancing, 8.2% self-defence.

Students completed the questionnaires both for non-grading (i.e., at measurement occasion one, three and five) and grading lessons (i.e., at measurement occasion two, four and six), to ensure that goal clarification and process feedback could be examined in both types of lessons. The non-grading and grading lesson were one week apart, and students were aware that they were graded. Overall, our approach resulted in six repeated measurements per student, and a total of 2637 ratings (see section 2.4. for the treatment of missing values). A researcher administered the questionnaires. It was communicated that there were no wrong answers and that students' responses would be treated confidentially. It took students 5–10 min to complete the questionnaires. Data was collected between January and June 2015.

2.3. Measures

All measures were assessed on a 5-point Likert scale anchored by 1 (*Strongly disagree*) and 5 (*Strongly agree*). The stem for all items was "During the last PE class ...". A complete list of items and detailed information on the internal consistency and factorial validity is presented as supplementary online data.

2.3.1. Goal clarification and process feedback

Students' perceptions of their teacher's goal clarification and process feedback were measured with items of the Students Assessment for Learning Questionnaire (SAFL-Q; Pat-El, Tillema, Segers, & Vedder, 2013). Both variables were measured with three items that most closely aligned with the definitions in our study. Items for goal clarification were "The teacher told us what the criteria are by which my assignment will be evaluated", "The teacher told us what we could learn from the assignments" and "I knew the areas I needed to work on to improve my results". Items for process feedback were "My teacher encouraged me to reflect on how I could improve my assignments", "My teacher discussed with me how to exploit my strengths to improve my assignments" and "My teacher talked to me about the progress I made". Internal consistency was calculated with coefficient omega (Dunn, Baguley, & Brunsten, 2014), which can be interpreted analogously to coefficient alpha (Reise, 2012), yet has less risk of overestimating or underestimating reliability (Dunn et al., 2014). Over six measurements, per time point, both scales were internally consistent with coefficient omega varying somewhat per time point $.66 \leq \omega_{\text{goalclarification}} \leq .81$ and $.85 \leq \omega_{\text{processfeedback}} \leq .93$. Next, we tested for measurement invariance (see Table 1 for the fit indices) to ensure that students interpreted the items similarly across occasions (i.e., metric invariance; Schout, Lugtig, & Hox, 2012) and that the intra-individual variability in our main variables was not due to a different interpretation of the items over time. Comparisons of the CFI (Cheung & Rensvold, 2009) for the configural versus metric invariance models yielded $\Delta\text{CFI} = 0.00$, which indicated no meaningful decrement in fit among these models (Cheung

Table 1
Goodness of fit indices for measurement invariance models.

	Chi-Square Test	SRMR	RMSEA 90% CI	CFI	TLI	AIC	BIC
Goal clarification and process feedback							
Configural invariance	$\chi^2 (48) = 160.42^{***}$	.03	.07 [.06, .09]	.98	.97	43,067	43,736
Metric invariance	$\chi^2 (68) = 191.99^{***}$	.04	.06 [.05, .08]	.98	.97	43,058	43,610
Need satisfaction and frustration							
Configural invariance	$\chi^2 (1422) = 3677.47^{***}$	.05	.06 [.06, .06]	.92	.90	153,994	157,062
Metric invariance	$\chi^2 (1512) = 3821.81^{***}$	.06	.06 [.06, .06]	.92	.91	153,958	156,497

Note. $^{***}p < .001$; SRMR = Standardised Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

& Rensvold, 2009), suggesting evidence for metric invariance.

2.3.2. Need satisfaction and frustration

Students' experiences of competence, autonomy and relatedness satisfaction and frustration during the past PE lesson were assessed with an adjusted version of the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS; Chen et al., 2015), which was previously modified to the PE context (Haerens et al., 2015). Each need was measured with four items. An exemplary item for competence satisfaction was "I felt capable at what I did", for autonomy satisfaction "I felt a sense of choice and freedom in the tasks I was participating in", for relatedness satisfaction "I felt close and connected with other people who are important to me", for competence frustration "I felt like a failure because of the mistakes I made", for autonomy frustration "I felt pressured to do certain tasks" and for relatedness frustration "I felt excluded from the group I wanted to belong to". Over six measurements, per time point, all scales were internally consistent with coefficient omega varying somewhat per time point: $.83 \leq \omega_{\text{competence satisfaction}} \leq .89$, $.77 \leq \omega_{\text{autonomy satisfaction}} \leq .84$, $.84 \leq \omega_{\text{relatedness satisfaction}} \leq .88$, $.82 \leq \omega_{\text{competence frustration}} \leq .89$, $.83 \leq \omega_{\text{autonomy frustration}} \leq .88$ and $.81 \leq \omega_{\text{relatedness frustration}} \leq .88$. Metric measurement invariance was confirmed, $\Delta\text{CFI} = 0.00$.

2.4. Analyses

2.4.1. Missing data

Not all participating students completed all six measurements (i.e., unit non-response; van Buuren, 2012; $n = 508$ in wave 1, $n = 464$ in wave 2, $n = 433$ in wave 3, $n = 421$ in wave 4, $n = 402$ in wave 5 and $n = 409$ in wave 6) and on average, 22.89% of missing data existed per measurement occasion. Multilevel analysis accounted for this unit non-response. There were several reasons for drop-out resulting in missing data. A first reason was that three classes ($n = 78$; on average 8.19% of the missing data) only participated at the start of the study. One teacher ($n = 32$ students) terminated participation after the third measurement without further notification (i.e., wave 1, 2 and 3 were retained for analyses). Further, students of two classes ($n = 26$ and $n = 20$) erroneously completed two questionnaires simultaneously and they did so on two occasions, which were removed from further analyses. Another reason for missing data was that we emphasised that participation was voluntary and that students could withdraw from the study at any point. As a result, a number of students did not repeatedly fill out the same questionnaires. Finally, some students dropped out because they did not participate in class for reasons such as minor sports and leisure injuries or illness. Together, this accounted on average for 14.71% of the missing data per occasion. In addition to unit non-response, there also was item-non response (van Buuren, 2012) which was relatively small (i.e., 0.38%), and was therefore treated with pairwise deletion.

2.4.2. Analyses

We used multilevel regression analyses (MLwiN version 2.31; Rasbash, Steele, Browne, & Goldstein, 2014) with three-levels (occasions nested in students and classes) and one model per dependent

variable. First, variance components models (M0) were fitted. Next (M1), goal clarification and process feedback were entered student mean centred at the occasion-level, class mean centred at the student-level, and grand mean centred at the class-level (Enders & Tofighi, 2007; Lüdtke, Robitzsch, Trautwein, & Kunter, 2009), considering the student and teacher/group levels as relatively stable contexts that we wanted to partial out. In this model, we also included the interaction term between student centred goal clarification and process feedback. We chose to include only the student-centred interaction term, since this was the level our research question targeted and including more interaction terms (e.g., at the student or teacher level) would stress the model unnecessarily. To check the psychometric quality of aggregated constructs, interclass correlations (ICC2) of goal clarification and process feedback were calculated. With values of 0.74 for goal clarification and 0.80 for process feedback at the student-level, and 0.76 for goal clarification and 0.81 for process feedback at the class-level, the ICC2's indicated acceptable to good levels of reliability (LeBreton & Senter, 2008; Lüdtke et al., 2009). Finally, the main model (M2) also included the covariates gender (0/1), lesson topic (dummy coded), and grading (0/1). We focused on the models including the covariates gender, lesson topic and grading (M2) for two reasons. First, our own findings pointed to significant associations between the covariates and need satisfaction and frustration. Second, previous research indicated that when examining motivational functioning, girls significantly differed from boys (e.g., girls' perceived competence was lower than that of boys during PE; Slingerland, Haerens, Cardon, & Borghouts, 2014; Vansteenkiste et al., 2012). Also, students reported differences according to lesson-topic (De Meyer et al., 2014) and according to whether their performance was graded or not (Krijgsman et al., 2017).

3. Results

Descriptive statistics and Pearson correlations are presented in Table 2. Perceived goal clarification and process feedback correlated positively ($r = 0.60$). Percentages of variance for experienced need satisfaction and frustration were low at the class-level and most variance resided at the student and occasion levels (the latter level including measurement error; see Table 2).

3.1. Goal clarification, process feedback and need satisfaction

Adding the goal clarification and process feedback variables (M1; Table 3) improved the model-fit significantly for all need satisfaction variables (i.e., $\Delta\chi^2 (7) = 272.84$, $p \leq .001$ for competence satisfaction, $\Delta\chi^2 (7) = 466.31$, $p \leq .001$ for autonomy satisfaction and $\Delta\chi^2 (7) = 125.63$, $p \leq .001$ for relatedness satisfaction). Both perceived goal clarification and process feedback were positively associated with experienced competence, autonomy and relatedness satisfaction at the occasion level. Goal clarification and process feedback explained high percentages of total variance for autonomy satisfaction (22%, a large effect) and smaller percentages were explained in competence satisfaction (12%) and relatedness satisfaction (6%).

The interaction term between goal clarification and process

Table 2
Descriptive statistics and Pearson correlations between measured variables averaged over all time points.

Variable	1	2	3	4	5	6	7	8
1. Goal clarification		.60***	.34***	.44***	.20***	-.15***	-.25***	-.13***
2. Process feedback		.53, .67	.22, .42	.40, .48	.11, -.25	-.25, -.07	-.31, -.19	-.21, -.07
3. Competence satisfaction			.26***	.39***	.18***	-.07***	-.15***	-.00
4. Autonomy satisfaction			.20, .37	.31, .47	.13, .23	-.11, -.03	-.10, .22	-.09, .04
5. Relatedness satisfaction				.58***	.35***	-.57***	-.39***	-.31***
6. Competence frustration				.50, .65	.26, .42	-.63, -.51	-.51, -.30	-.42, -.24
7. Autonomy frustration					.37***	-.33***	-.46***	-.22***
8. Relatedness frustration					.28, .43	-.37, -.31	-.52, -.40	-.29, -.14
<i>M</i>	0.00 ^a , 3.48 ^b	0.00 ^a , 2.90 ^b	3.63	3.36	3.66	2.02	2.22	1.67
<i>SD</i>	0.57 ^a , 0.87 ^b	0.62 ^a , 1.05 ^b	0.77	0.82	0.82	0.82	0.87	0.70
Range	-2.58–2.22a, 1–5b	-2.61–2.33 ^a , 1–5 ^b	1–5	1–5	1–5	1–5	1–5	1–5
% variance class-level	.12**	.15**	.02	.05*	.04*	.00	.05*	.04*
% variance student-level	.33***	.40***	.36***	.32***	.53***	.50***	.42***	.45***
% variance occasion-level	.56***	.45***	.61***	.63***	.43***	.50***	.54***	.51***

Note. Descriptive statistics calculated with measurements averaged over time points not controlled for nesting in classrooms; 0.40, 0.48 is the range of correlations per time point not controlled for nesting within students. **p* < .05, ***p* < .01, ****p* < .001. The percentage of total variance that can be attributed to differences in levels, with 0.30 regarded as high (Lüdtke et al., 2009).

^a Descriptive statistics of goal clarification and process feedback were calculated with both student-centred variables, since these predictors were used in our main analyses.

^b Descriptive statistics of goal clarification and process feedback calculated with raw scores.

Table 3
Students' need satisfaction: Variance component model (M0) and conditional models including goal clarification and process feedback (M1) and covariates (M2).

Parameter	Competence satisfaction			Autonomy satisfaction			Relatedness satisfaction		
	M0a	M1a	M2a	M0b	M1b	M2b	M0c	M1c	M2c
	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)
Fixed part									
Intercept	3.63(.03)	3.64(.03)	3.85(.05)	3.36(.04)	3.37(.03)	3.55(.05)	3.66(.04)	3.67(.04)	3.60(.06)
<i>Occasion level</i>									
Goal clarification		.19(.02)***	.19(.02)***		.20(.02)***	.20(.02)***		.09(.02)***	.09(.02)***
Process feedback		.08(.02)***	.09(.02)***		.16(.02)***	.16(.02)***		.08(.02)***	.09(.02)***
GC X PF		-.05(.03)	-.06(.03)*		-.05(.03)	-.06(.03)*		-.07(.03)**	-.07(.03)**
<i>Student level</i>									
Students' gender ^a			-.32(.04)***			-.03(.04)			.19(.05)***
Goal clarification		.34(.05)***	.34(.05)***		.43(.05)***	.44(.05)***		.21(.06)**	.21(.06)***
Process feedback		.07(.04)	.06(.04)		.12(.04)***	.12(.04)**		.09(.05)	.10(.05)*
<i>Teacher/Class level</i>									
Lesson topic ^b									
Ball games			-.08(.04)*			-.12(.04)**			-.06(.04)
Track & field			-.18(.04)***			-.29(.04)***			-.08(.04)*
Dance			.12(.06)*			-.12(.06)			-.04(.06)
Self-defence			-.08(.06)			-.21(.06)***			.01(.05)
Performance grading lesson ^c			.04(.02)			-.04(.02)			.04(.02)
Goal clarification		.36(.17)*	.37(.16)*		.41(.18)*	.37(.17)*		.15(.24)	.13(.24)
Process feedback		-.10(.12)	-.09(.11)		.06(.13)	.07(.12)		-.02(.17)	-.01(.18)
Random part									
σ _ε ² (Occasion)	.36(.01)***	.34(.01)***	.33(.01)***	.42(.01)***	.38(.01)***	.36(.01)***	.28(.01)***	.27(.01)***	.27(.01)***
σ ₀ ² (Student)	.21(.02)***	.16(.02)***	.14(.01)***	.22(.02)***	.12(.01)***	.12(.01)***	.36(.03)***	.33(.02)***	.32(.02)***
σ _{u0} ² (Teacher/class)	.01(.01)	.01(.01)	.01(.01)	.03(.01)*	.02(.01)*	.01(.01)*	.03(.01)*	.03(.01)*	.03(.01)*
Explained variance									
R ² occasion-level		6%	8%		10%	14%		4%	4%
R ² student-level		24%	33%		45%	45%		8%	11%
R ² class-level		0%	0%		33%	67%		0%	0%
Total R ²		12%	17%		22%	27%		6%	8%
-2*log likelihood (df)		272.84(7)***	109.79(6)***		466.31(7)***	67.17(6)***		125.63(7)***	23.80(6)***

Note. **p* < .05; ***p* < .01; ****p* < .001. Reference category = 0: ^a 0 = boy, 1 = girl; ^b 0 = gymnastics, 1 = ball games, 2 = track and field, 3 = dance, 4 = self-defence; ^c 0 = absence of performance grading, 1 = presence of performance grading.

feedback on relatedness satisfaction was significant, while the interaction terms in the competence and autonomy satisfaction models were insignificant.

Adding the covariates (M2) further improved the model-fit in all cases (i.e., $\Delta\chi^2(6) = 109.79$, $p \leq .001$ for competence satisfaction, $\Delta\chi^2(6) = 67.17$, $p \leq .001$ for autonomy satisfaction and $\Delta\chi^2(6) = 23.80$, $p \leq .001$ for relatedness satisfaction).

Both perceived goal clarification and process feedback remained positively associated with all three needs to a similar degree. After adding the covariates to the model, the interaction terms between goal clarification and process feedback became significant for all three need satisfaction variables. Interactions in models of the form $Y = i_1 + b_1X + b_2M + b_3XM$ (Hayes, 2013) were probed with the online tool of Preacher, Curran, and Bauer (2006). To probe the interactions, conditional (b_1 and b_2 estimates) and interaction terms (b_3 estimates) were calculated with three values of goal clarification; the lowest occurring score, the mean, and highest score in the dataset (see Table 2 for the range). The nature of all interactions was similar for all three needs (see Fig. 1). Areas of significance indicated that the relation between perceived process feedback and need satisfaction was not significant when perceived goal clarification (i.e., the moderator) was very high. Up to values of perceived goal clarification of 1.60, 1.32 and 0.58 for respectively competence, autonomy and relatedness satisfaction (more than one to two and a half standard deviation above their means), the relationships between perceived process feedback and the need satisfaction variables were significantly positive. In the presented graphs (Fig. 1), the black (—) and red (---) lines represent very low and average perceived goal clarification. At very high levels of goal clarification (the green -·-·- line), there was no significant relation between perceived process feedback and experiences of students' needs.

From the perspective of teaching, it is also relevant to examine how the relation between perceived goal clarification on need-based experiences depended on perceived process feedback (i.e., process feedback instead of goal clarification as moderator). Results showed that the relation between goal clarification and competence, autonomy and relatedness satisfaction were significantly positive up to values of perceived process feedback of 1.52, 1.59 and 0.55 for respectively competence, autonomy and relatedness satisfaction. At very high levels of process feedback (the green -·-·- line), there was no significant relation between perceived goal clarification and students' needs (see Fig. 2).

When adding the covariates in M2, we found that girls reported more relatedness, yet less competence satisfaction than boys. Moreover, students perceived track and field lessons to be less need satisfying compared to gymnastics. No associations were found for the presence or absence of performance grading.¹ In total, respectively for autonomy, relatedness and competence satisfaction, only 5%, 2% and 5% of additional variance was explained by the covariates.

3.2. Goal clarification, process feedback and need frustration

Adding the goal clarification and process feedback variables (M1;

¹ Additional analyses including three-way interactions between goal clarification, process feedback and grading showed that the interplay between perceived goal clarification and process feedback was not dependent on the presence or absence of grading for experiences of competence, autonomy and relatedness satisfaction (all $\chi^2 < 2.50$, $df = 1$, all $p > .11$). The two-way interaction between goal clarification and grading was significant for competence and autonomy satisfaction (respectively $b = .10$, $SE = 0.04$, $\chi^2 = 5.56$, $df = 1$, $p < .05$; $b = 0.10$, $SE = 0.05$, $\chi^2 = 5.17$, $df = 1$, $p < .05$) and between process feedback and grading for autonomy satisfaction ($b = -0.09$, $SE = 0.04$, $\chi^2 = 4.58$, $df = 1$, $p < .05$). Yet, follow-up analyses revealed positive relations between goal clarification and competence and autonomy satisfaction, and between process feedback and autonomy satisfaction in both the grading and non-grading lessons.

Table 4) improved the model-fit significantly for all need frustration variables (i.e., $\Delta\chi^2(7) = 58.38$, $p \leq .001$ for competence frustration, $\Delta\chi^2(7) = 106.84$, $p \leq .001$ for autonomy frustration and $\Delta\chi^2(7) = 47.18$, $p \leq .001$ for relatedness frustration). Perceived goal clarification was negatively associated with experienced competence, autonomy, and relatedness frustration at the occasion level, whereas no associations were found between perceived process feedback and students' experiences of competence, autonomy and relatedness frustration. Also, the regression coefficients of the interactions between goal clarification and process feedback on competence, autonomy and relatedness frustration were insignificant. Goal clarification and process feedback explained rather small amounts of variance for competence frustration (5%), autonomy frustration (7%) and relatedness frustration (6%).

Adding the covariates (M2) further improved the model-fit in all cases (i.e., $\Delta\chi^2(6) = 43.33$, $p \leq .001$ for competence frustration, $\Delta\chi^2(6) = 60.63$, $p \leq .001$ for autonomy frustration and $\Delta\chi^2(6) = 44.46$, $p \leq .001$ for relatedness frustration).

In line with the unadjusted model (M1), none of the examined interaction terms were statistically significant.

Adding the covariates in M2 showed that girls experienced less relatedness frustration but more competence frustration than boys. Students experienced more autonomy and relatedness frustration during track and field when compared to gymnastics. Furthermore, students experienced less autonomy and relatedness frustration in the presence (versus the absence) of performance grading.² In total, respectively for competence, autonomy and relatedness frustration, only 1%, 2% and 0% of additional variance was explained by the covariates.

4. Discussion

The importance of clarifying goals and providing process feedback for student learning and performance has been widely acknowledged in the assessment literature (Hattie & Timperley, 2007; Locke & Latham, 1990; Moeller et al., 2012; Sadler, 1989; Shute, 2008). Along similar lines, SDT research suggests that the use of goal clarification and process feedback is positively related to students' motivation and learning because of their critical role in fulfilling students' basic psychological needs (Haerens et al., 2018; Mouratidis et al., 2013). When students perceive that their teachers set clear goals and provide process feedback, students can not only expand their capabilities so that they feel capable in reaching the goals (i.e., competence satisfaction; Haerens et al., 2018; Mouratidis et al., 2013), they can also take more ownership over their learning trajectory (i.e., autonomy satisfaction; Butler & Winne, 1995; Carpentier & Mageau, 2016). Also, a more positive classroom atmosphere may be created such that also students' need for relatedness gets satisfied (i.e., relatedness satisfaction; Pat-El et al., 2012). We also explored the possibility that when students think they receive a lot of process feedback without having a good notion about what is expected, they may experience more feelings of failure (i.e., competence frustration) or pressure (i.e., autonomy frustration). This may point towards the importance of providing both goal clarification and process feedback in one and the same lesson, as suggested by Sadler (1989) and Schunk and Swartz (1993).

Thus, the present study adds to the existing literature in at least

² Additional analyses including three-way interactions between goal clarification, process feedback and grading showed that the interplay between perceived goal clarification and process feedback was not dependent on the presence or absence of grading for experiences of competence, autonomy and relatedness frustration (all $\chi^2 < 2.34$, $df = 1$, $p > .17$). From the six additional analyses including two-way interactions, only the two way interaction between goal clarification and grading on competence frustration was significant ($b = -0.11$, $SE = 0.04$, $\chi^2 = 6.08$, $df = 1$, $p < .05$). Results showed that the relation between goal clarification and competence frustration was significantly negative in both the grading on non-grading lessons.

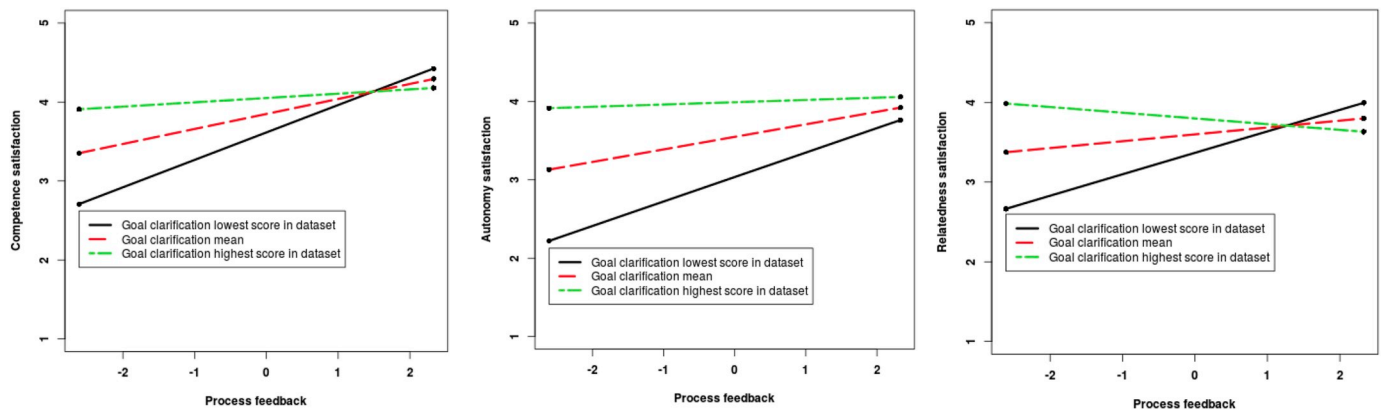


Fig. 1. The relation between students' experiences of competence, autonomy and relatedness satisfaction and perceived process feedback depending on the level of students' perceived goal clarification from lesson to lesson.

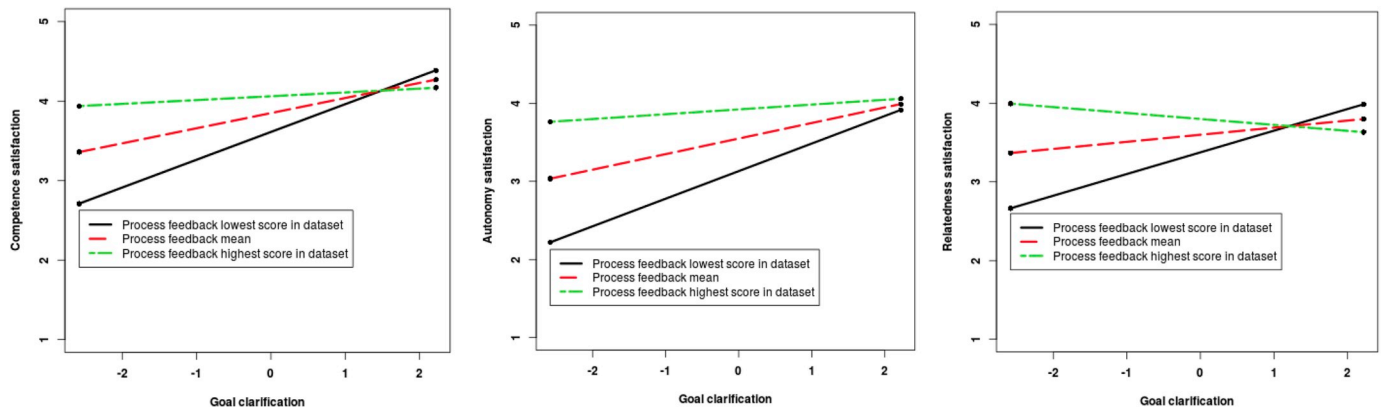


Fig. 2. The relation between students' experiences of competence, autonomy and relatedness satisfaction and perceived goal clarification depending on the level of students' perceived process feedback from lesson to lesson.

three ways. First, rather than examining the independent associations between either perceived goal clarification or process feedback and students' overall experiences of need satisfaction, we considered also their combined associations with student needs. Second, rather than focussing solely on need satisfaction, we also considered the frustration of students' needs, as need frustration is uniquely related to important maladaptive outcomes such as amotivation and ill-being (e.g., Haerens et al., 2015; Krijgsman et al., 2017; Vansteenkiste & Ryan, 2013). Third, whereas most previous studies examined the proposed associations at the between-student level (i.e., inter-individual variability; Levesque et al., 2004; Pat-El et al., 2012), we examined these relationships as processes at the within-student level (i.e., intra-individual variability).

The intra-individual approach proved to be very valuable as confirmed by high percentages of variance at the within-student level. From lesson to lesson, teachers' goal clarification as perceived by students showed stronger associations with students' reported need-based functioning than perceived process feedback. Overall, goal clarification and process feedback were positively associated with experiences of need satisfaction and negatively associated with need frustration. Conditional effects of perceived goals and process feedback on need satisfaction were confirmed.

4.1. Variability in goal clarification, process feedback and need-based outcomes

We found substantial lesson-to-lesson variability in the degree to which students reported that the teacher had clarified the goals (56% of variance including error) or had provided process feedback (45% of variance including error), as well as in the degree to which students

experienced competence, autonomy and relatedness satisfaction and frustration (respectively 61%, 63%, 43%, and 50%, 54% and 51% including error). These findings are in line with fairly recent work on teacher behaviour and students' needs (Krijgsman et al., 2017; Mainhard et al., 2011; Van der Kaap-Deeder et al., 2017), where similar levels of occasion-level variance were found. The findings imply that, although this lesson is taught by the same teacher, the degree to which students perceive the goals of the lesson to be clear, varies from one lesson to another. This applies to all of our study's variables.

4.2. Goal clarification and process feedback

In line with the AFL literature (Pat-El et al., 2013) and the SDT literature on structure (e.g., Aelterman et al., 2018), we found that goal clarification and process feedback are distinguishable (i.e., see Table 1) yet related constructs ($r = 0.60$). This suggests that levels of goal clarification and process feedback are shifting together. Thus, as is recommended, teachers who were perceived to communicate goals or expectations were perceived to provide process feedback as well, which has been shown to maximise student learning (e.g., Schunk & Swartz, 1993; William, 2011; William & Thompson, 2008). It is, however, also possible that when students perceive the goals to be clearer and they know in which direction they need to work, they may self-generate ideas on how to improve (i.e., internal feedback; Butler & Winne, 1995). This may have led students to report having received a greater amount of process feedback. Similarly, when students perceive to have received high levels of process feedback (i.e., external feedback given by a teacher; Narciss, 2013), students may infer the lesson goals themselves and therefore in retrospect rate teacher goal clarification

Table 4

Students' need frustration: Variance component model (M0) and conditional models including goal clarification and process feedback (M1) and covariates (M2).

Parameter	Competence frustration			Autonomy frustration			Relatedness frustration		
	M0d	M1d	M2d	M0e	M1e	M2e	M0f	M1f	M2f
	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)	b (S.E.)
Fixed part									
Intercept	2.04(.03)	2.04(.03)	1.94(.05)	2.24(.05)	2.24(.04)	2.28(.06)	1.69(.04)	1.69(.03)	1.69(.05)
<i>Occasion level</i>									
Goal clarification		-.11(.02)***	-.11(.02)***		-.13(.02)***	-.13(.02)***		-.07(.02)***	-.08(.02)***
Process feedback		.01(.02)	.00(.02)		-.02(.02)	-.03(.02)		.02(.02)	.02(.02)
GC X PF		-.01(.03)	-.00(.03)		-.05(.03)	-.04(.03)		-.02(.03)	-.02(.02)
<i>Student level</i>									
Students' gender ^a			.23(.05)***			-.01(.05)			-.14(.04)**
Goal clarification		-.21(.06)***	-.21(.06)***		-.38(.06)***	-.38(.06)***		-.24(.05)***	-.24(.05)***
Process feedback		.00(.05)	.02(.05)		.07(.05)	.06(.05)		.09(.04)*	.09(.04)*
<i>Teacher/Class level</i>									
Lesson topic ^b									
Ball games			-.04(.04)			.02(.04)			.15(.03)***
Track & field			.07(.04)			.12(.04)**			.11(.03)**
Dance			-.16(.06)**			.13(.06)*			.06(.05)
Self-defence			-.02(.06)			.10(.06)			.07(.05)
Performance grading lesson ^c			-.02(.02)			-.17(.03)***			-.07(.02)***
Goal clarification		-.36(.15)*	-.39(.15)**		-.58(.22)**	-.55(.21)**		-.48(.18)**	-.45(.17)**
Process feedback		.29(.11)**	.27(.11)*		.18(.16)	.17(.15)		.33(.13)*	.34(.13)**
Random part									
σ^2_{ϵ} (Occasion)	.34(.01)***	.33(.01)***	.33(.01)***	.40(.01)***	.40(.01)***	.39(.01)***	.25(.01)***	.25(.01)***	.25(.01)***
$\sigma^2_{\nu_0}$ (Student)	.34(.03)***	.32(.02)***	.31(.02)***	.32(.03)***	.28(.02)***	.28(.02)***	.23(.02)***	.21(.02)***	.21(.02)***
$\sigma^2_{\nu_0}$ (Teacher/class)	.00(.01)	.00(.00)	.00(.01)	.03(.02)*	.02(.01)	.02(.01)	.02(.01)*	.01(.01)	.01(.01)
Explained variance									
R ² occasion-level		3%	3%		0%	3%		0%	0%
R ² student-level		6%	9%		13%	13%		9%	9%
R ² class-level		0%	0%		33%	33%		50%	50%
Total R ²		5%	6%		7%	9%		6%	6%
-2*log likelihood (df)		58.38(7)***	43.33(6)***		106.84(7)***	60.63(6)***		47.18(7)***	44.46(6)***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. Reference category = 0: ^a 0 = boy, 1 = girl; ^b 0 = gymnastics, 1 = ball games, 2 = track and field, 3 = dance, 4 = self-defence; ^c 0 = absence of performance grading, 1 = presence of performance grading.

higher accordingly.

4.3. Goal clarification, process feedback and need-based outcomes

Our main goal was to investigate the degree to which lesson-to-lesson variability in student perceptions of teacher goal clarification and process feedback was related to variability in student need satisfaction and frustration. We found that in lessons where students said to be informed on the key goals of the lesson and to have perceived information on how to improve, they also reported to feel more in charge of their learning process (i.e., need for autonomy; Carpentier & Mageau, 2016; Levesque et al., 2004). Such findings are in line with the literature on self-regulated learning, where it has been recognised that when students understand in which direction they need to move, they will experience a heightened sense of volition and ownership over their learning (Butler & Winne, 1995). Furthermore, in line with SDT's theoretical premises (Ryan & Deci, 2017) and empirical work (Mouratidis et al., 2013), we also found positive relations between goal clarification, process feedback and students' feelings of effectiveness (i.e., competence). Similarly, when students perceived more goal clarification and process feedback, they also felt more connected and cared for (i.e., need for relatedness; Pat-El et al., 2012). These findings are in line with previous work that separately studied correlates of goals (Haerens et al., 2018; Kunter et al., 2007) and process feedback (Levesque et al., 2004; Pat-El et al., 2012). Also, our results showed that in lessons where students knew the goals of the lessons better, they felt less inefficient (i.e., competence frustration), pressured (i.e., autonomy frustration), or rejected (i.e., relatedness frustration). The presence of process feedback

did not relate to students' experiences of need frustration. Together, these are important findings, as we may speculate that a more motivating and stimulating learning environment will be created when teachers manage to clarify the goals and to provide sufficient process feedback to the benefit of students' need-based experiences. Indeed, need satisfaction has been related to important positive outcomes such as students' engagement (Jang, Kim, & Reeve, 2016) and learning (Mouratidis et al., 2013). Need frustration, on the other hand, is related to negative outcomes such as students' disengagement (Jang et al., 2016) and oppositional defiance (De Meyer et al., 2016). As such, our findings align with other empirical studies showing that the combination of goal clarification and process feedback benefits students' self-efficacy, learning and performance (Hall et al., 1987; Schunk & Swartz, 1993).

4.3.1. Are goal clarification and process feedback conditional on each other?

It has been argued that the combination of both goal clarification and process feedback will help students to feel most effective (i.e., competence satisfaction; Mouratidis et al., 2013) and to make the greatest learning progress (e.g., Sadler, 1989). However, the extent to which both should be provided and whether the presence of one of the two complements or compensates the outcomes of the other remained unclear (Butler & Winne, 1995; Zimmerman, 2008). Our study provides evidence for earlier claims (Hattie & Timperley, 2007; Sadler, 1989) that perceived goal clarification and process feedback depend on each other, at least to a certain degree. When students perceived that teachers provided both goal clarification and process feedback to a

moderate degree, they experienced that their needs were relatively highly satisfied. Goal clarification and process feedback seem to build on each other's positive effects. Only at very high levels of process feedback, goal clarification did not add anything to students' needs and only at very high levels of goal clarification, process feedback did not add anything to students' needs. These findings fit our expectation that if either one is very salient (e.g., high levels of goal clarification), this may provide students with the opportunity to self-generate the other (e.g., self-generated process feedback or internal feedback) or infer the other (e.g., detect which goals were critical based on the given feedback; Butler & Winne, 1995; Narciss, 2013).

However, keep in mind that the interaction term became only statistically significant after including the covariates and that we did not find empirical evidence for an interplay between perceived goal clarification and process feedback on students' need frustration. Further research should clarify how robust these findings actually are.

4.3.2. Goal clarification and process feedback at student and teacher level

Although not of our main interest, some results were found at the between student and teacher levels that are worth mentioning. Classes that perceived relatively more process feedback, experienced more ineffectiveness (i.e., competence frustration). Perhaps when teachers, across all lessons, give a lot (or perhaps too much) process feedback, students in those classes may feel that specifically their incapacities are highlighted (i.e., competence frustration). Also, students and classes perceiving more process feedback across all lessons, experienced more relatedness frustration, indicating that being heavily informed on how to improve has the potential to alienate students from others in their classroom, maybe because students perceive this as reiteration of their weaknesses and they find this difficult in front of others. On the other hand, in line with our expectations, classes that perceived relatively more goal clarification, experienced less competence, autonomy and relatedness frustration. This might indicate that when teachers clarify lesson goals and consequently students know what is expected, students may feel less incapable of reaching those goals (i.e., competence frustration), feel less pressure to reach up to the goals (i.e., autonomy frustration) and which might give them less feelings of alienation from others in the classroom (i.e., relatedness frustration).

Results further showed that students experienced less autonomy and relatedness frustration in lessons in which students' performance was graded. These findings differ from previous findings (cf. Krijgsman et al., 2017). Thus, performance grading seems to have complex associations with motivational functioning that deserve further investigation.

4.4. Limitations and future directions

Although the present study contributed to the recent body of knowledge, by addressing lesson-to-lesson variation (Bartholomew et al., 2018) in need-based experiences (Van der Kaap-Deeder et al., 2017), we were able to explain only small parts of the variance situated at the occasion level (ranging between 0% and 14%). Potentially, other key teaching strategies of AFL (e.g., engineering effective classroom discussions and activating students as instructional resources for one another; Wiliam & Thompson, 2008), which are less clearly related to providing classroom structure (Reeve, 2015), might be important here.

Further, the wording in the relatedness satisfaction and frustration items ("I felt excluded from the group ..." and "I felt close and connected with other people ...") may account for the low percentages of explained variance in need for relatedness (at the occasion level 4% for relatedness satisfaction and 0% for relatedness frustration), compared to the other needs (at the occasion level respectively 14% and 8% for autonomy and competence satisfaction and 3% and 3% for autonomy and competence frustration). Focussing the items on the relatedness to the teacher instead would have connected relatedness experiences more directly to students' perceptions of teacher goal clarification and

process feedback.

Moreover, the present study exclusively relied on self-reports. Therefore, the associations with perceived goal clarification and process feedback at the occasion level might potentially be biased. Nonetheless, the internal quality of the measure was good as was indicated by tests of reliability and measurement invariance. Moreover, associations between variables at the student and class level might be considered less biased, since these variables were aggregated constructs and thus less dependent on a participant's perspective at one moment in time.

In the current study we favoured an ecologically valid and large-scale approach above a more focussed and experimentally controlled study. Therefore, causation cannot be claimed. Experimental studies are needed to provide evidence regarding the need-satisfying effect of providing goals and process feedback. This is an interesting issue for future research to explore.

The design of the present study could be strengthened by taking the timing of goal clarification and process feedback into account. Communicating expectations and goals could be an activity that predominantly takes place at the beginning of a lesson (i.e., before engaging in the activity), while providing suggestions for improvement could primarily take place during the lesson (Haerens et al., 2013; Jang et al., 2010; Reeve, 2015). Taking the timing of the lesson into account might further enlighten our understanding of how perceived goal clarification and process feedback work together.

Finally, the findings presented in the current study were gathered in a PE context, a context in which teachers can perhaps more easily provide process feedback, because they can actually see how a student is performing. Although similar positive effects are to be expected in theoretical courses (Levesque et al., 2004; Pat-El et al., 2012) putting it into practice may be more challenging. This issue of generalisability is interesting for future research to explore.

4.5. Implications for education

The present results suggest that teachers may do well by clarifying the goals of the lesson and providing process feedback as suggested by Sadler (1989) to fully optimise students' need-based experiences (Mouratidis et al., 2013; Pat-El et al., 2012). Even if teachers provide very high levels of goal clarification, the additional provision of process feedback (or vice versa) does not seem to get in the way of students' need-based experiences. Yet, too much process feedback directed to the whole class on a structural basis is not recommended as this might be experienced as ineffectiveness (i.e., competence frustration) and as a reiteration of their weaknesses which they find difficult in front of others (i.e., relatedness frustration).

This study also showed that students' need-based functioning is malleable from lesson to lesson. Considering needs as a malleable within-student-trait is promising for teachers as it indicates the possibility to intervene in students' need-based functioning. Exploring which instructional features can be used to create the most interesting and motivating learning environment is a time-consuming but potentially inspiring and satisfying task for teachers to undertake.

4.6. Conclusion

Our results showed that goal clarification and process feedback seem to build on each other's positive effects. Yet, when perceiving very high levels of process feedback, additional benefits of goal clarification were no longer present. Similarly, when perceiving very high levels of goal clarification, additional benefits of process feedback were no longer evident. No such dependencies were found for experienced need frustration. In general, in lessons where students knew better what was expected and perceived to have received more information on how to improve, they also reported more need satisfaction and less need frustration. Because need satisfaction and need frustration are related to adaptive (i.e., autonomous motivation, learning and engagement) and

maladaptive (i.e., amotivation, ill-being, disengagement and oppositional defiance) educational outcomes, it is recommended for teachers to clarify the goals of the lesson and to provide process feedback.

Funding

This work was supported by the Netherlands Organisation for Scientific Research (Grant 023.004.015), the Netherlands, and by the Association Ons Middelbaar Onderwijs, the Netherlands.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.learninstruc.2018.12.005>.

References

- Aelterman, N., Vansteenkiste, M., Haerens, L., Soenens, B., Fontaine, J., & Reeve, J. (2018). Toward an integrative and fine-grained insight in motivating and demotivating teaching styles: The merits of a circumplex approach. *Journal of Educational Psychology*. Advance online publication <https://doi.org/10.1037/edu0000293>.
- Andrade, H., & Du, Y. (2005). Student perspectives on rubric-referenced assessment. *Practical Assessment, Research and Evaluation*, 10(3), 1–11.
- Andrade, H., Du, Y., & Mycek, K. (2010). Rubric-referenced self-assessment and middle school students' writing. *Assessment in Education: Principles, Policy & Practice*, 17, 199–214. <https://doi.org/10.1080/09695941003696172>.
- Bartholomew, K., Ntoumanis, N., Mouratidis, A., Katartzi, E., Thøgersen-Ntoumani, C., & Vlachopoulos, S. (2018). Beware of your teaching style: A school-year long investigation of controlling teaching and student motivational experiences. *Learning and Instruction*, 53, 50–63. <https://doi.org/10.1016/j.learninstruc.2017.07.006>.
- Broadfoot, P. M., Daugherty, R., Gardner, J., Harlen, W., James, M., & Stobart, G. (2002). *Assessment for learning: 10 principles*. Cambridge, England: University of Cambridge School of Education.
- Butler, D., & Winne, P. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, 65(3), 245–281.
- van Buuren, S. (2012). *Flexible imputation of missing data*. Boca Raton, Florida: Taylor & Francis.
- Carpentier, J., & Mageau, G. (2016). Predicting sport experience during training: The role of change-oriented feedback in athletes' motivation, self-confidence and needs satisfaction fluctuations. *Journal of Sport & Exercise Psychology*, 38, 45–58. <https://doi.org/10.1123/jsep.2015-0210>.
- Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., ... Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, 39, 216–236. <https://doi.org/10.1007/s11031-014-9450-1>.
- Cheung, G., & Rensvold, R. (2009). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, 9, 233–255. <https://doi.org/10.1207/S15328007SEM0902>.
- De Meyer, J., Soenens, B., Vansteenkiste, M., Aelterman, N., Van Petegem, S., & Haerens, L. (2016). Do students with different motives for physical education respond differently to autonomy-supportive and controlling teaching? *Psychology of Sport and Exercise*, 22, 72–82. <https://doi.org/10.1016/j.psychsport.2015.06.001>.
- De Meyer, J., Tallir, I., Soenens, B., Vansteenkiste, M., Aelterman, N., Van den Bergh, L., ... Haerens, L. (2014). Does observed controlling teaching behavior relate to students' motivation in physical education? *Journal of Educational Psychology*, 106, 541–554. <https://doi.org/10.1037/a0034399>.
- Deci, E., & Ryan, R. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227–268. https://doi.org/10.1207/S15327965PLI1104_01.
- Dunn, T., Baguley, T., & Brunsden, V. (2014). From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. *British Journal of Psychology*, 105, 399–412. <https://doi.org/10.1111/bjop.12046>.
- Enders, C., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multi-level models: A new look at an old issue. *Psychological Methods*, 12, 121–138. <https://doi.org/10.1037/1082-989X.12.2.121>.
- Haerens, L., Aelterman, N., Van den Bergh, L., De Meyer, J., Soenens, B., & Vansteenkiste, M. (2013). Observing physical education teachers' need-supportive interactions in classroom settings. *Journal of Sport & Exercise Psychology*, 35, 3–17. <https://doi.org/10.1348/000709902158883>.
- Haerens, L., Aelterman, N., Vansteenkiste, M., Soenens, B., & Van Petegem, S. (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, 26–36. <https://doi.org/10.1016/j.psychsport.2014.08.013>.
- Haerens, L., Krijgsman, C., Mouratidis, A., Borghouts, L., Cardon, G., & Aelterman, N. (2018). How does knowledge about the criteria for an upcoming test relate to adolescents' situational motivation in physical education? A self-determination theory approach. *European Physical Education Review*. Advance online publication <http://doi.org/10.1177/1356336X18783983>.
- Hall, H., Weinberg, M., & Jackson, A. (1987). Effects of goal specificity, goal difficulty, and information feedback on endurance performance. *Journal of Sport Psychology*, 9, 43–54. <http://doi.org/10.1123/jsp.9.1.43>.
- Harks, B., Rakoczy, K., Hattie, J., Besser, M., & Klieme, E. (2014). The effects of feedback on achievement, interest and self-evaluation: The role of feedback's perceived usefulness. *Educational Psychology*, 34, 269–290. <https://doi.org/10.1080/01443410.2013.785384>.
- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77, 81–112. <https://doi.org/10.3102/003465430298487>.
- Hayes, A. (2013). *Introduction to mediation, moderation, and conditional process analysis. A regression-based approach*. New York, New York: Guilford Press.
- Hay, P., & Macdonald, D. (2008). (Mis)appropriations of criteria and standards-referenced assessment in a performance-based subject. *Assessment in Education: Principles, Policy & Practice*, 15, 153–168. <https://doi.org/10.1080/09695940802164184>.
- Hay, P., & Penney, D. (2009). Proposing conditions for assessment efficacy in physical education. *European Physical Education Review*, 15, 389–405. <https://doi.org/10.1177/1356336X09364294>.
- Jang, H., Kim, E., & Reeve, J. (2016). Why students become more engaged or more disengaged during the semester: A self-determination theory dual-process model. *Learning and Instruction*, 43, 27–38. <https://doi.org/10.1016/j.learninstruc.2016.01.002>.
- Jang, H., Reeve, J., & Deci, E. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology*, 102, 588–600. <https://doi.org/10.1037/a0019682>.
- Ketonen, E., Dietrich, J., Moeller, J., Salmela-Aro, K., & Lonka, K. (2018). The role of daily autonomous and controlled educational goals in students' academic emotion states: An experience sampling method approach. *Learning and Instruction*, 53, 10–20. <https://doi.org/10.1016/j.learninstruc.2017.07.003>.
- Krijgsman, C., Vansteenkiste, M., Van Tartwijk, J., Maes, J., Borghouts, L., Cardon, G. et al. Haerens, L. (2017). Performance grading and motivational functioning and fear in physical education: A self-determination theory perspective. *Learning and Individual Differences*, 55, 202–211. <http://doi.org/10.1016/j.lindif.2017.03.017>.
- Kulhavy, R., & Stock, W. (1989). Feedback in written instruction: The place of response certitude. *Educational Psychology Review*, 1(4), 279–308.
- Kunter, M., Baumert, J., & Köller, O. (2007). Effective classroom management and the development of subject-related interest. *Learning and Instruction*, 17, 494–509. <https://doi.org/10.1016/j.learninstruc.2007.09.002>.
- LeBreton, J., & Senter, J. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods*, 11, 815–852. <https://doi.org/10.1177/1094428106296642>.
- Levesque, C., Zuehlke, N., Stanek, L., & Ryan, R. (2004). Autonomy and competence in German and American university students: A comparative study based on self-determination theory. *Journal of Educational Psychology*, 96, 68–84. <https://doi.org/10.1037/0022-0663.96.1.68>.
- Locke, E., & Latham, G. (1990). *A theory of goal setting and task performance*. Englewood Cliffs, New Jersey: Prentice Hall.
- Lüdtke, O., Robitzsch, A., Trautwein, U., & Kunter, M. (2009). Assessing the impact of learning environments: How to use student ratings of classroom or school characteristics in multilevel modeling. *Contemporary Educational Psychology*, 34, 120–131. <https://doi.org/10.1016/j.cedpsych.2008.12.001>.
- Mainhard, T., Brekelmans, M., & Wubbels, T. (2011). Coercive and supportive teacher behaviour: Within- and across-lesson associations with the classroom social climate. *Learning and Instruction*, 21, 345–354. <https://doi.org/10.1016/j.learninstruc.2010.03.003>.
- Martin, A., Papworth, B., Ginns, P., Malmberg, L., Collie, R., & Calvo, R. (2015). Real-time motivation and engagement during a month at school: Every moment of every day for every student matters. *Learning and Individual Differences*, 38, 26–35. <https://doi.org/10.1016/j.lindif.2015.01.014>.
- Mathan, S., & Koedinger, K. (2005). Fostering the intelligent novice: Learning from errors with metacognitive tutoring. *Educational Psychologist*, 40, 257–265. https://doi.org/10.1207/s15326985Sep4004_7.
- Moeller, A., Theiler, J., & Wu, C. (2012). Goal setting and student achievement: A longitudinal study. *The Modern Language Journal*, 96, 153–169. <https://doi.org/10.1111/j.1540-4781.2011.01231.x>.
- Mouratidis, A., Vansteenkiste, M., Michou, A., & Lens, W. (2013). Perceived structure and achievement goals as predictors of students' self-regulated learning and affect and the mediating role of competence need satisfaction. *Learning and Individual Differences*, 23, 179–186. <https://doi.org/10.1016/j.lindif.2012.09.001>.
- Narciss, S. (2013). Designing and evaluating tutoring feedback strategies for digital learning environments on the basis of the Interactive Tutoring Feedback Model. *Digital Education Review*, 23, 7–26. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1013726.pdf>.
- Panadero, E., & Jonsson, A. (2013). The use of scoring rubrics for formative assessment purposes revisited: A review. *Educational Research Review*, 9, 129–144. <https://doi.org/10.1016/j.edurev.2013.01.002>.
- Pat-El, R., Tillema, H., Segers, M., & Vedder, P. (2013). Validation of assessment for learning questionnaires for teachers and students. *British Journal of Educational Psychology*, 83, 98–113. <https://doi.org/10.1111/j.2044-8279.2011.02057.x>.
- Pat-El, R., Tillema, H., & Van Koppen, S. (2012). Effects of formative feedback on intrinsic motivation: Examining ethnic differences. *Learning and Individual Differences*, 22, 449–454. <https://doi.org/10.1016/j.lindif.2012.04.001>.
- Peterson, E., & Earl Irving, S. (2008). Secondary school students' conceptions of assessment and feedback. *Learning and Instruction*, 18, 238–250. <https://doi.org/10.1016/j.learninstruc.2007.05.001>.
- Preacher, K., Curran, P., & Bauer, D. (2006). Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics*, 31(4), 437–448.

- Rasbash, J., Steele, F., Browne, W., & Goldstein, H. (2014). *A user's guide to MLwiN*, v2.31. Centre for Multilevel Modelling, University of Bristol.
- Reeve, J. (2015). Rewards. In E. Emmer, & E. Sabornie (Eds.). *Handbook of classroom management* (pp. 496–515). (2nd ed.). New York, NY: Taylor & Francis.
- Reise, S. (2012). The rediscovery of bifactor measurement models. *Multivariate Behavioral Research*, 47, 667–696. <https://doi.org/10.1080/00273171.2012.715555>.
- Ryan, R., & Deci, E. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. New York, New York: Guilford Press.
- Sadler, R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, 18(2), 119–144.
- Schoot, R. Van De, Lugtig, P., & Hox, J. (2012). A checklist for testing measurement invariance. *European Journal of Developmental Psychology*, 9, 486–492. <https://doi.org/10.1080/17405629.2012.686740>.
- Schunk, D., & Swartz, C. (1993). Goals and progress feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology*, 18(3), 337–354.
- Shute, V. (2008). Focus on formative feedback. *Review of Educational Research*, 78, 153–189. <https://doi.org/10.3102/0034654307313795>.
- Slingerland, M., Haerens, L., Cardon, G., & Borghouts, L. (2014). Differences in perceived competence and physical activity levels during single-gender modified basketball game play in middle school physical education. *European Physical Education Review*, 20, 20–35. <https://doi.org/10.1177/1356336X13496000>.
- Tsai, Y.-M., Kunter, M., Lüdtke, O., Trautwein, U., & Ryan, R. (2008). What makes lessons interesting? The role of situational and individual factors in three school subjects. *Journal of Educational Psychology*, 100, 460–472. <https://doi.org/10.1037/0022-0663.100.2.460>.
- Van den Berghe, L., Vansteenkiste, M., Cardon, G., Kirk, D., & Haerens, L. (2014). Research on self-determination in physical education: Key findings and proposals for future research. *Physical Education and Sport Pedagogy*, 19, 97–121. <https://doi.org/10.1080/17408989.2012.732563>.
- Van der Kaap-Deeder, J., Vansteenkiste, M., Soenens, B., & Mabbe, E. (2017). Children's daily well-being: The role of mothers', teachers', and siblings' autonomy support and psychological control. *Developmental Psychology*, 53, 237–251. <https://doi.org/10.1037/dev0000218>.
- Vansteenkiste, M., & Ryan, R. (2013). On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *Journal of Psychotherapy Integration*, 23, 263–280. <https://doi.org/10.1037/a0032359>.
- Vansteenkiste, M., Sierens, E., Goossens, L., Soenens, B., Dochy, F., Mouratidis, A., ... Beyers, W. (2012). Identifying configurations of perceived teacher autonomy support and structure: Associations with self-regulated learning, motivation and problem behavior. *Learning and Instruction*, 22, 431–439. <https://doi.org/10.1016/j.learninstruc.2012.04.002>.
- Wiliam, D. (2011). What is assessment for learning? *Studies In Educational Evaluation*, 37, 3–14. <https://doi.org/10.1016/j.stueduc.2011.03.001>.
- Wiliam, D., & Thompson, M. (2008). Integrating assessment with learning: What will it take to make it work? In C. Dwyer (Ed.). *The future of assessment: Shaping teaching and learning* (pp. 53–82). Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Winstone, N., Nash, R., Parker, M., & Rowntree, J. (2017). Supporting learners' agentic engagement with feedback: A systematic review and a taxonomy of reciprocity processes. *Educational Psychologist*, 52, 17–37. <https://doi.org/10.1080/00461520.2016.1207538>.
- Wirth, J., Künsting, J., & Leutner, D. (2009). The impact of goal specificity and goal type on learning outcome and cognitive load. *Computers in Human Behavior*, 25, 299–305. <https://doi.org/10.1016/j.chb.2008.12.004>.
- Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal*, 45, 166–183. <https://doi.org/10.3102/0002831207312909>.