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Development of Positive Emotions in Physical Education in Association with Motivation: A Person-Centred Approach

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Development of positive emotions in physical education:

A person-centered approach for understanding motivational stability and change

A person-centered exploration of positive emotions in relation to self-determination theory might shed light on the hidden dynamics in the motivational processes in physical education (PE). In the present longitudinal study, PE students were followed during three years at secondary school (N = 1681). Latent class growth analysis revealed a three-class solution: The largest class (n = 1121) reported high levels of positive emotions over the three years. The second largest class (n = 275) reported low levels of positive emotions over the three years, and the smallest class (n = 112) reported a decrease in positive emotions over the three years. Further, the results revealed an association between the intensity of positive emotions, satisfaction of basic psychological needs, and quality of motivation. This person-centered study contributes to the identification of students' emotional engagement in PE as an indicator for understanding their processes of learning, development, and well-being.

Keywords: Latent class growth analysis (LCGA), positive emotions, self-determination theory, physical education, adolescents

One major goal in Norwegian Physical Education (PE) is to inspire a lifelong interest in an active lifestyle (Norwegian Directorate for Education and Training, 2015). Students' involvement and learning in PE offers the potential for engaging a broader audience in an active lifestyle, reaching all adolescents in their physical, social, affective, and cognitive development. However, the benefits are highly dependent on how PE is presented to and thus experienced by students (Bailey et al., 2009). A prior study from Norway has shown that while 12% of the adolescents reported that they did not like PE in school, 32% of the students argued that PE could be provided differently (Säfvenbom, Haugen, & Bulie, 2015). The results indicated that students react in emotionally different ways to the subject. More attention should be paid to the function of emotion in well-being (Vittersø, 2013), development (Fraser-Thomas, Côté, & Deakin, 2005), and learning (Pekrun, 2007; Vandercleyen, Boudreau, Carlier, & Delens, 2014) in order to understand students' emotional processes in PE.

At present, PE seems to favor adolescents who are involved in competitive youth sports (Erdvik, Haugen, Ivarsson & Säfvenbom, 2019; Säfvenbom et al., 2015). For adolescents who lack positive experiences from competitive youth sports, participation in PE can easily result in negative experiences, such as low mastery and enjoyment. These adolescents can potentially develop self-handicapping strategies for avoiding demonstrations of their lack of skill (Lyngstad, Hagen, & Aune, 2016; Ommundsen, 2004). Unless the perspective of all adolescents is considered and changes are made accordingly, PE could end up causing social inequity, which runs counter to the goals of school curricula and political aims for health.

Self-determination theory explains differences in the quality of motivation as *experience dependent* on the conditions for support and satisfaction of the psychological needs for competence, relatedness, and autonomy (Ryan & Deci, 2017). This theory

seems to have a good overall fit for predicting general engagement in PE (Taylor, Ntoumanis, Standage, & Spray, 2010; Ullrich-French & Cox, 2014). However, whereas the satisfaction of basic needs informs about the quality of motivation, emotional variables related to psychological need satisfaction may lead to enhanced knowledge on attitudes and *intentions* for involvement and learning in PE (Guzmán & Kingston, 2012).

The function of positive emotions

Emotions have at least two different functions: One function is to follow pre-established motivational regulations. Another function is to cause new directions for motivational interest and behavioral change. While positive emotions have the function of broadening our thought-action repertoire and building resources for action (Fredrickson, 2004), negative emotions have the opposite role, leading to a narrower mind-set. Our emotional experience is thus a direct approach to understanding consciousness within different environments and different activities. From an emotion-theoretical perspective, emotions can, on the one hand, be seen as a result of cognition, as dispositions for PE motivation, or as a result of the satisfaction of basic psychological needs (Ryan, 2007). On the other hand, emotions have a separate function that leads to action readiness, guiding behavior for more spontaneous reasons (Oatley, 1992).

These fine distinctions among positive emotions seem to be associated with different functioning: *interest* maintains attention to novel stimuli and challenging tasks, which relates to exploration and learning and encourages a person's engagement with the environment (Izard & Ackerman, 2000). Another positive emotion, *pleasure*, leads to coasting rather than striving; that is, to putting less effort into the goal one is pursuing (Carver, 2003). However, *pleasure* as a positive emotion facilitates a broadened mentality that looks for new goals and opportunities for action. Hence, it is likely that

students who are highly engaged in PE respond with positive emotions that represent the different functions, such as interest *and* pleasure. Following the functional well-being approach, interest is a typical *eudaimonic* feeling, and pleasure is a typical *hedonic* feeling (Vittersø, 2013, 2016).

While many approaches to generating positive emotions in PE include a construct of *enjoyment*, *happiness*, *liking* and *fun*, this measure can be criticized for being merely hedonic and thereby neglecting important experiential states that have other characteristics than just the affective (Kimiecik & Harris, 1996). While affect relates to hedonic feelings, eudaimonic feelings, such as *interest*, *engagement*, and *immersion*, might be more typically related to challenging tasks that require persistence and continuing concentration. Our concept of positive emotions includes both hedonic and eudaimonic feelings as a broad-spectrum measure of positive emotions (Løvoll, Røysamb & Vittersø, 2017).

Motivational regulations and psychological needs

Within self-determination theory (SDT: Deci & Ryan 1985; Ryan & Deci, 2017), the concept of basic psychological needs explains well-being and ill-being as a result of a perceived satisfaction of needs. The basic psychological needs are observable and are meaningful positive constructs for health and thriving, regardless of preferences, when attempting to specify psychological *essentials* for a good life. The need for *autonomy* refers to willingness and volition with respect to one's behavior. The need for *competence* refers to feeling effective in one's interaction in social environments. And the need for *relatedness* refers both to experiencing others as responsive and sensitive and being able to be responsive and sensitive to them (Ryan & Deci, 2017). The three psychological needs not only meet the criteria of needs but also explain a range of different phenomena, such as self-esteem, vitality, identity, and self-regulation. When

any of these three needs is less than satisfied, an individual will show diminished well-being, loss of volition, and so forth. As a consequence, the level of satisfaction of psychological needs informs about well-being, development, and human growth.

Variation of the degree to which these psychological needs integrate in the inner self informs about different qualities of motivation regulations. Ryan and Deci (2017) describe the different motivation regulations as a continuum, from controlled (extrinsic) motivation to autonomous (intrinsic) motivation, with introjected, integrated, and identified motivation regulations in between. On this continuum, the individual moves between different motivations, depending on how need satisfaction fluctuates over time and between contexts. Autonomous motivation seems to be the key to understanding future engagement in regular physical exercise (Standage, Sebire, & Loney, 2008; Taylor et al., 2010). Need satisfaction is highly context dependent and changes over time. Accordingly, the quality of studies on youth development would be enhanced through use of longitudinal study designs to explore stability and changes of psychological needs.

Emotional integration: An SDT approach to autonomy

According to the organismic perspective of SDT, our inner self includes capacities for self-regulation and volition, which underly our sense of autonomy (Ryan & Deci, 2017). The self includes a synthetic function that attempts to organize and integrate our experiences. In this process, affects and emotions are very important as they seem to filter the direction and the intensity of the integration process. Positive emotions are important to the integration process, but they do not necessarily result in autonomous motivation unless experiences are internalized through added value and meaning (Løvoll, Røysamb, & Vittersø, 2017). Positive emotions then have the potential to initiate an integration process, which is a precondition for starting the process of

autonomous involvement, and thus learning, in PE. When fewer positive emotions are experienced, this is more likely to develop controlled motivation regulation. Following this line of research, emotions carry important information for understanding processes of integration towards either more controlling or autonomy-driven motivation regulations (Hidi & Renninger, 2006).

Individual variation

In general, some negative trends have shown an overall decline in enjoyment as well as a moderate increase in extrinsic motivation during PE classes in grades 7 to 9, including students from 12-13 to 14-15 years (Yli-Piipari, John Wang, Jaakkola, & Liukkonen, 2012). The tendency is a change towards more controlled motivation. In addition to age, the decrease in general participation in physical activity for adolescents can be explained by gender, race, and social class differences (Azzarito & Solomon, 2005). Other studies have found that the motivational sequence embraced by self-determination theory is invariant across gender (Standage, Duda, & Ntoumanis, 2005) and when including both gender and age (Guzmán & Kingston, 2012). These findings support the postulation of SDT that the innate needs are universal across cultures, gender, and throughout all developmental periods (Ryan & Deci, 2017). Although there might be reasons to look for group differences, our hypotheses are that emotional variation relates to satisfaction of psychological needs and quality of motivation. One contribution of this study is to test the theoretical framework of SDT when applied to emotional and individual perspectives.

Aim

This study aims to explore developmental processes of emotional patterns in PE over a 3-year period from students' starting to the end of secondary school. Taking a

person-centered approach, this include analyses of individual measures on three repeated time points. The advantage of using a person-centered approach is that it gives the opportunity to classify individuals into meaningful distinct groups based on their response patterns so that individuals within a group are more similar than individuals between groups (Jung & Wickrama, 2008, p. 303).

The present research

Based on research presented above, we postulated three hypotheses:

(1) Different developmental trajectories for positive emotions in PE from grades 8 to 10, including students from 13-14, 14-15 and 15-16 years, are found when a person-centered approach is taken.

(2) Students in trajectories reporting higher levels of positive emotions in PE also report higher levels of need satisfaction in PE (i.e., autonomy, competence, and relatedness) compared to students in trajectories who report lower levels of positive emotions in PE.

(3) Students in trajectories reporting higher levels of positive emotions in PE also report higher levels of intrinsic regulation and identified regulation and lower levels of extrinsic regulation and amotivation compared to students in trajectories who report lower levels of positive emotions in PE.

Method

Participants

Participants were students from 23 different secondary schools located in four different counties of the Eastern parts of Norway. The sample was drawn according to a cluster sampling procedure, with schools as the basic unit, and schools were stratified

according to region, number of students and centrality. Appropriate permissions were received from the school principals and the study was carried out in accordance with the ethical approval from the "Norwegian Centre for Research Data (NSD)". Informed consent was obtained from all participants and their parents. Participants were given full anonymity and informed that they could withdraw from the data collection at any time and for no reason.

Informed consent letters were distributed by the 23 schools to a maximum of 2070 students, yet due to some students' absence from school the day of distribution we do not know exact how many parents who actually received the letter. Out of the 2070 students, 1681 students (81%) attended the first data collection. The participants were included in the study the year they turned 14 (Grade 8/first year of secondary school) and were followed over three years throughout secondary school (Grade 8 [T1], 9 [T2], and 10 [T3]). The distribution of gender was almost equal (boys 51%, girls 49%).

Procedures

Data was collected in each of the schools during regular school hours using a web-based questionnaire (SurveyExact). A project researcher who was present ensured that the data collection was conducted according to a data collection protocol. Students were once again informed that participation was voluntary and that they were free to withdraw from the study at any time without providing a reason. Students who did not take part in the data collection proceeded according to the regular schedule for the day. The completion of the questionnaire took approximately 60-90 minutes, and all questionnaire responses were anonymized.

Measures

Positive emotions in PE

Positive emotions in PE were measured using the Basic Emotion State Scale (Vittersø, Dyrdal, & Røysamb, 2005). Using a Likert scale ranging from 1 (*never*) to 7 (*always*), the participants were asked to respond to what extent they experienced six different positive emotions when they participated in PE (satisfaction, pleasure, happiness, interest, engagement and immersion). These responses were collapsed into a mean score. This broad spectrum measure of positive emotions have been used in an earlier study among populations yielding satisfactory internal consistency (Løvoll et al., 2017).

Basic psychological need satisfaction in PE

The Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006) was used to measure the participants' degree of satisfaction regarding their three innate needs for autonomy, competence, and relatedness when involved in PE. Four items were used to measure each of the three needs on a scale from 1 (*totally disagree*) to 7 (*totally agree*): autonomy (e.g., *Physical education classes are in agreement with my choices and interests*), competence (e.g., *I feel that I have made a lot of progress in relation to the objectives of physical education*), and relatedness (e.g., *I feel very comfortable with the students in physical education*). The scale had been used previously among PE pupils in Norway and had shown acceptable internal consistency (Erdvik et al, 2019).

Situational Motivation Scale (SIMS)

The Situational Motivation Scale (SIMS) was used to measure four different qualities of motivation in PE (Guay, Vallerand, & Blanchard, 2000): intrinsic motivation (e.g., *Because I think this activity is interesting*), identified regulation (e.g., *Because I am doing it for my own good*), external regulation (e.g., *Because I am supposed to do it*),

and amotivation (e.g., *There may be many good reasons to do this activity, but personally I don't see any*). Each motivational quality was assessed with four items, and the participants rated their agreement on each item using a 7-point Likert scale: 1 (*does not correspond at all*) to 7 (*corresponds exactly*). This scale had previously been used in a study among Norwegian adolescents in PE and indicated acceptable internal consistency (Erdvik et al., 2014; Säfvenbom et al., 2015).

Data analysis

Preliminary analyses were performed to screen the data for missing and normal distribution. The study included 1,681 participants (*N*). Students who were not present at the time of data collection were not able to respond at that specific data collection. The distribution of answers from the different time points were as follows: Student answering at one time point, $n = 420$ (25%); students answering at two time points, $n = 384$ (22.8%); student answering at all three time points, $n = 877$ (52.2%). Little's MCAR test indicated that the data were not missing completely at random ($X^2 = 58508.77$, $df = 54477$, $p < .001$). Consequently, an independent sample t-test was performed to investigate possible differences between those responding at all three time points ("completers"; $n = 877$) versus those responding at one and two time points ("non-completers"; $n = 804$). Those results indicated that completers had significantly higher levels of positive emotions at T1 and T3 compared to non-completers. At T1, completers had significantly higher scores in the needs for autonomy and relatedness, and intrinsic motivational regulation, and significantly lower degrees of amotivation compared to non-completers. At T2, completers were significantly higher in the need for competence and relatedness, and intrinsic and identified motivational regulations (see detailed results in Supplementary 1, Table 1). These significant findings were in the range of "very small" to "small" (Sawilowsky, 2009). Thus, these differences support

the MCAR results and indicate that the missing data was not at random (NMAR; Enders, 2011), which is considered to be "the most problematic pattern of missingness" (Buhi, Goodson, & Neilands, 2008, p. 85). This is due to difficulties in finding suitable imputation methods that fully remove the biases attached to the systematic missing data. However, Muthén and colleagues have argued that applying a full information maximum likelihood estimation (FIML; Enders & Bandalos, 2001) will still result in less-biased data compared to the more traditional ways of handling missing data such as listwise or pairwise deletion (Muthén, Kaplan, & Hollis, 1987). All participants answering at least one of the three timepoints were included in the study using M*plus* (M*plus* version 8.0; Muthén & Muthén, 2017), and the missing data were handled with an FIML (Enders & Bandalos, 2001). However, as recommended by Enders (2011), the logics of the systematic of missing data will be elaborated further in the discussion.

Further screening indicated that the data were normally distributed for skewness and kurtosis for all items at all three time points, ranging from [-1.40 to 2.01] and [-1.40 to 3.94] (Normal distribution within the range of [3.00 to 10.00]; Byrne, 2012; Kline, 2011). The facture structure of each scale at each time point was evaluated by confirmatory factor analyses (CFA) in M*plus*, using the first indicator approach to set the matrix with a maximum likelihood robust (MLR) estimation (Brown, 2006). The following combination of fit indices were used to evaluate the models (Brown & Moore, 2012; Schermelleh-Engel, Moosbrugger, & Müller, 2003); Comparative Fit Index (CFI) ≥ 0.90, Tucker–Lewis index (TLI) ≥ 0.90, Standardized Root Mean Square residual (SRMR) ≤ 0.08, and Root Mean Square Error of Approximation (RMSEA) ≤ 0.08. After obtaining acceptable fit on the scales with CFA, internal consistency was evaluated by score reliability using SPSS (Cronbach, 1951).

The main analyses were done in two phases. In the first phase, latent class growth analysis (LCGA) was chosen as an analytic procedure to explore for possible different growth trajectories of positive emotions in PE over the three years. This technique had the potential to identify different latent classes based on the individuals' observed responses (Clark & Muthén, 2009). The LCGA was performed in M*plus* using the guidelines of Jung and Wickrama (2008); the variance of the slope was fixed to zero and the variance of intercept was free. This was done to allow for more variance in the intercept (Jung & Wickrama, 2008) and thereby allowed for more within-class interindividual differences in the intercept (Ram & Grimm, 2009). The following criteria were used to evaluate the fit of both models and thereby also to decide which of the models best represented the observed data to select the number of latent classes: the smallest Aikaikes Information Criterion (AIC) and Bayesian information criteria (BIC); significant results on the Bootstrap Likelihood Ratio Test (BLRT); and the Lo-Mendell-Rubin adjusted LRT test (Asparouhov & Muthén, 2014; Jung & Wickrama, 2008; Ram & Grimm, 2009). Both the BLRT and LRT indicate whether the model with C – 1 classes should be rejected in favor of the model with C classes (Ram & Grimm, 2009). Finally, the decision on the number of classes should also consider the size of the classes (class proportion >.05%) and the classes' interpretability in relation to theoretical justifications (Jung & Wickrama, 2008). After deciding on the number of classes, the entropy should be evaluated and assessed as an indicator to evaluate the probability of individuals class membership (Ram & Grimm, 2009; Ramaswamy, DeSarbo, Reibstein, & Robinson, 1993). The entropy ranges from zero to one, where higher entropy indicates a higher class separation. There is no clear cut-off for what is considered an acceptable probability deciding the entropy; yet, the closer the entropy is

to 1.0, the better (Jung & Wickrama, 2008), and if the entropy is extremely low, this might indicate that the model is not fit for purpose (Feldman, Masyn, & Conger, 2009).

The second phase consisted of a series of analyses exploring differences between the trajectories at T1 and T3 on the distal outcomes from basic psychological needs and quality of motivation, and the control variables for gender and missing data (completers/non-completers) were conducted. M*plus* was also used in this phase, employing the three-step BCH approach for the continuous distal outcomes and the DCAT for the categorical control variables (for more information, see Asparouhov & Muthén, 2014). The BCH approach has been found to be more robust and flexible, yielding the least-biased estimates when compared to other analogous approaches (Bakk & Vermunt, 2016).

Results

Results from Confirmatory Factor Analyses (CFA) and internal consistency

Positive emotions were measured by a one-dimensional measure as described in the method. The results of the CFA for this measure indicated acceptable fit at all three time points: T1 ($\chi 2$ (6) = 21.14, $p < .05$, SRMR= .02, RMSEA = .05, (90% CI RMSEA = .03 to .07), CFI = .99, TLI = .98); T2 ($\chi 2$ (6) = 36.49, $p < .05$, SRMR= .03, RMSEA = .07, (90% CI RMSEA = .05 to .09), CFI = .98, TLI = .96), and T3 ($\chi 2$ (6) = 29.87, $p < .05$, SRMR= .02, RMSEA = .06, (90% CI RMSEA = .04 to .08), CFI = .99, TLI = .97). The results from the CFA for the three-dimensional construct of students perceived need satisfaction for autonomy, competence and relatedness indicated an acceptable fit at both T1 ($\chi 2$ (47) = 406.63, $p > .05$, SRMR= .04, RMSEA = .08, (90% CI RMSEA = .08 to .09), CFI = .94, TLI = .91), and T3 ($\chi 2$ (47) = 431.43, $p > .05$, SRMR= .05, RMSEA = .08, (90% CI RMSEA = .07 to .09), CFI = .94, TLI = .91). Also, the four-dimensional

construct of SIMS showed acceptable fit at both T1 ($\chi 2$ (94) = 677.18, p > .05, SRMR= .08, RMSEA = .07, (90% CI RMSEA = .07 to .08), CFI = .92, TLI = .90), and T3 ($\chi 2$ (94) = 703.03, p > .05, SRMR= .07, RMSEA = .07, (90% CI RMSEA = .07 to .08), CFI = .93, TLI = .91). Further, the internal consistency for all scales at all time points yielded sufficient alpha-scores in SPSS: Positive emotions (α_{time1} = .93; α_{time2} = .94; α_{time3} = .94); BPNS: Autonomy (α_{time1} = .87; α_{time3} = .90), competence (α_{time1} = .90; α_{time3} = .91), and relatedness (α_{time1} = .84; α_{time3} = .89); SIMS: Intrinsic regulation (α_{time1} = .93; α_{time3} = .94), identified regulation (α_{time1} = .81; α_{time3} = .87), external regulation (α_{time1} = .76; α_{time3} = .82), and amotivation (α_{time1} = .88; α_{time3} = .91).

Results from the LCGA

The results of the stepwise comparison of model fit in the LCGA favored a three-class solution (see Table 1). Both the AIC and BIC decreased the number of classes in the model, and the results of the BLRT and the LMR indicated in favor of a model with more classes. However, a consideration of the four-class solution showed that one of the classes would include only 1% of the participants. As this is not recommendable (Jung & Wickrama, 2008), the three-class solution was selected. The results indicated an entropy of .60, which can indicate that a model has some uncertainty regarding which class the cases belong to. However, the trajectories of the three-class solution were reasonable and theoretically sound and were thereby evaluated to be sufficient to move forward to testing the trajectories with the associated variables. It should be noted that *n* = 192 cases had missing data on the variable positive emotions at all three time points, and the results of the LGGA analyses are based on a sample consisting of *n* = 1508.

The three identified growth trajectories for positive emotions over three years at secondary schools were distinctly different and meaningful (Figure 1). Trajectory 1 (prevalence: n = 275, 18% of the total sample) has been labelled "low levels of positive emotions" due to the reporting of low levels of positive emotions in PE during all three years (Intercept: M = 2.85, SE = 0.14, p <.001; Slope: M = .28, SE = 0.14, p = 0.04). This trajectory increased the levels of positive emotions over the three years; yet, it could still be evaluated as having low levels of positive emotions at T3 (Grade 10). Trajectory 2 (prevalence: n = 112, 7% of the total sample) has been labelled "decrease in levels of positive emotions" because it started with higher levels of positive emotions in the first year of secondary school and then decreased significantly over the next two years (Intercept: M = 5.34, SE = 0.24, p <.001; Slope: M = -1.27, SE = 0.17, p <.001). Trajectory 3 (prevalence: n = 1121, 74% of the total sample), which has been labelled "high levels of positive emotions," represents the majority of the population. This class reported higher levels of positive emotions throughout the three years (Intercept: M = 5.52, SE = 0.07, p <.001; Slope: M = -.02, SE = 0.04, p =.65).

The results for the DCAT analysis for probability of class-membership according to gender at T1 (Grade 8) showed that there was one significant difference in gender for one of the trajectories (X^2 = 35.29, p < .001), in that girls had a higher probability of being in Trajectory 1 (low levels of positive emotions) compared to boys. Further, the results showed a significant difference in probability of class membership related to dropout from study (completers/non-completers) (X^2 = 28.20, p < .001), where non-completers were more likely to be in Trajectory 1 (low levels of positive emotions) compared to completers.

All the results for differences between the trajectories at T1 (Grade 8) and T3 (Grade 10) are presented in Table 2. The results of the analyses at T1 showed

significant differences ($p < .05$) between Trajectory 1 (low levels of positive emotions), Trajectory 2 (decrease in levels of positive emotions), and Trajectory 3 (high levels of positive emotions) in the expected direction for all three of the psychological needs and for the autonomous motivational regulations (intrinsic and identified). More specifically, Trajectory 1 (low levels of positive emotions) were significantly lower in all these variables compared to the other two trajectories. In addition, students in Trajectory 3 (high levels of positive emotions) scored significantly lower on amotivation compared to students in both Trajectory 2 (decrease in levels of positive emotions) and Trajectory 3 (low levels of positive emotions). Finally, Trajectory 2 (decrease in levels of positive emotions) was significantly higher in extrinsic regulation compared to Trajectory 3 (high levels of positive emotions). Interestingly, this showed that Trajectory 2 (decrease in levels of positive emotions) was significantly higher in the controlled forms of motivation compared to Trajectory 3 (high levels of positive emotions) even though both these trajectories showed high levels of positive emotions at T1.

To a great extent, the findings at T3 (Grade 10) mirrored the findings at T1 (Grade 8); however, it was expected that differences would be found between Trajectory 3 (high levels of positive emotions) and Trajectory 2 (decrease in levels of positive emotions), respectively, and between Trajectory 1 (low levels of positive emotions) due to the decrease in levels of positive emotions for Trajectory 2 (decrease in levels of positive emotions). The results showed significant differences ($p < .05$) for all the three needs and for the autonomous motivational regulations. In addition, Trajectory 3 (high levels of positive emotions) was significantly lower in amotivation compared to the other two trajectories. There were no significant differences in external regulation between the trajectories.

Discussion

As a result of taking a person-centered approach to positive emotions in PE classes, multiple dynamics appeared, which deepened our understanding of the process and function of emotions. A general finding was that students had different emotional reactions to PE, and there were identifiable patterns of change and stability over the three-year period. Moreover, in line with the theory, patterns of change and stability in positive emotions fell nicely into patterns of variations in the satisfaction of psychological needs and autonomous regulations (Ryan & Deci, 2017). Nevertheless, there were also exceptions: the results of positive emotions in relation to controlled motivational regulation were somewhat inconsistent in relation to the hypotheses. The general findings emphasized the importance of identifying individual variety, something that is often missing in statistical analyses on education in general and on experiences with PE in particular.

Three trajectories of positive emotions

The main group, which included 74% of the adolescents displayed a stable pattern with high levels of positive emotions in PE. For this group, PE could be considered a stable source of positive emotions, and this tendency did *not* decrease from grades 8 through 10. This is a robust finding, informing about stability and demonstrating a generally positive attitude to PE for the majority of the adolescents.

However, the two other trajectories inform about important dynamics regarding emotions in PE. Eighteen percent of the sample reported low levels of positive emotions in PE from grades 8 through 10. Even though this group reported a fair increase in positive emotions over the three years, there was a substantial difference between this group and the majority group at the upper end of the scale throughout their years at

secondary school. This finding is somewhat alarming. For these adolescents, PE represents a loss of the positive functioning of emotions, which is central to learning and well-being (Pekrun, 2007; Vittersø, 2013). The stability in this group indicates a low relational fit between the subject and the students over a period of three years, something that is not in accordance with the Norwegian Education Act (Opplæringslova, 1998). This finding could be associated with the challenges of low well-being and poor mental health for an increasing group of adolescents. For example, good school connectedness and good social connectedness are both important for the likelihood of completing secondary school (Bond et al., 2007). As PE classes represent all groups in society, the group reporting low levels of positive emotions should be of particular interest for PE teachers. For example, being ignored by the teacher relates to negative emotional affiliations, and students who are ignored have little chance of being seen in the future unless the teacher changes his or her practice (Lyngstad, Bjerke, & Lagestad, 2017).

Finding stability in the low register of positive emotions for the second largest group indicates that the individual perspective in PE needs attention and nurturing. There was an overrepresentation of females in this group. However, girls were highly represented in the main class of 74% as well, which informs that gender generalization can overlook important individual differences. However, the likelihood of being found on the lower part of the register of positive emotions is greater for females than males. Regarding gender, it must be said that there were also boys in trajectories 2 and 3. Thus, gender is an insufficient explanation of emotional variability. On the other hand, the findings give reasons to study why there are more girls in the lower part of the register of positive emotions than there are boys. One reason for this could be that there is something with how PE is presented in schools today, that PE favors more typical

masculine preferences and feminine preferences are less identified (Klomsten, Marsh & Skaalvik, 2005).

Trajectory 2 (decrease in levels of positive emotions, 7% of population) identified another interesting pattern of development in positive emotions as these adolescents started with a high intensity of positive emotions in Grade 8, but their emotional engagement had significantly decreased by Grade 10. For this group, there was a remarkable negative change in positive emotions during the three years at secondary school. Although this group was the smallest, the strong decrease influenced the general mean for the population and accounted for the tendency to interpret a decrease in positive emotions that was identified at a general level (Yli-Piipari et al., 2012). The situation for that 7% of the population is critical anyway as those adolescents could soon be at risk for lower levels of learning and well-being during the three years. The identification of positive emotions in Grade 8 was not a sufficient indicator of positive emotions in Grade 10. While the mean for the whole sample showed a small significant decrease from grades 8 to 10, this general finding disappeared when we opened for variance in the trajectories using the methods of LCGA.

Hypothesis 1 was supported as three different distinct trajectories were found. The general pattern was that most students associated PE with positive emotions. However, the two groups representing 26% of the sample informed about harmful tendencies related to their learning and well-being either as a low or as a decreasing tendency. This is not in accordance with the Norwegian PE curriculum, which affirms that enhanced global self-worth is a major objective for PE (Norwegian Directorate for Education and Training, 2015). In order to achieve national goals, it will be crucial for

future customization of PE to be based on an understanding of the dynamics associated with these two groups.

Differences between trajectories of positive emotions

In our second hypothesis, we suggested that the level of the satisfaction of basic psychological needs relates to emotional variability. As hypothesized, the analyses revealed noteworthy associations between levels of need satisfaction and the three different trajectories of positive emotions in PE.

For the decrease group, a change in positive emotions was identified with differences in basic psychological needs from T1 (Grade 8) to T3 (Grade 10). For these adolescents, basic psychological needs were highly satisfied in Grade 8, yet scored low in Grade 10. Hence, there is a strong association between satisfaction of basic psychological needs and emotions, as suggested in SDT (Ryan, 2007; Ryan & Deci, 2017). The findings support the initial theory that basic psychological needs are innate and invariant across gender (Ryan & Deci, 2017).

The identification of a strong association between satisfaction of basic psychological needs and positive emotions recognizes these phenomena as related in PE: There was support for the second hypotheses. However, we cannot say that satisfaction of basic psychological needs is a predictor or a consequence of emotions or that the relationship is bidirectional. Dynamics of motivation regulation include spontaneous change influenced by emotional processes (Hidi & Renninger, 2006).

Positive emotion and motivation regulation

The analysis of motivation regulation followed the main findings of the identification of three different trajectories. At both T1 and T3, Trajectory 3 (high levels of positive emotions) was accompanied with significantly higher levels of intrinsic motivation than

the other trajectories. This finding is supported by previous research that identifies autonomous forms of motivation as the most important predictors of effort for PE, exercise intentions, and leisure-time physical activity (Taylor et al., 2010). Trajectory 1 (low levels of positive emotions) was low on intrinsic motivation and on identified motivation in grades 8 and 10. This finding can also be explained by SDT as the relation between lower satisfaction of needs and lower levels of positive emotions (Adie, Duda, & Ntoumanis, 2008). However, the patterns of external motivation regulations were somewhat more complex. In the first year, there were significant differences between the classes with high and low levels of positive emotions. In the third year, this difference disappeared.

Further, Trajectory 2 (decrease in the levels of positive emotions) also showed an interesting pattern. Although positive emotions were high at T1, external regulation was higher for this group than for Trajectory 3 (high levels of positive emotions). There was no significant difference between Trajectory 2 (decrease in levels of positive emotions) and Trajectory 1 (low levels of positive emotions). The findings indicate that it was not merely the intensity of positive emotions during the first year that related to positive emotions in the third year, but the change in positive emotions in PE seems to be clearly associated with both the satisfaction of basic needs in PE and the regulation of motivation in PE. The findings contribute toward a greater understanding of the discrepancies between positive emotions and motivation. Introjected forms of motivation can be promising when starting a new activity, but it is necessary that this quality of motivation changes towards more autonomous motivation to prevent a loss of interest in the activity (Thøgersen-Ntoumani & Ntoumanis, 2006).

In the third year, there were no significant differences between trajectories, as all three trajectories displayed high on extrinsic regulation. This might not be a surprising

finding as the data collection was conducted just before the final summative student evaluation in secondary school. The general tendency is toward more external motivation regulation from grades 9 to 10. Even though the high levels of positive emotions were shown to be stable, it is worth paying attention to this. Because positive emotions are not a sufficient predictor of future intrinsic motivation regulation (Løvoll et al., 2017), it seems necessary for the process of autonomous integration of PE. Consequently, it is necessary to support the satisfaction of psychological needs to understand the function of positive emotions when determining future engagement with PE. Our third hypothesis suggesting a relation between positive emotions and autonomous and controlled motivation was only partly supported. In accordance with the theory (Ryan & Deci, 2017), the results at both T1 and T3 supported the assumptions that students with higher levels of positive emotions also had higher levels of autonomous motivation regulation compared to those students with lower levels of positive emotions. However, the findings related to the controlled forms of motivation at T1 were in contrast to what was expected. Trajectory 2 (decrease in levels of positive emotions) showed higher levels of controlled forms of motivation compared to Trajectory 3 (high levels of positive emotions) even though they both showed high levels of positive emotions at T1. Thus, observing positive emotions alone is not a sufficient approach for understanding motivational dynamics in PE. Understanding the full integration process of controlled forms of motivation at T1, such as amotivation and external motivation, seem to be variables that need attention.

Implications

Based on the findings, a strong focus needs to be directed on how to build and sustain a need-supportive environment for all PE students (Adie et al., 2008; De Meyer

et al., 2016; Hastie, Rudisill, & Wadsworth, 2013). Teachers of PE benefit from insights from motivational psychology and from paying attention to adolescents' need for good relationships, competence, and autonomy. In order to change the culture of PE, teachers need knowledge of motivational processes, and they should customize their practice to meet individual needs.

The study has theoretical implications for the identification of positive emotions and motivation regulation as related but different phenomena. Sometimes in the literature, positive emotions operate as the dependent variable of intrinsic motivation, whether task specific or toward a domain (Ryan & Deci, 2000). While positive emotions and intrinsic motivation are related, our findings demonstrate that positive emotions are not a sufficient identifier of intrinsic motivation. Rather, while positive emotions are important, the relation between positive emotions and motivation regulations inform about future intentions for participation in PE. When positive emotions and intrinsic motivation are both identified as high need satisfaction, this is likely to follow the pattern of Trajectory 3 (high levels of positive emotions). Our findings contribute to a greater understanding of the function of positive emotions in the integration process of need satisfaction and of the necessity to explore individual variation in PE classes. Prior research has shown that existing PE discourses, or a dominating sport discourse in particular (Kirk, 2010, 2013; Nyberg & Larsson, 2014), combined with a dominating "Demonstration-Explanation-Practice" learning model (Tinning, 2010) and rather traditional student evaluations (Leirhaug & Annerstedt, 2016), cause variation in students' attitudes to and motivation for PE. More research is needed; yet, when compared to empirical studies from Säfvenbom et al. (2015) and from Erdvik et al. (2019), there is reason to believe that our results mirror this challenge

and that there is need for a change in the often neglected, yet important curricular objectives of PE such as global self-worth.

Limitations and future research

Challenges associated with a longitudinal study include dropout and missing data, both of which might influence the results (Enders, 2011). In the current study, the analysis of missing data showed that the missing was not at random, which is described as "the most problematic pattern of missingness" (Buhi et al., 2008, p. 85), hence this could be considered a limitation of the study. However, these findings might also be of importance when studying the everyday life of adolescents at school. The results of the current study showed that non-completers were more likely to belong to the trajectory with low levels of positive emotions compared to the completers. The non-completers were those students who did not complete all three steps of the data collection. Because the data were collected during the school day, this student population most likely included those students who had a higher frequency of absenteeism from school. This finding is a reminder that the variables in this study only reflected a small piece of the puzzle for trying to understand how these adolescents enjoyed PE in particular and school in general. In other words, future research needs to address the challenges and potentials of students in the trajectory that experienced "low levels of positive emotions" in PE, using a broader theoretical and methodological lens in order to better understand how to facilitate thriving in both PE and at school.

Another limitation of this study is the indication of low entropy, which is an indication of the probability of individuals belonging to a class (Ramm & Grimm, 2009; Ramaswamy et al., 1993). However, when testing for differences between the classes using auxiliary variables, most of the results showed expected differences between the

trajectories, according to both previous research and theory. This strengthens the assumption that the classes found by model fit were suitable for teasing out classes that were different and theoretically sound (Jung & Wickrama, 2008).

Positive emotions were captured as a general measure relating to experiences of PE. Differences between momentary positive emotions and general positive emotions were not captured in these analyses. As there are differences between momentary and remembered positive emotions (Robinson & Clore, 2002), there might be more intense positive emotions during momentary PE experiences in the "low levels of positive emotions" class, as well as in the "decrease in levels of positive emotions" class.

From a functional well-being approach, hedonic and eudaimonic feelings will have different functions depending on different perspectives of the experience (Vittersø, 2016). As the measure of positive emotions was a *recall* of emotions during PE classes, the distinction between hedonic and eudaimonic feelings was not expected to be significant, as situational eudaimonic emotions gradually feels more hedonic over time (Løvoll, Vittersø & Wold, 2016). Rather, the 6-item measure of positive emotions is less reductive than a measure with only hedonic measures, as it is a balanced expression of both hedonic and eudaimonic elements. In this study we were not especially interested in selecting eudaimonic feelings, as we were not able to measure momentary experiences from specific PE classes. Future research should explore the differences between hedonic and eudaimonic feelings relating to PE experiences and how these experiences are remembered over time, to detect a more fine-grained pattern of the role of positive emotions.

However, the general capture of positive emotions might overlook momentary experiences but capture the remembered positive emotions, which is a more important predictor than momentary positive emotions (Wirtz, Kruger, Napa Scollon, & Diener,

2003). Future research on positive emotions in PE should include studies of momentary positive emotions as well as more contextual variables in order to understand more of the differences between positive emotions and motivation regulations. As coping strategies and verbalization are important factors of the emotional learning process in PE (Vandercleyen et al., 2014), more attention should be paid to supporting basic psychological needs.

Conclusions

Positive emotions inform about systematic variation in how PE is perceived in secondary school. Three different trajectories illustrated meaningful patterns of development. One group of students reported a high level of positive emotions, another group reported a low level of positive emotions, and a third group reported a decrease in the levels of positive emotions from high to low for the intensity of positive emotions from grades 8 to 10. The person-centered approach used in this study gave us the opportunity to identify these meaningful patterns of change and to study the associated characteristics for these different groups. The three groups of emotional patterns were identified according to the satisfaction of basic psychological needs. However, while this describes the main pattern, there were exceptions in the group that saw a decrease in the levels of positive emotions, where positive emotions and less satisfaction of psychological needs were identified in Grade 8. While the tendency for this group was to experience a decrease in the levels of positive emotions through Grade 10, more attention needs to be given to this matter in order to understand why basic psychological needs were not satisfied and how positive emotions could influence this process. This group needs more attention at all levels of the school system.

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Declaration of interest statement

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List of Tables and Figures:

Table 1

Fit Indices for Latent Class Growth Models of Positive Emotions for Different Number of Trajectories

No. of trajectories	No. of free parameters	AIC	BIC	BLRT (*p*-value)	L-M-R (*p*-value)	Entropy	Latent class proportions (%)
1	6	11038.461	11070.372				
2	9	10953.931	11001.798	.000	.007	0.62	342/1166 (23/77)
3	12	10895.002	10958.824	.000	.001	0.60	275/112/1121 (18/7/74)
4	15	10854.811	10934.589	.000	.0001	0.65	110/19/276/1103 (7/1/18/73)

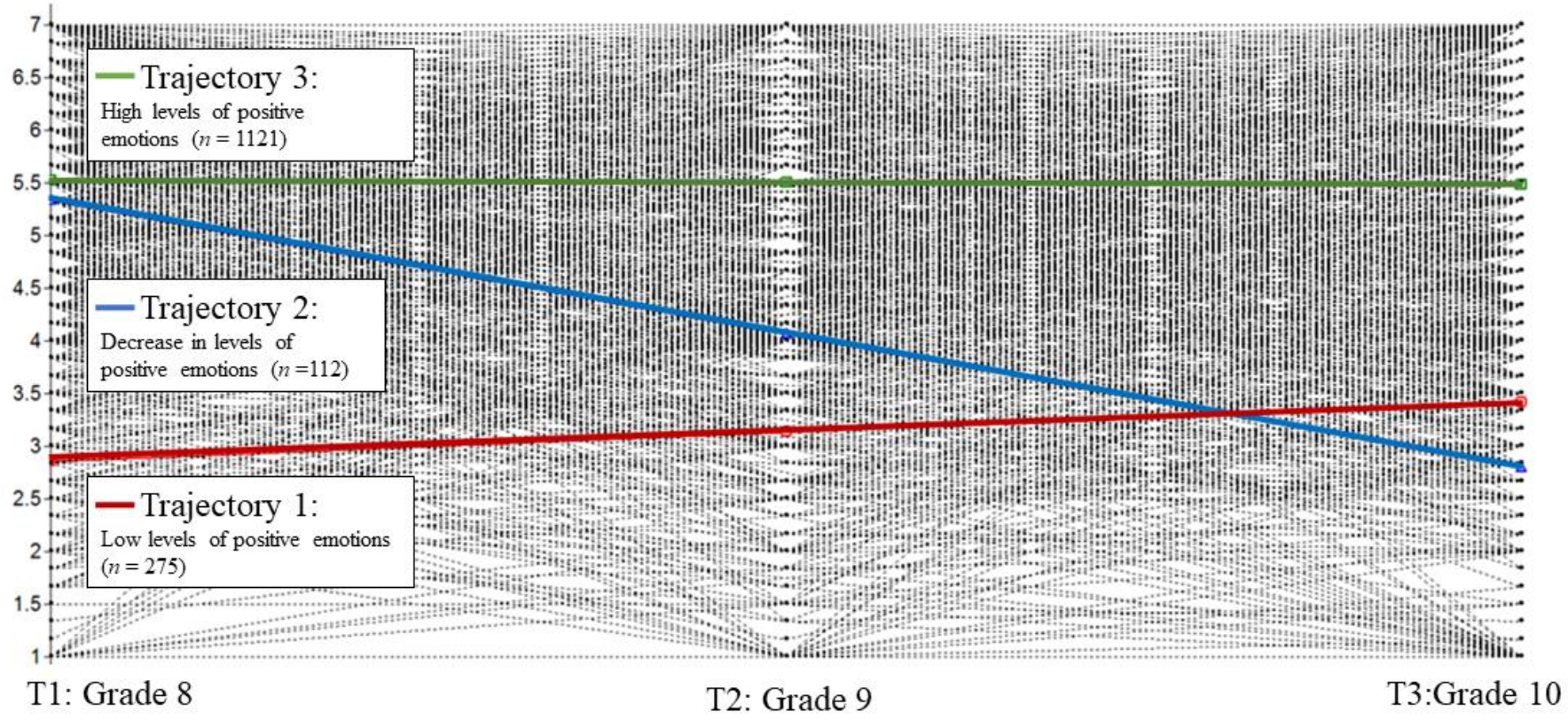
Note. *N* = 1508. AIC = Akaike's information criterion; BIC = Baysian information criterion; BLRT = Bootstrap Likelihood Ratio Test; L-M-R = Lo-Mendell-Rubin adjusted LRT test.

Table 2

Differences between Trajectories on Distal Outcome Variables at T1 and T3

Distal outcome variables	Trajectory 1 Low, *n* = 275 *M/SE*	Trajectory 2 Decrease, *n* = 112 *M/SE*	Trajectory 3 High, *n* = 1121 *M/SE*	Global X^2/*p*-value	1vs 2 X^2/*p*-value	1 vs 3 X^2/*p*-value	2 vs 3 X^2/*p*-value
T1 Autonomy	2.85 (.15)	5.21 (.28)	5.18 (.05)	**203.97*** **	**50.62/*** **	**203.44/*** **	.02
T1 Competence	3.19 (.15)	5.61 (.25)	5.66 (.05)	**238.19*** **	**62.31/*** **	**237.80/*** **	.03
T1 Relatedness	3.75 (.14)	5.45 (.25)	5.64 (.05)	**144.23*** **	**28.98/*** **	**143.32/*** **	.47
T1 Intrinsic	2.46 (.20)	5.66 (.30)	6.09 (.06)	**316.57*** **	**73.94/*** **	**316.36/*** **	1.87
T1 Identified	3.26 (.16)	5.66 (.26)	5.92 (.05)	**237.93*** **	**53.00/*** **	**237.49/*** **	.86
T1 Extrinsic	4.80 (.16)	5.29 (.28)	4.48 (.07)	**10.70****	1.83	3.06	**7.05/****
T1 Amotivation	3.24(.17)	2.72 (.33)	1.97 (.07)	**52.97*** **	1.62	**43.36/*** **	**4.57/****
T3 Autonomy	2.87 (.16)	2.93 (.20)	5.13 (.07)	**278.34*** **	.04	**164.35/*** **	**97.04/*** **
T3 Competence	3.30 (.15)	3.45 (.21)	5.74 (.07)	**352.67*** **	.02	**223.80/*** **	**91.34/*** **
T3 Relatedness	3.97 (.16)	3.70 (.21)	5.89 (.07)	**224.02*** **	.72	**116.98/*** **	**82.90/***
T3 Intrinsic	3.15 (.20)	2.59 (.22)	6.12 (.08)	**458.23*** **	2.78	**191.03/*** **	**216.53/*** **
T3 Identified	3.54 (.20)	3.15 (.23)	5.87 (.07)	**262.39*** **	1.27	**119.34/*** **	**114.55/***
T3 Extrinsic	5.27 (.18)	5.02 (.27)	5.12 (.07)	.59	.43	.51	.12
T3 Amotivation	3.35 (.20)	3.07 (.21)	2.51 (.08)	**19.94*** **	.75	**17.72/*** **	**5.01/****

Note: p-value * < .05, ** < .01, *** < .001.


Trajectory 3:
High levels of positive emotions (n = 1121)
Trajectory 2:
Decrease in levels of positive emotions (n =112)
Trajectory 1:
Low levels of positive emotions (n = 275)
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
T1: Grade 8
T2: Grade 9
T3:Grade 10

Supplements. Table 1. Independent sample t-test

	'Completers'			'Non-completers'						
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*df*	*p*	*d*
Positive emotions T1	717	5.08	1.44	277	4.87	1.65	-2.02	992	.001	.14
Positive emotions T2	753	4.89	1.54	308	4.62	1.65	-2.50	1059	.099	.17
Positive emotions T3	767	4.92	1.54	313	4.42	1.75	-4.68	1078	.005	.30
Autonomy T1	743	4.74	1.31	311	4.58	1.36	-1.71	1052	.454	.12
Competence T1	760	5.23	1.21	317	4.89	1.35	-4.08	1075	.013	.27
Relatedness T1	722	5.33	1.13	303	4.95	1.29	-4.62	1023	.002	.31
Intrinsic regulation T1	778	5.39	1.53	315	5.19	1.64	-1.86	1091	.017	.13
Identified regulation T1	768	5.43	1.30	315	5.27	1.38	-1.80	1081	.116	.12
External regulation T1	728	4.64	1.50	299	4.64	1.43	-.010	1025	.470	.0
Amotivation T1	737	2.21	1.49	297	2.62	1.69	3.84	1032	.000	.26
Autonomy T3	786	4.43	1.47	336	4.19	1.60	-2.42	1120	.098	.16
Competence T3	786	5.02	1.32	332	4.69	1.56	-3.59	1116	.000	.23
Relatedness T3	761	5.28	1.29	330	4.87	1.54	-4.56	1089	.000	.29
Intrinsic regulation T3	794	5.13	1.63	335	4.74	1.80	-3.50	1127	.006	.23
Identified regulation T3	783	5.09	1.53	332	4.82	1.69	-2.57	1113	.003	.17
External regulation T3	755	5.22	1.51	318	4.87	1.60	-3.33	1071	.411	.23
Amotivation T3	777	2.68	1.75	327	2.90	1.74	1.91	1102	.910	.13

P = Population, *M* = Mean, *SD* = Standard deviation, *DF* = Degree of freedom, *p* = Probability value, *d* = Cohen's d effect size: 0.01-0.19 (very small), 0.20-0.49 (small), 0.50-0.79 (moderate), 0.80-1.19 (large), 1.20-1.99 (very large), and 2.00 (huge) (Sawilowsky, 2009).