

Factors influencing flow experiences of adolescents during physical education

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Abstract:

Only 10 to 17% of adolescent girls and boys meet the recommendations of the World Health Organization (WHO) for physical activity behavior. Students' intrinsic motivation for physical exercise tends to decline from the age of 12 onwards. Physical Education (P.E.) lessons can potentially enhance positive emotions and flow experiences through bodily activity and therewith increase students' physical activity behavior outside the school setting. However, it is still unclear which variables may influence the frequency of students' flow experiences (dispositional flow) in P.E. lessons. This study examined the association between various independent variables and dispositional flow in 511 P.E. students at three different schools in Germany. The students answered an adapted version of Rheinberg's Flow short-scale (FKS) questionnaire. Regression analysis was used to evaluate the data. The results show a decline of flow experiences with increasing age of the students ($p < 0.05$; $\beta = -0.003$), boys experienced flow significantly more often than girls (95% - CI (-0.22;-0.05), $t(477) = -3.22$, $p < 0.01$). Competence ($p < 0.001$; $\beta = 0.21$), the presentation of clear goals during lessons ($p < 0.001$; $\beta = 0.15$), varying lesson contents ($p < 0.001$; $\beta = 0.14$), a sense of belongingness experienced by students ($p < 0.001$; $\beta = 0.13$), praise through the P.E. teacher ($p < 0.01$; $\beta = 0.06$) and the feeling of being accepted by the P.E. teacher ($p < 0.05$; $\beta = 0.06$) were positively associated with dispositional flow. A significant association between the frequency of flow experiences during P.E. and students' perceptions of self-determination and individually appropriate levels of difficulty could not be confirmed.

Key Words: Flow, Physical Education, Physical Activity Behavior, Motivation, Well-being

Introduction

Regular physical activity is positively associated with physiological and psychological health in children and adolescents (Schmidt et al., 2020). Low levels of physical activity, on the other hand, lead to obesity, cardiovascular diseases and a more detrimental physiological and psychological health status (Albrecht et al., 2016; Atakan et al., 2022). Yet, in Germany only 10% of the girls and 17% of the boys aged between 11 and 15 years are sufficiently active according to the recommendations of the World Health organization (WHO) (Bucksch et al., 2020). Empirical studies show a decrease of physical activity levels in children and adolescents from the age of 12 on, accompanied by a deteriorating motivation for conducting physical activities (Elbe et al., 2003; Gråstén et al., 2012; Sotos-Martínez et al., 2023; Yli-Piipari, 2011). Physical Education lessons have the challenging task and the potential to counteract this development and to encourage young students to engage in regular physical activity (Bakirtzoglou & Ioannou, 2011; Kamil & Aboshkair, 2022; Koka & Hagger, 2010). In order to foster lifelong sports affinity, a positive motivational climate within P.E. lessons seems necessary. This climate can be created through moments of enjoyment, happiness and flow (Ntoumanis, 2001) and therewith increase students' motivation to become physically active in their free time and in the future (ADA, 2018). Thus, this study aims at exploring possible determinants of flow experiences during P.E. lessons.

Experiencing positive emotions like enjoyment during physical activity is positively associated with high levels of intrinsic motivation. Some authors state that intrinsic motivation occurs when a behavior is driven by joy (Deci & Ryan, 1985), even though the two terms are technically describing different aspects. Enjoyment reflects general sensations as fun, pleasure and delight. It is described as a positively activating experience during an activity (Rodríguez Macías et al., 2021; Russell & Barrett, 1999), whereas intrinsic motivation is defined either as a readiness or willingness to act – aiming at an activity itself or the anticipated consequences of an activity (Rheinberg, 2006). It is self-explanatory that activities which are experienced as joyful are more likely to be executed out of intrinsic motivation than activities that are experienced as aversive (Leisterer, 2021). Based on Deci and Ryan's self-determination theory (1985), Engels and Freund (2018) developed a questionnaire to measure enjoyment during P.E. and determined enjoyment through three key variables:

pleasure, recovery and flow experiences. Flow experiences, therefore, seem to be linked directly to enjoyment and intrinsic motivation, but go beyond ‘having fun’.

In order to define the motivationally important state of flow, Csikszentmihalyi (1977, p. 36) states that a person “experiences a unified flowing from one moment to the next, in which he is in control of his actions, and in which there is little distinction between self and environment, between stimulus and response or between past, present, and future”. According to Csikszentmihalyi (2002), the concept of flow describes a psychological experience during an activity of any kind that involves nine key aspects:

- 1) a balance between personal skills and external challenge
- 2) a merging of action and awareness (not seeing oneself as separate from one’s actions)
- 3) clear goals
- 4) unambiguous feedback
- 5) high levels of concentration on the task at hand
- 6) a sense of perceived control over one’s actions
- 7) a loss of self-consciousness
- 8) a transformation of time
- 9) an autotelic experience (the person acts out of intrinsic motivation, purpose and curiosity)

Keller and Landhäußer (2011) refer to flow as a specific form of intrinsic motivation. The task at hand is intrinsically rewarding, absorbs a person’s full attention and there are no distracting or self-reflecting thoughts, even when the task is difficult to master (Csikszentmihalyi, 2002; Rheinberg, 2006). A state of flow requires an optimal balance between individual skills and the challenge at hand (Csikszentmihalyi, 1977). This balance is based on the individual’s perception and interpretation. Experiencing flow is most likely when subjective skills and the perception of a given challenge are moderate or high and the given task is sufficiently challenging (Rheinberg, 2006).

Motivation, motivational climate and the experience of flow are directly interrelated (ADA, 2018; González-Cutre et al., 2009; Moreno Murcia et al., 2009). According to the Achievement Goal Theory (Deci & Ryan, 1985), a motivational climate can be described as task-oriented (focused on personal improvement and mastering challenging tasks) or ego-oriented (focused on outperforming others and social comparison). Murcia et al. (2009) found out that dispositional flow of students in P.E. lessons was predicted in 45% of the cases by the motivational climate. A high task-orientation focusing on learning and self-improvement is positively related to flow experiences (ADA, 2018; González-Cutre et al., 2009; Moreno Murcia et al., 2009). According to other studies, students’ leisure time sport participation, their level of intrinsic motivation and the fulfilment of basic psychological needs (autonomy, competence, social relatedness) explained up to 25% of the variance of flow experiences in middle and high school students (ADA, 2018; González-Cutre et al., 2009; Keskin Akın et al., 2018; Stormoen et al., 2016).

Experiencing flow during physical activity is – according to the following studies – positively associated with:

- enjoyment, high levels of self-determined motivation, a positive mental state, enhanced physical self-concept (Martin et al., 2020)
- increased subjective well-being and contentment (Franz, 2020; Fritz & Avsec, 2007)
- reduced stress levels (Han & Park, 2020)
- increased individual performance (Engeser & Vollmeyer, 2005; Gaudreau et al., 2016; Jackman et al., 2021; Koehn et al., 2013; Lin et al., 2022)
- increased levels of physical activity (Barr-Anderson et al., 2008; Engels & Freund, 2018; Rodríguez Macías et al., 2021; Sanchez-Oliva et al., 2014)
- increased motivation for being physically active in the future (Franco et al., 2020; Han & Park, 2020; Jackman et al., 2021; Schüler & Brunner, 2009)
- the willingness to engage in more complex challenges (Csikszentmihalyi, 2014)

If students frequently perceive moments of flow and enjoyment during P.E. lessons, it is likely that their level of intrinsic motivation for physical activity increases (Engels & Freund, 2018; Fredrickson, 1998; Han & Park, 2020; Jackman et al., 2021). Engels and Freund (2018) state that enjoyment and flow experiences are the most important predictors of long-lasting maintenance of physical activity. Yet, in reality, the students’ level of motivation and enjoyment during P.E. lessons decreases the older they get (Engels & Freund, 2018; Rathmann & Hurrelmann, 2018).

Intervention studies aiming at creating flow in youth sport settings have mainly been unsuccessful so far (Jackman et al., 2021). As an exception, Kawabata (2018) conducted a 10-week intervention study with college students focusing on goal setting, feedback techniques and individually adapted challenges. Both intervention groups showed significant increases in dispositional flow compared to a control group. Yet, until now, no sound explanation exists on how flow actually occurs and how it can be successfully initiated. Thus, variables that may foster any of the nine presented key aspects of flow are assumed to increase the likeliness of flow experiences. Only few studies have focused on predictors of dispositional flow in P.E. lessons in Germany so far. Substantial information on the occurrence of flow in this setting are still missing.

Therefore, this study aims at exploring the association between dispositional flow in P.E. and possible determinants which we deduced from previous empirical studies and Csikszentmihalyi's (1977) flow model. Not all of the presented nine key aspects of flow were considered in our research questions due to practical reasons. The feasibility of the study required the used questionnaire to be comprehensible for all students participating in the study.

Thus, the following research questions constitute research deficits and hence guide the research process:

Research question 1: Is an individually appropriate level of difficulty in P.E. lessons positively associated with flow experiences?

Research question 2: Are clear goals during P.E. lessons positively associated with flow experiences?

Research question 3: Is received praise through the P.E. teacher positively associated with flow experiences?

Research question 4: Is the level of competence during P.E. lessons positively associated with flow experiences?

Research question 5: Are varying lesson contents positively associated with flow experiences?

Research question 6: Is a high level of self-determination positively associated with flow experiences?

Research question 7: Is a sense of belongingness with classmates positively associated with flow experiences?

Research question 8: Is the students' feeling of acceptance and appreciation (by the P.E. teacher) during P.E. lessons positively associated with flow experiences?

Material & methods

The study was conducted in accordance with applicable national law and the declaration of Helsinki from 1975 (current and revised version). All study participants or their legal representatives signed a declaration of consent on the anonymous utilization of the collected data prior to the study. The principals of the participating schools were fully informed on the purpose and goal of the study. Data collection took place from November 2022 until February 2023.

The presented study aimed at exploring possible determinants of flow experiences during P.E. lessons. A cross-section analysis was conducted in order to compare differences between girls and boys and age-related changes in flow experiences. The examined determinants based on existing definitions and current theoretical assumptions on factors assumed to potentially promote flow experiences.

The sample consisted of 511 students (girls = 256, boys = 255, age: 11-18 years) attending grades 5-12 of three different secondary schools in the federal states of Baden Württemberg and Niedersachsen, Germany. Via their class teachers, all students received a questionnaire designed to assess flow experiences during P.E. lessons. They filled in the questionnaires at the beginning of a regular school lesson. T

he original version of the questionnaire (original title: FKS = flow short-scale) was developed by Rheinberg et al. (2019). For the purpose of this investigation, the questionnaire was adapted and amended with additional questions on possible determinants of flow. In the original version, the answer scale consists of a seven stage Likert scale, which was substituted with a five stage Likert scale (ranging from 0 = never to 4 = always) in order to facilitate students' personal assessment of flow experiences. Additional questions addressed the aspect of goal setting in P.E. lessons, the variance of content during the lessons, autonomy experiences during the lessons, praise through the P.E. teacher, experiences of social relatedness during the lessons, the students' sense of acceptance (by the P.E. teacher) and the level of individual challenges during the lessons. In contrast to the original questionnaire, students evaluated their flow experiences retrospectively and referred to their experiences in the ongoing school year. In order to be able to include high numbers of students in the investigation, possible individual inaccuracies due to memory biases had to be accepted.

The original flow short-scale measures and identifies structure and frequency of flow experiences in P.E. lessons (dispositional flow). The scale consists of 16 items and assesses flow through three factors (smooth and automated processing; absorption; anxiety). The internal consistency according to Cronbach is very good (Cronbach's alpha: .90). The factor anxiety lies between alpha = .90 and alpha .80. Factorial validity showed that 72% of the variance could be explained by the three factors (Rheinberg et al., 2019).

Before statistical analysis was conducted, existing data were tested on normal distribution of residuals (via histogram of residuals), homoscedasticity of residuals (via residuals-versus-fitted-diagram), autocorrelation of residuals (Durbin-Watson-Test), multi-collinearity of independent variables (via VIF-values) and linear associations between independent and dependent variables (via scatter diagram between dependent and independent variables). The data showed no strong multicollinearity or autocorrelation between residuals. Normal distribution of the residuals was confirmed via Shapiro-Wilk test.

There was no violation of homoscedasticity and linearity assumptions. All preconditions for a multiple regression analysis were fulfilled. The data set included 14 missing answers on singular questions. These missing data were imputed with the median of all participants' answers. The flow score was internally consistent and could be used for the testing of the hypotheses.

The level of significance was set at $p < .05$ after correction of p values with Bonferroni.

Results

The following table descriptively shows mean values and standard deviation of the examined independent (5-12) and dependent (1-4) variables. For all examined parameters mean values between 0 and 4 were possible. Thus, the theoretically expected mean value is 2.

Table 1. Descriptive statistic, mean values, standard deviation (girls=256; boys=255)

Factors	Sex	Mean Value	SD
1 Overall Flow Score	♀	2.41	0.88
	♂	2.73	0.69
2 Appropriate level of difficulty	♀	2.01	0.87
	♂	1.91	0.85
3 Clear goals	♀	2.82	0.98
	♂	3.0	0.93
4 Received praise	♀	2.21	1.18
	♂	2.42	1.16
5 Competence	♀	2.85	1.08
	♂	3.21	0.96
6 Varying lessons contents	♀	2.47	1.21
	♂	2.68	1.10
7 Self-determination	♀	2.28	1.17
	♂	2.26	1.19
8 Sense of belongingness	♀	2.82	1.19
	♂	3.16	1.0
9 Acceptance	♀	3.05	1.12
	♂	3.28	0.94

511 students completed the questionnaire, 413 of them declared that they had experienced flow before, most of them occasionally (n=186) or often (n=159) and mainly in a sport club setting (n=243) outside school. Most of the students with previous flow experience rated their level of competence as *very good* or *good*. Boys experienced significantly more flow during P.E. lessons than girls (95% - CI (-0.22;-0.05), $t(477) = -3.22$, $p < 0.01$).

The multiple regression analysis showed a significant effect of the examined independent variables on the students' flow score, $F(15;477) = 52.73$, $p < 0.001$. A variance explanation of $R^2 = .624^{***}$ ($* = p < .05$, $** = p < .01$, $*** = p < .001$) indicates that 62% of the flow score could be explained with the independent variables.

The following table depicts the coefficients of the regression analysis.

Table 2. Results of the multiple regression analysis

Independent variables	B	β	p-value
Appropriate level of difficulty	0.00	- 0.003	0.90
Clear goals	0.21	0.15	< 0.001***
Received praise	0.01	0.06	0.01**
Competence	0.31	0.21	< 0.001***
Varying lesson contents	0.22	0.14	< 0.001***
Self-determination	0.04	0.02	0.27
Sense of belongingness	0.20	0.13	< 0.001***
Acceptance	0.07	0.06	< 0.05*
Age	-0.07	-0.03	0.01*

The regression analysis confirmed that the independent variables *clear goals* ($p < 0.001$), *varying lesson contents* ($p < 0.001$), *praise* ($p < 0.01$), *belongingness* ($p < 0.001$), *acceptance* ($p < 0.05$) and *competence* ($p < 0.001$) were significantly associated with flow experience in P.E. lessons. According to the presented data, the initial research questions could be answered as follows:

1. An individually appropriate level of difficulty experienced in P.E. lessons is not positively associated with flow experiences.
2. Having clear goals during P.E. lessons is positively associated with flow experiences. The association is very highly significant.
3. Receiving praise during P.E. lessons is positively associated with flow experiences. The association is highly significant.
4. The perception of the students' level of competence during P.E. lessons is positively associated with flow experiences. The association is very highly significant.
5. Varying lessons contents are positively associated with flow experiences in P.E. lessons. The association is very highly significant.
6. A high level of self-determination is not positively associated with flow experiences.
7. Experiencing a sense of belongingness during P.E. is positively associated with flow experiences. The association is very highly significant.
8. A student's feeling of acceptance and appreciation (by the P.E. teacher) during P.E. lessons is positively associated with flow experiences. The association is significant.

The effect sizes (β) of all analyzed independent variables are depicted in figure 1.

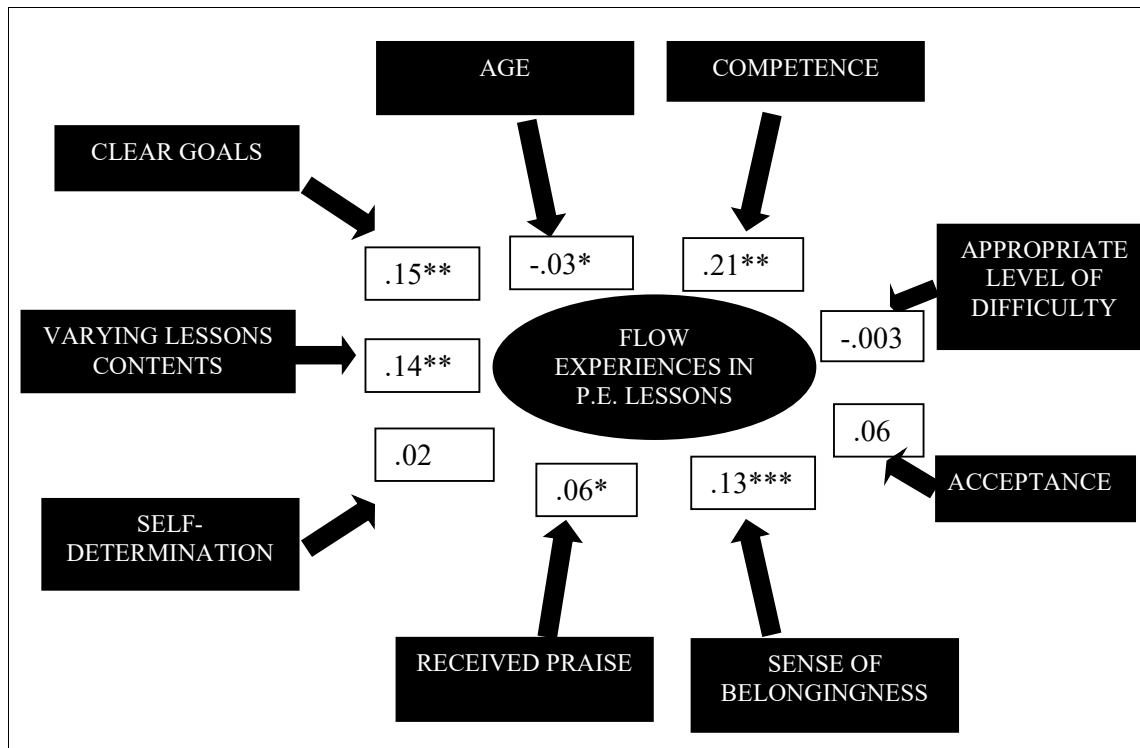


Figure 1. Effect sizes (β) of the analyzed independent variables

Discussion

The school curriculum in the federal state of Baden Wurttemberg, Germany, states that P.E. lessons should aim at increasing students' levels of enjoyment during P.E. (Ministry of Culture, Youth and Sport, Baden Wurttemberg, 2016). Teachers and schools face the challenging task to enhance positive emotions and possibly flow experiences in students in order to increase their general motivation for physical activity. Specific knowledge on possible determinants of flow is required to better understand conditions promoting flow experiences in P.E..

Dispositional flow, the frequency of flow experiences during physical activity, is positively associated with a willingness to remain or even increase physical activity behavior (Jackman et al., 2021). According to Csikszentmihalyi (1977), the experience of flow is so rewarding that individuals seek to replicate it. Flow goes along with additional psychological and physiological health benefits, for example enhanced well-being and self-concept (ADA, 2018; Jackman et al., 2021; Swann et al., 2012) and less school stress in students (Han & Park, 2020).

P.E. lessons address practically all children and adolescents and can potentially increase their physical activity behavior through positive emotions and flow experiences. Especially older female students, who generally experience less positive emotions during P.E. (Engels & Freund, 2018) could profit from conditions that enhance flow.

This study examined the frequency and determinants of students' flow experiences in P.E. at three secondary schools in Germany (Baden Württemberg and Niedersachsen) in the school year 2022/2023. The mean value of the calculated flow score (girls: 2.41; boys: 2.73) showed values above the middle value of the used Likert scale (2.0), indicating that male and female students experience flow regularly during P.E.. This finding is in line with data on students' levels of enjoyment during P.E. (Engels & Freund, 2018) and current representative surveys on the frequency of flow experiences in Germany, according to which only 10% of the population does not experience flow at all (Rheinberg, 2006).

Our data confirm that boys experience flow significantly more often than girls. This is consistent with studies showing that boys feel more comfortable and experience more positive emotions during P.E. than girls (Fernandes et al., 2020; Kleinert & Wolf, 2018). Some authors assume that the frequent implementation of games in P.E. lessons may be more appealing for boys and may partially explain the differences between the sexes (Prochaska et al., 2003). However, so far only few studies found gender-related differences in students with regard to flow (Jackman et al., 2021). Most studies could not confirm any differences between male and female students (ADA, 2018; Bakirtzoglou & Ioannou, 2011; González-Cutre et al., 2009; Jackman et al., 2021). Our study showed a negative association between flow and age. Flow experiences were more prevalent in younger students and dispositional flow decreased continuously with the students' age. This finding coincides with previous studies on joy, showing that the older students get, the less they seem to enjoy P.E. (Gerber, 2016; Gråstén et al., 2012).

In the following, the results of the presented study are discussed according to the analyzed independent variables.

Appropriate level of difficulty

According to Csikszentmihalyi (1977), reaching a state of flow requires an optimal balance between an individual's skill level and a given task a person is performing. Challenging and individually suitable levels of difficulty are often seen as a precondition of intrinsic motivation (Deci & Ryan, 1985), which in turn seems interrelated with flow experiences (ADA, 2018; Stoll & Ufer, 2021; Swann et al., 2012). However, the presented study could not confirm an association between individually appropriate levels of difficulty during P.E. and the frequency of students' flow experiences. Studies which could not prove an association between various contents used in P.E. lessons and students' positive emotions (Ramer et al., 2021) are rare.

Most studies could confirm a positive association between an appropriate challenge-skill balance and students' flow scores in P.E. lessons. In an intervention study, Kawabata (2018) used an 'open goal' approach and students were encouraged to choose gradually more difficult tasks over a course of ten weeks. The intervention groups showed significantly higher flow scores than a control group. Seifert and Hedderson (2010) documented similar results when observing and interviewing skateboarders, Rheinberg and Vollmeyer (2003) could document an association between flow and varying levels of difficulty in an experiment with students playing a computer game. Csikszentmihalyi (2002) points out that only in a setting offering challenges that suit an individual's skill set, flow seems possible to occur.

Our findings seems somewhat surprising since flow appears most likely to happen when skills and challenges are intermediate or high and when an optimal relation between both aspects exists. However, Nakamura and Csikszentmihalyi (2009) argue that one may be able to find flow in almost any activity. A fit of skills and challenges may be a precondition for flow to happen, but other factors than the level of difficulty may be more influential. Rheinberg (2006) could show that the importance of a task mediated the association between skills and challenges. The more important a given task was for the students, the less influential was the difficulty of a challenge.

Clear goals

Our study could confirm a positive association between the presentation of clear goals and the occurrence of flow experiences in P.E. lessons. Kawabata (2018) could also show that the presentation of clear goals significantly increased students' flow scores. According to Schiefele and Roussakis (2006), the specifications of a task have to be unambiguous and clear, so that there is no room for interpretation and the students know what to do at all times. Only then, according to the authors, can flow happen. In elite athletes, however, the factor 'clear goals' could not be confirmed as a facilitator of flow (Stoll & Ufer, 2021).

Praise

The presented study could confirm that students' flow scores were positively associated with the amount of praise they received through their P.E. teacher. According to Ada (2018), a positive motivational climate – the promotion of competence, relatedness, autonomy and task-goal orientation – can promote flow experiences. Therefore, praise, which is likely to induce positive thoughts and emotions and promote a task-oriented climate and intrinsic motivation, seems to be a likely determinant of flow. Accordingly, many authors see positive feedback as a facilitator of flow experiences (Masato Kawabata & Mallett, 2016; Swann et al., 2012), whereas a lack of confidence in one's competence seems to inhibit flow experiences (Jackman et al., 2021; Masato Kawabata & Mallett, 2016). Kawabata (2018) points out that any form of teacher feedback should be unambiguous in order to promote students' flow scores.

According to our data, praise and positive feedback could be a suitable tool to enhance the likeliness of flow experiences.

Competence

Deci and Ryan (2000) describe competence as a basic psychological need that is – together with autonomy and relatedness – associated with intrinsic motivation. Accordingly, people naturally seek out challenges that stretch their capacities.

In our study, the students' estimations of their level of competence in P.E. was the strongest predictor of flow. Engels and Freund (2018) could show that students' perceptions of their physical competences determine the level of joy they experience when being physically active. This is in line with reported positive associations between flow and competence (Keskin Akin et al., 2018; Swann, 2016). Also Stormoen et al. (2016) could show that the fulfillment of the basic psychological needs of competence, belongingness and autonomy accounted for 39% of the variance of flow experiences in 167 Norwegian high school students. According to their study, competence was the most influential determinant.

Some authors argue that a high level of competence may not be sufficient without an individually challenging task to be mastered. Seifert and Hedderson (2010) reported that skateboarders experienced flow only when overcoming challenges that required significant effort and concentration. In our study, the effect of competence on flow was independent of optimal individual challenges.

Varying lesson contents

Our results could confirm a positive association between the students' perceptions of varying, diverse lessons contents and the frequency of their flow experiences. This finding suggests that P.E. lessons need to include a variety of sports, games and challenges in order to address students' individual preferences. However, varying contents could also be the precondition for individually suitable levels of difficulty.

Self-determination

Self-determination as a basic psychological need (Deci & Ryan, 1985) has been associated with dispositional flow in P.E. classes and youth sport in several previous studies (Gaudreau et al., 2016; Masato Kawabata, 2018; Keskin Akin et al., 2018; Stormoen et al., 2016). In contrast to these findings, we could not confirm a positive association between the level of self-determination students perceived during P.E. lessons and the frequency of their flow experiences. Similarly, Engels and Freud (2018) could not prove an association between feelings of joy and self-determination in P.E. students. Our results seem contradictory but could be explained with other factors that may be more important when it comes to generating flow during P. E. (e.g.: competence).

Sense of belongingness

Social support and a strong sense of belongingness promote positive emotions during physical activities (Engels & Freund, 2018; Wienke & Jekauc, 2016). Our data confirm a positive association between belongingness and dispositional flow. Also Kawabata and Harimoto (2000) found out that a 'good atmosphere' in groups was a significant predictor of flow experiences, Gimeno et al. (2011) could show that flow experiences in the P.E. setting were associated with feelings of relatedness and Swann et al. (2015) reported that the caddie as a direct and important reference person was one of the most influential factors with regard to flow experiences in professional golfers.

Acceptance

Similarly, students' perceptions of acceptance and appreciation by the P.E. teacher during P.E. lessons are positively associated with flow experiences. This finding also is in line with previous studies on the association between social context and flow (Jackman et al., 2021).

Limitations of the study

The presented study was conducted at three different schools in Baden Wurttemberg and Niedersachsen. Two of the schools were secondary schools and one school was an integrated comprehensive school. Even though we interviewed students attending different school forms, generalizing conclusions on determinants of flow in P.E. lessons have to be drawn with caution. However, due to the big sample size and significant variance explanation, the results seem relevant. Our study could not confirm an association between the level of difficulty students experienced during the lessons and flow. This finding may be due to a slightly misleading formulation of the question ("For me personally, the challenges and demands in the P.E. lessons are **optimal**") which may be problematic in the context of P.E.. Firstly, challenges and demands during P.E. vary enormously between lessons and teachers and may also be different from one unit or lesson to the other. Hence, students may have been unable to properly assess this statement. Secondly, it may be possible that challenges need not be optimal for flow to occur but rather be considered as vaguely appropriate, so that the activity is not regarded as boring or uninspiring. Another formulation in order to assess an appropriate relation between skill level and challenge should be considered in future studies.

Conclusions

Dispositional flow seems to be influenced by an interaction of internal (e.g. thoughts and emotions), external (environment and situation) and behavioral factors (Swann, 2016). In the P.E. setting, internal and behavioral factors may only be addressed through the manipulation of external factors and the creation of

optimal conditions in order to increase students' levels of motivation and the likeliness of flow experiences. The presented study aimed at identifying associations between dispositional flow and relevant factors that can be directly or indirectly addressed by P.E. teachers during P.E. lessons.

According to Gimeno et al. (2011), who examined flow in a sample of 356 secondary school students, dispositional flow was predicted in 45% of the cases by motivational climate (relatedness) and task or performance goal-orientation. Our results could show that 62% of the variance in flow scores could be attributed to the examined variables. The relevance of factors like competence and relatedness in order to enhance flow could be confirmed (Jackman et al., 2021).

According to our data, the role of the teacher appears even more influential due to his or her significant influence on motivational climate and the presented possible determinants of flow. Thus, teachers have various possibilities to enhance the likeliness of students' flow experiences in P.E.. Creating an atmosphere which fosters high levels of competence and relatedness through positive communication, acceptance, individual praise and reinforcement, clear, unambiguous feedback and open (task-oriented) goals, individually challenging, varying and diverse lesson contents and the provision of differentiated learning opportunities may establish the foundation for flow experiences to occur in P.E.. Settings which focus on the exploration of personal potential may be particularly suited to enhance flow (Jackman et al., 2021).

Quintas et al. (2020) stress the positive effects of game-based P.E. lessons on dispositional flow in students. In this context, it seems important to enable students to actively participate and experience themselves as competent enough to do so.

Students attending P.E. lessons have different expectations, levels of competences and individual prior experiences. In order to address each individual's preferences at some point in the school year, it seems indispensable to offer a variation of interesting and attractive contents. Open and differentiating learning arrangements that leave students space to actively organize their learning process could have beneficial effects on flow experiences.

Since knowledge on factors that promote or inhibit the occurrence of flow in P.E. lessons is still scarce and inconclusive, further research in this field is still necessary (ADA, 2018).

Conflicts of interest

All authors consent final approval of the version to be published and agree to be accountable for all aspects of the work. They ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding: This research received no external funding

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki (WMA, 2013)

Informed Consent Statement: Informed consent was obtained from parents of all students involved in the study. Written informed consent has been obtained from the participants' parents to publish this paper" if applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

APPENDIX

Age: _____ years	Grade: _____
Sex: <input type="radio"/> male <input type="radio"/> female <input type="radio"/> diverse	Please tick one of the boxes!

This questionnaire refers to your personal perception of Physical Education lessons **in the ongoing school year!**
Please answer the questions as honestly as possible!

For me personally, the challenges and demands in the P.E. lessons are optimal.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
My thoughts and movements in the P.E. lessons feel smooth and easy.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I don't realize how time passes.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I have no difficulty in concentrating.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons my head is totally clear and free of troubling thoughts.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I am totally absorbed by what I am doing.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
The right thoughts and movements	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always

come easily during P.E. lessons.						
In the P.E. lessons I know what to do at any time.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I feel a sense of control over the situation.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I am oblivious of myself.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons something important is at stake for me.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I try to avoid mistakes.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I worry about failure.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons I know exactly what the goal is.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
The P.E. lessons are diversified and varied.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
In the P.E. lessons we are allowed to actively participate and make decisions.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
I receive praise by the P.E. teacher.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
I feel good and comfortable with my classmates in the P.E. lessons.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
I feel accepted by my P.E. teacher during the lessons.	never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	always
For me personally the tasks / challenges in the P.E. lessons are...	too easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	too demanding
I think I am...	not sportive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	sportive

Think of a situation when you were doing sport and you forgot everything around you, including yourself. Everything felt easy and smooth and you were highly concentrated. There were no feelings of fear or doubt. Conducting the activity felt exhilarating.

Have you ever experienced such a moment when doing sport?

- Yes
- No
- I don't know

If you ticked 'yes', please answer the following questions!

How often do you experience such moments when doing sport?

- often
- sometimes
- rarely

In which particular situation did you experience the described exhilarating sensation (most often)? (Please tick only one box!)

- In a sport club
- When doing sport with friends in a non-organized setting
- When doing sport on my own
- During P.E. lessons

What kind of sport did you do when you felt that way?

How good are you at that particular sport?

- Very good
- Good
- Ok
- Not so good

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

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