

## Preservice physical education teachers' beliefs about sustainable development in physical education —scale development and validation

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## Supplementary Information

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## Introduction

Ecologic and social consequences due to climate change (IPCC, 2022) are becoming tangible in many areas of life, including the sport and physical activity sector (Bernard et al., 2021). Here, too, the need for sustainable development (SD) is becoming stronger. On the one hand, sports and physical activity have great potential to contribute to SD, e.g., via active mobility promoting ecological SD and sports participation and leadership promoting social SD (Brand et al., 2021; Nigg & Nigg, 2021). On the other hand, they can also counteract SD, for example discrimination in sports compromising social SD or sports-related equipment and infrastructure limiting ecological SD (Nigg & Nigg, 2021).

Physical activities are an important part of children's and adolescent's lives (Schmidt et al., 2020). Thus, it is not only important to make children and adolescents aware of sport- and physical activity-related sustainability issues, but also a great chance to address them. An ex-

emplary game is “island in the sea”<sup>1</sup>. In this game, pupils have the task of finding out how all of the group can fit onto several gymnastics mats (island). During the course of the exercise, the mats are removed one by one, so that the pupils have less room to fit in. Pupils can cross to the mainland (other side of the gym) with the help of a raft (another mat), but they may not touch the floor. This exercise provides an opportunity to connect the “island” becoming smaller and smaller to rising sea levels as a consequence of climate change and to reflect the consequences of rising sea levels in real life. Therefore, physical education (PE) is a highly promising setting to reflect on sustainability issues as part of education for sustainable development (ESD; Baena-Morales, Ferriz-Valero, Campillo-Sánchez, & González-Villora, 2021; Bucht, Mess, Bachner, & Spengler, 2022), since almost all children and adolescents regularly attend PE lessons (Schmidt et al., 2020). PE teachers play a key role in implementing PE lessons as ESD. Whether and how PE teachers implement ESD in PE depends on the extent to which they consider sus-

tainability topics to be relevant in principle and what relevance they attribute to them in PE lessons. PE teachers' professional beliefs are assumed to be important determinants of their teaching practice, hence exerting a major influence on their pupils' learning in (SD-related) PE (Fives & Buehl, 2012).

Previous research on teachers' and preservice teachers' (PE teacher education students) SD beliefs has been largely limited to environmental aspects and focused on science or unspecified subjects. The literature regarding PE teachers' beliefs is limited, but growing (Baena-Morales et al., 2021; Baena-Morales, Prieto-Ayuso, Merma-Molina, & González-Villora, 2022a; Baena-Morales, Urrea-Solano, Gavián-Martin, & Ferriz-Valero, 2022b; Lohmann, Breithecker, Ohl, Gieß-Stüber, & Brandl-Bredenbeck, 2021). However, we are not aware of any measurement instruments that specifically assess PE teachers' beliefs regarding SD in PE. The current article aims to contribute to closing this research gap through a) illustrating the theoretical background and the item development to assess PE teachers' general and subject-specific SD-related beliefs in PE, b) investigating the psychometric properties and the criterion validity of the scales, and c) presenting empirical findings about preservice teachers' beliefs about the general and subject-specific relevance of SD in PE.

<sup>1</sup> “Island in the sea” is one of several physical activity games related to climate change issues, developed by PE teachers and scientists, more information can be found here: <https://www.sg.tum.de/sportdidaktik/praxismaterialien/klimabewegt/>.

The new instrument assesses one aspect of PE teachers ESD-related professional competence. It is intended to be used for evaluating ESD-related activities in school PE or PE teacher education, for example specific course programs or curriculum development.

## Background and theoretical lens

### Sustainable development and education for sustainable development in PE

In general, according to the Brundtland Commission (WCED, 1987), SD requires “difficult reconciliations in at least four dimensions, involving tensions between: a) present versus future generations; b) economic versus environmental perspectives; c) North versus South; d) scientific accuracy versus political acceptability” (Borowy, 2014, p. 5). Thus, in order to work towards SD, decision makers need to take a multidimensional view of issues, including environmental, sociocultural, and economic perspectives and their interconnectedness, to estimate short- and long-term action consequences (intergenerational justice) as well as consequences at individual, local, regional, and global levels (intra-generational justice; Borowy, 2014).

Education plays an important role in the societal transformation to shape a more sustainable development (UNESCO, 2020). Through ESD, learners should acquire knowledge and skills, but especially values and attitudes that empower them to recognize (non)sustainable developments, to contribute to building positive future scenarios, and to actively help shape transformation processes (UNESCO, 2020).

PE offers various opportunities for pedagogical reflections within the ESD framework. So far, however, the potential of PE for ESD has been neglected (Baena-Morales et al., 2022a; Bucht et al., 2022), although policy makers have pointed out the potential of sports, physical activity, and PE for achievement of the sustainable development goals (SDGs; e.g., WHO, 2018). For example, the Global Action

Plan on Physical Activity highlights the role of PE and physical activity programs for quality education (SDG 4) or reducing inequalities (SDG 10) via promoting social values, inclusion, and empowerment (WHO, 2018). Despite these positive expectations, environmental and social problems in sport are increasingly recognized (Müller et al., 2021). For example, an evaluation of the Olympic games across two decades showed declines across economic, social, and ecological sustainability (Müller et al., 2021), raising critical questions regarding how much sport can really contribute to SD. The example of mountain biking shows that recreational sports can also have a negative impact on wildlife and vegetation (Kuwaczka, Mitterwallner, Audorff, & Steinbauer, 2023) and lead to conflicts with different recreational user groups, such as hikers (Kleiner, Freuler, Arnberger, & Hunziker, 2022), thus counteracting ecological and social sustainability. This ambivalence of sport and physical activity regarding SD could be addressed particularly well in PE classes (Gieß-Stüber & Thiel, 2016). As a subject with a main focus on physical activity, PE offers particularly action-oriented learning opportunities that are usually linked to social situations or emotions and require direct engagement with the physical environment (Baena-Morales et al., 2022a; Bucht et al., 2022; Gieß-Stüber & Thiel, 2016).

Across Germany, ESD is formulated as a cross-curricular educational objective in school curricula (KMK, 2017). Most federal states also describe the contribution of individual school subjects to ESD. For example, the Bavarian curriculum emphasizes the potential of outdoor PE to develop a responsible approach to the natural environment (Staatsministerium für Unterricht und Kultus, 2023). This implies a certain focus on environmental aspects of sustainability; however, other overarching educational goals in the curriculum (e.g., health and wellbeing, social competence) also fit into the ESD framework and are related to the SDGs.

### ESD-specific professional competence of PE teachers—the role of teachers’ beliefs and values

If ESD is to become viable in PE, PE teachers with ESD-specific professional competence are needed (Lohmann et al., 2021; UNESCO, 2020). At the level of cognitive dispositions, professional competence comprises four relevant aspects: beliefs and values, professional knowledge, motivational orientations, and self-regulation (Baumert & Kunter, 2006; Baumgartner, 2022). It is important to consider both subject-specific (Baumert & Kunter, 2006) and topic-specific aspects of professional competence, for example regarding the SD concept generally, and SD issues in PE specifically. Our work is theoretically based on PE-specific (Baumgartner, 2022) and ESD-specific (Lohmann et al., 2021) literature about teachers’ professional competence. In this article we focus on SD beliefs and environmental values as important aspects of PE teachers’ ESD-specific professional competence.

*Beliefs* are described as a multidimensional system of an individual’s judgments about the nature, truth, and falsity of something or how it works (Fives & Buehl, 2012). Due to their interrelatedness, changes in one specific belief may change the whole belief system (Martin, Park, & Hand, 2019). Beliefs are adopted as personal truths, providing guidance and structure to professional thinking and actions (Skott, 2015), such as decisions regarding the lesson content and how it is framed or effort or persistence regarding certain topics (Fives and Buehl, 2012). Although the role of beliefs for action is not fully understood yet, empirical evidence highlights the role of beliefs as important predictors of classroom practice (e.g., Martin et al., 2019). Beliefs are usually operationalized using constructs like attitude or awareness, such as in the value-belief-norm theory (Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Based upon this, we use SD beliefs as an overarching term that includes attitudes towards and awareness of SD issues. In our study, we take a closer look at importance beliefs, in particular those regarding the relevance of the SD concept more gener-

ally, and subject-specific beliefs about SD in PE, specifically positive and critical attitudes. Taken together as a belief system, both types of beliefs might be important precursors of implementing ESD in PE.

According to the value-belief-norm theory (Stern et al., 1999), beliefs and values are directly related. Based on this theory, values are antecedents of beliefs: people who feel that their values (e.g., welfare of the planet and the people) are threatened are aware of the consequences coming from the threat (e.g., climate change) and believe that they are responsible for reducing the threats to protect their values (Stern et al., 1999). *Values* are defined as overarching motivational goals that serve as guiding principles and justification for actions in a person's life (Schwartz, 1992). The so-called *environmental values* (de Groot & Steg, 2007; de Groot & Steg, 2008; Steg, Perlaviciute, van der Werff, & Lurvink, 2014) could be relevant precursors for implementing ESD in schools (Tolppanen & Kärkkäinen, 2022). Theoretical considerations and empirical evidence suggest that self-transcendent value orientations (biospheric and altruistic values) and self-enhancement value orientations (egoistic and hedonistic values) are particularly important predictors of SD beliefs and sustainable behaviors (de Groot & Steg, 2007; de Groot & Steg, 2008; Steg et al., 2014). Indeed, previous studies in the general population (de Groot & Steg, 2008) and with teachers (Tolppanen & Kang, 2021) showed positive associations between biospheric and altruistic values and environmental awareness and attitudes. Based upon this, we assume for this study that PE teachers with strong biospheric and altruistic values may feel responsible for protecting their values by teaching about SD and implementing ESD.

### Empirical findings about PE teachers' SD beliefs

Previous research on teachers' and preservice teachers' SD beliefs (including attitudes and awareness) has been largely limited to science subjects (e.g., Esa, 2010) or does not allow conclusions about individual subjects (e.g., Ander-

sson, Jagers, Lindskog, & Martinsson, 2013; Mróz, Tomczyk, Ocetkiewicz, & Walotek-Ściańska, 2018; Rieß, Mischo, Reinbolz, Richter, & Dobler, 2008). Some researchers investigated the respective attitudes of students majoring in different study fields that were rated as more or less "environment-affiliated" (Pe'er, Goldman, & Yavetz, 2010; Yavetz, Goldman, & Pe'er, 2014), and only few specifically investigated PE teachers (Baena-Morales et al., 2021; Baena-Morales et al., 2022a; Baena-Morales et al., 2022b; Fröberg, Wiklander, & Lundvall, 2022).

Most research focuses on teacher's attitudes or views regarding the environment (Andersson et al., 2013; Ezpeleta & Echevoyen-Sanz, 2020; Esa, 2010; Pe'er et al., 2010; Tolppanen & Kärkkäinen, 2022; Yavetz et al., 2014), neglecting the other SD dimensions. Overall, most studies are cross-sectional and conclude that (preservice) teachers have rather high environmental or sustainability awareness. Longitudinal evidence demonstrates the potential of ESD by proposing that preservice teachers' attitudes towards SD change positively in response to an intervention, for example attending an ESD course (Nousheen et al., 2020).

Furthermore, rather clear tendencies could be identified regarding gender differences: female teachers were usually more concerned about SD (Baena-Morales et al., 2021) and their environmental awareness was also more pronounced (Ezpeleta & Echevoyen-Sanz, 2020) compared to male teachers. In addition, female students are more aware of the need for interventions and activism regarding the environment and are more willing to get personally involved (Sutton & Gyuris, 2015).

Regarding the assessment, environmental attitudes and awareness were mostly assessed with validated and well-established scales for a general audience, e.g., the Connectedness to Nature Scale (Mayer & Frantz, 2004), Environmental Identity Scale (Clayton & Opatow, 2003), or the New Ecological Paradigm Scale (Dunlap, van Liere, Mertig, & Jones, 2000). Although (E)SD is a multidimensional concept that goes beyond environmental issues, measurement instruments

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### Abstract

Climate change poses a major challenge to people and ecosystems and calls for action across all areas to contribute to a sustainable transformation of society. To shape this transformation, it is crucial that teachers implement education for sustainable development (ESD) in schools for a more sustainable future generation, which also applies to physical education (PE) teachers. However, little is known about PE teachers' beliefs, a key dimension of professional competence, regarding the implementation of ESD in PE. Hence, the goal of this study was to 1) develop a scale to capture PE teachers' beliefs about the relevance of sustainable development generally and in the context of PE, and 2) investigate its psychometric properties and criterion validity. The analysis using exploratory structural equation modeling in a cross-sectional sample of 206 preservice teachers resulted in a 10-item instrument with good psychometric properties (comparative fit index [CFI] = 0.976; root mean square error of approximation [RMSEA] = 0.047; standardized root mean square residual [SRMR] = 0.057) and reliability across three factors: a) general beliefs about the relevance of sustainable development, b) positive, and c) critical subject-specific beliefs about sustainable development in PE. Based on the value-belief-norm theory, criterion validity was confirmed through associations between biospheric values and beliefs. We conclude that the newly developed scale is appropriate for assessing PE teacher's beliefs about the implementation of ESD in PE.

### Keywords

Sport · Attitude · Sustainability ·  
 Environmental values · Questionnaire

capturing the different dimensions are rare. One instrument for multidimensional assessment is the Sustainability Consciousness Questionnaire, capturing attitudes across environmental, social, and economic aspects (Gericke et al., 2019). However, this questionnaire is also for a general audience and not sports or PE specific.

Regarding research about PE teachers' beliefs specifically, empirical evidence is still limited, with most empirical research in Europe so far coming from Spain (Baena-Morales et al., 2021; Baena-Morales et al., 2022b; Baena-Morales et al., 2022a), Sweden (Fröberg et al., 2022), and Germany (Lohmann et al., 2021). Baena-Morales et al. (2021) provide evidence for high sustainability awareness in PE teachers (divided into environmental, social, and economic dimensions), and even higher awareness in women than men. Fröberg et al. (2022) reported medium "sustainability competencies" with slightly higher values in the social compared to economic and environmental dimensions. The "sustainability competencies" in that study referred to what competencies PE teachers would promote in pupils related to different SDGs in PE (Baena-Morales et al., 2022b; Fröberg et al., 2022).

### Research gaps and purpose of this study

Summarized, previous research on teachers' SD beliefs has been focused on environmental aspects and mostly neglected the multidimensionality of SD, with little research specifically in PE teachers. In addition, the measurement instruments used in those studies were mostly validated but intended for a general audience and not specifically tailored to beliefs in (PE) teaching. As a part of this, these instruments only assess general beliefs that are not dedicated to a certain context like, for example, the teaching context or sports and physical activity. For example, the Sustainability Consciousness Questionnaire asks people to rate the importance of stricter laws to protect the environment, ensuring quality of life for future generations and reducing poverty (Gericke et al., 2019). These items aim

to assess personal beliefs, but their applicability for one's professional belief system is limited, and even less so for the PE context. Since professional and personal beliefs are not necessarily the same (e.g., Himi & Bonny-Noach, 2018), it is important to develop an instrument that assesses SD as part of PE teachers' professional belief system. Furthermore, some studies with teachers investigated SD beliefs in general or in science subjects (e.g., Esa, 2010; Mróz et al., 2018). But PE differs from most other cognitively focused subjects in the seated classroom (e.g., math), with a focus on physical activity and the kinesthetic experience (Chen, Martin, Sun, & Ennis, 2007). Hence, reflections and discussions around SD may be considered as competition to physical activity engagement, which should be specifically addressed. Beliefs about the relevance of the SD concept and especially subject-specific beliefs about SD in PE, i.e., about the importance of socioecological issues in the PE classroom, have neither been studied nor is there an instrument to measure these beliefs. Furthermore, environmental values have not been considered as part of ESD-specific professional competence among PE teachers, although they are considered important predictors of specific SD beliefs.

In this article we therefore developed a questionnaire to capture general beliefs about the relevance of SD as well as subject-specific beliefs about SD in PE and tested its psychometric properties and criterion validity. This instrument might be used for evaluating ESD-related actions in (PE) teacher education or schools.

## Methods

### Procedure

This study is based on cross-sectional data from the project ANONYMISED. The development and validation of the questionnaire was conducted in two steps: a) scale development, including analysis of psychometric properties; and b) criterion validation, using the construct of environmental value orientations. The study was conducted in accordance with

the Declaration of Helsinki. All participants were informed about the study in detail and provided informed consent, data were collected anonymously. The University of Augsburg stated that the study was exempt from ethical approval.

### Sample and data collection

Preservice PE teachers (university students) who were enrolled in PE teacher education programs for different school types at several universities in Germany were invited to take part in the study. The online questionnaire was designed with [www.sosicurvey.de](http://www.sosicurvey.de) and distributed via mailing lists and social media. A total of 216 participants responded to the survey. After data cleaning (5 persons were not preservice PE teachers, 5 persons responded to less than 5 of the relevant items for this study), the sample for this study consisted of  $N=206$  preservice PE teachers (117 female, 88 male, 1 diverse) with a mean age of 23.41 years (standard deviation = 4.3 years) studying in their first to 16th semester: 58 were enrolled in PE teacher education for primary schools (*Grundschule*), 34 for middle-level high schools (*Haupt- und Realschule*), 98 for upper high schools (*Gymnasium*), and 16 for other school types.

### Item development: beliefs about SD in PE

Fifteen items were developed for different aspects of SD beliefs (see electronic supplement for original item pool): a) general *beliefs about the relevance of the SD concept*, e.g., "For me personally, it is relevant to live according to the guiding principles of sustainable development," and subject-specific beliefs divided into b) *positive attitudes towards SD in PE*, e.g., "Problematic issues of global development can be illustrated to pupils particularly well using the example of sport during PE" and c) *critical attitudes towards SD in PE*, e.g., "It is not the job of PE to discuss socioecological issues." In general, ESD is associated with fostering competence and providing complex cognitive tasks (UNESCO, 2020). In PE, however, ESD should be linked to physical activity (Bucht et al., 2022). As men-

tioned above, this may pose a challenge for PE where the kinesthetic experiences are usually seen as core content (Chen et al., 2007). The subscales on subject-specific beliefs about SD in PE (b, c) therefore contain items that reflect the relationship between ESD and physical activity, e.g., the notion that physical activity can be combined well (positive attitude), and the notion that physical activity and ESD are not compatible, and that physical activity is the only important thing in physical education (critical attitude).

All items were answered on a six-point Likert scale ranging from 1 (do not agree at all) to 6 (fully agree). We formulated five items for each subscale so that we could delete items based on empirical analysis and still have each subscale consist of at least three items (Marsh, Hau, Balla, & Grayson, 1998).

### Measurement for criterion validation: environmental values

*Environmental values* were assessed with a short version of Schwartz's (1992) value scale, developed by de Groot and Steg (2007; de Groot & Steg, 2008) and adapted by Steg et al. (2014). The scale has been validated in various studies (e.g., de Groot & Steg, 2007; de Groot & Steg, 2008; Steg et al., 2014). Specifically, we used the German version of the instrument that has been used by Sargisson, de Groot, and Steg (2020). The value scale has 16 items, including four altruistic (e.g., social justice), four biospheric (e.g., protecting the environment), five egoistic (e.g., wealth), and three hedonistic (e.g., pleasure) values. Respondents indicated to what extent each value was important "as a guiding principle in their lives" on a nine-point scale, ranging from "opposed to my values" (-1) to "of supreme importance" (7). Respondents were instructed to vary scores as much as possible and to rate no more than two values as extremely important.

### Statistical analysis

All statistical analyses were conducted with the Software R (version 4.2.2, R Core

Team, 2018). The R code is available in the supplementary material.

To investigate the psychometric properties of the instrument, data were analyzed by combining exploratory and confirmatory procedures. We first conducted exploratory structural equation modeling (ESEM), a technique that integrates exploratory (EFA) and confirmatory factor analyses (CFA); it provides "confirmatory tests of a priori factor structures, relations between latent factors and multigroup/multi-occasion tests of full (mean structure) measurement invariance" (Marsh, Morin, Parker, & Kaur, 2014, p. 85). We used ESEM to simultaneously explore our newly developed instrument and confirm our theoretical assumptions about the allocation of items to specific factors. ESEM includes a) conducting EFA to investigate the structure of the scale in an open and data-driven way. In our case we restricted the model to three factors, used geominQ-Rotation, which does not emphasize getting rid of cross-loadings, and  $\Delta = 0.5$ ; b) setting up an ESEM model, a CFA-like model that allows cross-loadings; and c) fitting the ESEM model to the data (Silvestrin, 2020). We used the R packages "psych" (Revelle, 2017) for conducting EFA and "lavaan" (Rosseel, 2012) for setting up and fitting the ESEM model. After running the first model, we applied the so-called 0.40-0.30-0.20 rule (Howard, 2016), which suggests for the evaluation of EFA-retaining items with main loadings  $\lambda \geq 0.40$ , cross-loadings  $\lambda \leq 0.30$ , and a minimum difference between main and cross-loading of 0.20. We marked all items that did not meet one or more of these criteria and then decided which items to retain based on the empirical data and theoretical considerations. We refer to the original ESEM model with all items as Model 1a and the two adapted models as Model 2a and Model 3a. Second, as suggested by Marsh et al. (2014), we calculated regular CFAs for all three models, which would be preferable for further analysis following model parsimony. We refer to these models as 1b, 2b, and 3b. Third, after deciding on the final model, we calculated reliability values (Cron-

bach's  $\alpha$  and composite reliability  $\omega$ ) for the subscales.

Model fit was assessed using the  $\chi^2$  statistic, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR; Kline, 2016). The model fit was considered acceptable for  $CFI \geq 0.95$ ,  $RMSEA \leq 0.08$ , and  $SRMR \leq 0.10$  (Schermelleh-Engel et al., 2003). After investigating the psychometric properties and the decision for the final item sets for the scales, we calculated scale means for further descriptive and statistical analyses. Since previous research showed gender differences regarding SD beliefs (Baena-Morales et al., 2021; Ezpeleta & Echegoyen-Sanz, 2020), independent samples *t*-tests were calculated for examining gender differences.

To assess the criterion validity of the new instrument, we first examined to what extent the SD beliefs can be empirically differentiated as separate constructs from environmental values. Thus, bivariate correlations are expected to be low to medium ( $|r| < 0.70$ ). Subsequently, regression analyses were used to examine the extent to which environmental values predict SD beliefs. For the criterion validation, we hypothesized that:

**H1a.** Self-transcendent (i.e., altruistic and biospheric) values are positively associated with stronger beliefs about the relevance of SD and positive subject-specific beliefs about SD in PE, and negatively associated with subject-specific critical beliefs about SD in PE.

**H1b.** Self-enhancing (i.e., egoistic and hedonistic) values are negatively associated with stronger beliefs about the relevance of ESD and positive subject-specific beliefs about SD in PE, and positively associated with critical beliefs about SD in PE.

**H2a.** Beliefs about the general relevance of SD are positively predicted by self-transcendent values, and negatively by self-enhancing values.

**H2b.** Positive subject-specific beliefs about SD in PE are positively predicted

**Table 1** Model fit indices of models 1, 2, and 3

Model	$\chi^2$	CFI	TLI	RMSEA (90% CI)	SRMR
Model 1a	$\chi^2(63) = 133.73, p < 0.001$	0.892	0.820	0.084 (0.064; 0.104)	0.052
Model 1b	$\chi^2(87) = 161.22, p < 0.001$	0.869	0.841	0.079 (0.060; 0.098)	0.079
Model 2a	$\chi^2(33) = 43.11, p = 0.112$	0.978	0.957	0.048 (0.000; 0.084)	0.038
Model 2b	$\chi^2(51) = 84.49, p = 0.002$	0.928	0.906	0.071 (0.042; 0.097)	0.068
Model 3a	$\chi^2(18) = 16.53, p = 0.556$	> 0.999	1.009	< 0.001 (0.000; 0.068)	0.025
Model 3b	$\chi^2(32) = 41.57, p = 0.120$	0.976	0.967	0.047 (0.000; 0.084)	0.057

Models a are ESEM models, Models b are CFA models (robust results of estimation with MLR estimator). Final model is Model 3 (italics)

CFI comparative fit index, TLI Tucker–Lewis index, RMSEA root mean square error of approximation, SRMR standardized root mean square residual (robust estimates are reported), CI confidence interval, ESEM exploratory structural equation modelling, CFA confirmatory factor analysis

**Table 2** Items and standardized factor loadings for the final ESEM model (Model 3a)

No.	Item	$\lambda_{\text{relevance}}$	$\lambda_{\text{positive}}$	$\lambda_{\text{critical}}$
<i>Beliefs about relevance of SD</i>				
x1 <sup>a</sup>	Sustainable development does not concern me	0.40	-0.15	-0.23
x2	Everyone can contribute to sustainable development; this is required to succeed as society	0.52	-0.24	-0.12
x4	For me personally, it is relevant to live according to the guiding principles of sustainable development	0.79	0.05	-0.08
x5	Sustainable development is the most important task of today's society and must necessarily be shaped by political decisions	0.60	0.25	0.23
<i>Positive beliefs about SD in PE</i>				
x6	Problematic issues of global development can be illustrated to pupils particularly well using the example of sport during PE	0.02	0.56	-0.20
x7	The popularity of PE should be used to critically and analytically reflect on politically and socially relevant topics using sport as an example	0.10	0.78	-0.14
x10	Education for sustainable development is a task for the whole school where PE must contribute as well	0.09	0.33	-0.47
<i>Critical beliefs about SD in PE</i>				
x11	In PE, the focus is on physical activity. The available time should not be used for other tasks, e.g., cognitive tasks	0.07	-0.02	0.73
x12	The aim of PE is getting children physically active during the school day. Sociopolitical issues should be addressed in other subjects	-0.03	-0.25	0.65
x15	It is not the job of PE to discuss socioecological issues	-0.12	-0.03	0.66

Main factor loadings in *italics*, English items are not validated

ESEM exploratory structural equation modelling, SD sustainable development, PE physical education

<sup>a</sup>Reversly coded item

pool had their highest factor loadings on the theoretically assigned factor (except item x15, see electronic supplement). The model fit was close to acceptable (CFI = 0.892, RMSEA = 0.084, SRMR = 0.052). However, three items (x8, x13, x14) had high cross-loadings ( $\lambda > 0.50$ ), and these items have in common that they represent ESD in relation to or in competition with physical activity and motor learning in PE, instead of focusing on the relevance of ESD in PE. Excluding these items in the next ESEM in the adapted Model 2a resulted in an improved model fit (CFI = 0.978, RMSEA = 0.048, SRMR = 0.038). In Model 2a, the factor loadings on the relevance factor additionally indicated a dominance of item x4 (Table 1) and a low factor loading specifically on item x3 ( $\lambda = 0.25$ ). In the positive beliefs factor, item x9 also had a low factor loading ( $\lambda = 0.18$ ). In the critical beliefs factor, the remaining items (x11, x12, x13) had factor loadings above 0.65. Accordingly, we estimated a third model, in which we waived items x3 and x9. In Model 3a the model fit improved again compared to Model 2a (CFI = > 0.999, RMSEA = 0.047, SRMR = 0.029). The same pattern applied when calculating the more restrictive CFAs (Table 1), with the 10-item model (Model 3b) showing a slightly better model fit than the 12-item model (Model 2b) and the original 15-item model (Model 1b). Thus, we decided to use Model 3 as the final model. All subsequent analyses were calculated based on this model. Table 2 shows the factor loadings of the adapted ESEM model (Model 3a). For visibility reasons and since the ESEM and CFA results were comparable, Fig. 1 presents the more parsimonious CFA of Model 3b.

by self-transcendent values, and negatively by self-enhancing values.

**H2.** Critical subject-specific beliefs about SD in PE are positively predicted by self-enhancement values, and negatively by self-transcendent values.

In addition, we explored whether the association between self-transcendent or self-enhancing values and SD beliefs was

moderated by gender using interaction analysis.

## Results

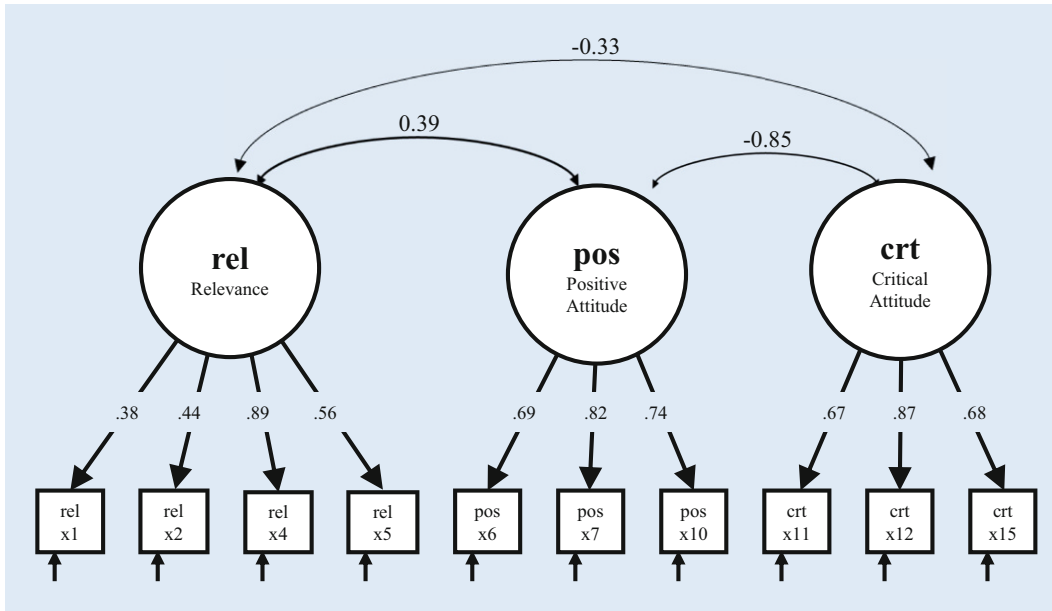
### Scale development: beliefs about SD and ESD in PE

#### Psychometric properties

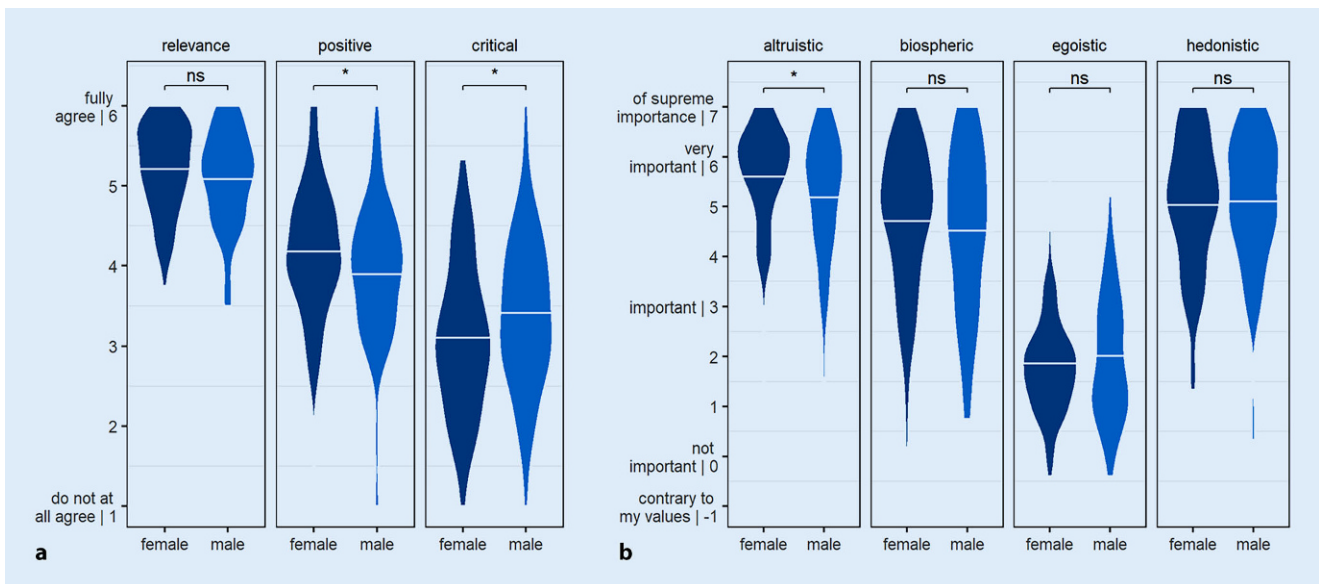
In Model 1a, the ESEM analysis showed that all 15 items of the original item

#### Descriptive statistics and gender differences

Means (M) and standard deviations of the items (Model 3) are displayed in Table 3. Participants generally believe that SD is relevant (M = 5.16, standard deviation = 0.59). While they have rather strong positive beliefs about ESD in PE (M = 4.06, standard deviation = 0.89), they simultaneously hold some critical beliefs (M = 3.24, standard



**Fig. 1** ◀ Results of the final CFA model (Model 3b) with standardized factor loadings



**Fig. 2** ▲ Gender differences in study variables. **a** Sustainable development beliefs. **b** Environmental values. \* $p < 0.05$ . White line represents the mean, ns not significant

deviation = 0.99). Female participants reported significantly stronger positive attitudes towards SD in PE than male participants ( $t(161.16) = 2.15, p = 0.03$ ) whereas male participants reported stronger critical attitudes towards SD in PE ( $t(169.49) = -2.17, p = 0.03$ ). No significant gender difference was found for beliefs about the relevance of SD (Fig. 2). A significant gender difference was also found for altruistic values ( $t(148.15) = 2.36, p = 0.02$ ), but not for the other values.

### Criterion validation

#### Bivariate correlations

SD beliefs significantly correlate with altruistic and biospheric, but not with egoistic or hedonistic values (Table 3), i.e., H1a is supported by our data, whereas H1b is rejected. All correlations were below  $r = 0.70$ . From this, we conclude that SD beliefs and environmental values are related but represent different constructs.

### Regression analyses

Table 4 shows the results of the regression analyses. We estimated three models with environmental values predicting SD beliefs, controlling for gender. All three hypotheses (H2a, H2b, H2c) are partly confirmed, which means that if values predict beliefs, they do so in the expected direction. However, only biospheric values were significant predictors of SD beliefs when controlling for each of the other values and gender (Table 4). Environmental values explained 35.8% of

**Table 3** Correlations of study variables

	1	2	3	4	5	6	7
1 Relevance of SD	–	0.29**	–0.24**	0.40***	0.56***	–0.09	0.08
2 Positive about SD in PE	–	–	–0.67***	0.18*	0.26***	0.03	0.03
3 Critical about SD in PE	–	–	–	–0.04	–0.17*	0.10	0.04
4 Altruistic values	–	–	–	–	0.55***	0.13	0.27***
5 Biospheric values	–	–	–	–	–	0.06	0.25***
6 Egoistic values	–	–	–	–	–	–	0.18*
7 Hedonistic values	–	–	–	–	–	–	–
Mean	5.16	4.06	3.24	5.42	4.42	1.92	5.06
Standard deviation	0.59	0.89	0.98	1.17	1.57	1.17	1.35
Cronbach's $\alpha$	0.65	0.79	0.79	0.75	0.89	0.75	0.86
Composite reliability ( $\omega$ )	0.66	0.80	0.79	0.76	0.89	0.74	0.86

Computed correlation used the Spearman method with pairwise deletion. Model fit for environmental values (4–7):  $\chi^2(98) = 138.84, p = 0.004$ ; comparative fit index (CFI) = 0.96, Tucker–Lewis index (TLI) = 0.96; root mean square error of approximation (RMSEA) = 0.05, 90% CI (0.03, 0.07); standardized root mean square residual (SRMR) = 0.07

SD sustainable development, PE physical education

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

variance ( $R^2_{adj} = 0.358$ ) in beliefs about the relevance of SD, 7.5% ( $R^2_{adj} = 0.075$ ) in positive and 5.1% ( $R^2_{adj} = 0.051$ ) in critical attitudes towards SD in PE. All interaction analyses between environmental values and gender were nonsignificant.

## Discussion

Teachers' beliefs may shape their practice (Fives & Buehl, 2012). SD beliefs are important aspects of teachers' ESD-specific professional competence and precursors of implementing ESD in class (Baena-Morales et al., 2021; Lohmann et al., 2021). Beliefs that relate aspects of SD to one's own subject seem to be particularly important. Research about ESD in PE is growing, but (preservice) PE teachers' subject-specific beliefs about SD in PE are not yet well understood. The purpose of this study was to present empirical findings about preservice PE teachers' beliefs about the relevance of SD in PE and to provide first indications on the psychometric quality and criterion validity of the instrument that was used to assess these beliefs.

## Scale development and psychometric properties

The ESEM supported the distinction of three aspects of SD-related beliefs in preservice PE teachers, suggesting that be-

liefs about the general and personal relevance of SD as well as positive and critical subject-specific attitudes about SD in PE are three distinct factors. Three items were deleted from the original item pool. The deleted items have in common that they have high cross-loadings, and they addressed SD in the context of physical activity (x8) or physical activity and sports performance as the most relevant content of PE (x13, x14). Without these physical activity-related items, the model fit improved appreciably. This indicates that PE teachers may, in principle, have a positive attitude towards ESD in PE, but only if ESD is not at the expense of a high amount of physical activity (Chen et al., 2007). Since this seems to be an issue that may be addressed on its own and does not fit into the structure of our questionnaire, we decided to exclude this thematic issue from the scale. The adapted model concentrates on positive and critical attitudes towards SD in PE, without interfering with beliefs about the role of cognitive activating learning tasks versus physical activity in PE. Two additional items (x3 and x9) were deleted in a second step because of low factor loadings. Item x4 still dominates the relevance factor to a certain extent, but the factor loading of item x5 is also quite high. These two items are at the core of the factor, as they quite explicitly address the relevance of orienting one's own life

or society towards sustainable development.

The newly developed questionnaire makes it possible to examine teachers' subject-specific beliefs about SD in the subject PE. In the research on SD beliefs of PE teachers, this questionnaire can be classified between the rather general Sustainability Consciousness Questionnaire (Gericke, Boeve-de Pauw, Berglund, & Olsson, 2019), which was used to assess the general sustainability consciousness (including awareness, knowingness, and behavioral intention) of individuals regardless of profession or context (Baena-Morales et al., 2021), and the very specific PESD-FT (Physical Education Scale for Sustainable Development in Future Teachers; Baena-Morales et al., 2022b), which captures which SDGs PE teachers believe could be worked on in PE. The questionnaire presented here can be considered complementary to these instruments to ask PE teachers whether they consider SD to be relevant for themselves and for PE at all.

We assumed that SD beliefs (in PE) comprise three interrelated factors: one rather general factor which measures how important the respondents consider SD for themselves and for society, and two subject-specific factors which capture beliefs about addressing SD issues in PE. It could also be argued that the instrument should be divided in order to assess general and subject-specific beliefs as two separate constructs. However, due to the interrelatedness of beliefs, we considered that overarching general beliefs are also relevant for the subject-specific beliefs and were thus included in the instrument.

## Criterion validation

The hypotheses for criterion validation were confirmed regarding the associations among SD beliefs and self-transcendence values. In line with the literature (de Groot & Steg, 2008; Tamar, Wirawan, Arfah, & Putri, 2021), biospheric and altruistic values were positively correlated with beliefs about the relevance of SD and positive attitudes towards SD in PE. Biospheric values negatively correlated with critical attitudes towards SD in PE.

**Table 4** Results of regression analyses

Predictors	Dependent variable											
	Relevance of SD				Positive beliefs about SD in PE				Critical beliefs about SD in PE			
	$\beta$	95% CI	t	p-value	$\beta$	95% CI	t	p-value	$\beta$	95% CI	t	p-value
(Intercept)	0.02	-0.16, 0.21	12.12	<0.001	0.12	-0.07, 0.31	6.60	<0.001	-0.12	-0.32, 0.07	5.35	<0.001
Altruistic	0.18	-0.01, 0.36	1.86	0.066	0.00	-0.18, 0.18	0.01	0.989	0.08	-0.10, 0.25	0.83	0.407
<i>Biospheric</i>	<i>0.52</i>	<i>0.34, 0.71</i>	<i>5.55</i>	<i>&lt;0.001</i>	<i>0.29</i>	<i>0.11, 0.46</i>	<i>3.27</i>	<i>0.001</i>	<i>-0.24</i>	<i>-0.42, -0.07</i>	<i>-2.73</i>	<i>0.007</i>
Egoistic	-0.09	-0.24, 0.06	-1.19	0.238	0.00	-0.14, 0.15	0.06	0.952	0.11	-0.04, 0.25	1.43	0.154
Hedonistic	-0.12	-0.28, 0.04	-1.44	0.154	-0.04	-0.20, 0.11	0.56	0.576	0.07	-0.09, 0.22	0.84	0.404
Gender	-0.05	-0.35, 0.24	-0.37	0.714	-0.27	-0.56, 0.02	-1.87	0.064	0.29	-0.01, 0.58	1.92	0.057
n	125				182				184			
R <sup>2</sup> /R <sup>2</sup> <sub>adj</sub>	0.38/0.36				0.10/0.08				0.08/0.05			

Standardized results are reported. gender: female = 1, male = 2

*italics*: significant predictor

SD sustainable development, PE physical education, CI confidence interval for  $\beta$

When controlling for the other values and gender in the regression analyses, only biospheric values were related to the SD beliefs. This supports the findings of Tolppanen and Kang (2021), who found biospheric values to be the strongest predictors of environmental attitudes and behavior, independent of other values. In our study, environmental values explained a considerable proportion of the variance in beliefs about the relevance of SD (28%) and less variance in subject-specific SD beliefs in PE (<10%). Our findings generally support the value-belief-norm theory (Stern et al., 1999): PE teachers with stronger biospheric values consider SD to be more important to their lives and society and have a more positive and less critical attitude towards SD in PE, which may lead to the implementation of ESD in PE to protect their (biospheric) values. In contrast to our hypotheses, self-enhancement values were not relevant in predicting SD beliefs. However, this finding also fits with the literature, where negative effects of self-enhancement values on sustainability awareness or behavior are generally assumed, but cannot always be confirmed (Tamar et al., 2021). Overall, the role of egoistic and hedonistic orientations in explaining SD-related attitudes seems to be more complex than that of self-transcendent orientations (Tolppanen et al., 2021) and remains to be further investigated.

Researchers so far have investigated environmental values in preservice (Tolppanen & Kang, 2021; Tolppanen

et al., 2022) and in-service (Suleri & Cavagnaro, 2016) teachers, mostly as predictors of pro-environmental behavior. However, they have hardly been studied as a part of (preservice) teachers' professional competence with the theoretical background presented here, especially not in PE. Thus, with regard to the environmental values, our study provides information on environmental value orientations in the group of future PE teachers beyond the criterion validity of the new questionnaire.

We conclude that the newly developed instrument serves to measure beliefs about the relevance of SD and subject-specific positive and critical attitudes towards SD in PE as related but clearly distinct constructs from environmental values. As expected, environmental values are, at least partially, associated with these beliefs in the expected direction. Together with the SD beliefs they might be interpreted in terms of a belief system that is part of PE teachers' ESD-specific professional competence which, in turn, is relevant for implementing ESD in PE (Lohmann et al., 2021).

### Gender differences regarding SD and ESD beliefs in PE and environmental values

Gender differences emerged for subject-specific positive and critical attitudes towards SD in PE but not for beliefs about the relevance of SD. In line with the literature (e.g., Baena-Morales et al., 2021), female participants had stronger positive

attitudes towards SD in PE than their male counterparts, and male participants had stronger critical attitudes. Regarding environmental values, we only found gender differences for altruistic values: female participants reported significantly stronger altruistic values than male participants. This is largely in line with the findings of Sargisson et al. (2020), whose cross-European study revealed that gender accounted for very little variance in environmental values.

Regarding the association between environmental values and SD beliefs in PE, moderation analysis did not reveal differences in the association between men and women. Hence, although SD beliefs in PE differ between women and men, the association between subject-specific beliefs about SD in PE and environmental values is the same. This indicates that promoting environmental values in teacher education may be a promising approach for male and female teachers to strengthen ESD-related professional competence.

### Limitations and implications for future research

The cross-sectional nature of the reported data precludes any causal conclusions about effects between study variables. Furthermore, we used convenience sampling for data collection, which might have led to a self-selection bias, i.e., students participating in the study who are especially interested in sustainability issues and ESD in sport and PE. There-

fore, our results should be interpreted as initial indications of the psychometric quality and validity of the questionnaire and should not be overgeneralized. Future studies in various samples (e.g., in-service teachers, PE teachers in other countries) are needed to further confirm the reliability and validity of the newly developed instrument. Additionally, this measure should be used in future studies to investigate associations among PE teachers' SD beliefs, classroom practice, and pupils' outcomes in terms of ESD, in order to test the predictive validity of the instrument.

Regarding the content of the questionnaire, we removed three items that had a rather strong focus on ESD as facilitator or represented a potential threat to physical activity time. In the future, it would be conceivable to create another factor that specifically focuses on the integration of ESD into PE in terms of combining cognitive activating ESD learning tasks and physical activity, with items like "I can well imagine designing physical activity and games on socioecological topics" or "I think integrating education for sustainable development into PE comes at the expense of physical activity time." In addition to positive or critical attitudes towards SD in PE, this would help to find out more about the (felt) antinomy between cognitive activating and physically active learning tasks (Chen et al., 2007).

When interpreting environmental values as predictors of SD beliefs, we only looked at value orientations and beliefs as separate constructs. Following Martin et al. (2019) and Tolppanen et al. (2022), value profiles or belief systems should also be considered in future research in addition to individual values and beliefs, because they might serve as better predictors for other beliefs and behavior.

### Implications for (PE) teacher education

Following the assumption that positive attitudes towards SD in PE contribute to PE teachers implementing ESD in PE, and that biospheric values are positively associated with positive beliefs about SD in PE, some implications for

PE teacher education can be derived. Biospheric values could be reinforced as principles in PE teacher education. For example, PE teacher students should be encouraged to actively reflect upon their values and, where appropriate, conflicts between their values and actions during coursework (Tolppanen et al., 2022). Nature-based or mindfulness-based activities like outdoor sports, forest bathing, or yoga could provide a useful framework for this (Ericson et al., 2014). But the evidence is mixed in terms of achieving the desired belief change in preservice teachers through coursework, field experiences, or student teaching (Fives & Buehl, 2012). Kyles and Olafson (2008), for example, found no changes in beliefs regarding self-efficacy, diversity, and hope in the quantitative part of their mixed-methods study after a one-semester field-based diversity course. But qualitative results showed that a process of changing beliefs had already begun. In line with previous literature, Kyles and Olafson (2008) suggest that a) belief change needs multiple opportunities across time to enable a differentiated and in-depth examination of one's own beliefs, and b) beliefs and belief change are dependent on prior experiences in a specific setting.

In terms of a whole-institution approach to ESD, it would be worth considering how biospheric and altruistic values could be strengthened in teacher education institutions through targeted coursework and the development of a common value system in an educational institution. However, currently, PE teacher education seems to emphasize hedonistic and egoistic (performance-oriented) values through performance testing, improvement of individual physical fitness, or sports-focused trips and excursions.

Finally, looking at schools, policies can be a powerful instrument to support the implementation of ESD in PE across schools. For example, in Germany, ESD is part of all federal school curricula across school types and school subjects (KMK, 2017). However, while ESD may be mandatory across subjects and schools, the specific implementation and the attention that it receives in PE still largely depends on the teacher.

Hence, combining targeting individual values and beliefs and (E)SD policies may be the most promising approach to establish ESD as part of PE.

### Conclusion

With sports and physical activity being an important part of children's and adolescents' lives, sports settings provide great potential for education for sustainable development (ESD), especially physical education (PE) as a compulsory part of the school curriculum. To implement ESD in PE, fostering and assessing ESD-related professional competence of the PE teachers is crucial. We provide a measurement instrument that can be used to assess (E)SD beliefs, one of the four key dimensions of professional competence, in the PE context. Our results indicate that preservice PE teachers hold positive, but at the same time critical beliefs about ESD in PE, and that promoting biospheric environmental values may be one way to promote positive ESD-related beliefs in PE in future PE teachers. Practically speaking, PE teacher education should promote ESD-related beliefs, reflect on problems future teachers see as critical for implementing ESD in PE, and provide solutions for how physically active PE and ESD can be implemented. Looking at 8.4 million children and adolescents (representing about 10% of Germany's total population; Federal Statistical Office of Germany, 2022) attending school and thus most of them also PE, PE teachers with ESD-related professional competence may serve as an impetus for educating a more sustainable next generation.

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## Declarations

**Conflict of interest.** J. Lohmann, C. Nigg, I. Hertle and C. Kugelmann declare that they have no competing interests.

For this article no studies with animals were performed by any of the authors. All studies mentioned were in accordance with the ethical standards indicated in each case.

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