

## Supplement A: Search strategy – Search terms, Boolean combinations and Search history

### Search terms

Nr	language	key concepts	search term
1	english	professional competence	"Professional competenc*" OR "professional knowledge" OR "professional action competenc*" OR "teacher knowledge" OR "teacher competenc*" OR "content knowledge" OR "pedagogical knowledge" OR "psychological knowledge" OR "pedagogical-psychological knowledge" OR "pedagogical content knowledge"
2	english	education for sustainable development	"education for sustainable development" OR "education for a sustainable development" OR "education for sustainability" OR "education for a sustainable future" OR "environmental OR sustainability education" OR "sustainability education" OR "global education for sustainability citizenship" OR "competenc* in sustainability" OR "outdoor education" OR "environmental education" OR "global citizenship education" OR "friluftsliv"
3	english	teacher	teacher OR educator OR "change agent" OR multiplier OR "higher education" OR "teacher education" OR "teacher training"
4	german	Professionelle Handlungskompetenz	„Professionelle Handlungskompetenz“ OR „Professionelle Kompetenz“ OR Professionswissen OR „professionelles Wissen“ OR „Fachwissen“ OR „fachdidaktisches Wissen“ OR „pädagogisches Wissen“ OR „pädagogisch-psychologisches Wissen“ OR „psychologisches Wissen“
5	german	Bildung für nachhaltige Entwicklung	„bildung für nachhaltige entwicklung“ OR „bildung für eine nachhaltige entwicklung“ OR „bildung für nachhaltigkeit“ OR „globales lernen,“ OR „lernbereich globale entwicklung“ OR „nachhaltiges denken und handeln“ OR „nachhaltigkeitsbildung“ OR „Umweltbildung“ OR „global citizenship education“ OR „BNE-Kompetenz“ OR „friluftsliv“
6	german	Lehrkraft	„Lehrkraft“ OR „Lehrer“ OR „Lehrerin“

### Boolean combinations

For databases ERIC, Web of science, ScienceDirect: 1 AND 2 AND 3

For databases peDOCS, fachportal-paedagogik, BISp-SURF: 4 AND 5 AND 6; 4 AND 5

**Supplement A: Search strategy – Search terms, Boolean combinations and Search history**

**Search history**

date	boolean combination	database	date searched	search term	number of records
13.08.2020	1 AND 2 AND 3	ERIC	2000-2020	((("professional competence" OR "professional competences" OR "professional competencies" OR "professional competency") OR "professional knowledge" OR ("professional action competence" OR "professional action competences" OR "professional action competencies" OR "professional action competency") OR "teacher knowledge" OR ("teacher competence" OR "teacher competences" OR "teacher competencies" OR "teacher competency") OR "content knowledge" OR "pedagogical knowledge" OR "psychological knowledge" OR "pedagogical-psychological knowledge" OR "pedagogical content knowledge") AND ("education for sustainable development" OR "education for a sustainable development" OR "education for sustainability" OR "education for a sustainable future" OR "sustainability education" OR "global education for sustainability citizenship" OR ("competence in sustainability" OR "competences in sustainability" OR "competencies in sustainability" OR "competency in sustainability") OR "global learning" OR "outdoor education" OR "environmental education" OR "global citizenship education" OR "friluftsliv") AND (teacher OR educator OR "change agent" OR multiplier OR "higher education" OR "teacher education" OR "teacher training"))	222
13.08.2020	1 AND 2 AND 3	ERIC	since 2001	((("professional competence" OR "professional competences" OR "professional competencies" OR "professional competency") OR "professional knowledge" OR ("professional action competence" OR "professional action competences" OR "professional action competencies" OR "professional action competency") OR "teacher knowledge" OR ("teacher competence" OR "teacher competences" OR "teacher competencies" OR "teacher competency") OR "content knowledge" OR "pedagogical knowledge" OR "psychological knowledge" OR "pedagogical-psychological knowledge" OR "pedagogical content knowledge") AND ("education for sustainable development" OR "education for a sustainable development" OR "education for sustainability" OR "education for a sustainable future" OR "sustainability education" OR "global education for sustainability citizenship" OR ("competence in sustainability" OR "competences in sustainability" OR "competencies in sustainability" OR "competency in sustainability") OR "global learning" OR "outdoor education" OR "environmental education" OR "global citizenship education" OR "friluftsliv") AND (teacher OR educator OR "change agent" OR multiplier OR "higher education" OR "teacher education" OR "teacher training"))	380
13.08.2020	1 AND 2 AND 3	Web of Science	2000-2021	((("professional competence" OR "professional competences" OR "professional competencies" OR "professional competency") OR "professional knowledge" OR ("professional action competence" OR "professional action competences" OR "professional action competencies" OR "professional action competency") OR "teacher knowledge" OR ("teacher competence" OR "teacher competences" OR "teacher competencies" OR "teacher competency") OR "content knowledge" OR "pedagogical knowledge" OR "psychological knowledge" OR "pedagogical-psychological knowledge" OR "pedagogical content knowledge") AND ("education for	66

**Supplement A: Search strategy – Search terms, Boolean combinations and Search history**

<b>date</b>	<b>boolean combination</b>	<b>database</b>	<b>date searched</b>	<b>search term</b>	<b>number of records</b>
				sustainable development" OR "education for a sustainable development" OR "education for sustainability" OR "education for a sustainable future" OR "sustainability education" OR "global education for sustainability citizenship" OR ("competence in sustainability" OR "competences in sustainability" OR "competencies in sustainability" OR "competency in sustainability") OR "global learning" OR "outdoor education" OR "environmental education" OR "global citizenship education" OR "friluftsliv") AND (teacher OR educator OR "change agent" OR multiplier OR "higher education" OR "teacher education" OR "teacher training")	
12.08.2020	1 AND 2 AND 3	Science Direct	2000-2020	((("professional competence" OR "professional competency" OR "professional competencies") OR "professional knowledge" OR "pedagogical content knowledge") AND ("education for sustainable development" OR "education for sustainability") AND (teacher OR higher education))	71
12.08.2020	1 AND 2 AND 3	Science Direct	2000-2020	((("professional competence" OR "professional competency" OR "professional competencies") OR "professional knowledge") AND ("sustainability education" OR "global citizenship education") AND (teacher OR change agent OR higher education))	37
12.08.2020	4 AND 5 AND 6	pedocs		"professionelle handlungskompetenz*" UND "bildung für nachhaltige entwicklung" UND "lehrkraft"	12
12.08.2020	4 AND 5 AND 6	pedocs		professionswissen UND "bildung für nachhaltige entwicklung" UND "lehrkraft"	18
12.08.2020	4 AND 5	pedocs		professionalisierung UND "Bildung für nachhaltige Entwicklung"	112
12.08.2020	4 AND 5	pedocs		professionswissen UND "bildung für nachhaltige entwicklung"	30
13.08.2020	4 AND 5	pedocs		professionalisierung UND "globales lernen"	57
12.08.2020	4 AND 5 AND 6	fis		professionalisierung UND "Bildung für nachhaltige Entwicklung"	9
12.08.2020	4 AND 5 AND 6	fis		professionswissen UND "bildung für nachhaltige entwicklung" UND "lehrkraft"	0
12.08.2020	4 AND 5 AND 6	fis		professionswissen UND "bildung für nachhaltige entwicklung" UND "lehrkraft"	0
12.08.2020	4 AND 5	fis		professionswissen UND "bildung für nachhaltige entwicklung"	2
13.08.2020	4 AND 5	fis		professionalisierung UND "globales lernen"	0

## Supplement B: Critical appraisal checklist

Adapted from JBI Critical appraisal checklist for text and opinion papers (Joanna Briggs Institute, 2020 <https://jbi.global/critical-appraisal-tools>).

Reviewer: \_\_\_\_\_

Date: \_\_\_\_\_

Author: \_\_\_\_\_

Year: \_\_\_\_\_

	Yes (1 Point)	No (0 Point)	Unclear (0 Point)	Not applicable (0 Point)
1. Is the source of the opinion clearly identified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Is there logic in the opinion expressed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Is the used model the result of an analytical process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Is there reference to the extant literature?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Is there a critical examination of the authors' own approach?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	sum (yes)			
	=			

Overall appraisal:

- ☐ high elaboration (4-5 yes)
- ☐ medium elaboration (2-3 yes)
- ☐ low elaboration (0-1 yes)

Comments (Including reason for exclusion)

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**Supplement C. Quantitative results: Number of codings per category in each paper.**

<b>reference</b>		[59]	[60]	[9]	[61]	[10]	[62]	[63]	[64]	[35]
<b>Authors</b>		Albareda-Tiana et al. 2016	Albareda-Tiana et al. 2018	Albareda-Tiana et al. 2020	Barth 2016	Bertschy et al. 2013	Cebrian et al. 2015	Foley et al. 2017	Fuertes-Camacho et al. 2019	Garcia et al. 2017
<b>CK – content knowledge</b>	sustainability knowledge	3			1	1		3	2	3
	understanding of systems and their behaviour		1	1						2
	understanding of the concept of SD		2	2						
	knowledge about values & emotions in context of (E)SD									1
<b>PCK – pedagogical content knowledge</b>	knowledge of ESD-specific teaching principles		4	4	1	3	3		3	17
	specific ESD-methods									1
	assessment									1
	students									1
	curriculum & resources	2	1	1		1			2	
<b>ICK – institutional context knowledge</b>	fostering institutional change									
	cooperation & communication				1					8
	socio-ecological impact of education		4	4					1	
	sustainable use of resources in education								1	
<b>Beliefs &amp; values</b>	subjective theory of SD & attitude towards SD	2				1				3
	subjective theory of ESD & attitude towards ESD		1	1		2			1	2
	epistemological beliefs about knowledge									2
	self-perception & self-reflection	1	2	2			1			5
<b>Motivational orientations</b>	self-efficacy for teaching ESD									
	intrinsic motivation & enthusiasm	2								4
<b>Self- regulation</b>	self-regulation									
<b>KSC - key sustainability competencies</b>	systems thinking competence						2	2		2
	anticipatory competence						1	1		1
	normative competence		2	2			1	2		
	strategic competence	2	2	2			1	2		
	collaboration competence	1						1		1
	critical thinking competence		2	2						
	self-awareness competence									2
	integrated problem-solving competence	1	2	2				1		2

**Supplement C. Quantitative results: Number of codings per category in each paper.**

<b>continued (2)</b>		[5]	[65]	[66]	[34]	[67]	[68]	[69]	[70]	[71]
		Hellberg-Rode et al. 2014	Hoppe et al. 2020	Malandrakis et al. 2019	Murphy et al. 2020	Perry 2013	Poza-Vilches et al. 2019	Rauch et al. 2013	Rosenkränzer et. al. 2017	Rosenkränzer et al. 2016
<b>CK – content knowledge</b>	sustainability knowledge	3		2					1	
	understanding of systems and their behaviour	2						1	1	1
	understanding of the concept of SD	2		2		2		1		
	knowledge about values & emotions in context of (E)SD	1				1				
<b>PCK – pedagogical content knowledge</b>	knowledge of ESD-specific teaching principles	1	1	3				6		
	specific ESD-methods	1		1				1	1	1
	assessment	1	3	1		1		1		
	students		9	1		1		1	1	1
	curriculum & resources			4		1		1	1	1
<b>ICK – institutional context knowledge</b>	fostering institutional change									
	cooperation & communication	1				1		3		
	socio-ecological impact of education			1						
	sustainable use of resources in education									
<b>Beliefs &amp; values</b>	subjective theory of SD & attitude towards SD					1		1		
	subjective theory of ESD & attitude towards ESD					4				
	epistemological beliefs about knowledge							3		
	self-perception & self-reflection	1								
<b>Motivational orientations</b>	self-efficacy for teaching ESD			1						
	intrinsic motivation & enthusiasm							1		
<b>Self- regulation</b>	self-regulation									
<b>KSC - key sustainability competencies</b>	systems thinking competence	2			1		1			
	anticipatory competence	1			1		1	1		
	normative competence				1		1	1		
	strategic competence	2			1		1			
	collaboration competence	5			1		1	1		
	critical thinking competence						1			
	self-awareness competence	3					1	1		
	integrated problem-solving competence	1				1		1		

**Supplement C. Quantitative results: Number of codings per category in each paper.**

continued (3)		[11]	[12]	[1]	[13]
		Sleurs 2008	UNECE 2012	UNESCO 2017	Vare et al. 2019
<b>CK – content knowledge</b>	sustainability knowledge	7	2	2	
	understanding of systems and their behaviour	2	2		1
	understanding of the concept of SD	3	1	1	
	knowledge about values & emotions in context of (E)SD	1			1
<b>PCK – pedagogical content knowledge</b>	knowledge of ESD-specific teaching principles	44	11	1	6
	specific ESD-methods	3			1
	assessment			1	
	students	2	2		
	curriculum & resources	3		1	
<b>ICK – institutional context knowledge</b>	fostering institutional change	4	1	1	
	cooperation & communication	5	2	2	1
	socio-ecological impact of education				
	sustainable use of resources in education				
<b>Beliefs &amp; values</b>	subjective theory of SD & attitude towards SD	1	1	1	
	subjective theory of ESD & attitude towards ESD	2	5	1	
	epistemological beliefs about knowledge	1	2		1
	self-perception & self-reflection	4	2		2
<b>Motivational orientations</b>	self-efficacy for teaching ESD				
	intrinsic motivation & enthusiasm	1	3		
<b>Self-regulation</b>	self-regulation	2			
<b>KSC - key sustainability competencies</b>	systems thinking competence	4	2		
	anticipatory competence	2	1		1
	normative competence	1			
	strategic competence	3			
	collaboration competence	5	1		1
	critical thinking competence	3			
	self-awareness competence	5	2	1	
	integrated problem-solving competence	1	1		

## ESD-specific teaching principles – synthesis from reviewed literature

### *Create participative learning environments*

Teachers should know about “participative processes and process steps” (Bertschy et al., 2013, p. 5076) in order to be able “to create opportunities for active involvement” (Rauch et al., 2013, p. 17). The aim is to empower learners to reason when proposing solutions, to explore different options for solutions, to actively deal with and participate in solutions and to create their own visions. Learners should be encouraged to test and evaluate (potential) “consequences of different decisions and actions” (Garcia et al., 2017, p. 781) and to analyse the structure and reasons for decision-making processes (e.g., within school and in societies decision-making). Participative learning environments have the potential to stimulate ownership and responsibility, to experience success and self-efficacy and the “opportunity for learners to express their ‘political existence’ - interacting with strangers as they find their place in the world” (Vare et al., 2019, p. 11).

### *Create an appreciative atmosphere respecting diversity*

On the one hand, teachers should create opportunities for sharing ideas, proposals, experiences and feelings in an atmosphere without prejudice or preconceptions and without fear of failure. On the other hand, teachers should “help students to clarify their own worldview and that of others through dialogue” and encourage them “to question their beliefs and assumptions” (Garcia et al., 2017, p. 781; Sleurs, 2008, p. 54) and “to reconstruct their alternative conceptions about [ecological] concepts towards valid scientific conceptions” (Hoppe et al., 2020). Consequently, teachers must “tolerate and accept that pupils sometimes arrive[d] at conclusions that differ[ed] from what they ha[ve] planned” (Rauch et al., 2013, p. 20). Therefore it is important for teachers “not to impose [their] own values and opinions” on learners (Sleurs, 2008, p. 54) and make “learners feel that their ideas, emotions, values, and pace of development are respected” (Vare et al., 2019, p. 11). Thus, teachers often play the role of a mediator and moderator. They need to deal effectively with opposing arguments, must be aware of social tensions and be able to negotiate processes of (intercultural) understanding and conflict resolution.

### *Use the knowledge base from multiple disciplines and take into account multiple perspectives*

In accordance with the previous principles, teachers should offer different perspectives, integrate the knowledge from multiple disciplines, and demonstrate local and global as well as short- and longterm consequences of solutions in teacher-centered teaching and demand reasoning from multiple disciplines and perspectives from the students in student-centered and action-oriented teaching. The teacher therefore must be able to develop “teaching and learning approaches based on [...] interdisciplinarity” (Cebrian et al., 2015, p. 6), to “work from different perspectives of dilemmas, problems, tensions and conflicts” (Garcia et al., 2017, p. 780) and “to encourage students to look at issues from different perspectives (angles and dimensions) as well as their short- and longterm consequences” (Sleurs, 2008, p. 60).

### *Use real world problems to create learning tasks*

Teachers should understand “how engagement in real-world issues enhances learning outcomes and helps learners to make a difference in practice” (UNECE, 2012, p. 13). This includes the “contextualisation of the contents” (Rauch et al., 2013, p. 18) or the use of “natural, social and built environment, including their own institution, as a context and source of learning” (UNECE, 2012, p. 13). Furthermore, with real world problems learners may learn more about their “local and global spheres of influence” (UNECE, 2012, p. 13).

### *Foster critical thinking*

One central aspect that lies behind this teaching principle is to empower students to “distinguish between objective (factual) knowledge and (value-based) opinions (Garcia et al., 2017, p. 781; Sleurs, 2008, p. 48) and to “explore underlying assumptions” (Vare et al., 2019, p. 12). In this process, teachers (and learners) should also “develop critical understandings of [the concept of] sustainable development” (Sleurs, 2008, 55). Vare et al. (2019, p. 12) emphasize that therefore, teachers must have “capacities to ‘construct’ (and not only analyze) a problem, to evaluate the reliability of information sources, to draw inferences and deductions and to control and monitor reasoning”.

### *Expose learners to uncertainty, dilemmas and conflicts of interests*

Several authors highlight the ability of teachers to “expose their learners to ethical dilemmas” (Vare et al., 2019, p. 12) and “appropriately confront learners with conflicts of goals and interests, and [...] to enable and guide their attempts at constructive coping with them” (Bertschy et al., 2013, p. 4) as an important aspect of teaching ESD. In this regard, the teacher is more like a moderator who guides “the students to deal with power relations and conflicting interest [sic!] e.g. in school, in local situations, between countries and between present and future generations” (Sleurs, 2008, p. 61). The teacher therefore needs to be able to make decisions and “act decisively yet cautiously, weighing up available evidence and recognizing the complexity of the issue” (Vare et al., 2019, p. 12).

### *Integrate values into teaching and make assumed norms explicit*

The guiding principle of sustainable development is a normative principle of our society. Teachers should be able to make the underlying norms of this principle and of teaching and learning “explicit so that they can be examined, debated, tested and applied” (Sleurs, 2008, p. 55). Beyond the exploration of those values teachers should be confident to help learners to reflect on “their own and others’ values” (Vare et al., 2019, p. 12) that guide decision making in school tasks and daily life. Therefore, teachers need to have “knowledge about a range of instructional methods related to values” (Sleurs, 2008, p. 55).

### *Inspire creativity and innovation*

One goal of ESD is that learners envision a desirable future or multiple possible futures in order to take action towards a sustainable future. Therefore, the educator is a central person who might “inspire creativity and innovation” (Garcia et al., 2017, p. 780; UNECE, 2012, p. 12) in order to foster “visioning and creative thinking in planning the future and reflecting change” (UNECE, 2012, p. 12).

## Supplement E: PE teachers ESD-specific professional action competence

Details about sport- and movement-related aspects of professional knowledge, beliefs and values, motivational orientations and self-regulations are written in *italic*.

Professional knowledge	
CK	<b>Sport-related sustainability knowledge</b> <ul style="list-style-type: none"> <li>- knowledge of challenges and problems of SD in the sport context <i>e.g., associations among sport-related mobility or consumption, climate effects and human rights; effects of sport activities on the natural environment; inclusive sport and sport for peace and development; mindfulness</i></li> <li>- and causal dimensions of SD problems and solutions <i>e.g., effects of individual and group sport activities, sport-related mobility or consumption on climate, nature, socio-economic aspects; effects of climate change on sport activities</i></li> <li>- disciplinary, interdisciplinary, transdisciplinary knowledge <i>connections between the sport context and e.g., geography, physics, biology, social and political science</i></li> <li>- knowledge of problem-solving approaches <i>e.g., sustainability strategies of small- and large-scale sport events; nature- and climate-friendly sport activities; mitigation measures for sport-related emissions; fair trade in the sport context</i></li> <li>- knowledge of goal conflicts <i>e.g., conflicts between different stakeholders in a certain area (outdoor sport: athletes/sport tourists, nature conservation, hunter, gastronomes and lift operators, communities); conflicts between profit orientation and volunteerism or between profit orientation and sustainability management in sport organizations</i></li> <li>- knowledge of the concept of citizenship <i>e.g., democratic vs. autocratic structures within sport organizations</i></li> <li>- knowledge of power relations <i>e.g., in sport organizations, the sport economy, and media</i></li> </ul>
	<b>Understanding of systems and their behaviour</b> <ul style="list-style-type: none"> <li>- knowledge about relationships, multiple influences and interactions within and between ecological, social, and economic systems <i>e.g., positive and negative socio-cultural, ecological and economic effects of individual and collective sport activity; entanglements between politics, media, athletes and officials during sport events</i></li> <li>- declarative knowledge about concepts and principles within systems science</li> <li>- procedural knowledge about actions or manipulations within the systems science</li> <li>- knowledge about visualization and explanation of systems</li> <li>- knowledge about limits of systems science and uncertainty</li> </ul>
	<b>Understanding of the concept of SD</b> <ul style="list-style-type: none"> <li>- knowledge of the concept of SD (definition, model, principles)</li> <li>- knowledge of relevant policy documents</li> <li>- knowledge that SD is an evolving concept</li> </ul>
	<b>knowledge about values and emotions in the context of SD</b> <ul style="list-style-type: none"> <li>- knowledge about ethical and value discourses <i>e.g., controversies around the concept of fairness, inclusive sport, questioning the performance principle, gender equality in sport</i></li> <li>- knowledge about ethical principles of SD <i>and knowledge about ethical principles in sport, differences and commonalities between ethical principles of SD and (performance) sport</i></li> <li>- knowledge about emotions and their relevance in context of SD <i>and knowledge about emotions and their relevance in sport and physical activity contexts</i></li> </ul>
PCK	<b>Knowledge of ESD-specific teaching principles</b> <ul style="list-style-type: none"> <li>- create participative learning environments and foster collaborative learning <i>leave students with relevant decision-making options, e.g., during field trips (travel, food, activities) and during regular PE</i></li> <li>- create an appreciative atmosphere respecting diversity by using methods of reflective teaching <i>invite pupils to share opinions, perspectives, emotions and feelings on specific issues and tasks; create inclusive PE; foster respect of the diversity of physical cultures</i></li> </ul>

## Supplement E: PE teachers ESD-specific professional action competence

	<p><i>and body images; foster mindfulness (e.g., yoga) and nature-connectedness (e.g., outdoor sport)</i></p> <ul style="list-style-type: none"> <li>- use the knowledge base from multiple disciplines, take into account multiple perspectives <i>use knowledge from sport and exercise science as well as science, social and political science, psychology and geography</i></li> <li>- use real world problems to create learning tasks by methods of enquiry-based learning <i>use examples from the sport and physical activity context and create real life learning experiences e.g., through role play, field trips</i></li> <li>- foster critical thinking <i>questioning the approach of local and global sporting events and their presentation in media; discuss political involvement and structures within the sport context; develop a critical attitude towards the performance principle and the ideal of slimness or undifferentiated postulates of sports policy</i></li> <li>- expose learners to uncertainty, dilemmas and conflicts of interests <i>in action-oriented tasks that involve physical activity and movement; let pupils negotiate rules for games and evaluate them; make the experience of fairness tangible; reflect links between the sport context and sustainability</i></li> <li>- integrate values into teaching and make assumed norms explicit <i>e.g., fairness, performance, fitness, health, social connectedness, nature connectedness</i></li> <li>- inspire creativity and innovation <i>through playful movement, non-standardised forms of movement, open-ended tasks</i></li> </ul>
	<p><b>Knowledge of ESD-specific methods, e.g.</b></p> <ul style="list-style-type: none"> <li>- visualization, illustration, representation, analogies</li> <li>- simulation and simulation or role play games</li> <li>- field trips and case studies</li> <li>- projects and real-world engagements</li> <li>- discussion forums, exhibitions, presentations, performances</li> <li>- <i>sport games and movement-based small games, outdoor sport</i></li> <li>- <i>physical activities to foster mindfulness (e.g., yoga, qui-gong, etc.)</i></li> </ul>
	<p><b>Knowledge of assessment in the context of ESD</b></p> <ul style="list-style-type: none"> <li>- general: ability to assess changes and achievements regarding learning goals (of ESD)</li> <li>- ability to analyze what students say to diagnose preconceptions</li> <li>- <i>ability to analyze what students do and how they decide in the context of sport, game and movement to diagnose preconceptions</i></li> <li>- ability to intentionally create diagnosing opportunities</li> <li>- use of multiple and appropriate evaluation methods</li> </ul>
	<p><b>Knowledge of students' thinking related to SD</b></p> <ul style="list-style-type: none"> <li>- ability to analyze students' preconceptions, prior knowledge, reasoning and perspectives <i>in the context of sport, game and play</i></li> <li>- ability to teach adaptively, taking students' experiences into account</li> </ul>
	<p><b>Knowledge of curriculum &amp; resources</b></p> <ul style="list-style-type: none"> <li>- knowledge about the concept of ESD, including learning goals and possible teaching topics</li> <li>- ability to select ESD-specific learning goals that fit in <i>PE</i> and school curricula</li> <li>- knowledge about educational resources and relevant policy documents regarding ESD and <i>PE</i></li> </ul>
ICK	<p><b>Fostering institutional change</b></p> <ul style="list-style-type: none"> <li>- development of school curriculum</li> <li>- fostering institutional change through whole institution approach</li> </ul>
	<p><b>Cooperation and communication</b></p> <ul style="list-style-type: none"> <li>- general cooperation and communication skills</li> <li>- establish and facilitate network with external partners</li> <li>- cooperation and communication with the school team</li> <li>- building positive relationships with students</li> </ul>
	<p><b>Knowledge of socio-ecological impact of education</b></p> <ul style="list-style-type: none"> <li>- analyse socio-ecological consequences of educational actions <i>e.g., PE, school physical activity, sport-related field trips</i></li> <li>- plan education with positive socio-ecological impact / mitigate impact through education</li> </ul>
	<p><b>Sustainable use of resources in the educational setting</b></p> <ul style="list-style-type: none"> <li>- act as role model through the sustainable use of resources within the school setting</li> </ul>

## Supplement E: PE teachers ESD-specific professional action competence

*e.g., energy and water consumption in sport facilities, consideration of ecological aspects and fair trade in the procurement of sports equipment, team clothing; nutrition and mobility in and around school*

### Beliefs and value

#### Subjective theory of & attitude towards SD

- acknowledge idea of emancipatory SD as important task for society with sense of urgency for change
- recognize that the current cultural development is the root for the ecological crisis
- realize that each person is important and may help
- embrace uncertainty as ethical, social and political attitude
- *acknowledge SD as a relevant sport-related issue that needs to be addressed in PE*

#### Subjective theory of & attitude towards ESD

- acknowledge ESD as a resource for tackling transformation towards SD s societal task
- pursue educational goals of an emancipatory ESD: key sustainability competencies *through sport game and movement*
- realize that ESD must build on students' experiences
- view ESD as an alternative way of education
- open school for partnerships

#### Epistemological beliefs about knowledge

- acknowledge that scientific evidence is important to support SD
- knowledge is culture and value driven, uncertain, contradictory, preliminary, must be challenged
- knowledge may and must be developed in a joint approach
- pre-existing knowledge determines how we see the world, new knowledge must be integrated into existing knowledge

#### Self-perception / self-reflection

- personal self-reflection: the teacher as critically reflective individual
- professional self-reflection: teacher as critically reflective practitioner
- self-perception of the teacher role: the teacher as facilitator and participant in the learning process

### Motivational orientations

#### Self-efficacy for teaching ESD

- subdimensions: values and ethics, systems thinking, emotions, action  
*in the context of sport, game and movement*

#### Intrinsic motivation and enthusiasm

- personal motivation to become sustainable  
*in one's personal sport- and physical activity-related decisions and actions (e.g., sport-related mobility and consumption; sport tourism; nutrition; health)*
- professional motivation to initiate education towards sustainable development *through PE*
- ability to motivate others (students and colleagues)

#### Self-regulation

- express and manage one's emotions and feelings

**PE-related suggestions are based on the following references**

- Bácsné-Bába, É., Ráthonyi, G., Pfau, C., Müller, A., Szabados, G. N., & Harangi-Rákos, M. (2021). Sustainability-Sport-Physical Activity. *International Journal of Environmental Research and Public Health*, 18(4).  
<https://doi.org/10.3390/ijerph18041455>
- Beery, T. H. (2013). Nordic in nature: friluftsliv and environmental connectedness. *Environmental Education Research*, 19(1), 94–117. <https://doi.org/10.1080/13504622.2012.688799>
- Breiling, M., & Charamza, P. (1999). The impact of global warming on winter tourism and skiing: a regionalised model for Austrian snow conditions. *Regional Environmental Change*, 1(1), 4–14.  
<https://doi.org/10.1007/s101130050003>
- Brock, S. J., & Hastie, P. A. (2007). Students-conceptions-of-fair-play-in-sport-education. *ACHPER Healthy Lifestyles Journal*, 54(1).  
[https://www.researchgate.net/profile/Sheri\\_Brock/publication/296466642\\_Students'\\_conceptions\\_of\\_fair\\_play\\_in\\_sport\\_education/links/5d8a9bcc92851c33e938ab83/Students-conceptions-of-fair-play-in-sport-education.pdf](https://www.researchgate.net/profile/Sheri_Brock/publication/296466642_Students'_conceptions_of_fair_play_in_sport_education/links/5d8a9bcc92851c33e938ab83/Students-conceptions-of-fair-play-in-sport-education.pdf)
- Dudfield, O., & Dingwall-Smith, M. (2015). *Sport for Development and Peace and the 2030 Agenda for Sustainable Development*. Commonwealth Analysis.
- Edgar, A. (2020). Sport and Climate Change. *Sport, Ethics and Philosophy*, 14(1), 1–3.  
<https://doi.org/10.1080/17511321.2020.1694601>
- Gieß-Stüber, P. (2008). Reflexive interculturality and interaction with strangeness in sport and through play. In P. Gieß-Stüber (Ed.), *Sport - integration - Europe: Widening horizons in intercultural education* (pp. 228–242). Schneider Verlag Hohengehren.
- Gieß-Stüber, P., & Thiel, A. (2016). Secondary Level I: Physical Education/Sports. In Standing Conference of the Ministers of Education and Cultural Affairs & Federal Ministry for Economic Cooperation and Development (Eds.), *Curriculum Framework: Education for Sustainable Development* (pp. 350–370). Cornelsen.
- Geiger, S. M., Otto, S., & Schrader, U. (2017). Mindfully Green and Healthy: An Indirect Path from Mindfulness to Ecological Behavior. *Frontiers in Psychology*, 8, 2306. <https://doi.org/10.3389/fpsyg.2017.02306>
- Giulianotti, R. (2011). Sport, peacemaking and conflict resolution: a contextual analysis and modelling of the sport, development and peace sector. *Ethnic and Racial Studies*, 34(2), 207–228.  
<https://doi.org/10.1080/01419870.2010.522245>
- Grapentin, S., & Bielig, Norman, Heidemüller, Anne, Sobek, Tilman. (o. D.). *Wie Boden, Flora und Fauna auf Mountainbiker reagieren: Ein Überblick zum Stand der Forschung*. [www.mountainbike-tourismusforum.de](http://www.mountainbike-tourismusforum.de)
- Grimminger-Seidensticker, E., & Möhwald, A. (2020). Enhancing social cohesion in PE classes within an intercultural learning program: results of a quasi-experimental intervention study. *Physical Education and Sport Pedagogy*, 25(3), 316–329. <https://doi.org/10.1080/17408989.2020.1741532>
- Gruno, J., & Gibbons, S. L. (2021). Using discussion to inform action: Formative research on nature-based physical activity as a means of fostering relatedness for girls in physical and health education. *European Physical Education Review*, 1356336X2199118. <https://doi.org/10.1177/1356336X21991181>

- Inoue, Y., & Kent, A. (2012). Sport Teams as Promoters of Pro-Environmental Behavior: An Empirical Study. *Journal of Sport Management*, 26(5), 417–432. <https://doi.org/10.1123/jsm.26.5.417>
- Jong, C. de (2020). Umweltauswirkungen der Kunstschneeproduktion in den Skigebieten der Alpen. *Geographische Rundschau*, 6, 34–39.
- Ladda, S. (2014). Using Sport for Social Change: Theory into Practice. *Journal of Physical Education, Recreation & Dance*, 85(6), 7–11. <https://doi.org/10.1080/07303084.2014.927669>
- Lohmann, J., Wegner, E., & Gieß-Stüber, P. (2019). BNE outdoor - Eine Modulkonzeption zur Bildung für nachhaltige Entwicklung durch Natursport. *Zeitschrift Für Studium Und Lehre in Der Sportwissenschaft*, 1(3), 5–13. <https://doi.org/10.25847/ZSL.2018.011>
- Lu, C., Tito, J. M., & Kentel, J. A. (2009). Eastern Movement Disciplines (EMDs) and Mindfulness: A New Path to Subjective Knowledge in Western Physical Education. *Quest*, 61(3), 353–370. <https://doi.org/10.1080/00336297.2009.10483621>
- Maennig, W. (2004). Korruption im internationalen Sport: Ökonomische Analyse und Lösungsansätze. *Vierteljahrshefte zur Wirtschaftsforschung*, 73(2), 263–291. <https://doi.org/10.3790/vjh.73.2.263>
- Marrosu, G. M., & Balvis, T. (2020). Environmental Impact Assessment in Climbing Activities: A New Method to Develop a Sustainable Tourism in Geological and Nature Reserves. *Geoheritage*, 12(1). <https://doi.org/10.1007/s12371-020-00427-w>
- Neuber, N. (2008). Entwicklungsförderung im Sport: Möglichkeiten und Grenzen sportpädagogischer Intervention. In S. Nagel (Ed.), *Schriften der Deutschen Vereinigung für Sportwissenschaft: Vol. 180. Sozialisation und Sport im Lebensverlauf: Jahrestagung der dvs-Sektion Sportsoziologie in Kooperation mit der dvs-Sektion Sportpädagogik vom 17. - 19. September in Chemnitz ; Abstracts* (pp. 31–32). Czwalina.
- Nigg, C., & Nigg, C. R. (2021). It's more than climate change and active transport-physical activity's role in sustainable behavior. *Translational Behavioral Medicine*, 11(4), 945–953. <https://doi.org/10.1093/tbm/ibaa129>
- SDG Fund. (2018). *The contribution of sports to the achievement of the sustainable development goals: A toolkit for action*.
- Roth, R., & Siller, H. (2016). *Zukunft Wintersport Alpen*.
- Steenbergen, J., Knop, P. de, & Elling, A. H. F. (2001). *Values and Norms in Sport*. Meyer & Meyer Sport.
- Thormann, T. F., & Wicker, P. (2021). Determinants of pro-environmental behavior among voluntary sport club members. *German Journal of Exercise and Sport Research*, 51(1), 29–38. <https://doi.org/10.1007/s12662-020-00700-8>
- United Nations. (o. D.). *Sport and the Sustainable Development Goals: An overview outlining the contribution of sport to the SDGs*. <https://en.unesco.org/themes/sport-and-anti-doping/sport-charter>
- Wicker, P. (2019). The carbon footprint of active sport participants. *Sport Management Review*, 22(4), 513–526. <https://doi.org/10.1016/j.smr.2018.07.001>
- Wicker, P. (2017). The carbon footprint of active sport tourists: An empirical analysis of skiers and boarders. *Journal of Sport & Tourism*, 22(2), 151–171. <https://doi.org/10.1080/14775085.2017.1313706>