Measuring professional action competence in education for sustainable development (PACesd)

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Conceptualizing and Measuring Professional Action Competence in Education for Sustainable Development (PACesd)

Introduction

In recent decades, urgent concerns facing humanity such as climate change, food scarcity, and growing inequality have prompted a particular focus on incorporating education for sustainable development (ESD) into school curricula and teacher education around the world (Evans, Stevenson, Lasen, Ferreira, & Davis, 2017; Rieckmann, 2017; UNESCO, 2015). Indeed, in several educational systems, ESD is increasingly becoming part of curricula to help learners develop the knowledge and the attitudes necessary to take action regarding complex sustainable development issues (Evans et al., 2017). In this process, teachers are often regarded as key actors in ESD implementation as they have an influential role in determining the scope and depth of ESD implementation in schools and classrooms (Boeve-de Pauw, Gericke, Olsson, & Berglund, 2015; Evans et al., 2017). Nevertheless, implementing ESD is not an easy task for teachers as they are required to address complex interdisciplinary sustainable development issues with intertwined environmental, social, and economic dimensions, and must foster critical thinking skills incorporating conflicting and often unfamiliar perspectives (Boeve-de Pauw et al., 2015; Borg, Gericke, Höglund, & Bergman, 2012; Evans et al., 2017; Sinakou, Donche, Boeve-de Pauw, & Van Petegem, 2019; Taylor et al., 2019). Therefore, the implementation of ESD in school education as well as in initial teacher education and continuous teacher professional development is often challenged by a range of issues such as teachers' perceived lack of expertise and confidence in implementing ESD (Evans et al., 2017; Taylor et al., 2019).

The opportunities and barriers in implementing ESD are often addressed by an emergent body of theoretical and empirical research aiming to understand the multifaceted set of

teacher competencies required to implement ESD (Bertschy, Künzli, & Lehmann, 2013; Birdsall, 2015; Bürgener & Barth, 2018; Effeney & Davis, 2013; Malandrakis, Papadopoulou, Gavrilakis, & Mogias, 2019). Several studies have shed some light on different aspects of teachers' professional competence regarding ESD (Effeney & Davis, 2013; Gan & Gal, 2018; Malandrakis et al., 2019; Moseley, Huss, & Utley, 2010). Nevertheless, much of this research focuses on isolated aspects of teachers' ESD competences, such as their self-efficacy or content knowledge regarding ESD, and remains limited to certain contexts and educational settings. An example of research that acknowledges the complexity of professional competences needed for implementing sustainability education is the work by Redman, Wiek, and Redman (2018). They additionally advocated focusing on in-service teachers because they are more likely to show leadership when change is required. Still, theoretical and empirical research initiatives that aim to capture and operationalize the broader range of competences needed for implementing ESD are lacking, as are psychometric instruments for measuring said competences.

This study aims to complement existing measurement instruments by a) introducing an integrated framework of teacher competence in implementing ESD and, b) making this measurable through a reliable and valid psychometric instrument. Addressing the first aim, we introduce and define the framework of Professional Action Competence in Education for Sustainable Development (PACesd) as a framework derived from theories of action competence (Breiting, Hedegaard, Mogensen, Nielsen, & Schnack, 2009; Jensen, 2000; Jensen & Schnack, 1997; Sass et al., 2020). As we did not wish to exclude non-formal educational efforts by e.g. nature centers and organizations that offer citizenship projects to schools, we opted for calling the framework 'professional' action competence rather than limiting it to 'teacher' professional action competence. Based

upon the concept of action competence, we identify three core features of PACesd that are needed to implement Education for Sustainable Development (ESD) by teachers: (1) willingness/passion-commitment, (2) knowledge of pedagogical approaches and, (3) confidence/self-efficacy. To reach the second aim, we investigate the validity of the hypothesized construct of PACesd. To this end, an instrument is developed to grasp the PACesd constructs empirically. In line with recommendations by Redman et al. (2018) the instrument is tested in a sample of 557 primary and secondary school in-service teachers in Flanders, Belgium. Confirmatory factor analysis is applied to assess its measurement properties in terms of reliability and validity.

Background

Education for sustainable development and action competence are confusing terms, as they have been used to refer to different concepts in the literature. In their seminal work on action competence (AC), scholars from the Danish School of Education stated that the concept is an educational approach 'in a broad sense' (Mogensen & Schnack, 2010). However, they also acknowledged that competence is strongly linked to the individual (Mogensen & Schnack, 2010). This has prompted two different understandings of AC (Piasentin & Roberts, 2018). Some view action competence as an educational approach (Ellis & Weekes, 2008), while others refer to it as a competence of individuals and groups (Chawla & Cushing, 2007). Sass et al. (2020) entangled the different interpretations of the concept as being an *educational approach* versus that of AC as a *competence of people* (either individuals or groups). In this, they took a stance, redefining AC as a competence of (groups of) individuals. In the same study they further developed the concept of AC as an ecology of subconstructs (conceptual knowledge of possibilities for contributing, willingness to contribute, confidence in one's own capacities for carrying out actions, and confidence that the action will contribute to solving the issue at stake).

Furthermore, they argued for referring to the educational approach that aims to foster AC within learners as *ESD*. In line with Sass et al. (2020), the current study refers to AC as a generic competence of individuals or groups, whereas the educational approach in question is referred to as ESD. Additionally, we will make a difference between this specific educational approach, i.e. ESD, and more generic education regarding sustainability as described by Redman et al. (2018), which will be referred to as Sustainability Education. In what follows, we first focus on sustainability education and ESD before elaborating on the concept of AC, and finally linking the concepts of ESD and AC in the framework of PACesd.

Sustainability Education and Education for Sustainable Development (ESD)

In order to assess their newly developed continuing professional development program regarding sustainability education, Redman and colleagues (2018) measured the participating in-service teachers' knowledge of sustainability and sustainability competencies, perceived self-efficacy, and intentions to apply these skills and knowledge in their teaching practice. Thus, they focused on 1) intended learning outcomes of sustainability education, i.e. sustainability-related knowledge and competencies, and 2) teacher-related features, i.e. self-efficacy and intended behavior (Redman et al., 2018). As such, in addition to the two teacher-related features, which we will get back to when discussing the concept of action competence, it targets the *what* of sustainability-focused education. In this, it differs from ESD, which looks into the *how* of educational approaches related to sustainability, i.e. through a holistic, pluralistic, and action-oriented pedagogy. Given the complexity of SD issues, that comprise interconnected environmental, social, and economic dimensions with links to past, present, and future generations on a local, regional, and global scale, ESD requires a *holistic* approach (Öhman, 2008). Such an approach wants to avoid understanding holism as 'aiming for a

single and uncontested set of understandings and for complete consensus concerning future action' (Stables & Scott, 2002) (p. 54). This applies to the what, but also to the how of teaching (Andreasen Lysgaard & Simovska, 2016). By acknowledging that different perspectives on (E)SD issues and possible solutions to them are worthwhile, and by facilitating the expression of different (contrasting) arguments, both students and teachers get opportunities for learning and becoming active players in a democratic environment (Rudsberg & Öhman, 2010). Consequently, when referring to ESD in the current study, we mean a *pluralistic* (also called democratic) approach to ESD, as suggested by Mogensen and Schnack (2010) and Öhman (2008). This presupposes teachers' as well as students' willingness to provide well-informed arguments for the choices they suggest (Breiting et al., 2009). Thus, teachers who adopt a holistic and pluralistic approach to ESD act as role models for their students. At the same time, these students get opportunities for constructing a holistic view of SD issues through a pluralistic pedagogy. This includes enhancement of gaining experience in generalizing, specifying, sharing and reflecting on personal and societal values, comparing, and testing perspectives, i.e. the what of learning, through a teacher's actions that facilitate pluralistic co-construction of understanding, i.e. the how of learning (Andreasen Lysgaard & Simovska, 2016; Mogensen & Schnack, 2010; Rudsberg & Öhman, 2010). This resonates with Levy and Zint's (2013) hypothesis that providing students with opportunities for expressing their views on SD issues may enhance their environmental political efficacy. To avoid inducing feelings of helplessness and disinterest that could lead to pessimism, teachers may want to focus on knowledge of action possibilities and solutions rather than on the size and global scale of SD issues (Jensen & Schnack, 1997; Redman et al., 2018). Group work can also enhance personal and collective self-efficacy. Especially when distant goals are broken down into several subgoals that can be more easily controlled,

students and teachers are more likely to experience success, which in turn will result in a stronger feeling of self-efficacy (Bandura, 2006; Chawla & Cushing, 2007). Next to holism and pluralism, ESD is characterized by a third essential ESD component, i.e. orientation toward *action* (Sinakou et al., 2019). Through pluralism and group work, students get opportunities to experience that they can contribute and be heard when different action possibilities are discussed and co-decided upon. This action-oriented approach is likely to support a sense of trust in their influencing capacities. Action experiences and critical discussion on how the action evolved provide opportunities for learning what facilitated or hindered a successful outcome of actions undertaken. This provides opportunities for finding alternative (possibly more successful) ways to achieve goals, which enables a more relaxed and optimistic atmosphere (Hasslöf & Malmberg, 2015; Mogensen, 1997; Sinakou et al., 2019). The open-ended quality of complex SD issues facilitates the construction of a 'language of possibility' (Mogensen & Schnack, 2010). Additionally, opportunities for collaboration in group work can add to creating an atmosphere of mutual support and friendship, which builds motivation and inspiration, while being a benefit on its own account for participating in joint action (Chawla & Cushing, 2007).

In sum, ESD is an educational approach that involves three necessary components, i.e. holism, pluralism, and an orientation toward action-taking. The implementation of this complex approach to education poses a challenge to teachers and schools as it implies a cross-curricular teaching approach that encourages multiple perspectives. This requires moving beyond mere information transmission, embracing values, attitudes, and procedural knowledge that facilitates action (Redman et al., 2018). Consequently, teachers need to start cooperating across subjects such as language and science teaching, which may adhere to different teaching traditions (Sund, Gericke, & Bladh 2020). The

resulting complexity inherent in ESD may give rise to contrasting views on how to attain a successful implementation in the classroom context. Consequently, teachers should possess the necessary competence for taking on this challenge. In the next section, we will sketch why action competence fits this requirement.

The concept of action competence (AC) and the framework of professional action competence in implementing ESD (PACesd)

Action is a behavior that is decided on by who acts (Jensen, 2000) and directed towards change in order to solve an issue (Breiting et al., 2009), which is a problem that incites controversy on how to solve it (Hungerford & Volk, 1990). As was outlined in the previous section, the implementation of ESD is an example of such an issue, because different subjects, possibly adhering to contrasting teaching traditions, are required to develop a common approach in cross-curricular teaching. Therefore, we suggest that, if teachers need to possess the necessary competence to implement a complex educational approach such as ESD, action competence and collective action are required. *Action competent* people are passionate and committed, show confidence in their capacities for contributing to finding solutions to such issues while also possessing the relevant knowledge and skills (Sass et al., 2020). In this, passion is a strong type of intrinsic motivation, i.e. a motivation from within who acts, rather than being imposed by others (Vallerand, 2015). Moeller & Grassinger (2013) connected the concept of passion to commitment, as both concepts explain why individuals persist in putting effort and dedication into difficult tasks despite the obstacles or negative experiences they encounter on the way. They further conceptualized commitment as the extent to which someone identifies with the goal set (identification), intends to perform a certain behavior (intent), and sets long-term goals (goals) for achieving the desired outcome (Moeller & Grassinger, 2013). This resonates with Redman et al. (2018), who also looked into

teachers' behavioral intentions before and after participating in a continuing professional development trajectory regarding sustainability education. Moeller and Grassinger's (2013) conceptualization of passion, which they labelled 'desire', drew from Vallerand's (2015) dual model of passion. Sass et al. (2020) stated that confidence in one's capacities is related to the concept of self-efficacy, in particular to capacity expectations, which expresses to what extent someone is confident they are capable of performing a certain action (Bandura, 2001). Finally, the knowledge and skills involved are related to the issue at stake. It is the issue to be resolved that determines what knowledge and skills are required (Sass et al., 2020). When AC is directed towards solving ESD implementation issues in the classroom, teachers' knowledge and skills regarding ESD and implementation possibilities will define this AC subconcept. In this, we divert from Redman et al.'s (2018) measurement of self-efficacy, which focused on teachers' confidence in their knowledge about key competencies in sustainability, i.e. the intended learning outcomes, rather than knowledge about ESD as an educational approach. In what follows, we refer to action competence regarding ESD implementation as *Professional Action Competence in implementing ESD (PACesd)*.

Teachers' and other educators' PACesd becomes manifest in their modelling of principles of holism, pluralism, and an orientation towards action taking (Öhman, 2008; Sinakou et al., 2019). Thus, the teaching approach also becomes the content of learning for the teachers. By acknowledging the complexity of ESD issues and the limitations of a single teacher's competencies, other stakeholders and colleagues may be called in to provide opportunities for considering different perspectives and options (i.e. pluralism). Experience-based teaching and team effort add to opportunities for critical thinking, which enable learning about alternative ways and envisaging the future if they would succeed in implementing ESD as a team effort. This may create an atmosphere of

possibility, mutual support, and friendship, which enhances a feeling of self-efficacy and adds to motivation for and commitment to taking part in (future) ESD implementation actions.

In sum, the framework of PACesd consists of teachers'/educators' confidence in their capacities, willingness, (pedagogical content) knowledge, and skills regarding implementing ESD. In this, ESD refers to a holistic, pluralistic, and action-oriented approach to teaching students how they can contribute to resolving SD issues. This may be (too) much to ask from the individual teacher or educator. However, viewing ESD implementation as collective action which involves a team effort, can render this complex task more feasible. Not every individual teaching professional needs to live up to this ideal notion of action competence as long as the team as a whole shows PACesd. In contexts where any direct colleagues are lacking, opportunities for developing their PACesd in partnership with others (within or beyond their own organization) may offer support.

The operationalization of PACesd into a questionnaire research instrument. Insights from previous research.

Despite the increasing importance of teacher competence for ESD in schools, research on teachers' competence in implementing ESD is still at an incipient stage. Although current theoretical models tapping into teacher competence for ESD (Bertschy et al., 2013; Bürgener & Barth, 2018) describe sets of competences largely consistent with the three core components of PACesd outlined above, current empirical studies directed at their measurement tend to focus predominantly on pre-service teachers enrolled in initial teacher training institutions and on isolated aspects of teachers' competence for ESD. More specifically, the few available instruments have been developed to tap specifically into teachers' confidence in their capacities (i.e. teachers' self-efficacy for ESD) while

also looking to some extent at their ESD-related knowledge and skills (Effeney & Davis, 2013; Gan & Gal, 2018; Malandrakis et al., 2019). In these studies, teachers' willingness to implement ESD is not directly measured but often indicated as an important correlate of self-efficacy beliefs (e.g. Effeney & Davis, 2013; Malandrakis et al., 2019).

The study of Malandrakis et al. (2019) was identified as most informative for the current research for several reasons. It aimed to develop a valid and reliable questionnaire research instrument to capture the concept of teachers' self-efficacy for ESD. Their work was guided mainly by social cognitive theory (Bandura, 2001) and a review of widely accepted scales assessing science teachers' self-efficacy (e.g. Moseley & Taylor, 2011; Sia, 1992; Tschannen-Moran & Hoy, 2001). The authors acknowledged that many of the existing teacher self-efficacy instruments were focused mainly on science teachers and/or environmental aspects of ESD and developed a scale that considered key features of current ESD conceptualizations such as holism, pluralism, and action-orientedness. The instrument was tested among 924 primary education student teachers and 88 in-service primary teachers in Greece, with results indicating good measurement properties. In addition, Malandrakis et al. (2019) developed an instrument tapping into teachers' perceived pedagogical content knowledge and content knowledge. They found a high association ($r = 0.866$) between this scale and teachers' self-efficacy beliefs.

Although this study (Malandrakis et al., 2019) is undoubtedly an example of advancements made in measuring teacher competence for ESD, it leaves space for further development. First, the study is successful in capturing the complexity of SD issues. Still, it rests on the assumption that teachers' self-efficacy is at the core of their competence in implementing ESD, failing to tap into important features of a broader framework of teacher competence in ESD (e.g. willingness to implement ESD). Second, similar to other studies (e.g. Effeney & Davis, 2013), the work is embedded in a particular context (the

Greek educational system) and it mainly documents the suitability of the measurement instrument for pre-service teachers in primary education (the largest part of the sample surveyed for the study) leaving space for further validation of the constructs in other contexts and samples (e.g. in-service).

The current study

Given the framework of professional action competence in education for sustainable development (PACesd), this study will contribute to research on teachers' competence in implementing ESD by introducing an integrated framework of teacher competence in implementing ESD encompassing teachers' confidence in their capacities, their willingness, (pedagogical content) knowledge, and skills regarding implementing ESD. Moreover, the study aims to contribute with a reliable and valid measurement instrument tapping into the hypothesized framework of PACesd and its features. Furthermore, unlike previous research that mainly looked at aspects of teachers' competence for ESD among pre-service teachers (see Effeney & Davis, 2013; Gan & Gal, 2018; Malandrakis et al., 2019), but in line with Redman et al.'s (2018) recommendations, this study aims to report on the professional action competence in ESD of in-service teachers (in primary and secondary education). To this end, our inquiry was driven by the following research question:

> *Is the PACesd questionnaire (PACesd-Q) a reliable and valid instrument for measuring teachers' action competence in implementing ESD within primary and secondary school teachers in Flanders?*

Method

Participants and procedure

This research is part of a larger project, Valorizing Integrated and Action-Oriented Education for Sustainable Development at School (VALIES), that aims to study the critical success factors and barriers for bringing integrated and action-oriented ESD into schools in Flanders, Belgium. For the current research, data were collected through convenience sampling in January to March 2019 from 557 teachers of 49 different schools in Flanders participating in VALIES, that expressed consent to participate in this research. Of these teachers, 191 were teaching in primary education and 366 in secondary education. All primary school teachers taught a broad range of subjects under the core curricular areas of literacy, numeracy, and science. Teachers in secondary education were specialized in teaching particular subjects under subject areas such as science (22%), social science (15%), language (17%), vocational and esthetical subjects (14%) as well as of some other specialized subjects connected to one or more of the previous groups (32%).

The sample was balanced in terms of the participants' age and their years of experience in education. Specifically, the age distribution in the sample was balanced for the ages of 22 to 29 (18%), 30 to 39 (29%), 40 to 49 (26%) and, 50 to 59 (23%). Fewer participants (4%) were over 60 years old. In terms of experience in education, roughly one in five teachers (19%) had teaching experience of 5 years or less, 15% for 6 to 10 years, 27% for 11 to 19 years, 23% for 20 to 29 years, 13% for 30 to 39 years and finally about 3% for more than 40 years. Female teachers were overrepresented in the sample (68%), reflecting to a large extent the gender distribution in the overall population of teachers in primary and lower secondary schools in Flanders (Organization for Economic Cooperation and

Development, 2020).

Measures

Several items and scales were adapted to the Flemish context to develop a measurement instrument for the three core components of teachers' PACesd. In a first step, based upon the framework of PACesd, literature was searched for existing items and measures that captured its dimensions. To this end, an item pool was generated from items collected from several existing scales: the 10-item Comm.Pass Scale developed by Moeller and Grassinger (2014) informed the development of the willingness to implement education for sustainable development items; the TSESESD (Teachers Self-Efficacy Scale for Education for Sustainable Development) and the perceived Pedagogical Content Knowledge (pPCK) scales (Malandrakis et al., 2019) informed the development of the self-efficacy and the perceived pedagogical content knowledge items, respectively. Subsequentially, these items were examined against our conceptualization of the defining PACesd dimensions. The items were selected and adapted to fit our framework, the Dutch language, and the Flemish context and were piloted in preliminary data collection waves of the VALIES project. In the pilot phase, the teachers were an active part in assessing the quality of the measurement instruments. The appropriateness of the items as well as their clarity and connectedness to the day-to-day realities in implementing ESD in Flemish primary and secondary schools were extensively discussed with teachers and head teachers in individualized school feedback sessions.

Following this procedure, we arrived at a PACesd instrument that consists of 31 items measuring its three core features (see Table 1 for an English version of the PACesd instrument). All 31 items are rated by the participants on a six-point Likert scale ranging from "strongly disagree" (= 1) to "strongly agree" (= 6). More specifically, willingness

to implement education for sustainable development (Wesd) consists of 10 items encompassing teachers' commitment and passion for ESD. Teachers' perceived pedagogical content knowledge of education for sustainable development (pPCKesd) consists of 11 items capturing their perceived skills and pedagogical content knowledge concerning ESD implementation and adopting holistic, pluralistic, and action-oriented approaches in their teaching. Finally, ESD self-efficacy (SEesd) consists of 10 items measuring the teachers' confidence to work along ESD principles (i.e., pluralism, holism, and action-orientedness).

In addition, to assess criterion-related validity, an instrument measuring the perceived importance of education for sustainable development (IMPesd) inspired by Effeney & Davis's (2013) previous research was developed following a similar procedure (see Table 1). The IMPesd is captured by three items that reflect whether teachers perceive the implementation of ESD as their task. These items are included in the questionnaire using a six-point Likert scale. Based on previous work, we expect a positive association between the teachers' perceived importance of ESD in their practices and their PACesd.

Analytical strategy

Data preparation and descriptive and reliability analyses were carried out using IBM SPSS (IBM Corp., 2015). Data were screened to detect missing data patterns and to examine the distribution of responses.

The PACesd instrument's reliability was tested by calculating Cronbach's alpha for each of the scales and sub-scales. For ease of interpretation, we provide descriptive statistics such as mean values and standard deviations per subscale and item to summarize data distribution.

The validity of the PACesd-Q was investigated in a factor analytical framework (Brown, 2014). Confirmatory factor analysis was applied to investigate how well the data fitted our framework of PACesd. All CFA analyses were performed in Mplus 7.4 (Muthén & Muthén, 2017). Since the data were ordinal and data screening confirmed notable departures from univariate normality with response patterns concentrated toward the positive end of the Likert scale, the weighted least squares mean and variance estimator (WLSMV) with delta parametrization was used to estimate the CFA model. Moreover, to handle missing data, we used the full information maximum likelihood (FIML) method implemented in Mplus 7.4. This method uses all available information for any variable, excluding only cases with missing data on all variables. The number of cases with missing data on all variables for this research was 62.

Furthermore, since the data had a multilevel structure with teachers nested within schools, we implemented the TYPE = COMPLEX option of Mplus 7.4 that adjusts model goodness-of-fit statistics and standard errors of the parameter estimates for the dependency in the data.

To evaluate model fit, the commonly used (Brown, 2014; Wang & Wang, 2012) goodness of fit indices for the categorical CFA approach were applied, i.e. the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI). For an acceptable model fit we refer to common guidelines (i.e., RMSEA & lower and upper for 90% confidence interval of RMSEA < 0.08; CFI > 0.90; TLI > 0.90) (Brown, 2014; Wang & Wang, 2012). Goodness of fit was further examined by evaluating the parameter estimates' interpretability, size, and statistical significance (Brown, 2014).

Finally, in the last step, we assessed the criterion-related validity (also referred to as predictive validity) of the PACesd instrument by examining the strength of its correlation with a related instrument, teacher's perceived importance of ESD in their practices, with

the expectation that the two instruments should be correlated but should not fully converge.

Results

Internal consistency and descriptive statistics

Reliability measures in terms of Cronbach's α were calculated for the PACesd instrument as a whole as well as for all the different subscales: Wesd, pPCKesd, SEesd. The α-values reported in Table 1 indicate an instrument with good reliability for all its components. All scales showed high reliability with Cronbach's α ranging from 0.84 to 0.96, indicating strong consistency among the items tapping into the different components of PACesd. Summary statistics in terms of means and standard deviations (see Table 1) show that respondents expressed on average partial agreement with all PACesd items (M = 4.00, sd = 0.69). Participants agreed the most with items underlying self-efficacy regarding education for sustainable development (SEesd, M = 4.38, sd = 0.68), followed by the items capturing their perceived pedagogical content knowledge (pPCKesd, M = 4.26, sd = 0.78), and to a lesser extent by items tapping into their willingness for ESD (Wesd, M = 3.32, sd = 1.00) where answers reflected on average partial disagreement.

Table 1. *PACesd and IMPesd: items, sub-scales, reliability and descriptive statistics*

	Scale/Item*	**Cronbach's α**	**Mean****	***SD***
PACesd	**Professional action competence in education for sustainable development**	0.96	4.00	0.69
SEesd	**Self-efficacy regarding education for sustainable development**	0.92	4.38	0.68
	I am confident that as a teacher I can……			
SEesd1	develop students' ability to view a problem from different points of view.		4.64	0.81
SEesd2	develop students' ability to weigh different solutions to sustainability issues.		4.48	0.78
SEesd3	develop students' ability to reflect on their own actions.		4.65	0.81
SEesd4	develop students' ability to express their own views on sustainability issues.		4.61	0.79
SEesd5	develop students' ability to understand the interconnectivity between the social, environmental and economic aspects of sustainable development.		4.36	0.89
SEesd6	make students realize that there are conflicting interests on the road to sustainable development.		4.56	0.88
SEesd7	make students realize that the road to sustainable development contains a high degree of uncertainty.		4.36	0.86
SEesd8	develop students' ability to act for sustainable development at a local level (e.g. in the school).		4.52	0.88
SEesd9	develop students' ability to act for sustainable development at a regional level (e.g. in the municipality).		3.98	1.00

SEesd10	develop students' ability to act globally for sustainable development (e.g., boycott certain goods).		3.62	1.14
pPCKesd	**Perceived pedagogical content knowledge about education for sustainable development**	0.94	4.26	0.78
	I am confident that as a teacher I can……			
pPCKesd1	make Education for Sustainable Development happen in my class (es).		4.37	0.92
pPCKesd2	make Education for Sustainable Development happen in my school.		4.33	0.89
pPCKesd3	evaluate an ESD project I (we) have implemented.		4.17	1.01
pPCKesd4	address the environmental aspects of sustainability issues in my teaching.		4.38	1.02
pPCKesd5	address the social aspects of sustainability issues in my teaching.		4.32	0.96
pPCKesd6	address the socio-economic aspects of sustainability issues in my teaching.		4.02	1.06
pPCKesd7	address the global aspects of sustainability issues in my teaching.		3.89	1.11
pPCKesd8	work on sustainable development in the spirit of the attainment targets.		4.33	1.00
pPCKesd9	work across disciplines on sustainable development.		4.52	0.95
pPCKesd10	formulate learning objectives for my students regarding sustainable development.		4.36	1.01
pPCKesd11	have the flexibility to design learning environments to work on sustainability issues.		4.17	1.03
Wesd	**Willingness to implement education for sustainable development**	0.96	3.32	1.00
	Please indicate your level of agreement with the statements below…			
Wesd1	Each day, I make sure that I have enough opportunities to dedicate myself to Education for Sustainable Development (ESD).		3.24	1.10
Wesd2	ESD is typically me.		3.85	1.08
Wesd3	ESD is close to my heart. Without ESD I wouldn't be myself.		3.30	1.23
Wesd4	Implementing ESD gives me energy.		3.41	1.13
Wesd5	I try to plan my daily work so that I have as much time as possible to spend on ESD.		2.78	1.16
Wesd6	When I'm working on ESD, I experience that as an intense experience.		3.17	1.21
Wesd7	ESD will play an important role in my life.		3.50	1.17
Wesd8	I often feel a strong urge to work with ESD.		3.21	1.21
Wesd9	I am often really looking forward to working with ESD.		3.29	1.22
Wesd10	Many of my personal goals are related to ESD.		3.42	1.23
IMPesd	**Importance of education for sustainable development**	0.84	4.48	0.88
	With these questions we want to gauge your understanding of what may or may not be the task of teachers in the context of ESD.			
IMPesd1	Providing students with education regarding sustainable development is a core task of teachers.		4.23	1.03
IMPesd2	As a teacher I am prepared to take up my task regarding Education for Sustainable Development.		4.58	1.00
IMPesd3	I am convinced that as a teacher I have to play a role in Education for Sustainable Development.		4.64	1.00

*Note: * Items are rated on a six-point Likert scale ranging from "strongly disagree" (= 1) to "strongly agree" (= 6); ** For ease of interpretation, we decided to report here descriptive statistics in terms of averages and standard deviations. We note however that these data are ordinal and that this aspect was fully taken into account in our data analysis strategy.*

Construct and convergent validity

Confirmatory factor analysis (CFA) was used to confirm the hypothesized factor structure of the PACesd model. In a first step, we tested a three-factor first-order model and inspected the correlations between the three first-order latent constructs: Wesd, pPCKesd, SEesd. The three factors were correlated with associations of 0.428 between Wesd and SEesd, 0.608 between Wesd and pPCKesd, and 0.670 between pPCdesd and SEesd,

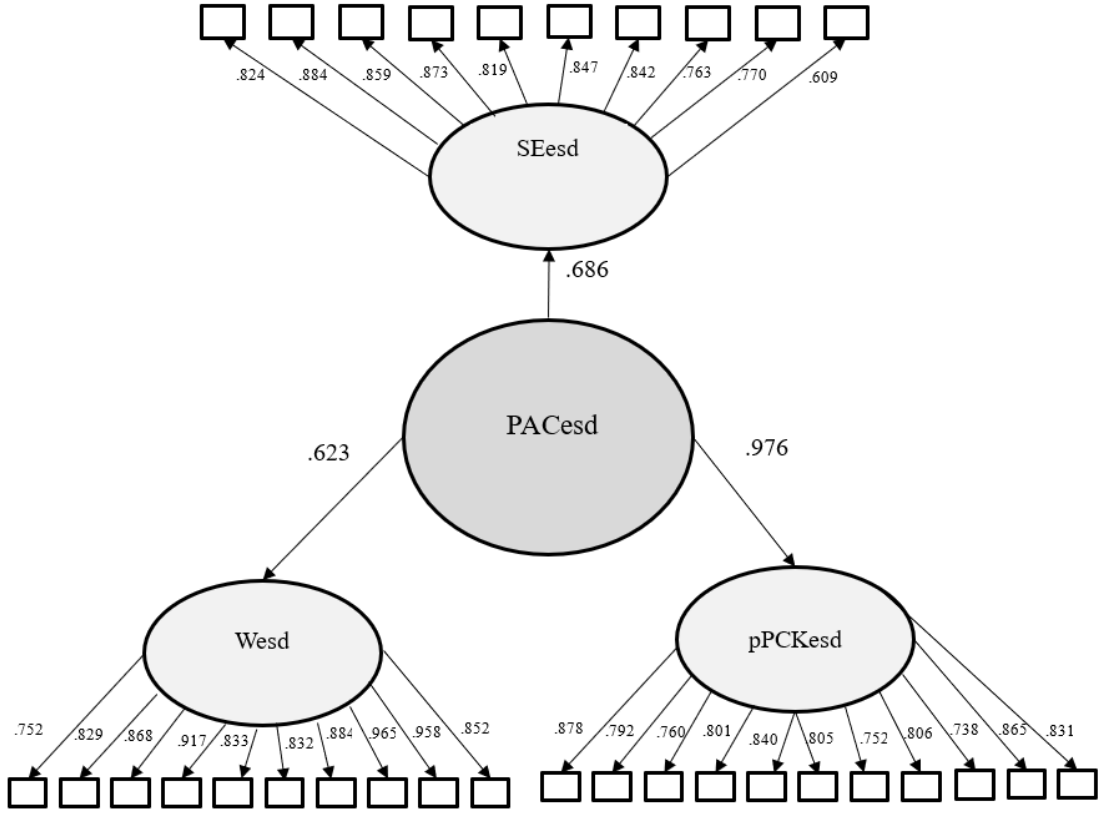

Figure 1. Results of second-order CFA analysis for PACesd
Note: standardized coefficients: item and factor loadings; Model fit indices: RMSEA = 0.077; CFI = 0.964; TLI = 0.961.

providing evidence that a second-order structure is viable (Brown, 2014). Therefore, we proceeded to test the fit of a second-order factor model as shown in Figure 1. Based on our theory, the model consists of a second-order latent construct of PACesd, which is composed of three first-order latent constructs: Wesd, pPCKesd, SEesd. This factor structure was confirmed with the majority of model fit indices well within acceptable boundaries (RMSEA = 0.077; 90% Confidence Interval of RMSEA = [0.073, 0.081]; CFI = 0.964; TLI = 0.961). Most fit indices (i.e. RMSEA, CFI, TLI) are in line with commonly used cut-offs for goodness of fit indices in the categorical CFA approach (Brown, 2014; Wang & Wang, 2012). An exception is the upper 90% confidence interval of RMSEA that slightly exceeds the threshold of <0.08 taking a value of 0.081. Nevertheless, the majority of fit indices indicate an acceptable model fit that is further demonstrated by other aspects of model evaluation, such as the strength of the associations between the items and the first-order latent variables (item loadings) and between the first and second-

order latent variables (factor loadings).

The standardized parameter estimates of this model in terms of item and factor loadings are reported in Figure 1. All parameters are statistically significant at $p<0.001$. Results indicate that all 31 items are strong indicators of their corresponding factors with item loadings ranging from 0.609 to 0.965. Factor loadings are also substantial and lower-level factors load into the higher-level factor in line with the theory. Specifically, the three core hypothesized dimensions of PACesd (i.e. Wesd, pPCKesd, and SEesd) are good indicators of the second-order factor with factor loadings of 0.623, 0.976, and 0.686, respectively. Notably, the analysis shows a particularly high association between perceived pedagogical content knowledge (pPCKesd) and PACesd (r = 0.976), suggesting a particularly strong dependency of perceived professional action competence on perceived pedagogical content knowledge.

In a last step of the analysis, we looked into the association of the PACesd construct with the related construct of teachers' perceived importance of ESD in their practices (IMPesd). To this end, we extended our previous CFA model to incorporate a correlation with the IMPesd described by the three items developed based on Effeney & Davis (2013) (see Table 1). The analysis was also conducted in a structural equations modelling framework using Mplus 7.4. The results indicated an acceptable model fit (RMSEA = 0.067; 90% Confidence Interval of RMSEA = [0.063, 0.070]; CFI = 0.964; TLI = 0.962). The three items tapping into IMPesd loaded highly on the corresponding framework with factor loadings of 0.788 for IMPesd1, 0.690 for IMPesd2, and 0.771 for IMPesd3 (Please refer to Table 1 for item wording). Moreover, the IMPesd and PACesd were found to show a moderate association with a standardized correlation of r = 0.554, statistically significant at $p<0.001$, indicating that about 30% (r^2 = 0.307) of the variance in PACesd could be explained by IMPesd. In line with our expectation, the association between the

two constructs is meaningful but not very high, suggesting that the two instruments measure related but different constructs ("ERIC - ED565876 - Standards for Educational and Psychological Testing, 2014 Edition, American Educational Research Association (AERA), 2014).

Discussion and conclusions

In the current study, inspired by the concept of action competence (Breiting et al., 2009; Jensen, 2000; Jensen & Schnack, 1997; Mogensen & Schnack, 2010; Sass et al., 2020), we introduced the multifaceted framework of Professional Action Competence in Education for Sustainable Development (PACesd). PACesd was introduced here to address the need for broader frameworks of teacher competence in implementing ESD that are still scarce in current research that is aimed mainly at investigating isolated teacher ESD competence features (e.g., teachers' self-efficacy). The PACesd framework tackles this need by proposing an integrated framework of professional action competence in ESD described by three defining features: willingness, knowledge of pedagogical approaches, and self-efficacy regarding implementing ESD. This implementation poses a challenge for schools and teachers. Therefore, we have argued that the motivational aspect of willingness should be a strong autonomous type of motivation if school teams are to stay committed when facing obstructions and setbacks. Consequently, we drew from Moeller and Grassinger's (2014) commitment and passion model for measuring this aspect of PACesd. Furthermore, teachers need relevant pedagogical content knowledge and should have confidence in their capacities for implementing ESD. In view of the complex nature of (E)SD issues and AC, we call for collaborative efforts. In a team, not all features of action competence need to be shown within one individual: what one individual is lacking can be complemented by other

members as long as the team as a whole shows these PACesd features. Moreover, opportunities for developing PACesd in collaboration with others outside one's own school or organization may broaden perspectives while additionally catering for solitary teachers' or educators' needs.

To validate this framework, we developed the PACesd-Q, a questionnaire measurement instrument in line with our framework of PACesd. Available frameworks and instruments (Effeney & Davis, 2013; Malandrakis et al., 2019; Moeller & Grassinger, 2014) were informative in this process. The questionnaire was administered to a sample of 557 primary and secondary school in-service teachers in Flanders, Belgium. The instrument's psychometric quality was assessed in terms of its reliability, construct, and criterion-related validity.

Our main research question was directed at establishing the reliability and construct validity of the PACesd measurement instrument in our sample. Structurally, the instrument consists of a higher-order construct described by three factors: teachers' willingness, knowledge of pedagogical approaches, and self-efficacy regarding the implementation of ESD in their practices. Reliability measures (Cronbach's α) estimated for each sub-scale and the overall construct indicate a highly reliable instrument with strong consistency among the items tapping into the different components of PACesd (Cronbach's α ranging from 0.84 to 0.96). Results of hierarchical (second-order) confirmatory factor analysis confirmed the construct validity of the instrument in our sample showing that while three aspects of professional action competence in implementing ESD can be distinguished (i.e. willingness, knowledge of pedagogical approaches and, self-efficacy in implementing ESD), they all relate to the underlying framework of PACesd in meaningful ways. Specifically, the results indicated that all items are strong indicators of their corresponding factors. Likewise, the three dimensions

(willingness, perceived PCK, and self-efficacy regarding ESD implementation) are good indicators of the PACesd framework, which depends most strongly on perceived pedagogical content knowledge. Moreover, evidence of criterion-related validity was provided by results illustrating the correlation between PACesd and a related construct, i.e. teachers' perceived importance of education for sustainable development (see also Effeney & Davis, 2013). In line with theoretical expectations, the empirical results confirmed that the two instruments are significantly related (with a moderate association of $r = 0.554$); high scores on PACesd tend to be associated with high perceived importance of ESD.

Given this body of evidence, detailed in the results section, we conclude that the PACesd-Q can be considered a valid and reliable instrument for measuring teachers' professional action competence in implementing ESD in primary and secondary schools in Flanders. We are confident that the instrument can be successfully used to provide educational practitioners with a tool to monitor and eventually identify professional development needs concerning their professional action competence in education for sustainable development.

Although the current study has particular strengths, we also acknowledge some limitations that may open avenues for further research. A first limitation concerns the way PACesd was measured. More specifically, to assess PACesd, we relied on teachers' self-reports that may be affected by social desirability. Complementing the data with a qualitative research design that relies on teacher behaviors (e.g. observations of teaching practice) and on an in-depth account of their views (e.g. cognitive interviews) might provide a more nuanced account of their competences. In-depth case studies may also reveal what barriers and facilitating factors they encounter in the process of developing PACesd. A second limitation lies in that the findings reported here are particularly

relevant for our sample of primary and secondary teachers in the Flemish context. Further research could be directed at investigating whether the measurement instrument performs equally well in larger samples of teachers in Belgium as well as in other countries including aspects of comparability (measurement invariance) among different groups of educational practitioners and countries. This would enhance the instrument's strength and applicability and make it possible to conduct comparisons between teachers or educators at different levels in their training (pre-service versus in-service), teaching different subjects, and working in different educational contexts (in schools or in non-formal educational centers). Such research, enabled by the current study, could be a powerful additional resource in the process of incorporating and monitoring the implementation of ESD into school curricula and teacher education around the world. The PACesd-Q was based on particular frameworks, such as action competence, passion-commitment, and self-efficacy. This provides both strengths and limitations. On the one hand it is firmly anchored in well-established frameworks. On the other hand, the choice for these frameworks left out other perspectives that are acknowledged in frameworks such as Redman et al.'s (2018). When looking into the measurement results at the level of PACesd subconstructs willingness, perceived PCK, and self-efficacy regarding ESD implementation in teachers' classroom practice, schools get useful information for analyzing their teachers' professional development needs. Moreover, the overall PACesd-Q results could monitor the extent to which teachers and teaching teams are ready to launch, enhance, or continue the implementation of ESD in the classrooms.

In conclusion, we are confident that the current research is a step forward in the study of teachers' competence in implementing ESD. Unlike most of the available literature that often zooms in on isolated aspects of teachers' competence, this work built on a valuable and relevant framework for ESD (i.e. the concept of action competence) to propose and

successfully operationalize and measure an integrated framework of teacher competence in implementing ESD (PACesd) that encompasses teachers' confidence in their capacities, their willingness, and pedagogical content knowledge regarding implementing ESD. Moreover, in contrast to previous research that mainly looked at aspects of teachers' competence among pre-service teachers, we successfully measured and validated this framework and its underlying features among in-service teachers in primary and secondary schools. In doing so, we answered calls for more research targeting in-service teachers' competence and enabling in-service teachers and schools to assess their strengths and needs when implementing ESD (Evans et al., 2017; Malandrakis et al., 2019; Redman et al., 2018; Taylor et al., 2019). The current research was a research-practitioner collaborative effort. Along with other quantitative and qualitative instruments, our results can be used to inform teacher and school self-assessment of professional development needs regarding ESD implementation within the boundaries of what is deemed achievable and purposeful.

Acknowledgements

The authors would like to thank all participating schools and respondents for their constructive cooperation and feedback. We thoroughly appreciated the feedback and comments on the initial draft of the questionnaire received from the members of the VALIES advisory board and core team. We are especially grateful to Eli Janssen for her great involvement in the initiation of this study. Finally, we greatly valued the thoughtful and constructive comments of the journal's editor and anonymous reviewers.

Funding and ethics

This study is part of the VALIES project and is funded by the Flanders Research Foundation (FWO) under grant agreement S010317N within the Strategic Basic Research program.

In all data collections the ethical guidelines and advice of the researchers' institution were observed (the University of Antwerp Ethics Committee for Social and Human Sciences, approval number SHW_18_25).

This study is published in *Environmental Education Research* on September 2021 (copyright Taylor & Francis), available online:

https://doi.org/10.1080/13504622.2021.1976731

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