Article

Differences in Teachers' Professional Action Competence in Education for Sustainable Development: The Importance of Teacher Co-Learning

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Abstract: This study builds on a research-practitioner partnership embedded within an education for sustainable development (ESD) project and aims to explore the major potential challenges (i.e., disciplinary boundaries set by subject specialization, especially in secondary education) and success factors (i.e., teacher co-learning experiences in ESD) associated with differences in teachers' professional action competence (PACesd) in a sample of 557 in-service teachers in primary and secondary schools in Flanders, Belgium. The study employed a recently validated PACesd measurement instrument and involved quantitative data analysis in a structural equation modelling framework. The results show that primary education teachers tend to report higher PACesd levels compared to their peers in secondary education. Moreover, regardless of educational level, gender and teaching experience, all teachers participating in a working group or a learning community in ESD are more likely to show higher levels of PACesd. Implications of the findings, limitations and directions for future research are discussed.

Keywords: teachers' professional action competence (PACesd); education for sustainable development (ESD); teacher co-learning; in-service teachers; primary and secondary schools; Flanders; Belgium

1. Introduction

Worldwide, there is a growing consensus that education for sustainable development (ESD) can be a powerful tool in addressing urgent environmental, social and economic challenges such as the climate crisis, mass loss of biodiversity, pollution, pandemic diseases, extreme poverty and inequalities and violent conflicts [1–6]. The international significance of integrating all aspects of sustainable development (SD) into school education is emphasized by the work of several international organizations. For example, the sustainability agenda in educational systems worldwide is highly supported by the United Nations (UN) agency for education (UNESCO) through its initiatives such as the UN Decade of Education for Sustainable Development (2005–2014) or the current "Education 2030 Agenda" that provides guidance in implementing 17 Sustainable Development Goals [1]. Specifically, SDG Target 4.7 aims to ensure that by 2030 *"all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of*

peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" [1] (p. 14). Educational systems and educators across the world are encouraged to implement ESD as a core curriculum component at all educational levels [2] and to develop "*capacities to foster societal transformation for a sustainable future*" [1] (p. 23). Similarly, the European educational policy agenda reflected by the Strategic Framework for European Cooperation in Education and Training towards the European Education Area (2021–2030) [7] recognizes the importance of the UN's 2030 Sustainable Development Goals agenda and explicitly features sustainability aspects in formulating key educational policy aims: "*Education and training have a vital role to play when it comes to shaping the future of Europe, at a time when it is imperative that its society and economy become more cohesive, inclusive, digital, sustainable, green and resilient, and for citizens to find personal fulfilment and well-being, to be prepared to adapt and perform on a changing labour market and to engage in active and responsible citizenship*" [7] (p. 4).

Undeniably, the educational policy focus on sustainable development places teachers and educators of all educational levels at the core of education for sustainable development implementation. Teachers are to foster a high-quality sustainable development education that provides learners with a set of knowledge, skills, values and attitudes essential for becoming sustainable development change agents [2,5]. This complex set of cognitive and non-cognitive skills includes, for example, critical thinking, creativity, complex problem-solving, collaborative decision-making, dealing with risk and uncertainty, systemic thinking and action competence, empowering individuals and societies to take action on sustainable development issues [1,2,4,5]. In doing so, teachers themselves need to employ a complex set of professional competences, including knowledge of sustainable development issues and of pedagogical strategies for implementing ESD but also confidence and passion for education for sustainable development issues [8]. For example, research shows that teachers taking a *holistic* approach are more effective in stimulating their students to address complex interdisciplinary sustainable development issues with intertwined environmental, social and economic dimensions and with implications at a local, regional and global scale and links to the past, the present and the future [9–11]. Moreover, through a *pluralistic* pedagogy [9,12], they facilitate the democratic expression of different and often controversial points of view and enable critical thinking, creativity, complex problem-solving and collaborative decision-making. Furthermore, and arguably most importantly, they should guide and provide their students with learning opportunities that empower them with the competences necessary to take (collective) action regarding sustainable development issues (i.e., *action-orientedness* [13]).

Evidently, these competences are not easily mastered. Several quantitative studies as well as review studies show that pre-service as well as in-service teachers at different levels of education may feel unprepared to tackle sustainable development issues and often report a range of challenges to education for sustainable development implementation in their classrooms [4,5,14,15]. These challenges are various and related to several factors, ranging from personal considerations (e.g., perceived lack of sustainable-development-related knowledge, feelings of incompetence and commitment to education for sustainable development) to institutional features (e.g., overcrowded curricula, lack of teacher training) or to education level and related disciplinary boundaries (particularly in secondary education) that leave limited space for interdisciplinary, holistic approaches [4,5]. However, in spite of these barriers, educational institutions and educational practitioners worldwide are increasingly committed to the implementation of education for sustainable development and several partnerships have been forged in order to share successful education for sustainable development practices and empower teachers and learners to develop the competences necessary for implementing education for sustainable development [16]. Teachers' professional development through co-learning is one such partnership that has proven promising for alleviating the strain of the many competences that teachers need to implement education for sustainable development successfully. Such co-learning can range from spontaneous conversations related to challenges and successes in implementing

education for sustainable development to structural co-learning opportunities embedded in the school's formalized organization [17].

This study describes one such initiative (embedded within the Valorizing Integrated and Action-Oriented Education for Sustainable Development at School project, VALIES) that was directed toward facilitating education for sustainable development implementation in primary and secondary schools in Flanders, Belgium. Specifically, by means of quantitative (survey) data analyses, the study aims to identify potential challenges and success factors in developing teachers' professional action competence in education for sustainable development in a sample of 557 in-service teachers. In doing so, guided by insights from the literature, we zoom into one potential challenge to education for sustainable development implementation (i.e., disciplinary boundaries set by education levels) and one influential success factor (i.e., teacher co-learning experiences in education for sustainable development). These aims are further elaborated in the following research questions that guide this empirical study:

(1)   Are there difference in teachers' professional action competence in education for sustainable development among in-service teachers teaching at different levels of education (i.e., primary and secondary education)? Do these differences persist over and above other teacher background characteristics (i.e., gender, teaching experience)?

(2)   Are teacher co-learning experiences in education for sustainable development associated with their professional action competence in education for sustainable development over and above other teacher characteristics?

In what follows, the study presents the concept of teachers' professional action competence in education for sustainable development (PACesd) and discusses potential differences in teachers' competence that are due to educational levels (i.e., primary versus secondary education) as well as the importance of teacher co-learning experiences in education for sustainable development. We then describe the characteristics of the particular educational context and of the VALIES project and present the methodology of this empirical study as well as a synthesis of our main findings. We conclude with a discussion of our findings and a reflection on potential avenues for future research in the field.

1.1. Teachers' Professional Action Competence in ESD (PACesd)

Undoubtedly, teachers and teachers' competences lie at the core of education for sustainable development implementation [4,5,18]. At a theoretical level, scholars tend to agree that teachers' competence in education for sustainable development implies a multifaceted set of beliefs, skills and knowledge. These include teachers' confidence in their capacities to implement education for sustainable development in their classrooms (i.e., teachers' self-efficacy concerning education for sustainable development), teachers' knowledge and skills regarding sustainable development and education for sustainable development implementation and teachers' personal engagement, commitment and passion to implement education for sustainable development and to empower their students as agents of change for a sustainable future [4,6,8,19]. Simultaneously, a growing body of empirical research into teachers' competence in education for sustainable development is also emerging. However, empirical research into teachers' competence in education for sustainable development is still at an incipient stage [8]. Specifically, many of the available studies are focused on isolated competency dimensions (e.g., teachers' self-efficacy in education for sustainable development and/or their education-for-sustainable-development -related knowledge and skills, often neglecting to address teachers' willingness and passion for education for sustainable development), and tend to focus preponderately on pre-service teachers (i.e., relatively limited studies focus on in-service teachers' education for sustainable development competence). Moreover, these studies are often embedded in specific curricular areas (e.g., science education) as well as certain countries and educational contexts [16,20–23]. Aside from some exceptions [8], the existing studies do not simultaneously consider different aspects of teachers' competence in education for sustainable development and a broad

view on education for sustainable development that takes into account complex education for sustainable development principles such as pluralism, holism and action-orientedness.

With the aim of adding to previous research, in recent work [8,24], we built on the concept of action competence to propose a framework for conceptualizing and measuring teachers' professional action competence in education for sustainable development (PACesd). The main features of this conceptualization are described next.

The concept of action competence (AC) is a useful framework for conceptualizing the set of competences necessary to take action concerning pressing societal issues [12]. Although we acknowledge the theoretical discussion regarding the conceptualization of AC [12,25–27], here we define action competence as a generic competence of (a team of) teachers who aim to implement education for sustainable development in their educational practice. Specifically, action competence refers to an ecology of subconstructs such as conceptual knowledge of possibilities for contributing, willingness to contribute and self-efficacy (i.e., confidence in one's own capacities for carrying out actions that will contribute to solving the issue at stake [24], which is education for sustainable development implementation in the case of PACesd).

1.2. Challenges and Success Factors in Developing PACesd

Although research into the factors that enable or hinder different aspects of teachers' competence in implementing education for sustainable development is still at an incipient stage, recent reviews of the literature have shed light on major constraints and on potential success factors regarding education for sustainable development implementation in different educational systems around the world [4,5]. These studies were concerned with the implementation of education for sustainable development in secondary education [4] as well as in teacher training [5]. A reading of this literature and its several informative primary sources, e.g., [8,23,24], highlights one important challenge, which is the potential boundaries set by educational levels, and one promising way forward, i.e., teacher co-learning in education for sustainable development. We will now elaborate on these two aspects.

1.2.1. Potential Boundaries Set by Educational Levels

In a systematic review of 73 studies regarding education for sustainable development implementation in the secondary school sector in a wide range of countries, Taylor and colleagues [4] conclude that, although teachers at all educational levels struggle to implement education for sustainable development, teachers in primary education tend to find it easier to integrate education for sustainable development in their curricular practices as compared to their peers in secondary education. The main reason behind such a finding relates to the fact that in many educational systems (including Flanders, Belgium) primary school teachers often tend to cover the majority of the curriculum, which facilitates their competence in using interdisciplinary and holistic approaches and paves the way for more easily creating common grounds for teacher collaboration [5,14]. The authors [4] proceed by identifying different categories of major constraints in implementing education for sustainable development in secondary education. Most importantly, these include "conceptual", "educational" and "attitudinal" barriers such as a lack of agreement regarding sustainable development issues, feelings of incompetence (in terms of knowledge and skills) and/or commitment to education for sustainable development issues. Such perceptions seem to be enabled by the organization of secondary school curricula into distinct disciplines with specific traditions and by a pressure to prioritize specific subjects due to high-stakes examinations. Consequently, regardless of the benefits that subject specialization offers, secondary education teachers are often constrained by their subject-specific knowledge and find it difficult or too ambitious to tackle complex interdisciplinary topics or to apply holistic and pluralistic pedagogical approaches, while a potential lack of commitment and willingness to teach education for sustainable development, largely due to prioritizing

subject-specific topics and methodologies, may also hinder their support for education for sustainable development practices [4,14,28–31].

Given these insights from previous research, which were also corroborated by the subjective impressions of the school coaches participating in the VALIES project, in this study, *we hypothesize that teachers in secondary education will tend to show lower levels of professional action competence in education for sustainable development compared to their primary education peers.*

1.2.2. The Importance of Teacher Co-Learning Experiences in ESD

Broadly defined as "teachers at the same school working collaboratively based on shared values to improve a specific component of student learning" [10], p. 62, teacher co-learning has gained considerable support from research demonstrating that sustained interaction between groups of teachers is a key form of professional development [17,32–36]. Research shows that, when teachers in a school learn together and share practices with learning purposes, such activities have a series of benefits, which include higher student outcomes, higher levels of perceived competence and greater openness to educational innovation [17,32–37]. In terms of teacher competence, teacher co-learning through collaborative communities of practice tends to foster the development of a shared pedagogical understanding, pedagogical content knowledge and feelings of (collective) self-efficacy.

When applied to the field of education for sustainable development implementation, it is evident that teacher co-learning can play an important role in building a shared sense of commitment, a common understanding of education for sustainable development issues and its pedagogical approaches as well as feelings of efficacy. Indeed, an increasing body of empirical evidence identifies teacher co-learning through collaborative communities of practice as a central theme to the success of education for sustainable development implementation efforts in several countries [1,4,5,14,16,31,38].

Therefore, in this study, we hypothesize that teacher co-learning experiences will positively relate to higher levels of perceived professional action competence in education for sustainable development among all teachers.

2. Methods

2.1. Research Context

The current study took place in the context of primary and secondary schools in Flanders, Belgium. Flanders is a Dutch-speaking sub-national entity of the Belgian federal state. In Flanders, education for sustainable development is embedded in the curriculum of compulsory education through both subject-specific and cross-curricular educational goals [39,40]. Sustainability is one of the key competences to be fostered at both primary and secondary education levels [41]. However, compared to other countries, schools in Flanders are quite autonomous in how they achieve these goals. Therefore, the organization of education for sustainable development learning experiences can vary widely from school to school. Differences in education for sustainable development implementation are also to be expected between primary and secondary schools as primary school teachers generally teach a broad range of subjects while secondary school teachers are specialized in particular subjects. Nevertheless, the professionalization of education for sustainable development practitioners is a key educational policy priority. Networking, developing and disseminating education for sustainable development expertise is supported by a series of initiatives, such as implementing UNESCO's Education 2030 Agenda and its sustainable development goals, the "eco-schools" programs and a range of other opportunities for school innovations in education for sustainable development practices and school partnerships [3,39].

This study is embedded in such a co-creative researcher-practitioner partnership, the Valorizing Integrated and Action-Oriented Education for Sustainable Development at School (VALIES) project [42]. The project focuses on the professional development of teachers and aims to make education for sustainable development implementation successful in primary and secondary schools in Flanders. Researchers are working closely

with the school team to identify critical success factors and barriers for bringing integrated and action-oriented education for sustainable development into schools.

Participants and Procedure

To answer the research questions raised in this study, we zoom in on one of the most important aspects of the VALIES project, which is teachers' perceived competence in ESD and (contextual) factors that may impede or facilitate the development of such competence. We rely on data from a quantitative online survey that was administered in January to March 2019 to 557 teachers of 49 primary and secondary schools. A total of 366 of the teachers were teaching in secondary schools and were specialized in specific subject areas such as science (22%), language (17%), social science (15%), vocational and esthetical subjects (14%) as well as other specialized subjects connected to one or more of the other groups (32%). A total of 191 of the teachers were teaching in primary schools and were responsible for teaching a broad range of subjects. The teaching experience of the respondents varied from 0 (beginning teachers) to 45 years, with an average teaching experience of 15.68 years. A total of 69% of the respondents were women. All teachers expressed consent to participate in the research and interest in being part of the VALIES project by learning about and engaging in education for sustainable development implementation activities. A total of 38 percent of the teachers reported that they were already involved in a working group or a learning community on education for sustainable development.

Before being presented with the online survey that, among other topics, gathered data on their education for sustainable development competences and background characteristics (see Variables section), the teachers were introduced to the working definition of education for sustainable development (ESD) and made aware of the ESD principles of pluralism, holism and action-orientedness.

2.2. Variables

2.2.1. Outcome Variables

This study's outcome variables are teachers' professional action competence in education for sustainable development (PACesd) and its three core components: self-efficacy regarding education for sustainable development (SEesd), perceived pedagogical content knowledge of education for sustainable development (pPCKesd) and willingness to implement education for sustainable development (Wesd). In previous research [8], we developed and validated a PACesd questionnaire instrument tailored to the Flemish context. The instrument is based on the concept of action competence, takes into account ESD principles such as pluralism, holism and action-orientedness and builds on existing operational frameworks for measuring self-efficacy, pedagogical content knowledge and willingness regarding ESD and its implementation [21,43]. Thirty-one questionnaire items explore teachers' perceptions of their PACesd (SEesd: 10 items; pPCKesd: 11 items; Wesd: 10 items). In order to ensure accurate surveying by providing the respondents with the opportunity to carefully consider the question, these items were measured on a six-point Likert scale, ranging from "strongly disagree" (=1) to "strongly agree" (=6). Table 1 presents the constructs, the items and their descriptive statistics. Factor scores for the second order factor (PACesd) as well as its three core components (SEesd, pPCKesd, Wesd) were estimated using confirmatory factor analysis (CFA) and construct validity was achieved [44,45]. More specifically, a CFA model consisting of a second-order latent construct of PACesd which is composed by three first-order latent constructs (SEesd, pPCKesd, Wesd) indicated an adequate model fit (RMSEA = 0.077; CFI = 0.964; TLI = 0.961; also see Figure 1). The corresponding scales show high reliability with Cronbach's α ranging from 0.92 to 0.96. For further details we refer to the Results section, Table 1 and Figure 1.

Table 1. Outcome and explanatory variables (descriptive statistics).

Label	Construct/Item */Operationalization	Cronbach's α	Mean	SD
	Outcome Variables			
PACesd	**Professional action competence in education for sustainable development**	0.96	4.00	0.69
	Second-order construct with three core features: SEesd, pPCKesd, Wesd			
SEesd	**Self-efficacy regarding education for sustainable development**	0.92	4.38	0.68
	I am confident that as a teacher I can......			
S_1	develop students' ability to view a problem from different points of view.		4.64	0.81
S_2	develop students' ability to weigh different solutions to sustainability issues.		4.48	0.78
S_3	develop students' ability to reflect on their own actions.		4.65	0.81
S_4	develop students' ability to express their own views on sustainability issues.		4.61	0.79
S_5	develop students' ability to understand the interconnectivity between the social, environmental and economic aspects of sustainable development.		4.36	0.89
S_6	make students realize that there are conflicting interests on the road to sustainable development.		4.56	0.88
S_7	make students realize that the road to sustainable development contains a high degree of uncertainty.		4.36	0.86
S_8	develop students' ability to act for sustainable development at a local level (e.g., in the school).		4.52	0.88
S_9	develop students' ability to act for sustainable development at a regional level (e.g., in the municipality).		3.98	1.00
S_{10}	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... . . .			
P_1	make education for sustainable development happen in my class (es).		4.37	0.92
P_2	make education for sustainable development happen in my school.		4.33	0.89
P_3	evaluate an ESD project I (we) have implemented.		4.17	1.01
P_4	address the environmental aspects of sustainability issues in my teaching.		4.38	1.02
P_5	address the social aspects of sustainability issues in my teaching.		4.32	0.96
P_6	address the socio-economic aspects of sustainability issues in my teaching.		4.02	1.06
P_7	address the global aspects of sustainability issues in my teaching.		3.89	1.11
P_8	work on sustainable development in the spirit of the attainment targets.		4.33	1.00
P_9	work across disciplines on sustainable development.		4.52	0.95
P_{10}	formulate learning objectives for my students regarding sustainable development.		4.36	1.01
P_{11}	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 . . .			
W_1	Each day, I make sure that I have enough opportunities to dedicate myself to education for sustainable development (ESD).		3.24	1.10
W_2	ESD is typically me.		3.85	1.08
W_3	ESD is close to my heart. Without ESD I wouldn't be myself.		3.30	1.23
W_4	Implementing ESD gives me energy.		3.41	1.13
W_5	I try to plan my daily work so that I have as much time as possible to spend on ESD.		2.78	1.16

Table 1. *Cont.*

	Outcome Variables			
Label	**Construct/Item */Operationalization**	**Cronbach's α**	**Mean**	**SD**
W_6	When I'm working on ESD, I experience that as an intense experience.		3.17	1.21
W_7	ESD will play an important role in my life.		3.50	1.17
W_8	I often feel a strong urge to work with ESD.		3.21	1.21
W_9	I am often really looking forward to working with ESD.		3.29	1.22
W_{10}	Many of my personal goals are related to ESD.		3.42	1.23
	Explanatory variables			
Label/Construct	**Operationalization**	**Percentage**	**Mean**	**SD**
Level of education	Dichotomous variable differentiating between primary and secondary education teachers. Reference category = primary education.	62%		
Gender	Dichotomous variable differentiating male and female. Reference category = male.	69%		
Teacher experience	Continuous variable indicating teacher's' years' experience.		15.68	15.38
Teacher co-learning	Dichotomous variable indicating the teacher's participation in a working group or a learning community on ESD. Reference category = no participation.	38%		

Note: * All items are rated on a six-point Likert scale ranging from "strongly disagree" (=1) to "strongly agree" (=6).

2.2.2. Explanatory Variables

Table 1 presents all the explanatory variables and their descriptive statistics.

The main explanatory variables in this study are *level of education* and *teacher co-learning*. *Level of education* is captured by a single item asking teachers to indicate whether they work in a school for primary or secondary education. The corresponding variable distinguishes between primary and secondary education teachers (primary = 1; secondary = 2). To get insight into *teacher co-learning* experiences, teachers were asked to indicate whether they are part of a working group or learning community on ESD. The corresponding variable distinguishes between the teachers that take part in such a collaborative initiative and those who do not (0 = no; 1 = yes). Given the large degree of autonomy in Flemish schools and within the VALIES project, when participation is indicated this may mean a variety of collaboration forms, ranging from occasional meetings throughout the school year to more intensive collaboration and co-creation of educational arrangements.

The covariates used in this research included teacher *gender* and *teacher experience*. *Gender* is measured by a single binary indicator distinguishing between male (=0) and female (=1) teachers. *Teacher experience* is measured by a single item asking teachers to indicate how many years they have been working in education.

2.3. Analytical Strategy

A series of analytical approaches were applied in this research. Data compilation and recoding, along with descriptive statistics and reliability analyses, were conducted using IBM SPSS [46]. The main analyses were performed in a structural equations modelling (SEM) framework using Mplus 7.4 [47]. The estimation considered the categorical character of the PACesd items (rated on a six-point Likert scale) and the multilevel structure of the data (teachers nested within schools). Specifically, the weighted least squares mean and variance estimator (WLSMV) with theta parametrization was used to analyze the categorical data and Taylor Series Linearization was applied to account for the stratification of observations (i.e., teachers within schools). To handle missing data, we used the full information maximum likelihood (FIML) method that uses all available information for any variable, excluding only cases with missing data on all variables. A total of 62 cases had missing data on all variables in this research.
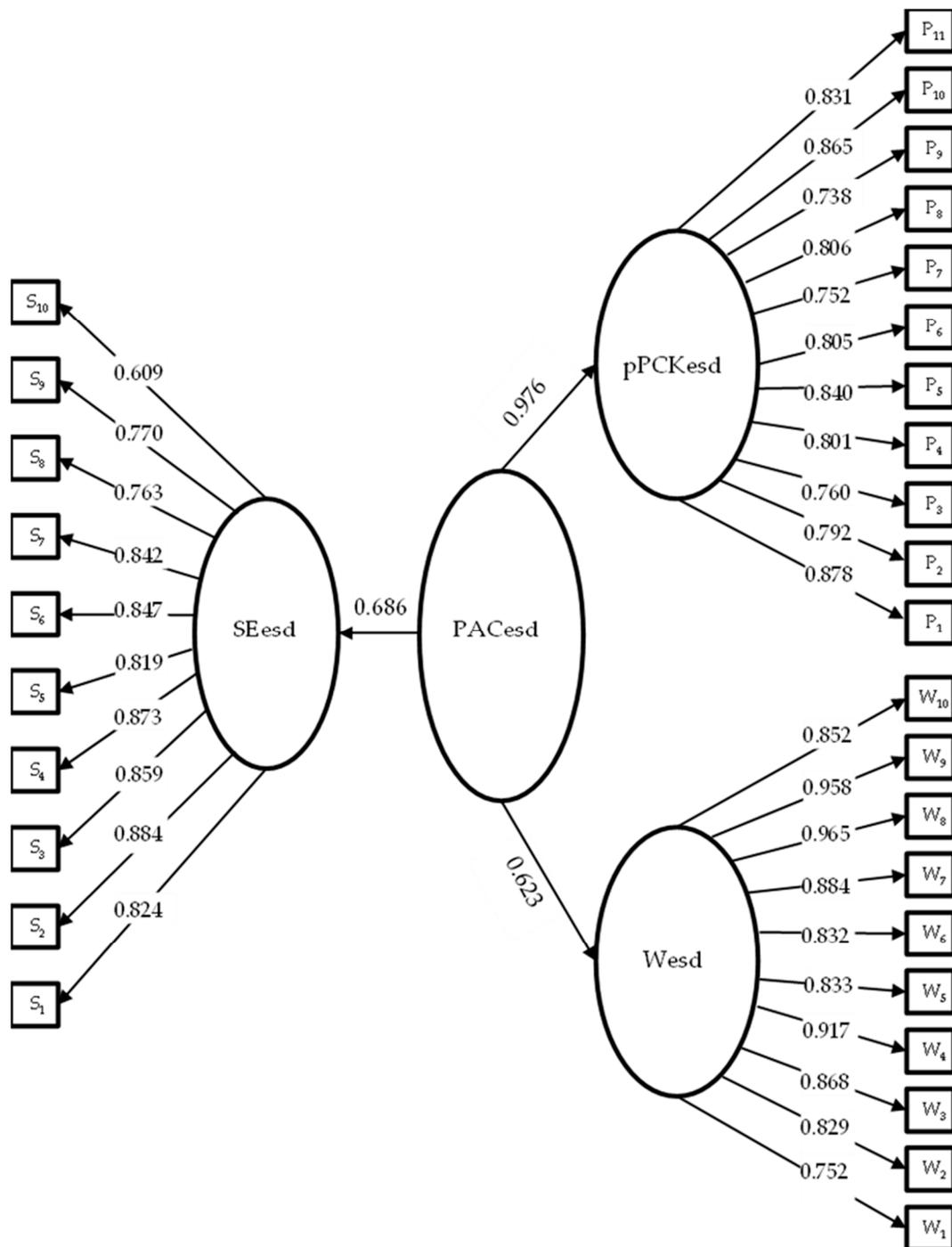
Figure 1. Results of second-order CFA analysis for PACesd. Standardized coefficients: item and factor loadings; model fit indices: RMSEA = 0.077; CFI = 0.964; TLI = 0.961.

In order to address the two research questions, we applied a series of analyses. First, we applied categorical second-order CFA to estimate the measurement model of PACesd and its three core components: SEesd, pPCKesd and Wesd see also [13]. The following goodness of fit indices (relevant for categorical CFA) were applied: the root mean square error of approximation (RMSEA), the comparative fit index (CFI) and the Tucker-Lewis index (TLI) [44]. These fit indices indicate an acceptable model fit when RMSEA is lower or equal to 0.08 and CFI and TLI values are above 0.90 [44,45]. In a second step, we extended this model to incorporate the relationship between the explanatory variables and PACesd as well as SEesd, pPCKesd and Wesd. Specifically, we estimated a series of structural

models aimed to test: (a) the associations between the education level taught and the outcome variables, (b) the associations between education level and the outcome variables, controlling for teacher background characteristics (i.e., gender, teaching experience) and (c) the associations between teachers' co-learning experiences in ESD and the outcome variables controlling for teacher characteristics (i.e., gender, teaching experience, education level). The same goodness of fit indicators were used to evaluate model fit.

3. Results

In this section, we will first present the results of the measurement model (CFA) of PACesd and subsequently the results of the structural models estimated to answer the two research questions.

3.1. Teachers' Professional Action Competence in ESD (PACesd)

Table 1 presents descriptive statistics (i.e., means and standard deviations) as well as reliability measures (i.e., Cronbach's α) for the 31 items measuring PACesd and its three core components, SEesd, pPCKesd and Wesd. These preliminary results indicate high reliability of the scales (Cronbach's α ranging from 0.92 to 0.96) and average partial agreement with all PACesd items (M = 4.00, sd = 0.69). Notably, teachers agreed the most with SEesd (M = 4.38, sd = 0.68) and pPCKesd (M = 4.26, sd = 0.78) items while average partial disagreement is found with respect to the Wesd items (M = 3.32, sd = 1.00).

The results of the second-order CFA measurement model are reported in Figure 1. A factor structure consisting of a second-order latent construct (PACesd) composed by three first-order constructs (Wesd, pPCKesd and SEesd) was confirmed with model fit indices indicating an adequate model fit (RMSEA = 0.077; CFI = 0.964; TLI = 0.961). Moreover, the adequate model fit was also supported by the results obtained for the parameter estimates such as factor and item loadings (Figure 1). All these parameters are statistically significant at $p < 0.001$. Item loadings ranging from 0.609 to 0.965 indicate that the 31 items are strong indicators of their corresponding first-order factors (SEesd, pPCKesd, Wesd). Moreover, in line with the literature, factor loadings indicate that SEesd (0.686), pPCKesd (0.976) and Wesd (0.623) are good indicators of the second-order factor (PACesd). We therefore retained the second-order measurement model of PACesd for further analysis.

3.2. Differences in Teachers' PACesd among In-Service Teachers Teaching at Different Levels of Education

Having examined and confirmed the construct validity of PACesd, our next step was to examine this study's first research question and estimate the differences in PACesd among in-service teachers teaching at different levels of education. Building on the literature, we acknowledged that differences in teachers' PACesd may be explained also by other teacher characteristics such as gender and teaching experience. Therefore, the results presented here (Tables 2 and 3) stem from two sets of analyses. First, in parallel analyses, we estimated differences in teachers' PACesd, as well as their SEesd, pPCKesd and Wesd, without controlling for teachers' background characteristics (Table 2). Second, we estimated the same models controlling for teachers' background characteristics, such as gender and teaching experience (Table 3).

Table 2 illustrates the results of the first set of analyses. In line with our hypothesis, the parameter estimates show a statistically significant association between the level of education (secondary versus primary) and teachers' PACesd, indicating that primary education teachers tend to report, on average, higher levels of PACesd. A similar pattern is also found when relating the level of education to the three core components of PACesd: SEesd, pPCKesd and Wesd. Primary education teachers tend to report higher levels of self-efficacy (SEesd), perceived pedagogical content knowledge (pPCKesd) and willingness regarding implementation of education for sustainable development (Wesd). These differences are most pronounced regarding teachers' willingness and perceived pedagogical content knowledge.

Table 2. Differences in teachers' PACesd by level of education.

	PACesd		SEesd		pPCKesd		Wesd	
ON	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Level of education (primary = 1; secondary = 2)	−0.220	0.056 ***	−0.126	0.062 *	−0.187	0.051 ***	−0.195	0.052 ***
Model fit indices RMSEA = 0.074; CFI = 0.966; TLI = 0.964			*Model fit indices* RMSEA = 0.074; CFI = 0.966; TLI = 0.963					

Note: Standardized coefficients. * *p*-value < 0.05; *** *p*-value < 0.00; PACesd = professional action competence in education for sustainable development; SEesd = self-efficacy regarding education for sustainable development; pPCKesd = perceived pedagogical content knowledge of education for sustainable development; Wesd = willingness to implement education for sustainable development.

Table 3. Differences in teachers' PACesd by level of education; models controlled for teacher characteristics.

	PACesd		SEesd		pPCKesd		Wesd	
ON	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Level of education (primary = 1; secondary = 2)	−0.224	0.060 ***	−0.126	0.066 ns	−0.180	0.054 **	−0.210	0.052 ***
Gender (0 = male; 1 = female)	0.027	0.055 ns	0.030	0.054 ns	0.052	0.061 ns	−0.013	0.043 ns
Teacher experience	−0.044	0.049 ns	−0.093	0.048 ns	−0.033	0.043 ns	0.016	0.052 ns
Model fit indices RMSEA = 0.068; CFI = 0.967; TLI = 0.965			*Model fit indices* RMSEA = 0.071; CFI = 0.965; TLI = 0.963					

Note: Standardized coefficients. ns = non-significant; ** *p*-value < 0.01; *** *p*-value < 0.00; PACesd = professional action competence in education for sustainable development; SEesd = self-efficacy regarding education for sustainable development; pPCKesd = perceived pedagogical content knowledge of education for sustainable development; Wesd = willingness to implement education for sustainable development.

Table 3 illustrates the results of the second set of analyses, where control variables such as teachers' background characteristics (i.e., gender and teaching experience) are considered. The results show that differences in PACesd-favoring primary education teachers tend to persist even after controlling for teacher background characteristics. This is partially true also when looking at results regarding the three core components of PACesd. Specifically, primary education teachers tend to show higher willingness and perceived pedagogical content knowledge even when gender differences and teacher experience are considered. The association between level of education and self-efficacy regarding education for sustainable development is no longer statistically significant.

3.3. The Association between Teacher Co-Learning Experiences in ESD and Their PACesd

Results regarding the association between teacher co-learning experiences in ESD and their professional action competence in ESD over and above other teacher characteristics are reported in Table 4. In line with our expectations, teachers participating in a working group or a learning community on ESD tend to have higher levels of PACesd. This positive association is found over and above the impact of other characteristics such as gender, teacher experience and level of education. The same pattern is found when looking at the three components of PACesd. Specifically, opportunities for teacher co-learning are positively associated with teachers' self-efficacy, perceived pedagogical content knowledge and willingness in ESD. Moreover, opportunities for teacher co-learning tend to alleviate to some extent initial differences (mainly determined by educational levels) in teachers' PACesd (including SEesd, pPCKesd and Wesd).

Table 4. The relationship between teacher co-learning and teachers' PACesd; models controlled for teacher characteristics.

ON	PACesd		SEesd		pPCKesd		Wesd	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Level of education (primary = 1; secondary = 2)	−0.130	0.059 *	−0.083	0.066 ns	−0.102	0.055 ns	−0.120	0.052 *
Gender (0 = male; 1 = female)	0.019	0.054 ns	0.019	0.054 ns	0.046	0.058 ns	−0.020	0.043 ns
Teacher experience	−0.040	0.047 ns	−0.094	0.046 *	−0.028	0.043 ns	0.020	0.048 ns
Teacher co-learning (participation in ESD group; 0 = no; 1 = yes)	0.300	0.062 ***	0.159	0.050 **	0.263	0.060 ***	0.293	0.057 ***
Model fit indices			*Model fit indices*					
RMSEA = 0.067; CFI = 0.964; TLI = 0.962			RMSEA = 0.069; CFI = 0.962; TLI = 0.959					

Note: Standardized coefficients. ns = non-significant; * p-value < 0.05; ** p-value < 0.01; *** p-value < 0.00; PACesd = professional action competence in education for sustainable development; SEesd = self-efficacy regarding education for sustainable development; pPCKesd = perceived pedagogical content knowledge of education for sustainable development; Wesd = willingness to implement education for sustainable development.

4. Conclusions and Discussion

Education for sustainable development (ESD) can be a powerful tool in addressing urgent environmental, social and economic challenges by providing learners with a set of knowledge, skills, values and attitudes essential for becoming sustainable development change agents [1,2,4,5,7,31]. Educational institutions and educational practitioners worldwide are increasingly committed to the implementation of education for sustainable development and recognize that teachers and educators at all educational levels have a crucial role to play in education for sustainable development implementation and must be supported [1,7]. However, an increasing body of empirical evidence shows that education for sustainable development implementation is not easily achieved by teachers, pointing out both challenges and promising ways forward [4,5,14,16,30].

In this study, building on a research-practitioner partnership embedded within the VALIES project [42], we set out to identify some of these potential challenges and success factors in developing teachers' professional action competence in education for sustainable development in a sample of 557 in-service teachers in primary and secondary schools in Flanders, Belgium. To measure teachers' professional action competence in education for sustainable development and its core components (i.e., self-efficacy, perceived pedagogical content knowledge and willingness regarding ESD implementation), we applied a recent, validated survey measurement instrument (PACesd) developed by Sass et al. [8]. To explore major potential challenges (i.e., disciplinary boundaries set by educational levels taught) and success factors (i.e., teacher co-learning experiences in ESD) associated to differences in teachers' professional action competence, we conducted quantitative (survey) data analysis in a structural equations modelling (SEM) framework. Building on insights from extant literature on education for sustainable development implementation, e.g., [4,5,8], we advanced two hypotheses. First, teachers in secondary education will tend to show lower levels of professional action competence in education for sustainable development compared to their primary education peers. Second, teacher co-learning experiences will positively relate to higher levels of perceived professional action competence in education for sustainable development among all teachers. We will first briefly discuss the results concerning the measurement qualities of the PACesd instrument and the corresponding results in our sample. We will then discuss the most relevant results, addressing our two research questions and corresponding hypotheses. While doing so, we will illustrate the strengths and limitations of this study and offer suggestions for present and future research.

4.1. The Measurement of Teachers' Professional Action Competence in ESD (PACesd)

Teacher competence in education for sustainable development is a complex, multi-faceted concept that involves a set of beliefs, skills and knowledge [4,5,19]. However, very few instruments in the field are able to capture all these important features, especially

in research concerned with in-service teachers [8]. In the context of the VALIES project, building upon the concept of action competence [12,24], Sass and colleagues [8] developed a survey instrument for measuring teachers' professional action competence in education for sustainable development (PACesd). Using this survey instrument for the current study and beyond has the advantages associated with using a measurement instrument that was specifically designed to address the need for broader frameworks of teacher competence in implementing education for sustainable development. The instrument proved successful in proposing, operationalizing and measuring an integrated framework of teacher competence in implementing education for sustainable development that encompasses a multifaceted set of competences, such as teachers' confidence in their capacities, their willingness and their pedagogical content knowledge [8]. Mirroring previous findings [8], in this research, the results of confirmatory factor analysis (see also Results) confirmed the reliability and construct validity of the instrument in our sample supporting the assumption that three aspects of professional action competence in education for sustainable development can be distinguished (i.e., willingness, pedagogical content knowledge, self-efficacy) and that they all meaningfully relate to an underlying framework of PACesd. Given this evidence, we are confident that this instrument was successfully used in this study to tap into teachers' perceptions of their competence in education for sustainable development and we welcome research aimed at applying it to larger samples of teachers and/or various country contexts. We believe that such research will be informative for teacher self-assessment and professional development. However, while this initial application shows promising results, there are areas for improvement. First, in designing this instrument, we relied on the survey method involving teacher self-reports. Therefore, we were neither able to account for socially desirable answers nor able to dig deeper into teachers' views and understandings. Mixed-methods studies involving data triangulation, cognitive interviews and/or classroom observations may shed further light on these aspects. Second, for this study, we worked with a sample of teachers that already had some motivation to reflect on their competence in education for sustainable development, as all teachers in our sample expressed interest and consent to participate in the VALIES project. A desirable next step in this line of research would be to apply this measurement instrument using representative samples of teachers in Flanders and elsewhere.

4.2. Differences in Teachers' PACesd among In-Service Teachers Teaching at Different Levels of Education

Research into potential challenges faced by teachers when implementing education for sustainable development in different educational contexts around the world underscores the particular difficulties experienced by teachers in secondary education, as compared with their peers in primary education, and how these difficulties impact their perceived competence for implementing education for sustainable development [4,5,14,30]. In this study, we set out to test this hypothesis in our Flemish sample of primary and secondary education teachers. The results of this research have confirmed this hypothesis. Specifically, we found differences in teachers' competence in education for sustainable development favoring primary education teachers, even after taking into account relevant background characteristics such as gender and teacher experience. A closer look at these differences regarding the three core PACesd components (i.e., self-efficacy, perceived pedagogical content knowledge and willingness to implement ESD) revealed that, once the background variables are considered, such differences are statistically significant regarding willingness and perceived pedagogical content knowledge. In other words, this study has shown that primary education teachers tend to show higher willingness and perceived pedagogical content knowledge compared to their peers in secondary education. Given the insights from the literature and the impressions gathered from the field in the context of the VA-LIES project, such findings are not surprising. Previous studies have documented that secondary education teachers may tend to have, in particular, lower levels of commitment and higher feelings of incompetence in terms of knowledge and skills regarding education

for sustainable development implementation [4,14,48]. In the literature, such perceptions are explained by constraints set by the organization of secondary education that promotes subject-specific knowledge and leaves relatively little space for teacher training and the implementation of the interdisciplinary and holistic approaches essential for competence in education for sustainable development. Nevertheless, while these results are consistent with the literature, there are some aspects that need further exploration in future research. Due to a relatively small sample size, our analysis did not differentiate between secondary education teachers of different subject areas. Such a path for further research, well-illustrated by the works of Borg and colleagues [14,30], may shed some light on the specific challenges faced by teachers of different subjects.

4.3. The Association between Teacher Co-Learning Experiences in ESD and Their PACesd

In our review of the literature, we documented the importance of teacher co-learning experiences in education for sustainable development [4,5,16]. This finding was further substantiated by the solid body of research into teachers' professional development [32–36]. Building on these insights, we hypothesized that teacher co-learning experiences can be a powerful tool in fostering teachers' competence in education for sustainable development (i.e., PACesd and its components). The findings of this study enabled us to confirm this assumption. More specifically, while taking into account teachers' genders, experience and the educational level taught at (i.e., primary versus secondary), we found that teachers participating in a working group or learning community regarding education for sustainable development tend to have higher levels of competence. Moreover, the same pattern was found when examining the association between teacher co-learning and the three core PACesd components (i.e., self-efficacy, perceived pedagogical content knowledge and willingness in ESD). In other words, regardless of their gender, teaching experience and educational level, teachers participating in a working group or a learning community in education for sustainable development were more likely to show higher levels of self-efficacy, perceived pedagogical content knowledge and willingness to implement ESD. Furthermore, we found that, once teacher co-learning was taken into account in the analyses, the difference in competence between teachers of different genders, educational experience and level of education were either no longer statistically significant or showed very weak associations with teachers' PACesd as well as its three components. Such findings indicate that, to some extent, teacher co-learning experiences tend to alleviate initial differences (largely determined by educational levels) in teachers' competence in education for sustainable development. In view of the great need to identify the best strategies that would support teachers in their education for sustainable development implementation efforts, this finding is particularly important. It corroborates research findings as well as educational policy directions that promote teacher co-learning as a key success factor in education for sustainable development implementation [1,2,4,5,16]. However, here in particular we need to signal some limitations and suggest further areas for improvement in this line of work. First, we must note that this study only captured the tip of the iceberg in the well-developed research field of teacher co-learning. More specifically, in this study, we were only able to differentiate between the teachers that reported that they were involved in a working group or learning community on education for sustainable development and those who were not. Largely due to the impact of the COVID-19 pandemic on the VALIES project and this study, we were not able to dig deeper into important questions that could be addressed in the future by both quantitative and qualitative research. Such questions, building on the solid state-of-the-art in the field [33–37], could shed light on the forms and characteristics of teacher co-learning in education for sustainable development, on the most effective forms of collaboration in the field as well as on the contextual and organizational factors that could support such initiatives. Second, another limitation of this study is its correlational nature that limits our possibility to infer causal links between teachers' co-learning experiences and their PACesd levels. Indeed, it could be argued that teachers that are more self-efficacious, have a higher confidence in their pedagogical content

knowledge and are more willing to implement education for sustainable development will be more likely to engage in teacher co-learning experiences. Although the findings reported here are echoed by previous studies, such alternative hypotheses should be explored in future research that may employ quasi-experimental or even randomized studies.

To conclude, despite the words of caution mentioned above, we are confident that this research can make a few contributions to the field of teacher competence in ESD implementation. First, we introduced a valid and reliable multifaceted measurement instrument of teachers' professional action competence in education for sustainable development (PACesd). Second, we corroborated research findings pointing to stronger challenges in implementing ESD for teachers in secondary education. Third, we documented the potential effectiveness of teacher co-learning regarding ESD and its implementation. Taken together, the current findings point to the value of sustained interaction between groups of teachers (i.e., teacher co-learning) around ESD issues as a key form of professional development that has the potential to foster the complex set of competences teachers need to implement education for sustainable development successfully. We hope that our results, coupled with other quantitative and qualitative research approaches, may be equally informative for researchers, policy makers and practitioners devoted to advancing the knowledge base supporting teacher professional development needs regarding education for sustainable development implementation.

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