Research Article

Exploring knowledge of prospective biology teacher about education for sustainable development

Ivo Novidsa [a,1,*], Widi Purwianingsih [b,2], R. Riandi [b,3]

[a] Biology Education, School of Postgraduates, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 299, Bandung City, West Java 40154, Indonesia

[b] Departement of biology education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 299, Bandung City, West Java 40154, Indonesia

[1] ivonovidsa15@upi.edu*; [2] widipurwianingsih@upi.edu; [3] rian@upi.edu

* Corresponding author

ARTICLE INFO

ABSTRACT

Education for Sustainable Development (ESD) is crucial program hold by United Nations in realizing the Sustainable Development Goals (SDGs). It is necessary to prepare competent teacher which can be started with debriefing through lectures. The purpose of this study was to analyze the prospective biology teacher's knowledge about ESD. The ESD competencies which were analyzed in this study including knowledge, actions, ethical values, attitudes, and emotions. The research subjects used were 30 students of their third year biology teacher education and taking Kapita Selekta Biology course in Indonesian University of Education (UPI). This descriptive study used a questionnaire about knowledge on ESD given to prospective biology teachers before they were given a briefing about ESD. The data gained were analyzed using percentage. The results showed that the persentage of knowledge of prospective biology teachers about ESD was still low (under 50%). Based on the findings, it is necessary to do ESD debriefing so that prospective biology teachers are able to integrate ESD in their learning design.

INTRODUCTION

Sustainable Development (SD) is an idea agreed upon by States with the definition is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Klarin, 2018; UNESCO, 2012). More clearly Kuhlman and Farrington (2010) states that the term sustainability is a concept of a better human life amidst the limitations of nature by maintaining the balance of life in three dimensions, which is social, economic, and environmental. SD includes 17 goals known as Sustainable Development Goals (SDGs) with 169 targets that have indicators that have been agreed globally (Janouškov, 2018; UNESCO, 2017). SDGs have become a worldwide concern after the publication of the 2030 Agenda for Sustainable Development, but lifelong learning, especially for students and teachers is also

seen as important for the achievement of many other SDGs (Cebri, Junyent, & Mul, 2020; English & Carlsen, 2019). One effort to realize SDGs is through education known as Education for Sustainable Development (ESD) (Boeren, 2019; UNESCO, 2017). ESD plays a role in realizing SDGs through the formation of knowledge, attitudes, and values that are relevant to economic, social, and environmental life so as to create a peaceful society in life (Osman, Ladhani, Findlater, & McKay, 2017).

ESD is seen as education that helps in developing attitudes, skills and knowledge to make the right decisions for the benefit of present and future generations (Anyolo, 2018). ESD aims to enable future generations to act in the face of complex problems. The more developing life, especially technology, the problems that will be faced will be more complex. Based on this, the education world needs to develop skills that are relevant to a complex and sustainable situation. There are eight competencies in ESD that must be possessed by students including systems thinking, anticipatory, normative, strategy, collaborative, critical thinking, self-awareness and integrated problem solving, so students have skills in sustainable development (Anyolo, 2018; UNESCO, 2017).

Schools as an institution play a major role in implementing the principles SD so that students have the competencies required in ESD (Bertschy, Künzli, & Lehmann, 2013). Implementing primary schools in schools is a way to implement ESD so that SDGs can be achieved. Through ESD the characters that create a sustainable life will be formed in students. This character will determine the attitudes and actions of students in the future for the sustainability of world life. Education in schools is inseparable from the role of the teacher in shaping the character of students. In order to deliver ESD-based learning, teachers need to have competencies that can realize SD. Mochizuki and Fadeeva (2010) stated that competency is a necessity in increasing the professionalism of teachers as student facilitators facing changes in education that lead to the principle of sustainability.

Education and science play an important role in realizing sustainable development in people's daily lives (Gagnidze, 2017). The findings from Meyer, Mader, Zimmermann, and Çabiri (2016) show that there is the possibility of educators in higher education to promote sustainable development to the community through collaboration with science and society. Based on these findings it can be seen if universities are one of the important agents in achieving sustainable development. One thing that can be done in achieving it is integrating the principles of sustainability in education known as ESD. ESD can run as it should if the teachers involved have ESD competencies.

There are five competencies that must be mastered by teachers in ESD learning. Among these competencies are knowledge, systems thinking, emotions, ethics & values and actions. These five competencies are interconnected with each other and teachers must apply them in their professional competencies (Cebrián & Junyent, 2015). Knowledge in ESD consists of concepts, facts and actions related to a subject or material. The knowledge possessed by prospective teachers must be connected across time (past, present, and future) and space (local and global) and built on multidisciplinary knowledge. The next competence is system thinking, namely awareness to be part of the earth's life systems in space and time. Through this competence and ESD integrated attitude will be seen. The third competencies that needed in realizing ESD is emotional competence, because thinking, reflecting, evaluating, making decisions, and acting are inseparable from emotional ties. Having a sense of being attached to the world is the key to realizing ESD, so empathy and compassion are the main keys in realizing ESD. The next competencies are ethics and values, these two competencies greatly influence perception and thinking, so ethics and values become one of the competencies that must be possessed by a teacher in realizing ESD. The main blend principle of ESD is justice and equality so that fundamental ethics are needed to be able to build justice and equality. Last competence is action, which is a process in which the four previous competencies join in the effort to realize ESD (Bertschy et al., 2013).

ESD aims to produce a sustainable future through education (Merritt, Hale, & Archambault, 2019), thus ESD becomes increasingly important at all levels of education, including tertiary or university education (Bedawy, 2014). In order for this goal to reach students, the first attitude and sustainable thinking must be possessed first by the teacher or prospective teacher. The results of research by Cebrián and Junyent, (2015) and Merritt et al.,(2019) prove that ESD training for prospective educators is needed. Most of these programs are not provided by universities. While Groening and Kelly (2019) argues that education for teachers is the key to the implementation of ESD in schools. Teachers need to develop competencies related to ESD so that they can carry out integrated learning in sustainable development at school. For this reason, the ESD briefing program is one of the means by which prospective teachers have the competencies needed in sustainable development.

ESD debriefing can be done through integration in a particular subject that teaches prospective teachers to prepare or design learning. Through such courses which are preceded by debriefing ESD, it is expected that prospective teachers can design learning in which to integrate ESD. The debriefing activity that ended with this assignment can be applied in the Kapita Selekta Biology course (Rahmadhani, Rahmat, & Purwianingsih, 2016). The Kapita Selekta Biology course is one of the compulsory subjects for prospective teachers in the Department of Biology, Indonesian University of Education. This subject was attended by prospective teachers in semester VI. Students who take this course are students who have graduated from biology basic courses and study and study biology.

The preliminary study through the analysis of the Semester Learning Plan Kapita Selekta Biology course illustrates that the lectures conducted have directed students to develop their professional knowledge, namely Pedagogical Content Knowledge (PCK) which is also followed by technological knowledge. In addition, prospective teacher students are also required to analyze concepts, principles, theories, laws, and biological processes in real life. Furthermore, the Kapita Selekta Biology course for prospective teacher students is also developed to have an attitude of responsibility, understanding of selected material, reasoning, skills, and PCK through the activities and assignments given. Judging from the description and learning outcomes, the Kapita SeleKta Biology course can be used a means for debriefing ESD to prospective teachers. It is hoped that through this briefing, prospective teacher students have the ability to be able to design and implement integrated learning ESD.

To be able to equip the ESD capability integrated in the learning design, it is necessary to explore how far the students' knowledge about the ESD is. The research related to the measurement of ESD competency knowledge in prospective teachers is an important thing to do to develop competent teachers in achieving ESD (Cebrián et al., 2019; Lozano, Merrill, Sammalisto, Ceulemans, & Lozano, 2017). Therefore, in this study ESD students will be analyzed the knowledge of prospective biology teachers, before debriefing ESD. One way to train ESD for prospective teachers is to integrate certain subjects. Courses that can be integrated with ESD training are courses that facilitate teacher candidates to develop their professional competence in designing learning plans. One of these Kapita Selekta Biology course, it is important to measure the prospective teacher's knowledge of ESD competence so that it can become a reference for carrying out structured ESD training in "Kapita Selekta" of Biology course.

METHOD

This research is a descriptive study with the aim of analyzing in depth and explaining the early abilities of prospective biology teachers related to ESD based on the answers to the questionnaire. Questionnaires were distributed to research subjects in February 2020 at the beginning of the lecture. The research subjects were 30 third-year students who were taking the "Kapita Selekta" of Biology course at the Indonesian University of Education (UPI). This subject is a compulsory subject in which one of the tasks is to design learning from the chosen topic. It is hoped that after being given ESD debriefing, students will be able to integrate ESD knowledge into the learning design they will create.

The data in the study were collected using a questionnaire adapted from Cebrián and Junyent (2015) consisting of 6 questions that explore prospective teacher's knowledge of ESD competencies. The initial knowledge of teacher candidates regarding the five competencies needed in implementing ESD is illustrated from the answers to questions number 1 & 2 which will be discussed in depth in this study. It aims to explore teacher knowledge in determining ESD integrated material and learning objectives. Because an important task of a teacher in ESD is to determine specific subject subjects so that they can integrate competencies for sustainability with specific goals from SDGs (Schreiber & Siege, 2016; UNESCO, 2017). The design of the questionnaire is shows in Table 1.

Table1 shows that the questionnaire was preceded by a narrative about the project to be carried out in a school related to forest conservation and accompanied by six questions that could explore prospective teacher's knowledge about competence in integrating ESD in the project. To make it easier to describe the teacher's knowledge of ESD competencies through a questionnaire, scoring is made on the answers to the questionnaire. The final score of prospective teachers is obtained through comparison of scores obtained by prospective teachers with maximum scores. The drilling is done based on the assessment rubric that has been prepared. Each question has a different maximum score as shown in Table 2.

Table 1. Teacher candidate ESD competency questionnaire design

I'm Martha, a primary school teacher. Last year, in a school meeting, the teachers of the science committee were asked to prepare a new thematic/monographic project for the next academic year. Right next to the school, there is a forest, so I thought it could be a good opportunity to design a project related to this space. My idea interested the other teachers, so this year, the guiding theme we are going to engage in will be "Let's make the forest more alive and smile!" This monographic is related to the primary education curriculum.

No	Question
1	Imagine that you participate in this project. Could you define four learning objectives to be achieved in its development?
2	What content do you think that students could learn in this project?
3	Think about at least four professional competencies that you would need to mobilize as a teacher. Justify briefly why you have chosen these competencies.
4	What do you think you should actively promote in this project? Prioritize from a high to low level of importance (from 1 to 12).
5	Choose four competencies that should be developed by the students in an ESD school project.
6	Imagine a sustainable school. Write 10 words to describe it.

Source: adapted from Cebrián and Junyent (2015).

Table 2. Maximum score of each question questionnaire

Question to	Maximal score
1	5
2	5
3	4
4	3
5	4
6	10
Total maximal score	31

RESULTS AND DISCUSSION

The results of the questionnaire collection given to 30 prospective teachers are listed in Table 3.

Table 3. Scores of prospective teacher answers on knowledge of ESD competitions

Prospective teacher students	Obtaining a score on each answer						Total Score	Final Score (%)
	(1)	(2)	(3)	(4)	(5)	(6)		
INM	3	2	2	2	3	3	15	48
FHA	3	2	3	1	1	4	14	43
HZ	4	1	4	2	3	3	17	54
MCF	4	1	3	-	-	-	8	25
EWY	2	-	1	-	-	-	3	9
DA	4	1	3	2	-	-	10	31
ANR	1	1	3	1	-	5	11	34
INP	2	1	2	-	2	2	9	29
ABS	2	1	2	-	1	1	7	22
AF	2	2	2	2	1	3	12	38
AHW	3	-	2	1	-	-	6	19
DNA	3	2	2	2	1	-	7	22
DWG	3	1	1	2	2	-	10	31
SNH	3	1	1	-	1	-	6	19
FJ	1	3	1	-	-	5	10	32
IH	2	1	2	-	3	5	13	41
MR	2	1	2	-	2	-	7	22
APC	2	1	-	-	-	-	3	9
AFM	1	1	1	2	-	-	5	16
RIPN	1	1	-	-	-	-	2	6
SRU	2	1	-	-	-	-	3	9
RA	2	4	2	-	-	-	8	25
SAS	2	1	2	-	-	-	5	16
AHD	4	3	4	3	1	-	18	58
RAP	3	1	-	-	-	-	4	13
RAR	1	1	2	-	-	-	4	13
RM	2	1	2	-	2	-	7	22

Prospective teacher students	Obtaining a score on each answer						Total Score	Final Score (%)
	(1)	(2)	(3)	(4)	(5)	(6)		
YSS	1	1	2	1	-	-	5	16
RDR	1	1	1	-	2	-	5	16
HNS	2	2	1	-	2	4	11	35
Average	**2**	**1**	**2**	**2**	**2**	**4**	**9**	**28**

Note: (1) Learning objectives, (2) Content to be learned by students, (3) Professional competencies that need to be mobilized by teachers, (4) Competencies that must be actively raised, (5) Competencies that students must master, (6) The description of schools that apply the principles of sustainable development

The results of the questionnaire provide an illustration if the average acquisitions of the total score of prospective biology teachers is 9 with an average final score of 28%. This acquisition rate is relatively low compared to the maximum total score, which are 31. The highest score on the results of this questionnaire is 54% obtained by one prospective teacher, namely HZ. This indicates that prospective teachers do not yet have good knowledge about ESD competencies. Five competencies that must be mastered by prospective teachers in integrated ESD learning, which is knowledge, attitudes, actions, values & ethics, and emotions (Cebrián & Junyent, 2015; Kioupi & Voulvoulis, 2019) are illustrated from answers number 1 & 2 Based on Table 1 it can be seen that the average teacher's knowledge on answer number 1 is 2 and the average knowledge for answer number 2 is 1. The average performance of this score is relatively low when compared with the maximum score that must be obtained for answer number 1 & 2, which are 5.

Question number 1 assesses the knowledge of prospective teachers about the learning objectives to be achieved by students in an ESD-based project on forest sustainability (Cebrián & Junyent, 2015) listed in the questions in the questionnaire. Question number 2 assesses the teacher's knowledge of what content students will learn in the project. Average total score for answers number 1 & 2 seen if the prospective biology teacher does not have good knowledge about ESD competence. Student answers from prospective teachers show that knowledge related to ESD competence which is dominant is knowledge competency, followed by attitude and action competency. Each student has not been able to bring up the five competencies simultaneously. For more details, the data related to the answers of prospective teachers in answers number 1 and 2 are described in Table 4.

Table 4. Description of answers number 1 & 2 about the five competencies that prospective teacher must have

Question to	The competencies identified from the answers	The number of prospective teacher who answer	Sample answer
1	Knowledge	23	"Students can understand the role of forests in life" "Students can understand how to preserve forests for the future starting from small things" "Students understand the causes of damage in the forest" "Students understand the benefits of forests for life"
	Action	19	"Conserve natural resources by cultivating them" "After doing the answers, students can formulate forest conservation efforts" "Students can find solutions to issues / problems related to trees" "Students can arrange an area to preserve trees" "Students can design projects based on the environment" "Students can apply the learning environment in everyday life"
	Attitudes	13	"Building environmental care for students" "Students are required to have empathy for the forest / natural wealth" "After students learn how to protect the forest, students can apply this method in their daily lives" "Students are able to work to preserve and preserve nature"
	Ethical values	5	"Awareness of the environment" "Train children to be closer to nature" "After practicing planting trees in the forest students can prevent damage that occurs in the environment"
	Emotions	3	"Students can love nature" "Creating the doctrine of environmental love"
2	Knowledge	24	"Environment, diversity of living things" "Biodiversity, benefits and functions of forests, forest

Question to	The competencies identified from the answers	The number of prospective teacher who answer	Sample answer
			"conservation efforts"
			"Content about the importance of protecting the environment"
			"Forest ecosystems, vegetation and fauna diversity"
			"Reforestation"
	Action	5	"Conserve natural resources"
			"The ability to preserve forests & trees in one way"
			"plant Trees"
	Attitudes	7	"Caring attitude towards the environment, especially forests & trees", "Plant maintenance"
			"The importance of protecting the environment, especially forests for human survival"
			"Call to care for the important role of forests"
	Ethical values	3	"Responsible for using natural resources"
			"Important value in protecting the environment, forests & trees"
	Emotions	2	"Love the environment"

Based on the description of the answers to prospective biology teachers in Table 4 it can be see if the prospective teacher is still focused on one competency that is knowledge competency. The dominant competence that appears in answers number 1 and 2 is knowledge competency. In Table 3 it can be seen from 30 prospective teachers who were the subjects of the study, 23 people have demonstrated knowledge related to knowledge competencies for answer number 1 and 24 people for answer number 2. The number was obtained from the calculation of the number of prospective biology teachers who gave rise to each competency in the answers numbers 1 & 2 were listed in Table 3. In the acquisition of answers to questions number 1 & 2 there are differences in the appearance of competency attitudes and actions. Teacher competency attitudes and actions appear more in answer number 1 than answer number 2. This shows that prospective teachers have not been able to determine the content that must be mastered by students related to attitudes and actions.

The least competence arises is emotional competence which is only shown by three prospective biology teachers in the answer to question number 1, they are AHW, DA, and MC. For question number 2, emotional competence appears in the answers of two prospective teachers, they are DA and HNS. Each of the five ESD competencies does not appear together from the answers of prospective teachers. Even in the answers to questions number one and two there are prospective teachers who only have knowledge of one of the ESD competencies. This can be seen in the acquisition of scores in Table 1, the score number shows the number of competencies that appear in students' answers.

Knowledge competence is competence about a material, in applying ESD the knowledge of prospective teachers must be integrated in the principles of sustainability (Olmos-g, Estrada-vidal, Ruiz-garz, Rafael, & Mohamed-mohand, 2019). The answers written by prospective teachers can be seen if they have started to show knowledge related to content that has indirectly integrated ESD. As in the answers "students can understand the role of forests in life", "students can understand how to protect the forest for the future starting with small things", "students understand the causes of forest damage", and "students understand the benefits of forests for life" answers it has explicitly begun to show the integration of the principles of sustainability. From these answers, the narrative, how to preserve forests for the future, has not clearly appeared in the knowledge of prospective teachers.

Prospective teacher knowledge related to action competencies can be seen based on the answers, such as "after students learn how to protect the forest, students can apply this method in daily life" and "after students listen to the teacher's explanation of forest conservation, students can explain back in front of their peers". The answers above can illustrate if they have knowledge related to competent actions in the form of efforts that will be made to preserve forests. Cebrián et al (2019), explains that action competencies are procedural skills, problem solving, communication and the form of an action. The scope of the competency from the statements outlined by prospective teachers in the answers to questions number 1 and 2.

Furthermore, the prospective teacher's knowledge of competency attitudes in the form of cooperation, participation, and respect (Cebrián et al., 2019). The answers "students can protect the environment", "protect the forest ecosystem", and "develop children's awareness". The answers illustrate the knowledge of prospective teachers about attitude competency. Knowledge related to values & ethical competencies can be seen as in the answer to "environmental awareness". Values & ethics competence includes a way of thinking

of a prospective teacher about how to interact with others and nature integrated outlined with education (Sonetti, Brown, & Naboni, 2019). This is reflected in the answers of prospective teachers.

Emotional competence can be seen as in the answers "love the environment" and "create the doctrine of environmental love". Emotional competence includes knowledge of self-including emotional feelings that can regulate themselves, emotional competence component and its function are important factors in the implementation of social competence (Zsolnai, 2016). Emotion has a substantial influence on the cognitive processes in humans, including perception, attention, learning, memory, reasoning, and problem solving (Tyng, Amin, Saad, & Malik, 2017). This can be seen with the emergence of a statement stating love for the environment. Through a feeling of environmental love will encourage attitudes and actions that lead to always maintain the harmony of the forest. The answers of the prospective teachers have provided information that they unconsciously had the knowledge related emotional competence to the integration of ESD in learning, even though that knowledge was not enough.

In Table 3 shows that only 5 prospective teachers who provide answers about emotional competence for question 1 and 2. The answers only show the emotional to love environment, there is no other emotions toward environment appear in the answer of prospective teachers. Cebrián et al (2019), stated that low emotional competence shows that prospective teachers tend to be more concerned with competencies that lead to content and actions, rather than building emotions in students. This this is consistent with the results of this study, where prospective teachers are more likely to show knowledge on knowledge competencies. ESD competency evaluation tools must ensure progress in the development of values, skills and behaviors related to sustainability (Dlouh, Heras, Mul, Salgado, & Henderson, 2019).

This knowledge overview of prospective teachers is the basis for consideration in being able to present an innovation in learning that can facilitate them to have competence in integrating ESD in their learning. Cognitive, affective, behavioral, application- and curriculum-oriented aspects of sustainability competencies are part of SDG integration learning (Cebri et al., 2020). Integrating ESD in learning requires prospective teachers to have knowledge related to natural, social, and human sciences. These three knowledge can help prospective teachers to understand ESD (Al-naqbi & Alshannag, 2018). Brandt, Bürgener, Barth, & Redman, (2019), stated that making teachers who are competent in realizing ESD requires the right efforts and strategies. Then prospective teachers who still have low knowledge of ESD need to obtain a briefing related to the integration of ESD, so that they are able to formulate ESD material and learning objectives.

Determination and achievement of learning objectives in teacher education to apply the principle of sustainability requires a maximum effort because the competence to realize ESD is very complex (Brandt et al., 2019; Mochizuki & Fadeeva, 2010). This requires the knowledge needed to apply the principle of sustainability in this case in the form of knowledge content (CK) of teachers and teacher knowledge in designing learning plans Pedagogical Content Knowledge (PCK), and motivation from within each prospective teacher in this case can be said to be their attitude (Brandt et al., 2019; Shumba & Kampamba, 2013). One of the efforts that can be done is to pass a transition by inserting the principles of sustainability in an agency (Lambrechts, Verhulst, & Rymenams, 2016). This effort can be done by applying it in a course that equips prospective teachers in understanding the material and designing learning plans, one of which is the Kapita Selekta biology course. Kapita Selekta Biology is a course that specifically asks prospective teachers to prepare a lesson design after analyzing selected material in depth. Through such courses that are preceded by debriefing ESD, it is expected that prospective teachers can issue a learning in which ESD (TPACK-ESD) is integrated. The debriefing activities that end with the assignment can be applied to the Kapita Selekta Biology course (Rahmadhani et al., 2016).

The success in integrating ESD competence in higher education is the initiative of a group to realize it in learning in higher education (Lambrechts et al., 2016). Problems related to sustainable development will become an interest and become a form of concern from the world for several decades to come (Filho, Manolas, & Pace, 2015). However, there are still many shortcomings contained in manifesting it (Nikolic, Milutinovic, Nedanovski, & Mrnjaus, 2017). Kieu, Singer, and Gannon (2016), stated the challenges in implementing ESD-related material in higher education were the lack of teaching staff and supporting facilities. However, this can be overcome through collaboration between various parties to realize the integration of ESD material in higher education to produce competent teachers in implementing ESD.

CONCLUSION

Teacher candidates' knowledge of ESD competencies in determining learning content and the goals students want to achieve is not good. The dominant competence that appears in prospective teachers is knowledge competence. Meanwhile, the least competences for knowledge, actions, attitudes, values & ethics, and emotions are emotional competence. Based on these findings, it is necessary to provide ESD training so that prospective biology teachers are able to integrate ESD in their learning designs, starting with debriefing prospective teachers while studying in college. It is hoped that in future studies it can develop instruments to assess the ESD competence of prospective teachers and teachers.

REFERENCES

Al-naqbi, A. K., & Alshannag, Q. (2018). The status of education for sustainable development and sustainability knowledge, attitudes, and behaviors of UAE university students. *International Journal of Sustainability in Higher Education*, *19*(3), 566–588. doi: https://doi.org/10.1108/IJSHE-06-2017-0091

Anyolo, E. O. (2018). Implementing education for sustainable development in Namibia: School teachers' perceptions and teaching practices. *Journal of Teacher Education for Sustainability*, *20*(1), 64–81. doi: https://doi.org/10.2478/jtes-2018-0004

Bedawy, R. E. L. (2014). Embedding sustainable development into higher education: A case study from Egypt. *International Review of Management and Business Research*, *3*(1), 465–484. Retrieved from https://www.irmbrjournal.com/papers/1395805752.pdf

Bertschy, F., Künzli, C., & Lehmann, M. (2013). Teachers' competencies for the implementation of education al offers in the field of education for sustainable development. *Sustainability*, *5*, 5067–5080. doi: https://do i.org/10.3390/su5125067

Boeren, E. (2019). Understanding Sustainable Development Goal (SDG) 4 on "quality education" from micro, meso and macro perspectives. *International Review of Education*, 1–14. doi: https://doi.org/10.1007/s11159-019-09772-7

Brandt, J.-O., Bürgener, L., Barth, M., & Redman, A. (2019). Becoming a competent teacher in education for sustainable development. *International Journal of Sustainability in Higher Education*, *20*(4), 630–653. doi: https://doi.org/10.1108/IJSHE-10-2018-0183

Cebri, G., Junyent, M., & Mul, I. (2020). Competencies in education for sustainable development: Emerging teaching and research developments. *Sustainability*, *12*(2), 1–9. doi: https://doi.org/10.3390/su12020579

Cebrián, G., & Junyent, M. (2015). Competencies in education for sustainable development: Exploring the student teachers' views. *Sustainability*, *7*(3), 2768–2786. doi: https://doi.org/10.3390/su7032768

Cebrián, G., Pascual, D., & Moraleda, Á. (2019). Perception of sustainability competencies amongst Spanish pre-service secondary school teachers. *International Journal of Sustainability in Higher Education*, *20*(7), 1171–1190. doi: https://doi.org/10.1108/IJSHE-10-2018-0168

Dlouh, J., Heras, R., Mul, I., Salgado, F. P., & Henderson, L. (2019). Competences to address SDGs in higher education — A reflection on the equilibrium between systemic and personal approaches to achieve transformative action. *Sustainability*, *11*(13), 1–23. doi: https://doi.org/10.3390/su11133664

English, L. M., & Carlsen, A. (2019). Lifelong learning and the Sustainable Development Goals (SDGs): Probing the implications and the effects. *International Review of Education*, 1–7. doi: https://doi.org/10.1007/s11159-019-09773-6

Filho, W. L., Manolas, E., & Pace, P. (2015). The future we want key issues on sustainable development in higher education after Rio and the UN decade of education for sustainable development. *International Journal of Sustainability in Higher Education*, *16*(1), 112–129. doi: https://doi.org/10.1108/IJSHE-03-2014-0036

Gagnidze, I. (2017). The role of international educational and science programs for sustainable development (systemic approach). *Kybernetes*, *47*(2), 409–424. doi: https://doi.org/10.1108/K-03-2017-0114

Groening, Z. P., & Kelly, V. L. (2019). Senior secondary school teachers' understanding of education for sustainable development. *International Journal of Biology, Physics & Matematics*, *2*(2), 128–138. Retrieved from https://zambrut.com/wp-content/uploads/2019/03/Teachers-Development.pdf

Janouškov, S. (2018). Global SDGs assessments: helping or confusing indicators ? *Sustainability*, *10*(5), 1–14. doi: https://doi.org/10.3390/su10051540

Kieu, T. K., Singer, J., & Gannon, T. J. (2016). Education for sustainable development in Vietnam: lessons learned from teacher education. *International Journal of Sustainability in Higher Education*, *17*(6), 853–874. doi: https://doi.org/10.1108/IJSHE-05-2015-0098

Kioupi, V., & Voulvoulis, N. (2019). Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes. *Sustainability*, *11*(21), 1–18. doi: https://doi.org/10.3390/su11216104

Klarin, T. (2018). The concept of sustainable development: From its beginning to the contemporary issues. *Zagreb International Review of Economics & Business,* *21*(1), 67–94. doi: https://doi.org/10.2478/zireb-2018-0005

Kuhlman, T., & Farrington, J. (2010). What is sustainability? *Sustainability*, *2*(11), 3436–3448. doi: https://doi.org/10.3390/su2113436

Lambrechts, W., Verhulst, E., & Rymenams, S. (2016). Professional development of sustainability compe tences in higher education: The role of empowerment. *International Journal of Sustainability in Higher Education*, *18*(5), 697–714. doi: https://doi.org/10.1108/IJSHE-02-2016-0028

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. *Sustainability*, *9*(10), 1–15. doi: https://doi.org/10.3390/su9101889

Merritt, E., Hale, A., & Archambault, L. (2019). Changes in pre-service teachers' values, sense of agency, motivation and consumption practices: A case study of an education for sustainability course. *Sustainability*, *11*(1), 1–15. doi: https://doi.org/10.3390/su11010155

Meyer, J., Mader, M., Zimmermann, F., & Çabiri, K. (2016). Training sessions fostering transdisciplinary collaboration for sustainable development: Albania and Kosovo case studies. *International Journal of Sustainability in Higher Education*, *18*(5), 738–757. doi: https://doi.org/10.1108/IJSHE-02-2016-0032

Mochizuki, Y., & Fadeeva, Z. (2010). Competences for sustainable development and sustainability significance and challenges for ESD. *International Journal of Sustainability in Higher Education*, *11*(4), 391–403. doi: https://doi.org/10.1108/14676371011077603

Nikolic, V., Milutinovic, S., Nedanovski, P., & Mrnjaus, K. (2017). ESD professional development of university educators in Serbia, Croatia and Macedonia. *International Journal of Sustainability in Higher Education*, *18*(6), 923–938. doi: https://doi.org/10.1108/IJSHE-02-2016-0036

Olmos-g, C., Estrada-vidal, L. I., Ruiz-garz, F., Rafael, L., & Mohamed-mohand, L. (2019). Making future teachers more aware of issues related to sustainability: An assessment of best practices. *Sustainability*, *11*(24), 1–21. doi: https://doi.org/10.3390/su11247222

Osman, A., Ladhani, S., Findlater, E., & McKay, V. (2017). *A curriculum framework for the sustainable development goals* (1st ed.). Retrieved from https://www.thecommonwealth-educationhub.net/wp-content/uploads/2018/04/CFSDG_UPDF-003.pdf

Rahmadhani, Y., Rahmat, A., & Purwianingsih, W. (2016). Pedagogical Content Knowledge (PCK) guru dalam pembelajaran biologi SMA di Kota Cimahi. In *Prosiding Seminar Nasional Sains dan Pendidikan Sains* (pp. 17–24). Retrieved from https://www.researchgate.net/publication/325257406_Pedagogical_Content_Knowledge_PCK_Guru_dalam_Pembelajaran_Biologi_SMA_di_Kota_Cimahi

Schreiber, J.-R., & Siege, H. (Eds.). (2016). *Curriculum framework education for sustainable development*. Retrieved from https://www.globaleslernen.de/sites/default/files/files/link-elements/curriculum_framework_education_for_sustainable_development_barrierefrei.pdf

Shumba, O., & Kampamba, R. (2013). Mainstreaming ESD into science teacher education courses : A case for ESD pedagogical content knowledge and learning as connection. *Southern African Journal of Environmental Education*, *29*, 151–166. Retrieved from https://www.ajol.info/index.php/sajee/article/view/122267

Sonetti, G., Brown, M., & Naboni, E. (2019). About the triggering of UN sustainable development goals and regenerative sustainability in higher education. *Sustainability*, *11*(1), 1–17. doi: https://doi.org/10.3390/su11010254

Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The influences of emotion on learning and memory. *Frontiers in Psychology*, *8*, 1–22. doi: https://doi.org/10.3389/fpsyg.2017.01454

UNESCO. (2012). *Education for sustainable development in action sourcebook*. United Nations Educational, Scientific and Cultural Organization. Retrieved from https://sustainabledevelopment.un.org/content/documents/926unesco9.pdf

UNESCO. (2017). *Education for sustainable development goals learning objective*. the United Nations Educational, Scientific and Cultural Organization. Retrieved from https://www.iau-hesd.net/sites/default/files/documents/247444e.pdf

Zsolnai, A. (2016). Social and emotional competence. *Hungarian Educational Research Journal*, *5*(1), 1–10. doi: https://doi.org/10.14413/herj.2015.01.01.