

T-learning for geosciences education: proposal for a sustainable pedagogy

Andrea Gerbaudo¹ & Marco Davide Tonon¹

¹ Dipartimento di Scienze della Terra, Università di Torino.

 AG, [0000-0003-3536-1810](https://orcid.org/0000-0003-3536-1810); MDT, [0000-0001-7544-6742](https://orcid.org/0000-0001-7544-6742).

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Short note

Corresponding author e-mail: andrea.gerbaudo@unito.it

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ABSTRACT

In the last years there has been a growing awareness that Earth Sciences provide essential knowledge for a sustainable future; on the other hand, however, the educational offerings of Earth Science departments are still poorly oriented toward ecological challenges. How, then, to ensure that departments develop educational strategies suited to this end? In this short note, we point out the T-Learning methodologies (where “T” stands for *transformative*, *transgressive* and *transdisciplinary*) as valuable tools to connect science education with the broader concept of Education for Sustainability. As a case study, we describe a workshop entitled *Walking Pianalto*, that was held in May 2022 as part of an Earth Science didactics course for future teachers. The results of a survey conducted among the participants confirm the effectiveness of this workshop in terms of improving participants' perception of their relationship with nature and addressing educational strategies towards sustainability.

KEY-WORDS: geoscience education, education for sustainability, transformative learning, transdisciplinary, T-learning.

INTRODUCTION

In an article with the significant title “*Earth Science education as a key component of Education for Sustainability*” (Vasconcelos Orion, 2021), which is very recent but has already become a landmark in the scientific literature dealing with these topics, the authors attempt to answer two questions: “*Does Earth Science education have the potential to change human behavior? How can Earth Science educators promote this attitude change?*” The two questions are crucial for those interested in the geosciences but, with an easy sleight of hand, one can easily see that they apply to science education in general (just remove “*of the Earth*” from

both formulations) and not only that, they are crucial for those who wonder about the education of the future (also remove the word “*science*”).

In the field of didactics, Earth Sciences are experiencing a paradoxical moment: on the one hand there has been a growing awareness that they provide essential knowledge for understanding the real possibilities our planet offers for problems such as water availability and management, demand for mineral resources and raw materials, and the transition from fossil to renewable energy resources (IUGS, 2022), and that therefore an education for sustainability that takes place in the absence of geological sciences risks having a short-sighted approach (Fildani Hessler, 2021); on the other hand, however, the educational offerings of Earth Science departments, at least in Italy, are still poorly oriented toward ecological problems and challenges, so much so that it is possible for most Earth Science students to graduate without having taken a course explicitly focused on how geosciences can address sustainable development goals and contribute to their achievement (Gerbaudo et al., 2022).

How, then, to ensure that Earth scientists become fully aware of their responsibility to become agents of change and that departments develop educational strategies suited to this end? In this short note, we point out the T-Learning methodologies (where “T” stands for *transformative*, *transgressive* and *transdisciplinary*) as valuable tools to connect science education with the broader concept of Education for Sustainability (EfS, Sterling, 2010). After a brief introduction, necessary to give some definitions about T-learning (view section 2), we will describe a workshop entitled *Walking Pianalto* (view section 3), that was held in May 2022 as part of an Earth Science didactics

course for future teachers, during which some outdoor activities involving various senses and parts of the body were proposed to the participants. In Section 4 we will report the results of a short survey conducted with an inbound and an outbound questionnaire, aimed at understanding whether the workshop led to a change in participants' perceptions of their connection with nature. Finally (view section 5) we will argue that is suitable for building a new pedagogical path for geosciences education that is transformative, transgressive and transdisciplinary; we will also propose an enlargement of the concept of T-Learning, adding other 3 T's.

Theoretical framework: building a T-learning project

In accordance to EfS and its purposes, it seems clear that the challenge of teaching to live in a sustainable way needs an innovative education, adequate in a globalized world (Masschelein, 2010), that takes us into the depth of things (Schumacher, 1997). In this context, as Sterling noticed, *when there's a call for re-examination of assumptions and values, critical thinking and new creativity, the concept of transformative learning is coming more to the fore* (2010). Moving from this intuition, we accept here the idea of transformative learning as a deep shift in thoughts, feeling and actions, that involves our relationships with other humans and with the natural world (O'Sullivan et al., 2002).

On this broad definition, more holistic and intuitive compared to the original perspective of Mezirow (1997), the transgressive learning blossomed as a sub-branch of the wide transformative learning tree (Macintyre et al., 2020). Born in the middle of XXth century and mostly used in different contexts, such as decolonization and feminism (Conception & Eflin 2009; Rodney 2016), the idea of transgressive learning has been lately explored to address learning challenges in times of climate change and environmental crisis, in order to change practices towards sustainability (<https://transgressivelearning.org/2017/09/06/mean-t-learning-definitions-acts-defining/>). Furthermore, the first limits that people have to learn to transgress are those who mark the boundaries of disciplines, in order to expand epistemological horizons and create new forms of social activities (Lotz-Sisika et al., 2015). The transdisciplinary perspective is thus necessary to a transformative and transgressive educational project, that requires to grasp the complexity of reality, to take into account scientific and societal views and to link theory and practices (Hirsch Hadorn et al., 2008). For our pedagogical aims we refer to the seminal definition by Piaget (1972) of a superior level which will not be limited to recognize the interactions and reciprocities between the disciplines, but which will locate these links inside a total system without stable boundaries.

Hence transformative, transgressive, transdisciplinary are the three 'T' adjectives that we put as benchmarks to design our educational project, that we may call a T-Learning project. The three terms are united by the Latin prefix *trans-*, understood here in its meaning of *beyond*: the conviction is that education should *go beyond* to encourage a pedagogy of change.

MATERIALS AND METHODS

Walking Pianalto: the workshop's design

Our project was designed as a two-day workshop focused on outdoor activities. Referring to the original Latin *e-ducere*, the term educate means *to draw out*, *to bring out* what is inside, but it may be interpreted also as *to experience outside*, in the real world (Masschelein, 2010). Experiencing outside means thus being able to discover a territory with a sensory, bodily approach. We accept here the seminal definition of outdoor education as an experiential method of learning, based upon inter-(or trans-) disciplinary curriculum, that requires the use of all senses to understand the relationships between humans and natural elements (Priest, 1986).

The participants were 22 students of University of Turin attending Master's Degree in Primary Education, a single-cycle, five-year degree program that prepares preschool and Primary school teachers capable of meeting today's educational challenges and ensuring quality education for all (https://formazioneprimaria.campusnet.unito.it/do/home.pl/View?doc=/Il_Corso/perche_studiare_con_noi.html). The workshop, entitled *Walking Pianalto*, was an elective one that they chose among the list of laboratories proposed within the course of Concepts and Natural Science Education.

The two following paragraphs illustrate more specifically the setting and the activities of the workshop, framing them in the two approaches that we took into account: the practice of walking with educational purposes and the use of an art-based methodology to science, in particular geoscience education.

The first day of the workshop has been dedicated to a trekking, starting from the Department of Earth Sciences in Turin to the EcoMuseum of Clay MunLab in Cambiano (TO). The route was constructed by joining several trails that are part of the Turin Hill trail network, with a final length of about 20 kilometers. The trails used were:

- **Trail 16:** from Parco Leopardi to Parco della Rimembranza;
- **Trail 12:** from Parco della Rimembranza to Eremo;
- **Trails 40 and 32:** from Eremo to Madonna della Scala;
- **Blue Way Pistaaaa:** from Madonna della Scala to Cambiano.

The pedagogical value of walking deals with the possibility of a reflection on the limits of a static observation, but also with the consciousness of the educational opportunities lying behind everything we may encounter along the path (Castiglioni et al., 2020). For this reason, we decided to start walking in front of the Department, a place for an education *inside-the-walls*, turning back and moving towards and education *outside-the-walls* (Nadelson & Jordan, 2012).

The activities proposed to participants were aimed to foster an openness towards the *Other*, intended as every living and non-living element of the landscape (Fig. 1a). During the entire itinerary, each one of the participants had to focus on a singular aspect of the landscape (shapes, colours, movements, water traces, type of substrates, etc.) and to make a report of the observation on a notebook, adding drawings and pictures. In addition, some moments have been dedicated to different ways of walking, such as the blindfolded walk and the silent walk.



Fig. 1 - Trekking on Turin hills, around Pecetto Torinese (1a); collecting clay in the Cambiano (TO) quarry (1b) - (Photo by M.D.Tonon).

Another task was to collect any natural elements that caught their attention (leaves, branches of wood, little stones, shells, seeds) and to save it into a bag. Some of these elements were then used for other activities during Day 2.

The location for the second day of the workshop was the EcoMuseum of Clay MunLab in Cambiano (TO), where the trek of day 1 ended and where we spent the night on a camping accommodation. Munlab, Ecomuseum of Clay, took shape in 2001 at the behest of the association La Fornace Spazio Permanente, active since 1993 in the disused spaces of the Carena Furnace in Cambiano. Included in the Network of Ecomuseums of the Province of Turin in 2001, in 2007 it entered the circuit of Ecomuseums of the Piedmont Region, joining the Piedmont Ecomuseum Network in 2010. Since its foundation, the LFSP Association, now the managing body, had focused on the goal of telling through art the reality in which it was settled, connecting the reality of a community, that of Cambiano and furnace workers, with the reality of a place, the decommissioned buildings and the former clay quarry (<https://www.munlaborino.it/identita/#chi-siamo>).

The artistic manipulation of clay has been used many times in educational projects, with the creations of individual and collective handcrafts, like *Golem* (Tonon et al., 2017) anthropic figures or symbolic manufacts like *Dorodangos*, a Japanese art form where clay is rolled into a ball and slowly dried by hand into a shiny sphere (Hartemink et al., 2013). This kind of manipulation has been often used in order to stimulate a meta-reflection, for instance on the process of the evolution of organic forms (Van Boeckel, 2020), but the purpose can be also to show the composition and the structure of different soils (Hartemink et al., 2013).

Thanks to the possibility of having a clay quarry at their disposal, the participants spent the morning in collecting samples of soil of different colours in various spots of the quarry (Fig. 1b). After

leading to the more wet area, we ask them to pick up an amount sufficient to shape two balls, one big and the other smaller, needed for subsequent activities. During the afternoon we proceeded with a session, first individual and then collective, of manipulation and creation of some manufacts in a social art form.

The survey

Our small-scale study tried to answer to the following research questions:

- Which is the average level of connection to nature perceived by the participants before the workshop?
- Did the workshop lead to a change in participants' perceptions of their connection with nature?

Two user-friendly online questionnaires were prepared using Google forms; the link for inbound questionnaire was sent one week before the workshop, the outbound ten days after the end of it, in order to give them a few times more to reflect on the experience. The answers were anonymous.

In order to answer the first research question, we decided to use two indicators: the first was the Inclusion of Nature in Self scale (INS, Schultz, 2002) in the Illustrated version (IINS) adapted by Kleespies et al. (2021, Fig. 2). The IINS scale is a single-item question, builded to measure how much individuals feel nature as a part of their identity. It asks participants to rate their connection to nature choosing one of the seven pairs of circles that differ in their degree of overlap: the circle representing nature is illustrated with a drawing of a green landscape and a river flowing from the mountains in the background; the circles representing 'me' shows the pictogram of a human. To have a score, the seven possibilities

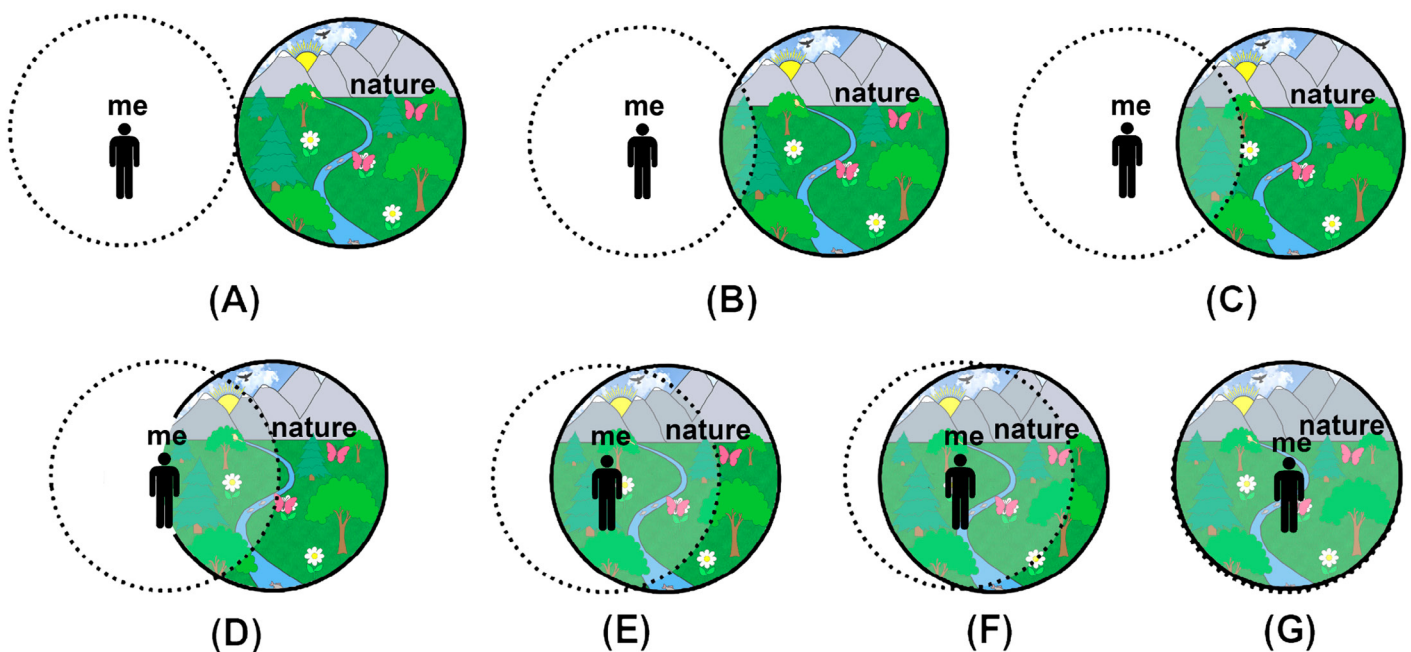


Fig. 2 - The seven diagrams of the Illustrated Inclusion of Nature in Self scale (Kleespies et al., 2021); respondents had to choose one of the options to represent their connection to nature.

are simply rated from 1 to 7, where 1 is for A (circles non overlapping, people not connected to nature) and 7 is for G (circles completely overlapping, people very connected to nature).

The second indicator we used was the Nature Relatedness Scale (NRS), designed to measure people's relatedness with the natural world. The original scale (Nisbet & Zelensky, 2013) consists of 21 items, but we decided to use the short form of the scale (NR-6, Nisbet & Zelensky, 2013) made up by 6 items, that has a good reliability too and is more suitable to use where time and space are limited. The 6 items are rated on a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). The scale is created by adding the total score and dividing by 6.

For the validation of the scales, we referred to the original studies (Schultz, 2002; Nisbet & Zelensky, 2013). The internal reliability of NR-6 using Cronbach's alpha is .87; as a single-item scale, INS cannot be measured using Cronbach's alpha but Schultz tested its validity by examining correlations with other scales.

In the second questionnaire we reposted the INS and the NR-6 to make a comparison between the answers before and after the workshop and understand if there has been a change of perspective in the connection to nature.

RESULTS

The results of INS and NR-6 in the inbound questionnaire are shown in Tab.1. As indicated by results, which are slightly more than an average score, our group of participants had a good level of previous connection to nature.

The results of the re-test of INS (tab.2a) show that there has been an increase of E-type answers (from 5 to 8) and G-type answers (from 1 to 3). C-type answers have decreased strongly (from 5 to 1) and F-type slightly (from 4 to 3). The total score has been 110 (+11 compared to the previous) and the average score is now 5 (+0,5). A little increase is registered also by the retest of NR-6 (tab.2b). Here we have three subitems with an increased score (2, 3 and 5) and three with a decreased one (1, 4 and 6). The average score is now 3,81 (+0,06).

DISCUSSION

As described in the literature (Tam, 2013; Nisbet & Zelensky, 2013), the correlation between the two indicators is strong. Our results confirm that connection, showing that the previous level of connection to nature is above the average according to both

Table 1 - Results from the two indicators used in the inbound questionnaire, Inclusion of Nature Scale (INS, Schultz 2002, 1a) and Nature Relatedness Scale with 6 items (NR-6, Nisbet & Zelensky, 2013, 1b).

(1a)								
Answers	Rate	Frequency		Score				
A	1	0		0				
B	2	0		0				
C	3	5		15				
D	4	7		28				
E	5	5		25				
F	6	4		24				
G	7	1		7				
Total score				99				
Average ($\div 22$)				4,5				

(1b)								
N	Statements	Disagree strongly (pt=1)	Disagree a little (pt=2)	Neither agree nore disagree (pt=3)	Agree a little (pt=4)	Agree strongly (pt=5)	Total score	Average ($\div 22$)
1	My ideal vacation spot would be a remote, wilderness area	0	2	8	10	2	78	3,54
2	My connection to nature and the environment is a part of my spirituality	2	3	3	9	5	78	3,54
3	I always think about how my actions affect the environment	0	2	4	9	7	87	3,95
4	I take notice of wildlife wherever I am	0	2	2	10	8	90	4,09
5	My relationship to nature is an important part of who I am	1	2	5	7	7	83	3,77
6	I feel very connected to all living things and the earth	0	3	5	11	3	80	3,63
							Average	3,75

Table 2 - Results from the two indicators used in the outbound questionnaire, Inclusion of Nature Scale (INS, Schultz, 2002, 2a) and Nature Relatedness Scale with 6 items (NR-6, Nisbet & Zelensky, 2013, 2b).

(2a)								
Answers	Rate	Frequency		Score				
A	1	0		0				
B	2	0		0				
C	3	1		3				
D	4	7		28				
E	5	8		40				
F	6	3		18				
G	7	3		21				
Total score							110	
Average ($\div 22$)							5	

(2b)								
N	Statements	Disagree strongly (pt=1)	Disagree a little (pt=2)	Neither agree nore disagree (pt=3)	Agree a little (pt=4)	Agree strongly (pt=5)	Total score	Average ($\div 22$)
1	My ideal vacation spot would be a remote, wilderness area	0	3	4	14	1	75	3,40
2	My connection to nature and the environment is a part of my spirituality	1	3	2	11	5	82	3,72
3	I always think about how my actions affect the environment	0	2	0	12	8	92	4,18
4	I take notice of wildlife wherever I am	0	2	2	11	7	89	4,04
5	My relationship to nature is an important part of who I am	1	0	5	9	7	87	3,95
6	I feel very connected to all living things and the earth	0	3	6	10	3	79	3,59
							Average 3,81	

indicators and that, after the workshop, the perception of the relatedness with nature has increased.

To achieve scientific education that leads to a spontaneous respect for the environment, it is necessary to develop in students a sense of belonging to and interdependent relationship with the surrounding natural environment. *Walking Pianalto* focused on experimenting with new integrated learning models designed to develop a deep awareness of the relationships that connect humans to the environment. Through practices of walking, artistic expression and emotional sharing of experiences, we think we achieved our goal of building a transdisciplinary teaching, providing different views of the world and stimulating “well-rounded” learning, integrating cognitive, perceptual-motor and emotional-relational aspects. About its transformative potential, the results of our survey suggest that this educational experience had a transformative impact and improved participants’ perception of their relationship with nature. Finally, projects like this are transgressive in the above mentioned sense of addressing educational strategies in times of environmental crisis and changing practices towards sustainability.

CONCLUSIONS

In a recent paper entitled “*Geoethics to start up a Pedagogical and Political path towards Future Sustainable Societies*” (Peppoloni & Di Capua, 2021), the authors declare that the ethical principles and values connected to geosciences must be embodied into a pedagogical project that has to be inspired by principles of dignity, freedom and responsibility. As researchers and teachers’ trainers, we share the same feeling of an urgent need of renovation in pedagogical practices; in times of ecological crisis, we also agree that these practices must be founded on a set of values that enhances an ethical regeneration of human beings and are consistent with the sustainable development goals.

As a final food for thought, we propose here other “3 T’s,” three concepts that in our opinion are equally fundamental for future education: together, tomorrow, and territory. Sustainable education must go beyond the individual dimension and become community education (together); it must rethink the concept of conservation (problematic, even in the environmental field) and link it to a new vision of the future (tomorrow); it must put territory

at the center as the place where reality is encountered in all its complexity (territory), also overcoming the opposition between natural and artificial environments (e.g., cities), which often implies a dangerous dichotomy between man and nature.

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