

# The fifth SOLO level connecting Sustainability and Environmental Management System

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## Abstract

The *Structure of the Observed Learning Outcomes* (SOLO taxonomy<sup>1</sup>) created 35 years ago still remains a reliable tool for understanding a student's learning today, in times of increased societal complexity, inundation by accessible data and decision uncertainty throughout the process of striving for sustainability.

Universities are urged to reform education in accordance with societal needs, reflected in sustainability policies. This paper proposes to extend the SOLO structure to the fifth level beyond its extended abstract knowledge level and to deploy a systemic and holistic approach for restructuring education through Learning for Sustainability.

Outstretched SOLO is also suggested, including a circular improvement approach, which is accepted in modern standard management systems, so that learners become accustomed to dynamic leadership and broader innovative and creative competences in their future professions. It is an encouraging new approach to let students be market assets for sustainability, not just an instantaneous refill that fits unoccupied production gaps.

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<sup>1</sup> Biggs, J., Collis, K. (1982).

## Key words

SOLO, taxonomy, learning for sustainability, environmental management system.

## Acronyms

AI ... Artificial Intelligence

EMS ... Environmental Management Systems (in general)

ESD ... Education for Sustainable Development

HE ... Higher Education institutions

LfS ... Learning for Sustainability (in this paper used instead of ESD, Education for Sustainable Development)

SDG ... 17 Sustainable Development Goals

## Introduction

The current great meta narrative concerns sustainability in all its multifaceted aspects as explicitly presented in scientific papers, followed by mass media or chatted as preconceived collective knowledge. The struggle for sustainability started with Rachel Carson<sup>2</sup>, proceeded in the Club of Rome<sup>3</sup> and the Brundtland report<sup>4</sup> and is now presented by UN's Agenda 2030<sup>5</sup>, to mention some of the more important milestones of sustainability awareness. The (post)industrial machine-driven era has flattened out and artificial intelligence<sup>6</sup> (AI) is preparing to take over a leading position. Decisions made by AI need the guidance of "real" people, pointing out the direction and scope of intentions for sustainability. There can be no higher expectation for the future than fulfilling future generations' basic hu-

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<sup>2</sup> Carson, R. (1962).

<sup>3</sup> Club of Rome (1968).

<sup>4</sup> Brundtland Commission (1987).

<sup>5</sup> UN General Assembly (September 2015) *The 17 SDG*.

<sup>6</sup> Tegmark, M. (2017).

man needs, in both the South and the North. Evolutionary residues in our brains make us most interested in short term commodity gains and higher quarterly revenues, a result of instincts important for our ancestor's survival in small hunter-gatherer groups, but now only an obsolete feature in the global complex world. Nevertheless, humankind's activities undertaken individually in families or by big organizations are contributing to the devastation of global resources.

The urge for high quality education for sustainable development in HE has been pointed out by the UN (2001)<sup>7</sup> and is related to the introduction of learning activities outside of disciplinary boundaries. The UN has expressed concerns about blatant global non-sustainability and has called for sustainable development that would both evolve and change. UN proclaimed 2005-2014 the decade of Sustainability Education<sup>8</sup>. In the UN perspective, education for sustainable development (ESD) is a continuous process of learning and elucidating new approaches to leadership (decision-making) by those providing formal, non-formal and informal learning. In this paper, we prefer to use the expression Learning for Sustainability (LfS) instead of ESD. LfS seems to reduce the reproduction of artefacts of unsustainable models and practices and goes beyond the competences educators possess for good quality teaching in their discipline.

## Theoretical framework

It is important to see difference between Environmental Education (EE) and Learning for Sustainability (LfS). The origin for sustainability always lies in an environmental ecosystem, and to gain progress and functioning in sustainability, education

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<sup>7</sup> UN Economic and Social Council (2001) *Learning for future*.

<sup>8</sup> UNESCO *UN Decade of ESD (2005-2014)*.

*about* the environment must have a societal dimension and explain how to make it function, i.e. learn *for* sustainability<sup>9</sup>.

SOLO - taxonomy<sup>10</sup>, a valuable tool of pedagogical methods that is useful in any topic or discipline, elucidates how to understand the structural processes of gaining knowledge in four consecutive hierarchical steps. Principally, each step in SOLO brings new knowledge beyond that of the previous level. The two first steps (Biggs, Tang (2011<sup>11</sup>), known as *a) the quantitative declarative phase*, increase knowledge about the subject matter. They identify the basic nomenclature, reveal known structures and describe, combine and use a factual platform grounded on evidence. The quantitative declarative phase is based on historical knowledge sources up to the present time. Historical (older) data are valuable for gathering facts in causality chains to avoid past flaws. The declarative phase is used at the ground level of all scientific topics.

To a certain degree, the quantitative phase is used in the highest third and fourth steps, where SOLO embodies *b) the qualitative phase* of deep understanding<sup>12</sup> and functioning knowledge. The third step is characterized by relational knowledge empowering the student's ability to analyse, compare, relate and explain causes, whilst the fourth, last step, consisting of an extended abstract, permits the student to theorize, hypothesize, generalize and reflect<sup>13</sup>.

**Question 1.** Does SOLO's *quantitative phase* embrace sustainability?

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<sup>9</sup> Jucker, R. (2014) *Do we know what we are doing?*

<sup>10</sup> Biggs, J., Collis, K. (1982) *Evaluating the Quality of Learning*.

<sup>11</sup> Biggs, J., Tang, C., (2011) p 86-93.

<sup>12</sup> (ibid, Marton and Säljö, p 90).

<sup>13</sup> (ibid, p 91).

SOLO taxonomy develops education from a prestructural “null”-level of understanding the topic to the highest level of extended abstraction.

Current higher education spends time on teaching sustainability through *declarative knowledge*, i.e. applying the quantitative phase in SOLO’s unistructural and multistructural levels: accepted theories, methods and evidence. It uses historical facts and is consequently always a step behind the latest developments. Superannuated information approaches measures and improvements in recognized unsustainable issues using tools that, in most cases, correspond to the knowledge that produced them.

Teaching with focus on the quantitative phase will consume time and miss or constrain the more important learning outcome – a higher level of deep understanding. In the sustainability context, declarative knowledge means teaching *about* facts that bring the past to the present time, whereas functioning knowledge in the qualitative phase relates current decision-making processes to future aspects (Fig 1).

The *declarative* knowledge achieved in the quantitative phase does not outline means of prevention or alternative methods of solving yet undeclared tasks. To resolve sustainability problems requires, on one hand, a deep understanding of many disciplines eligible to pick up and, on the other hand, broad (deep) responsiveness of cooperation among disciplines appropriate for establishing a coherent methodology to attain the relevant goal.

Sustainability is not an established scientific discipline. From this perspective it makes room for Question 2.

**Question 2.** Are advanced levels of understanding within SOLO's *qualitative phase* sufficiently up-to-date for students to learn to tackle emerging sustainability problems?

Some researchers argue that a deeper understanding and focus on the topic in general is more important than pinpointing current (un)sustainability in the curriculum and therefore they consider that sustainability is integrated.

Epistemology and worldview become even more important elements to consider in education. Emphasis should be on participation, appreciation, gender, equity and community instead of individualism, manipulation, rivalry and control. A holistic and critical approach must be developed in generic terms. These aspects form the basis of a model for transformation all of the societal system<sup>14</sup>. Universities and educators need to develop an understanding of key ecological concepts to prevent learners from retaining their own misconceptions, following from poor understanding of essential ideas related to sustainability. Sustainable development requires a change in our contemporary mindset. Sterling (2013)<sup>15</sup> stated two problems within higher education:

“...first, higher education institutions are not primarily reflexive learning systems (learning organisations) but teaching and research systems. Second, higher education is not primarily engaged in the provision of deep learning to students, but in first-order learning: the transmission of information and the development of instrumental skills aligned (increasingly) to the perceived need of the economy.”

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<sup>14</sup> Sterling, S. (2009).

<sup>15</sup> Sterling, S., Maxey, L., Luna, H., Editors (2013), p 34.

Learning for sustainability (LfS) extends and adapts present '*declarative knowledge*' to the educators' toolkit of '*functioning knowledge*' as an intrinsic part, regardless of the teaching topic. LfS explains the phenomenon of sustainable development through numerous perspectives and variable contexts. LfS challenges the paradigms on which the level itself is built. LfS is related to stipulate learning outcomes and the effects of sustainability in societal practice.

LfS boosts progression and includes tools and unrestrained activities of a general character not restricted to specific disciplines.

LfS is supposed to link to SOLO at the extended abstract level of functioning knowledge in a qualitative phase of deeper understanding aiming to promote inter-/trans-disciplinarity.

LfS also concerns regulations improving both corporate management and mitigating environmental burdens at a practical level, through increasing the learner's comprehension and commitment to sustainability (Fig 1).

LfS tools encompass a hidden hiatus appearing simultaneously to the '*functioning knowledge*' and outstretching the highest levels of SOLO (Fig 1).

In our perspective, LfS educates for the future. It leaves a safe harbour of permitted practices, methodologies and outlines new perspectives, comprehensible solutions originating in illumination of complexity, instability, dynamics, unpredictability, unaccountability, interactivity and differentiation of incoming problems. Concrete tools for LfS, found elsewhere, and compiled user-friendly by Roorda (2001)<sup>16</sup>, will grasp and help get around the complexity and dynamics of sustainability issues in higher education pedagogy. The fifth level of SOLO en-

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<sup>16</sup> Roorda, N. (2001) AISHE.

compassing a deep understanding with a systemic, holistic and transdisciplinary approach to attain the intended learning outcomes for sustainability can thus be introduced.

## Regulations

Higher educational institutions (HE) in Sweden are urged by law to include sustainable development in their educational program:

“In the course of their operations, higher education institutions shall promote sustainable development to assure for present and future generations a sound and healthy environment, economic and social welfare, and justice.”<sup>17</sup>

In addition to all the governmental authorities in Sweden, HE are also required by law<sup>18</sup> to implement environmental management systems (EMS) in their processes. The introductory environmental review defines education as a significant environmental aspect at universities. Consequently, according to the ordinance<sup>19</sup>, universities should *register* their environmental management system based on EMAS<sup>20</sup> or *certify* it in accordance with ISO 14001<sup>21</sup>. Nevertheless, a university can demonstrate compliance with ISO by a) self-determination and self-declaration (internal) or b) a confirmation by stake holders (internal second party audit) or c) an external third-party audit.

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<sup>17</sup> The Swedish Higher Education Act (SFS 1992:1434), Chap 1, Sec 5.

<sup>18</sup> Ordinance SFS 2009:907.

<sup>19</sup> (ibid, 2 §)

<sup>20</sup> EU *Eco- management and audit scheme*, EG 1221/2009 (EMAS).

<sup>21</sup> SS-EN ISO 14001:2015.

## Environmental management system (EMS), why ISO?

The International Organisation of Standards (ISO) has the active support and participation of 163 nations and 700 international organizations. More than 1300 standards coordinate activities in a widespread range of disciplines, from treatment of waste water and drinking water, e.g. improving sanitation for 2.4 billion people, to management issues. ISO 14001 is one of eleven globally most used management<sup>22</sup> standards, altogether with more than 1.6 million certificates. During the past, management standards have been updated to an identical core, improving integration with many other management systems. In Sweden, 3700 companies comply with the environmental management standard and 4300 with the quality standard. Other management standards are related to IT, road traffic security, information security, food, medical devices, automotive production, business continuity, energy, and the supply chain. This frequent use of management standards in Sweden and abroad makes it predictable for students in management positions to meet relevant systems as part of their engagements.

The latest version of ISO 14001 introduces a new core of management standards, called Annex SL<sup>23</sup>, with several vital changes concerning interpretation and implementation, e.g. definition of the (in)direct environmental aspect is removed and all aspects are evaluated on the basis of risk assessment. The intention is to make standards more dynamic and flexible for integration with the organization's main management systems, i.e. all the aspects the organization can control are embraced and no environmental aspect is addressed explicitly in advance:

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<sup>22</sup> [www.iso.org](http://www.iso.org), *Executive summary 2016*. September 2017.

<sup>23</sup> Annex SL (normative) (2015) *Proposal for management systems standards*.

‘... in all circumstances it is the organization that determines the degree of control it is able to exercise, the environmental aspects it can influence, and the extent to which it chooses to exercise any such influence.’

‘The organization should understand which needs and expectations of parties become compliance responsibility.’

‘The organization shall consider processes rather than routines in the previous version of the standard and maintain them to the extent necessary to have confidence that the processes can be carried out as planned.’

The iterative circular arrangement in PDCA<sup>24</sup> (Fig 2) in a management system ensures continuous improvement to an increasingly higher level of the monitored process, i.e. education in this case. EMS cannot be treated as a project but is a continuous, on-going and actively developing process comprehensible at higher educational institutions. A mode of management strategy developed in Annex SL is proposed be part of SOLO’s outstretched level five.

## Results

Today’s objectives in management systems are to create and disseminate divergent solutions to emerging problems, not to uphold the status quo hegemony of collective knowledge. SOLO does not relate to the broad societal needs of learning *for* sustainability, either explicitly or implicitly. SOLO deserves developing connectivity to sustainability by the suggested fifth level, even when the highly respected fourth step (Fig 1) theorizes and reflects on an extended abstract level.

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<sup>24</sup> Deming, E. has introduced PDSA (Plan-Do-Study-Act, by Shewhart, W.).

The latest changes in EMS (ISO 14001:2015), especially those concerning the engagement of top management and environmental aspects, acknowledge a highly qualified contribution and accentuation of activities striving to establish learning for sustainability in higher education. This approach corresponds to the academic freedom to define and analyse significant environmental aspects in syllabuses and appeals to the university's leadership and performance amplification. The restructuring of SOLO by the fifth level will improve the learning progression mechanism, essential for both academic discipline and the students' awareness and comprehension of sustainability. As we understand it, this fifth level in SOLO has not yet been considered, introduced or implemented by universities.

## Discussion

### Obstacles identified

Do we have to teach/learn all the earlier (established, descriptive) knowledge within a specific theme to the extent that we do now, or can we *make room* for functioning knowledge to promote LfS? Not surprisingly, frequent comments consider the time budget for the course's discipline to be sacred. Connections to sustainability are not noticeable and they remain somewhere outside the subject matter, not as an intrinsic part of the discipline or the education.

Educators refer to their *insufficient or shallow knowledge* of sustainability.

Educators are asking for a *suitable frame/model* showing what is sustainable and what is not.

Educators are not *motivated* to teach beyond their responsibility as high quality specialists in the discipline.

*Restructuring* the syllabus is time-consuming when the aim is to find new perspectives with suitable LfS activities referring to the discipline.

*Initially, it is not easy to* understand the students' preconceived worldview about sustainability.

*Ensure* the novelties in syllabus are sustainable, by complying with the strategy and policy of the university.

### Activity objectives for up-to-date education

*Implement* LfS-tools compliant with the type of discipline in courses and programs.

*Emphasize* the learner's approach to deep understanding of transdisciplinary relationships, providing a reliable base for resolution of emerging problems.

*Verify* the role of management standards as LfS-tools in higher education.

*Ensure* curriculum awareness of sustainability through connection to the 17 goals in UN Agenda 2030.

### Methodology

*Start* with the LfS-tool list in Roorda (2001).

*Compile* accessible course activity tools suitable for LfS.

*Assess* annual management performance reports.<sup>25</sup>

*Manage sustainability surveys* addressing educators, students and alumni in prolonged time studies. Start preferably with Roorda (2001).

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<sup>25</sup> Swedish universities report to The Ministry of Education and Research and to The Swedish Environmental Protection Agency

*Appraise* the effects of environmental management standards (EMS) on environmental aspects in general and compare LfS with the intended outcomes and engagement of leadership at the university (Fig 2).

*Reflect* if the following sustainability phrase - '*Sustainability means be useful for many, for a long time and not destroying eco systems or natural resources*' would be a helpful guide to opening sustainability discourse?

Education for a sustainable future depends on an educator's reliable *functioning knowledge* and acceptability of LfS integrated in the curricula. If educators do not understand complex relationships in earth and human systems<sup>26</sup>, holistic and systemic perspectives, how can they then teach sustainability to students? Here we might be facing one of the fundamental problems of progress towards sustainable development: systemic illiteracy.

The toolkit of Roorda (2001) for LfS consists in a battery of methods/pedagogical activities used elsewhere in HE. The difference from disciplinary coherence is learning to keep a broad focus to ensure that the arguments are *reasonable for many, for a long time, and have the lowest impact on the environment that we depend on*.<sup>27</sup>

The learning outcomes of LfS explain how the tool approach to sustainability can be used, not what the sustainability goals themselves would be. The annual audit and performance report comments on the enhancement level related to sustainability objectives. Back-casting (frequently used) can get us on

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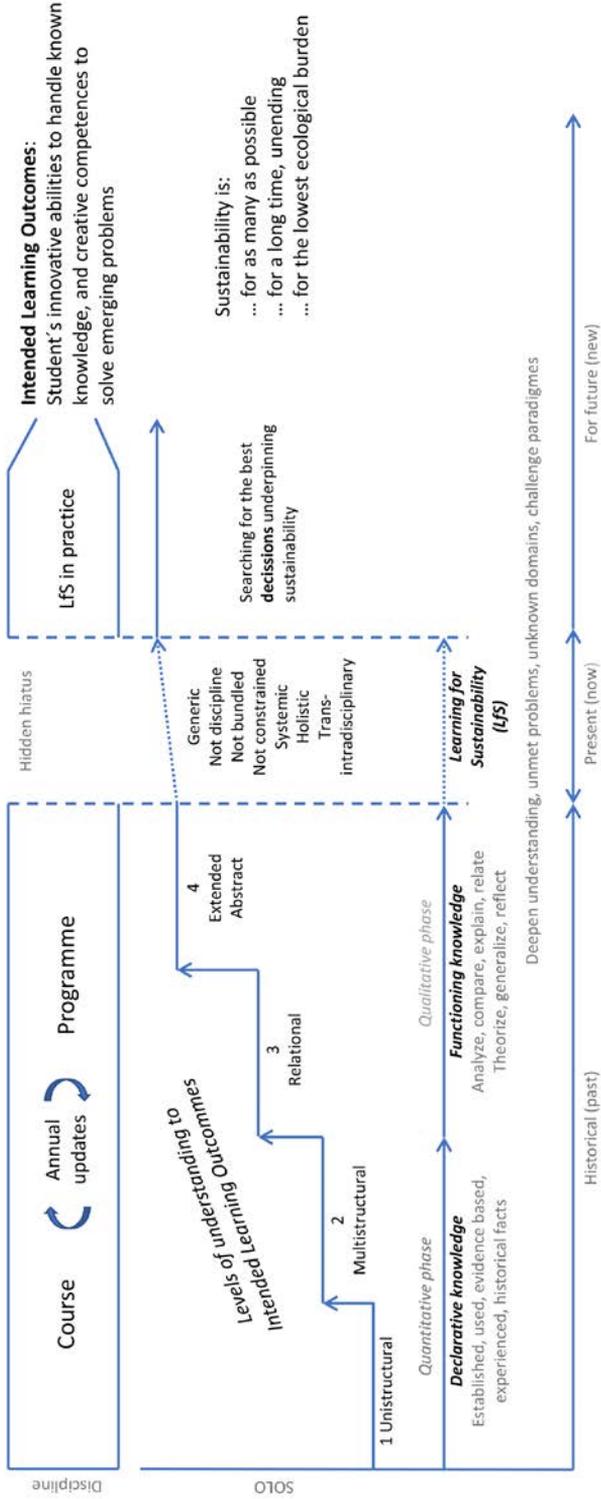
<sup>26</sup> IPCC *The Fourth Assessment Report*, Figure I.1.

<sup>27</sup> Expression inspired by 'conservation programme' Roosevelt, Th (1858-1919), in Scott, W., Gough, S. (2004) *Key issues in sustainable development and learning, A critical review*. RoutledgeFalmer, NY.

the track, while adjustments of timetables and suitable measures must be revised on the go.

The methodology of LfS is freely generic, and it should be trained as an integrated part of education, not solely developed to serve only a specific discipline. It is freely applicable and suitable for further exploitation of progression in pedagogy as well as simultaneously broadening and deepening understanding of the subject.

The declarative (known) knowledge is historical, from ancient sources up to latest yesterday's news. Educational activities in LfS compile appropriate historical parts and modern features to create improved methods for solving emerging problems. LfS applies new values, attitudes and competences suitable for risk evaluation, challenging paradigms and executing new processes for a more sustainable future. LfS-tools applied to university programs would help accomplish this goal.



**Fig 1** Learning /or Sustainability integrated in SOLO activities for Intended Learning Outcomes. Inspired by SOLO-taxonomy (Biggs, Tang (2011)).

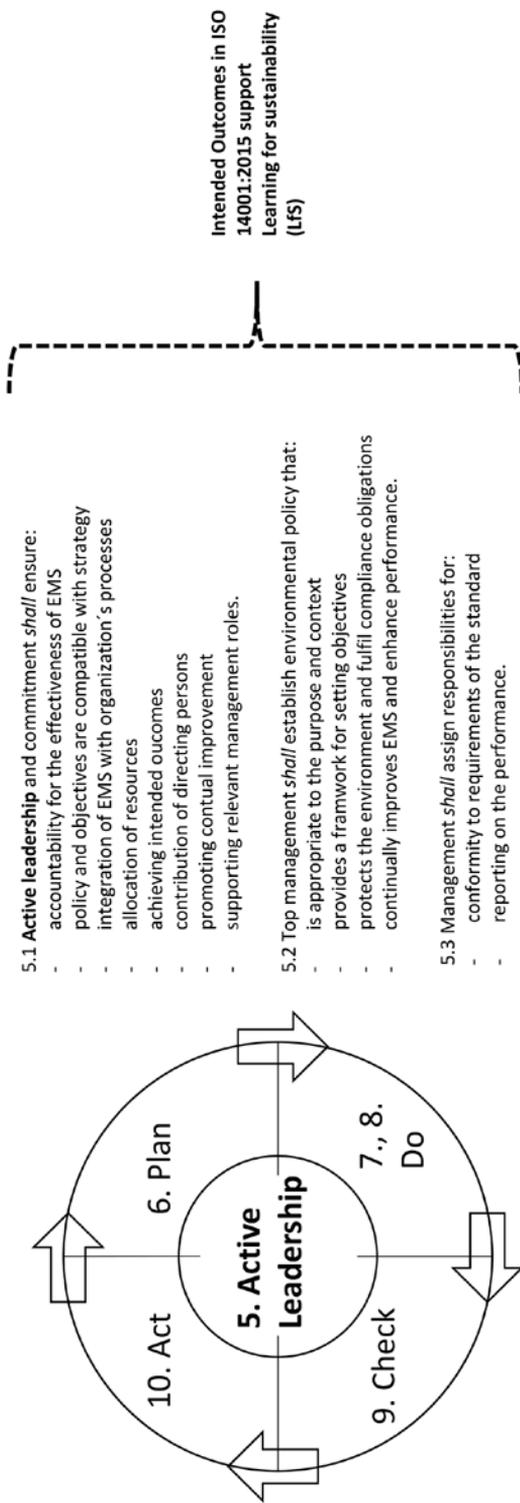


Fig 2 Active environmental leadership and management accentuates Learning for Sustainability (LFS). Numbers correspond to actions in Deming's iterative process to achieve continual improvement by ISO 14001:2015 (EMS), Section 5.

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