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Article

The Art of Interconnected Thinking: Starting with the Young

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Abstract: Despite many efforts to deal with the various complex issues facing our societies, plans and problem solutions are seldom long lasting, because we, as individuals, and our leaders are most likely to fall into the trap of using traditional linear thinking. It is natural and easy, but does not usually deliver long-term solutions in the context of highly complex modern communities. There is an urgent need for innovative ways of thinking and a fresh approach to dealing with the unprecedented and complex challenges facing our world. It is essential for future leaders and citizens to be prepared for "interconnected" thinking to deal with complex problems in a systemic, integrated and collaborative fashion; working together to deal with issues holistically, rather than simplistically focusing on isolated features. An educational tool (Ecopolicy) is used as the main mechanism to achieve this aim. The Ecopolicy cybernetic simulation "game" is a challenging, but playful, method by which students are introduced to the idea of thinking in terms of relations, in feedback cycles, in networks and in systems. Participation in this stimulating simulation enhances the capacity of young people to change their way of thinking. This would be expected to prepare them to develop into leaders or citizens who can effectively deal with a complex and challenging future.

Keywords: systems thinking; systems education; complexity; Ecopolicy simulation game; lifelong learning; evolution; management; sustainability

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1. Introduction

We are surrounded by systems and are indeed a part of systems. Humans are not, however, in the habit of seeing this or of thinking systemically. Even when we can see that "something is wrong with the system", we tend to analyse the problem by breaking the system down to smaller and smaller parts, looking for that which is faulty, until we begin to lose sight of the interactions between all of the elements [1–3]. This type of thinking is a logical consequence of the sheer difficulty of observing and interpreting the actions and reactions of people or things synthetically (or holistically). That is, it is mentally easier to break a thing down to inspect individual components than to study the component and its relationship to other components simultaneously. Linear thinking might be satisfactory if you are deciding where to build a house if there are no councils and no environmental regulations. Similarly, developing modern economies would be easy if we could burn oil and coal without any consequences. However, like all activities, these activities have consequences.

Actions are often difficult to understand; interactions multiply that difficulty. Yet, it is only by appreciating the dynamic interplay of all of the elements in a system that today's complex social, economic or environmental problems can be solved [4–8].

Current management approaches to such complex problems are universally *ad hoc* and non-systemic [9,10]; and the lack of cross-sectoral communication and collaboration in such complex environments compromises the leaders of our society, managers in business and organisations and policy makers in governments [11,12]. These problems are not new [13], and there are various seminars and courses that focus on finding solutions and entire books written on these problems [12,14–17]. However, little has been done that is new or that has proven able to overcome the barrier to communication caused by differing mental models of the world and to devise systemic management strategies towards complex problems [18].

In addition, government and business institutions are under pressure to make the right investment decisions in the face of a continually changing world. Managers and leaders today are expected to deliver innovative solutions to cope with increasing change and uncertainty. There is an urgent need to step outside our collective "comfort zone" and to develop new ways of thinking and acting in the interest of our future. It is essential for current and future managers and leaders to be equipped with new ways of thinking in order to deal with complex problems in a systemic, integrated and collaborative fashion.

An important question arises from the above: "Do we need a paradigm shift towards systems and interconnected thinking?" The answer to this question is undoubtedly "yes". Bosch *et al*. [18] have identified and addressed three key leverages, which could help such a paradigm shift by particularly addressing the aforementioned issues. These leverages include: (1) establishing evolutionary learning laboratories (ELLabs) as platforms for collaborative learning for how to manage complex issues; (2) introducing the young generation (future managers and leaders) to systems and interconnected thinking; and (3) "infiltrating" formal traditional disciplinary-focused education with systems thinking concepts [19].

A recent paper provides a comprehensive description of the first leverage (systems-based approach) and its application in four case studies [20]. The generic application of the ELLab approach has also been reported in several other publications (currently in review). Similarly, a forthcoming paper will report on the third leverage [21].

This paper provides an overview of the systems thinking concept and the current state of systems education. It then elaborates on and discusses in detail the second leverage, namely "starting with the young".

2. Systems and Interconnected Thinking

In beliefs about the relationship between humans and the rest of the natural world, in philosophical understandings of the universe or in medicine and healing, we see numerous examples of cultures that have, throughout history, operated with a "holistic view", seeing things as a whole or a system. This is the essence of systems and interconnected thinking. The following examples clearly illustrate the centuries-old existence of systems thinking in many cultures.

For millennia, Native Americans have employed traditional healing modalities that are very old in methodology and holistic in nature. This ancient holistic approach is still used today by many Native Americans to resolve healthcare problems [22].

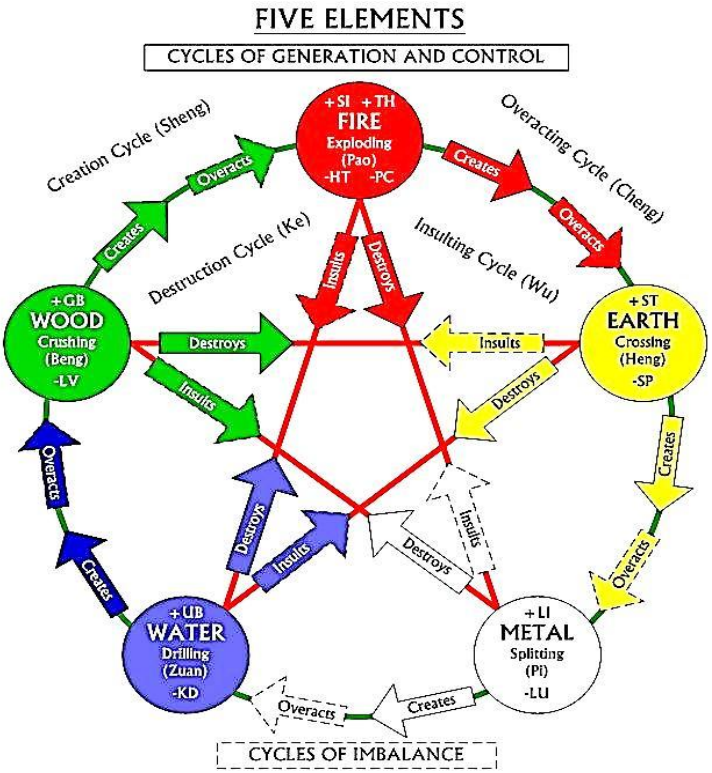
Australian indigenous cultures (the oldest continuing cultures in the world) have a deep connection with the land that is expressed in their stories, art and dance. For them, country is a word for all the values, places, resources, stories and cultural obligations associated with that area and its features. It describes the entirety of their ancestral domains. Systems concepts have also been present in the thinking and philosophy of the Maori people in New Zealand. These indigenous people highlight the importance of the "Earth Mother" and the "Sky Father" and perceive that everything in the universe is connected.

Eastern philosophy has evolved a unique, systemically non-linear and holistic worldview. For example, ancient Chinese philosophers believed that everything in the universe was made up of two forces called "yin" and "yang". According to Chen *et al.* [23], yin-yang reflects not only the collective wisdom of the ancient Chinese people on the fundamental features of the universe, but also influences the way of metaphysical thinking of subsequent Chinese in various schools or movements. Another Eastern systems concept is the theory of wuxing or Five Elements (Figure 1). This theory indicates that Wood feeds Fire, Fire creates Earth (ash), Earth bears Metal, Metal carries Water (as in a bucket or tap, or water condenses on metal) and Water nourishes Wood. This is truly an interconnected feedback system.

One of the well-known scientific practices based on the theories of yin-yang and wuxing is Chinese herbal medicines (CHMs). Chen *et al*. [23] emphasize that Eastern medicine understands the body as an "open system" connected to the external world. In contrast, modern Western medicine regards our body as a "closed, self-contained system". CHMs have played an important role in clinical therapy for many diseases, especially as a valuable, readily available resource for healthcare in many oriental countries for thousands of years. An estimated 1.5 billion people now use CHMs worldwide [24]. Li *et al*. [24] also believe that CHMs, which produce effects across multiple sub-systems of a whole person, have been and will undoubtedly continue to be most important in world medicines.

Ohnishi and Ohnishi [25] point out that Ki (in Japanese) or Qi (in Chinese) is the key concept in Eastern medicine. In eastern medicine, it is believed that the head and the various inner organs are connected to specific points in distal areas (*i.e*., hands and legs) with "meridians". Along these meridians, there are about 350 acu-points, which are used for acupuncture therapy. Acupuncture allows the Ki to flow smoothly [25]. Essentially, the concept of finding acu-points is very similar to the concept of identifying "leverage" points commonly found in the contemporary literature on systems thinking [26,27].

Figure 1. Five Elements of cycles (Author: Don Reynolds, March 2007 [28]).



However, Western thinking was heavily developed on three fundamental pillars, namely Greek reductionism, the separation of mind and matter advocated by René Descartes and a deterministic-monotheistic worldview originated by Isaac Newton [25]. René Descartes taught Western civilization that the thing to do with complexity was to break it up into component parts and tackle them separately [29]. This is still the prevalent mode of thinking in the West.

As the wonderful conservationist, John Muir, pointed out: "When we try to pick out anything by itself we find it hitched to everything else in the Universe" [30]. A new "shift in thinking" began with Ludwig von Bertalanffy in 1928 and has developed during the latter half of the 20th century into a new way by which to examine and to think about the world [31]. Various scholars in the West have devoted their time to the study of systems and systems approaches in an attempt to address the above issue. For example, Midgley [32,33] suggests that the field and study of systems began in the early 20th century with either Alexander Bogdanov [34] or Ludwig von Bertalanffy [35,36]. It is widely acknowledged in the literature that Checkland [29,37] and Senge [27,38] have proposed influential systems thinking approaches.

Systems thinking is a very broad field. Sherwood [39] concludes that it would be impossible to cover all of its associated tools, techniques, methods and approaches in a single document. Understandably, there have been various books and papers written on the topic of systems thinking. For example, see Emery [40], Flood and Gregory [41], Midgley [42], Jackson [43], Hammond [44] and Francois [45] for a "rich storehouse" of different systems approaches and inclusive sources about the systems thinking concepts. Many scholars have also attempted to write "easy-to-read" books to "demystify systems thinking and make it accessible to a wide range of audiences", e.g., Haines [46], Weinberg [47], Sherwood [39], Maani and Cavana [48].

The application of systems thinking has been evident in many diverse fields and disciplines, such as, to mention but a few, management [43], business [49,50], decision making and consensus building [51], human resource management [52], organizational learning [53], health [54,55], commodity systems [56], agricultural production systems [57], natural resource management [58], environmental conflict management [59], education [60], social theory and management [61], food security and population policy [6], sustainability [5,62] and complexity management [20]. Additionally, humans instinctively understand the importance of systems and their parts. What we do not instinctively do in society at large is regularly solve problems by considering the whole system, tending to focus instead on the part that appears to be malfunctioning [39,63]. Thus, governments attempt to control obesity by encouraging exercise or influencing food choices without also considering food culture, city planning, pet ownership, economic pressures, advertising, agriculture, human nature, serving portions, convenience, the availability of time for food preparation or other health issues that inhibit activity; or try to save species by establishing national parks with porous boundaries and already full of feral animals.

We have all become interconnected in a vast physical and digital web. Potentially contentious issues, such as healthcare, environmental protection, gender relationships, poverty, mental health, economic development, migration, land use or water allocation (just to name a few), are now tangled and magnified in a global system of ecological, economic, social, cultural and political processes, ideas and dynamic interactions [64–67] in relentlessly challenging ways not experienced before the Industrial and Technological Revolutions.

Despite its extensive application in various fields, systems thinking has mostly been used and applied by systems scientists and some academics. The applications of systems thinking by policy makers, managers, practitioners and ordinary people remain limited. This can be attributed, but not limited, to several factors, including: the "difficulty of selling systemic thinking" [68], systems thinking is not yet a phrase in general use [29], it is a frequently misunderstood term meaning many things to many people [46], the emphasis in formal education is evidently placed on events, parts and isolated processes, rather than systemic relationships [69], and the bulk of systems education to date has been focused on training specialists [70]. In addition, the diverse schools of systems thoughts create confusion about the systems thinking concept. There is an urgent need to make systems and interconnected thinking become popular, or "unremarkable" as suggested by Allen [71], and easy to understand by all, *i.e*., become "a common language" as proposed by Zhu [72] or "absorbed into scientific research, in the same way that statistics is today an integral part of all sciences" as postulated by Bosch *et al*. [73].

3. Starting with the Young

3.1. Current State of Systems Education

Having discussed the extensive application and development of systems thinking in the previous section, it is not surprising to see that there are various systems courses and programs currently being offered around the world [74,75]; many of these courses target the young.

Nevertheless, there is still much needed to be done by systems scientists and systems educators in order to make systems thinking part of everyday life. Results from a study with middle school

students [76] indicate that most of them encounter difficulties in all aspects of systems thinking, even in the very basic ones. According to Jacobson and Wilensky [77], even university students tend to solve complex systems problems using simplistic arguments. It is suggested that skills for comprehending the structure and the visible aspects of the behaviour of a system are most easily acquired by young students [78], and systems thinking skills are important in helping younger students understand the many complex relationships that exist in the natural and social world [51]. Evagorou *et al*. [79] review the work of many researchers and educators highlighting the importance of elaborating systems thinking skills in the learning routine of specific scientific fields, such as ecology, physics and social sciences, as a prerequisite for the conceptual understanding of the topics taught [80–83]. However, Evagorou *et al*. [79] claim that the resources for teaching systemic thinking within science are limited and that learning about complex systems is difficult in the current educational settings. This argument is supported by many studies reported in the literature [84–87].

In addition, Herrscher [68] observes that around the world, proposals are often made to universities to include systems theory or thinking in the curriculum. In all cases, the university's president was 100% in favour of the project. However, when it came to implementation, he had to rely on one of his faculty or department deans. There the trouble began. Deans are "area oriented", *i.e*., there is no dean in charge of "overall wisdom" or "general knowledge". In most cases, the proposal already died at the first step, when deciding which "specialized area" should handle this "unspecialized" teaching and research [68].

Herrscher's observation was noted more than 15 years ago. Unfortunately, things have not seemed to change. Recently, the then President of the International Society for the Systems Sciences stated that: "…there are remarkably few institutions in systems science that have proven to be stable and robust enough to outlive their creators for long. Deans step in and dismantle what they do not understand, taking the money for their discipline-centred favourites" [88] (p. 3).

This is sadly true, at least in the cases of universities in Australia. There had been three very successful systems groups in three of the biggest universities in Australia, namely The University of Western Sydney (UWS), Monash University and The University of Queensland (UQ). Unfortunately, all of them have been "disestablished" due to the "silo"- and "discipline"-oriented thinking of senior managers.

The first group at UWS had achieved huge successes in the late 1980s and early 1990s in introducing systems thinking and practices in the education of agriculturalists [89], systems programs [90] and systems approaches to agricultural development [91]. Unfortunately, this innovative systems agriculture paradigm is barely alive at UWS today [92]. The second group (the Systemic and Action Research group) at Monash University had also been very active and successful in the late 1990s and early 2000s. This group is now sharing the same fate with the first group.

The third group at UQ (School of Integrative Systems) had done extremely well in the first decade of the 21st century [4,73,93–95]. For example, one of its systems thinking course commenced with 11 enrolments in 2009; the enrolments had increased to 109 and 113 students in 2010 and 2011, respectively. This course has been taken by students from all faculties at UQ.

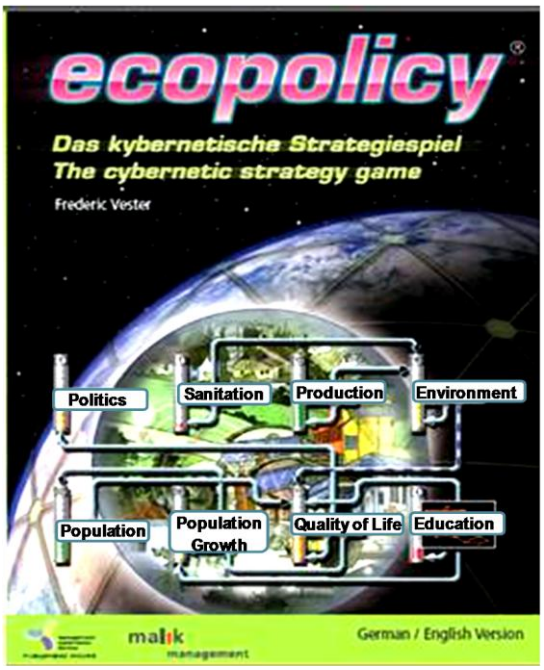
Unfortunately, the School had also been "disestablished" from early 2011. It is not within the scope of this paper to write on this case in detail. A forthcoming paper will be devoted to this, which will be similar to what Petterson [92] has reported on the UWS case.

The discussion in this section does not mean to set a negative scene for the state-of-the-art of systems education. It reinforces the importance of introducing systems and interconnected thinking to people in the early stages of their lives [79,96]; that is, "starting with the young".

3.2. Ecopolicy Program: A Mechanism for Staring with the Young

As mentioned before, it is an extremely difficult process to change the mindset of a society from typical, simple cause and effect, linear thinking to more realistic and "interconnected" thinking. "Starting with the young" has been identified as one of the major leverages to address this difficult problem [18]. This is therefore one of the objectives of the program discussed in this paper. Another objective is to introduce young people to the concepts of systems and interconnected thinking (through "Ecopolicy"). Ecopolicy is a cybernetics simulation game (Figure 2) that was developed in Germany [97,98].

Figure 2. Ecopolicy cybernetic strategy game [97,98].



"Gaming" is part of the culture and language of young people and "Schoolchildren are at an age in which they can access interconnected thinking with the greatest of ease. As a matter of fact, training in interconnected thinking should start early—before specializing in a certain field of study. We need experts who do not pursue their special topics in isolation, but in an end-to-end context, integrating it in a systemic overall understanding" [99].

In the last few decades, society has become more aware of the environment. Yet, we have hardly begun to develop an understanding of how everything in our world is interconnected. Every intervention in the complex system in which we live has highly complex effects—feedback, time lags and delayed repercussions. There could hardly be a better reason for learning how to apply an awareness of system principles. If we can learn to visualize how effects will interact in highly industrialized areas, we will realize how truly impossible it is to plan or develop individual areas separately or in isolation. Unfortunately, so far, we still keep trying to do things the old way [97].

Ecopolicy may help to discover the possibilities that "interconnected thinking" or "systemic thinking" offers for a future-oriented way of control and management of our complex world. The simulation game has three fictitious countries (Cybernetia, Cybinia and Cyboria) that serve the purpose of demonstrating playfully how easily interventions in a complex system can lead to unexpected developments. The players experience playfully what it means to control complex systems while attempting to attain a flourishing economy, healthy environmental conditions, as well as personal well-being through investments of money, influences and ideas and to stabilize the situation in the country [98].

No matter what happens, players are encouraged to attempt to analyse objectively the reasons for their particular actions. They learn what impact investments and bad investments, long-term consequences and time delays will cause; and the impossibility of turning back the course of things in a constantly changing dynamic system. Once an intervention has begun its journey through the networked system, it can rarely be undone. At most, it can be compensated for, balanced to a degree: one can utilize forces that have already taken effect or change the direction somewhat through self-regulation. Such causal relationships and long-term consequences are evidenced in the economy and environment [97].

What is special about Ecopolicy is that it is fast, and obvious solutions are generally proven to be inadequate; just as in real life. By getting familiar with the interconnected levels of the reality they are dealing with, the players experience how to achieve resilient and sustainable systems by developing relevant and future-oriented decisions. The players act like the government of a country in despair, with the goal to stabilize the country through developing a balance between education, health, politics, production, environment, quality of life and population growth. These are all important sectors of human life, and they are all interlinked in such a way (in the game) that each decision results in a chain of effects and repercussions.

The highest score is automatically calculated from the nature and effectiveness of the decisions that the players make. The results of both foundering the fictitious country with short-term decisions, as well as leading it towards a stable and sustainable country are experienced.

Students learn through playing the Ecopolicy game how to shift from traditional, mainly linear thinking approaches to a new way of thinking in relations, in feedback cycles, in patterns, in networks, in systems. Most important, the game is fun, with illustrations, animations and music, leading to a strong emotional engagement with the message of the game [18].

3.2.1. First Introduction of the Ecopolicy Program in Australia

The Ecopolicy computer game was introduced in July, 2012, as a competition in 16 high schools in Adelaide, Australia, by the Systems Design and Complexity Management (SDCM) Alliance of the University of Adelaide Business School.

These schools took part in a series of competitions in several rounds between small teams (three students) within classes, between classes and within schools, until a winning team for each school was determined. Around 3000 students in Adelaide were taking part in the various rounds. During the competitions, students learned through playing the cybernetics computer simulation game how to balance the conflicting demands of production, the environment, education, health, politics, quality of life and population growth.

The final competition was held in December, 2012, as an "Ecopolicyade", when all of the winning teams from each school competed against each other in the Adelaide City Council Chambers (Figure 3) and in the presence of invited guests from all walks of life. The Lord Mayor of Adelaide opened the event and made special mention of the students, parents, teachers, principals and Business School staff who had been involved and supported the event and also welcomed State Members of Parliament and government officials who attended the final.

Figure 3. Adelaide Ecopolicyade in the town hall chamber.

The winning and runner-up teams of South Australia's inaugural Ecopolicy competition went to Vietnam to take part in the first International Ecopolicyade being organized by the authors as part of the 57th World Conference of the International Society for the Systems Sciences from 14 to 19 July 2013, in Haiphong City.

The Ecopolicy game is currently being extended to other schools in the State of South Australia as an annual event, with the intention to eventually be deployed nationwide.

3.2.2. First Introduction of Ecopolicy in Vietnam

Ecopolicy was launched during a seminar on 22 August 2012, in Haiphong City in the north of Vietnam. Haiphong is a Category 1 city in Vietnam, and it is administratively equivalent to a province in Vietnam or a state in Australia. Schools, university representatives and people from all levels of government were invited to this event (Figure 4). The launch was enthusiastically received, and there was an immediate response in which a total of 22 educational institutions (18 high schools and four universities) expressed their interest in implementing Ecopolicy in 2013. This event carried very high media coverage through Television and newspaper articles (see the Appendices).

A follow-up Ecopolicy workshop was conducted in December, 2012, to provide the necessary training for a number of government officials and teachers from the universities and high schools in Haiphong. This group of high schools and universities was the first in Vietnam to take part in a series of competitions to learn about interconnected thinking.

The individual schools and universities organized their own finals to determine a winning team for each school and university. These were regarded as important and official events and attended by top government officials of Haiphong. The Lord Mayor of Haiphong addressed the students at several of these final events. In many of the schools, the teachers also formed teams and competed against each other during the school and university finals.

Subsequently, the Ecopolicy program was successfully implemented in HPC-Phase 1 of the Ecopolicy program in HPC [100].

Figure 4. Professor Bosch and Dr. Nguyen launching Ecopolicy in Haiphong.

The first final Ecopolicy competition in Haiphong (Ecopolicyade) was held on 14 May 2013. It was the end result of the various competitions that involved more than 50,000 participants (students and teachers). Ten teams reached the final Ecopolicyade (Figure 5), which was attended by around 1000 representatives from the schools, different Haiphong City offices, district offices, government departments and other organisations.

Figure 5. Winning teams at the Haiphong Final Ecopolicyade.

Eight of the winning teams (three from universities and five from high schools) represented Haiphong at the 57th World Conference of the International Society for the Systems Sciences 2013 to compete in the first International Ecopolicyade against the two best teams from Adelaide, Australia (Figure 6). At this event, the teams were able to obtain advice from a world audience of systems

scientists and representatives of international governments, large companies and organisations; a truly inter-generational and inter-cultural co-learning experience for all involved on how to deal with the complex issues facing our world.

Figure 6. The First International Ecopolicyade.

4. Discussion and Conclusions

In this paper, we argued that a new way of thinking is urgently needed to address the complex issues facing our society. The ability to think in systems and understand the implications of the high degree of interconnectedness between components of a system is in itself the most important leverage towards a societal change to move away from traditional linear thinking. This was well confirmed by the students, who, in playing the Ecopolicy game, experienced the pitfalls of the usual practice of concentrating on isolated problems; that is, solving one problem and creating several new ones. When students started to play the game for the first time, most of them were in a "linear thinking " mode and were not able to get much further than the second or third round before being "thrown out of government".

Surveys were conducted with many students (before they participated in the Ecopolicy program) and with the 30 students (three students × 10 winning teams, eight from Haiphong and two from Adelaide) after they completed the final Ecopolicy competition in Haiphong (Ecopolicyade). The main aim of the surveys was to explore to what extent the objectives of the program had been achieved. The survey questions were designed to identify any changes in the students' way of thinking and systems knowledge after being involved in the Ecopolicy program. The same 10 questions were used in both the "before" and "after" surveys. They included:

(1) What would you regard as the first prerequisite for solving a difficult problem?
(2) Why do you agree that it would be better for each country to solve its own problems by itself?
(3) What do you think about the general statement that: "The best solution to a problem in a specific area of interest/discipline will come from experts in that area"?
(4) How would you solve the symptom of a problem? (e.g., how would you reduce the high crime rate in Shanghai?)
(5) What do you understand by the concept of feedback between different components of a system?
(6) What do you think about the fact that an intractable problem should become part of the management environment?

(7) What do you think about the statement that: "Individual organisations or companies do not have to take the changing nature of the world into account when they have to solve a problem that relates only to their own organisation or company"?

(8) Why do you agree that the best way of solving a difficult problem is to try out various strategies until you find the one that works?

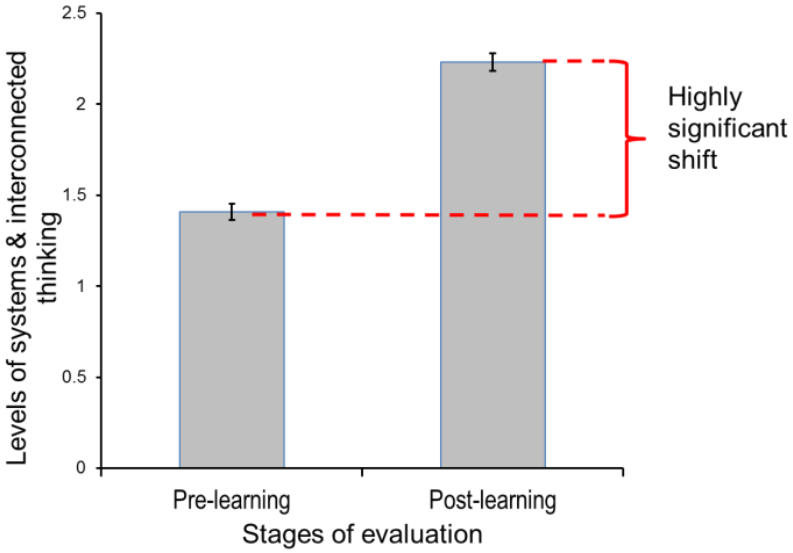
(9) Are you aware of any systems tools that can help you to address a difficult problem? If yes, please name them.

(10) Why have you decided to participate in this program and are you happy that you are being involved in it?

A sample of 27 ("before" and "after") completed surveys (out of the 30 students mentioned above) was chosen for analysis. Qualitative data were encoded for the ease of evaluation. Therefore, the numbers (0, 1, 2, 3) were used to quantify the students' levels of understanding for the purpose of comparison before and after the program. The encoded data (0, 1, 2, and 3) were not ordinal numbers, but they represent the students' levels of interconnected thinking. The students' levels of thinking were evaluated and categorized based on their responses to the set of questions (answers to the first eight questions × 27 students = 216 data points (levels of thinking)) in both the "before" and "after" surveys.

The standard errors (SE) represent the tendency of the "true mean" of the levels of thinking (over 216 data points, not 27 data points). Therefore, the comparison between "before" and "after" participating in the program was rational to see how their levels of thinking had changed.

Figure 7. Average shifts of the students' systems knowledge and perceptions after being involved in the Ecopolicy program. The vertical bars (I) represent the standard error (SE). Source: [101].



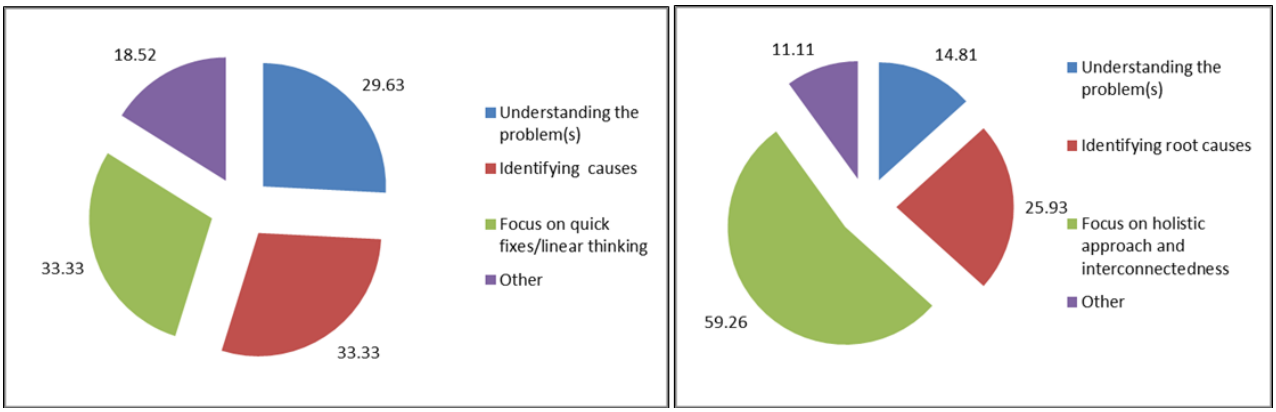
The levels of understanding systems concepts and interconnected thinking has been evaluated by using four levels to score the responses (3: advanced; 2: moderate; 1: limited; 0: no understanding). Half band scores were applied for more accurate results. The encoded data were analysed using the General Linear Model procedure in the Minitab® statistical package (version 15, Minitab Inc., State College,

PA, USA). In the "before" survey, the tendency of the students' level of systems and interconnected thinking was around 1.4 (in between the "limited" and "moderate" thinking levels). After participating in the program, the students had a better understanding and improved their ways of thinking, with the level of systems and interconnected thinking increasing to around 2.2 (Figure 7). No significant differences (at $p < 0.05$) were found among gender groups.

The largest shift was evident from the responses of the students to Question 1 regarding "the first prerequisite for solving a difficult problem". There was an increase from a limited understanding and thinking in a linear way (0.96 ± 0.11) to a more coherent and interconnected way of thinking, with an average score of 2.44 ± 0.11 ($p < 0.001$). The comparison is illustrated in the two pie charts below.

Figure 8 clearly indicates that 33.3 percent of the students were inclined to jump to the solution (*i.e.*, treating the symptoms and "quick fixes") at the "pre-involving" stage. Only three students out of the 27 mentioned the importance of identifying the root causes. Interestingly, after being involved in the Ecopolicy program, nearly 60% of the students mentioned systems-based approaches, highlighting the system component interactions, root causes, unintended consequences, leverage points and systemic interventions.

Figure 8. Comparison of the students' way of thinking and approaches to problem solving before and after being involved in the Ecopolicy program. Source: [101]. (**a**) Pre-involvement in Ecopolicy; (**b**) after involvement in Ecopolicy.



(**a**) (**b**)

Vietnam is the first example in the world where Ecopolicy has been implemented in a developing country. The success of the pilot program in Haiphong indicates a high potential for the Ecopolicy program to be extended to other parts of the country. The research team (authors of this paper) has been invited by the Government of Danang City (located in the central part of Vietnam) to introduce the Ecopolicy program into high schools and universities in Danang in July, 2014. The Team is also working with the Centre for Thinking Science (CTS) and the Centre for Technological Advancement and Young Talents in Hanoi (the capital city of Vietnam) on the development of a project to introduce the Ecopolicy program nationwide.

The Government of Haiphong has acknowledged the value of this revolutionary learning tool and is now leading a second phase in which more schools and universities are involved. The government has also decided that all officials, policy makers and other employees from all the Haiphong City offices, district offices and government departments become involved in Ecopolicy competitions in order to

raise their awareness of the importance of systems and interconnected thinking. This was seen as important, because until now, quick fixes through linear thinking still remained prevalent in their day-to-day tasks. The participants also had to develop systemic strategies for the sustainable development of Haiphong. Many teams from several departments also have done a written examination on systems thinking concepts, and they had to develop their strategic plan (for each department) using what they have learned about interconnectedness and systems thinking. Further information on these is available from the links in the Appendices (Ecopolicy launched in Vietnam).

The Department of Education and Training in Haiphong is considering the incorporation of Ecopolicy into school and entry year university curricula.

Ecopolicy has not yet been so enthusiastically received in Australia, especially amongst government officials. This is in contrast with what has happened in Vietnam and also in Europe, where, for example, the Federal Government of Germany is involved in the Ecopolicyades in a great way. This is probably due to the fact that the South Australia State Government and Federal Government have not been actively engaged in the process. This is expected to change in the near future when Ecopolicy will be launched at a national level in an upcoming program to be jointly coordinated by the authors of this paper and the International Centre for Complex Project Management (ICCPM).

It was clearly shown that a "champion" is needed to develop an enthusiastic and energetic uptake of the learning tool. In Vietnam, the top government officials were involved right from the onset of the program and played an important role in introducing and now extending the learning tool to other schools and universities. The "starting with the young" pilot projects in both countries have so far achieved various important outcomes:

- Exposing the young generation to systems and interconnected thinking and how it offers a holistic and integrative way of appreciating that all sectors in life are highly interconnected. This has been achieved by successfully implementing the Ecopolicy program in Adelaide and Haiphong.
- Realizing that interdisciplinary, cross-sectoral communication and collaboration are the only ways in which issues of a multi-dimensional and multi-disciplinary nature can be addressed. This has been evident during the different rounds of "playing" Ecopolicy and especially how students at the onset of the competitions seldomly got further than the first rounds, but rapidly learn to think more in systems and, as a result, achieved high scores in completing all of the rounds of the game.
- Understanding that short-term fixes can only "treat the symptoms", and problems need to be addressed systemically at the root causes. This is shown in the analysis of the surveys.
- Enhancing the capacity of young people through improving their understanding of systems thinking, preparing them to become effective leaders for a future in which they will have to deal with increasingly more and complex issues.
- Getting acquainted with the pattern recognition and parallel processing of the interconnected levels of the reality they are dealing with, the younger generation experienced how to develop relevant and future-oriented decisions in order to achieve resilient and sustainable systems. This has been evident through studying the functions in the model behind the game and the intensive discussions that followed before decisions were made during the different rounds.

- Valuable inter-generational co-learning experiences were created through the first International Ecopolicyade as the student teams were able to obtain advice from a world audience of systems scientists and representatives of international governments, large companies and organisations (participants at the 57th World Conference of the International Society for the Systems Sciences, July, 2013, in Haiphong, Vietnam).

The "starting with the young" initiative, together with many other initiatives from around the world, can contribute significantly to the efforts of the systems community in making systems thinking and systems education become "unremarkable" [71] and "absorbed" into society [73].

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Author Contributions

Both of the authors have provided an equal amount of work for the implementation of this reported research. The first named author has contributed 55% and the second name author has contributed 45% to the writing of this paper, respectively.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendixes

Note: Some links are in Vietnamese, but if you click on the top line on "TRANSLATE" (not "English"), the news articles are translated into English. Although the English is not very good, the main messages are clearly understandable.

Ecopolicy launched in Vietnam

http://ecopolicy.isss2013.gov.vn/en-us/home.aspx
http://ecopolicy.isss2013.gov.vn/tabid/387/The-competition-of-Ecopolicy-game-for-the-first-time.aspx
http://blogs.adelaide.edu.au/business/2013/04/02/sdcm-now-also-launched-ecopolicy-in-vietnam/
www.thp.org.vn/artice/1914/ban-tin-thoi-su-toi-ngay-14052013.html
http://haiphong.gov.vn/Portal/Detail.aspx?Organization=UBNDTP&MenuID=8317&ContentID=42640
http://www.thp.org.vn/artice/2167/ban-tin-thoi-su-toi-ngay-07062013.html
http://haiphong.gov.vn/Portal/Detail.aspx?Organization=UBNDTP&MenuID=8317&ContentID=43410
http://haiphong.gov.vn/Portal/Detail.aspx?Organization=UBNDTP&MenuID=8317&ContentID=42564
http://blogs.adelaide.edu.au/business/2013/05/17/starting-with-the-young-initiative-vietnam/

Vietnam Ecopolicyade completed first round

http://blogs.adelaide.edu.au/business/2013/05/17/starting-with-the-young-initiative-vietnam/

Systems Design and Complexity Management: Schools takeover the Town Hall Chambers in Adelaide for the Ecopolicy Final

http://business.adelaide.edu.au/documents/Starting-with-the-Young-Launch.pdf
http://blogs.adelaide.edu.au/business/2012/07/09/ecopolicy-cybernetics-simulation-game/
http://blogs.adelaide.edu.au/business/2013/01/24/systems-design-complexity-management/

Ecopolicyade video (in English)

http://www.video-artwork.ch/vorschau/ecopolicyade_en.htm
http://www.youtube.com/watch?v=mtJCh2xBw1o&list=PL01E1C9C4A1D39757&index=5&feature=plpp_video

Ecopolicyade website (it is currently in German)

http://www.ecopolicyade.info/de/