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Article

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The Central European Review of Economics and Management (CEREM)

Provided in Cooperation with:

WSB University in Wrocław

Suggested Citation: Zepeda Quintana, David Slim; Esquer, Javier; Anaya, Carlos (2019) : Teaching and mindsets regarding sustainable development - a Mexican case study, The Central European Review of Economics and Management (CEREM), ISSN 2544-0365, WSB University in Wrocław, Wrocław, Vol. 3, Iss. 4, pp. 91-102, <http://dx.doi.org/10.29015/cerem.860>

This Version is available at:

<http://hdl.handle.net/10419/229814>

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Teaching and mindsets regarding sustainable development – a Mexican case study

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Abstract:

Aim: The world has become increasingly interconnected and complex, posing serious challenges to sustainable development, which may be easily ignored as they are often of a low probability nature. This creates the need to identify and deal with these challenges. This research aims to identify if teaching interventions, applied to engineering students, produces changes in students' perceptions and mindset about business sustainability and sustainable development and, as consequence, support the creation of necessary cognitive capabilities for dealing with complex problems.

Design / Research methods: Questionnaires were applied in a Mexican university to students of a course in sustainable development. The experiment consists of three phases: (1) a pre-test (n=337), (2) intervention and (3) a post-test (n=329) in order to assess the differences after the interventions.

Conclusions / findings: Changes in the students' perception were observed. While this on the one hand shows that teaching supports the creation of students' cognitive capabilities necessary to contribute to business sustainability, effects may also be contrary to what was intended. The results must be threatened carefully; nevertheless, they provide the basis for further research.

Originality / value of the article: This paper provides a new perspective on the conditions for teaching sustainable development and sustainable business. It presents a case study on the development of students' awareness of and capacities to solve the complex problems of sustainable development

Keywords: Sustainable development, complexity, teaching interventions, education for sustainable development, functional stupidity

JEL: Q01, D81, A20

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Received: 23.10.2019, Revised: 23.11.2019, Revised: 11.12.2019, Revised: 18.12.2019; Accepted: 18.12.2019.

doi: <http://dx.doi.org/10.29015/cerem.860>

1. Introduction

Although sustainable business has become increasingly popular (at least the literature), there is no clear information or evidence available about successful practice (Dyllick, Muff 2016). On the contrary, it seems that problems have worsened due to the interconnectivity and complexity of human systems and activities (Helbing 2009; Taleb 2012). This situation may be the result of a lack of real understanding of the concept (Stubbs, Cocklin 2008; Bocken et al. 2014) or that we do not really have the proper information or capacity to solve these complex problems of business sustainability (Allen et al. 2014). In this context, the creation of human capital with the necessary capacities to generate sustainable strategies in an environment of complexity and uncertainty becomes relevant (Naveen 2006; Voss et al. 2007).

The world has become increasingly interconnected and complex (Taleb 2012). This represents a great challenge for sustainable business and consequently for sustainable development itself. When we talk about sustainable development, we usually talk about a balance between environment, society and economy; systems that face complex challenges individually and that require some knowledge, information and strategies in the task of finding solutions to complex problems (Miller et al. 2014). Therefore, a change is required not only in business management structures but also in the generation of talent and capabilities of professionals who make and will make decisions in business (Vora 2013).

During the last decades the application of knowledge management techniques has become widespread among firms and is currently set as a paradigm for management of business (Gonzalez, Martins 2017). However, this focus on knowledge may result in the neglect or ignorance of other equally important factors influencing the performance of businesses including the unknown (Carrillo 2007). Therefore, the development of instruments that reduces ignorance as well as fragilities of business are required, this with the intention of being prepared to deal with unexpected events that can threaten sustainability.

In this context, universities emerges as an interesting change factor since they have the responsibility to lead society towards a sustainable future through the

generation of professionals, managers and decision makers which play significant roles in national and global economies (Bekessy, Burgman, 2003). However, it seems that the talent and human resources that are being generated lack the capacity to face these complex problems (Lambrechts et al. 2013). To solve these complex problems, a set of skills is required that are not openly discussed or at least not explicitly in common teaching structures.

This research is based on the work of Platje et al. (2019). The authors refer to a “fragilizing mindset” among students that may poses challenges for sustainable development. This fragilizing mindset, according to the authors, is given by the following elements:

- **Functional stupidity:** According to the Alvesson and Spicer (2012), it refers to not voluntarily use intellectual abilities beyond the “here and now”, that is, limiting cognitive and reflexive capacities to issues close to individuals in matters of time and distance (according to Platje et al (2019), in a myopic way). It consists of reflexivity, justification and substantive reasoning (Alvesson, Spicer 2012, based on Boltansky, Thévenot 2006; Alvesson, Skoldberg 2009).
- **Adherence to techno-centric paradigm (mental models):** This refers to the belief that technology can solve all the problems facing the world (Gladin et al. 1995). This can lead to the omission of events that can cause significant and irreversible damage that can lead to collapse scenarios (Platje 2016).
- **Trust:** The lack of trust in general can create difficulties in the search for cooperative solutions that require instant reactions in case of unexpected events. (Raiser et al. 2007).
- **Lack of awareness of vulnerability and fragility issues:** This refers to the need to be aware of fragilities in the systems (e.g. weakest links and bottlenecks) that can generate non-linear consequences. (Carrillo, 2007; Taleb 2007).

Based on this theoretical framework, an interesting question is whether universities, through the current teaching structures, can produce students with an non-fragilizing mindset that can reduce the challenges for sustainable development.

This includes the generation of strategies that allows to reduce ignorance and the fragility of business. This paper presents a case study on the impact of teaching interventions on the perception and mindset of students regarding business sustainability and sustainable development with the intention to relate to the question whether universities are producing professionals with the necessary cognitive capabilities for the solution of complex problems that can lead us to collapse scenarios.

2. Method

In order to obtain relevant information about students' perception on business sustainability and the conditions for teaching development and sustainable business an experiment was carried out. The experiment consisted of the application of a questionnaire consisting of different statements that were evaluated with a 5-point Likert-items scale. The statements included in the questionnaire are directly related to the elements of a fragilizing mindset (Table 1).

Students had to assess the statements presented in Table 1 on a Likert-type scale in the range from (1) strongly disagree to (5) strongly agree, with the option "don't know". The questionnaires were carried out in 15 groups of students taking part in the subject "sustainability in the engineering" of the engineering division of the University of Sonora, México. The experiment consisted of three phases: (1) a pre-test (n=337), (2) intervention and (3) a post-test (n=329) in order to assess the differences after the interventions. This experiment follows a similar procedure than the one presented in Platje et al. (2019).

Procedure

In Summer 2018, the questionnaires were filled out beginning of the semester. This in order to ensure that the opinion of the students was not compromised or subject to bias on the part of the teacher. The "Microsoft Forms" digital platform was used, which could accessed through a personal cell phone or laptop.

Table 1. Items used for teaching experiment questionnaire

Statement	Elements of an anti-fragile mindset
1. The world increases in complexity so fast, that increase in knowledge cannot keep up.	Knowledge and complexity
2. It is no problem when mistakes are not discussed in the company.	Functional stupidity – reflexivity
3. It is no problem when it is impossible to doubt about and criticize management decisions in a company.	Functional stupidity – substantive reasoning
4. It is no problem when changes in the rules in a company are not openly discussed.	Functional stupidity – reflexivity
5. It is no problem when the management of a company does not provide reasons and explanations for their decisions	Functional stupidity – justification
6. It is no problem when a company ignores threats to its existence which are difficult to quantify.	Functional stupidity – substantive reasoning
7. It is no problem when a company ignores low probability threats	Functional stupidity – substantive reasoning
8. It is no problem for a company when it is dependent on one or a few main suppliers.	Indicators of fragility
9. It is no problem for a company when it is dependent on one or a few customers.	Indicators of fragility
10. It is no problem when people in the company do not provide feedback to other people.	Functional stupidity – justification
11. It is no problem when the innovations of a company make the management more complex.	Indicators of fragility
12. In general, people can be trusted.	Trust
13. The ecosystem is resilient – nature is able to deal with environmental problems.	Mental models
14. Technology will solve eventual problems with energy supply in the future.	Mental models
15. Innovations and development of technology will solve problems with environmental pollution and overuse of natural resources.	Mental models
16. Traffic jams can be solved by building more roads.	Mental models
17. Climate change is not caused by human beings.	Mental models
18. We should sacrifice economic growth for preventing climate change.	Mental models
19. Climate change is a very dangerous threat to society.	Mental models
20. The social responsibility of business is to increase its profits.	Mental models
21. It is no problem when innovations of a company increase the reliance on high skilled, difficult to find employees.	Indicators of fragility
22. A company should take unlikely disasters into consideration in crisis management.	Indicators of fragility
23. It is no problem when the innovations of a company make it reliant on one or two suppliers.	Indicators of fragility
24. Stocks and buffers, which seem not to be useful, can be eliminated.	Indicators of fragility

Source: Platje et al. 2019, questions obtained from Joost Platje, WSB University in Wrocław, Poland.

The intervention phase of the experiment was an integral element of the course work, as the elements researched in the questionnaire fit into the course syllabus,

which was dealt with in 12 workshops. During classes, theoretical and practical aspects of sustainable development were dealt with. Focus was on understanding the relationship between human activities and environmental deterioration, social and economic crises. Issues related to the aforementioned fragilizing mindset, non-linearity (e.g. related to consumption habits and environmental deterioration), low-probability events (e.g. business disasters such as Chernobyl and oil spills), lack of general trust (e.g. corruption in the political structures of Mexico) and adherence to technocentric paradigm (e.g. energy efficiency, industry 4.0) were topics discussed during class.

During the workshops, short lectures were given on topics such as complexity of systems, innovation, fragilities and “black swans”. At the end of the course, the repeat questionnaire was carried out, using the same platform as for the first questionnaire. The participants were not informed the repeat questionnaire was the same as the first questionnaire. The duration of the workshops was 45 – 60 minutes the time lapse between applications (phase 1 and phase 2) was approximately 4 months. SPSS was used for analysis. Analysis has been carried out based on statistical hypothesis testing in order to assess differences between the two samples.

3. Results

The answers to the items of the two groups are presented in Table 2. The groups were analyzed using a two-tailed test for hypothesis testing among groups and among pre and post test for each item. All items were tested for significant differences. In the table, means of pre-test and post-test are presented, as well as the differences, the z-statistic and the p-value for each item. A critical z-score value for rejection ($-z_{\alpha/2} = -1.96$ and $z_{\alpha/2} = 1.96$) was used assuming 5% significance level (split 2.5% each on either side) to test the following hypothesis:

- (1) $H_0. \mu_1 = \mu_2$
- (2) $H_1. \mu_1 \neq \mu_2$

Equation (1) establishes that the means of pre-test and post-test have no significant changes while equation (2) establishes that there exists a significant statistical change in the means.

After performing the statistical test for both samples, it was found that the null hypothesis cannot be rejected ($z = 0.609$; $p = 0.2709$), so it can be said that there are no significant statistical changes before and after the intervention; However, after performing the test for each of the questions, it was found that there are significant changes in items 1, 2, 3, 4, 6, 7, 8, 14, 16, 18 (Table 2).

The statement with the greatest variation between pre-test and post-test is statement 1 “The world increases in complexity so fast, that increase in knowledge cannot keep up”. Most participants went from *neither agree nor disagree* to *agree* with this statement. This may be because issues related to the interconnection of systems, complexity and limitations of knowledge were explicitly discussed during the workshops.

Items 2-7 related to functional stupidity, show a decrease between pre-test and post-test. A tendency to agree less with statements such as "It is no problem when mistakes are not discussed in the company" and "It is no problem when a company ignores low probability threats" can be observed. This situation is interesting as it shows the reported willingness of the students to openly discuss situations that normally may be omitted.

Statement 8 “It is no problem for a company when it is dependent on one or a few main suppliers” showed a slight reduction in the level of agreement. It is worth mentioning that this situation may not only be due to the intervention, but also to the economic context of the region where there is a strong dependence mainly on one or two industrial sectors (automotive and aerospace) which, during the realization period of the experiment, have suffered the impacts of the application of different policies and structural reforms by the federal government.

Table 2. Results of two tailed test

Statement	Pre-test mean	Post-test mean	Differences*	z-statistic	p-value
1. The world increases in complexity so fast, that increase in knowledge cannot keep up.	3.018	3.605	0.587	-6.33	0.000***
2. It is no problem when mistakes are not discussed in the company.	1.843	1.529	-0.314	4.15	0.000***
3. It is no problem when it is impossible to doubt about and criticize management decisions in a company.	2.003	1.763	-0.240	3.06	0.000***
4. It is no problem when changes in the rules in a company are not openly discussed.	1.935	1.760	-0.175	2.35	0.009***
5. It is no problem when the management of a company does not provide reasons and explanations for their decisions	1.769	1.766	-0.003	0.04	0.484
6. It is no problem when a company ignores threats to its existence which are difficult to quantify.	1.763	1.608	-0.155	2.36	0.009***
7. It is no problem when a company ignores low probability threats	2.145	1.888	-0.258	3.64	0.000***
8. It is no problem for a company when it is dependent on one or a few main suppliers.	2.457	2.207	-0.250	3.07	0.000***
9. It is no problem for a company when it is dependent on one or a few customers.	2.148	2.006	-0.142	1.84	0.033
10. It is no problem when people in the company do not provide feedback to other people.	1.970	1.991	0.021	-0.29	0.386
11. It is no problem when the innovations of a company make the management more complex.	2.766	2.784	0.019	-0.19	0.425
12. In general, people can be trusted.	2.970	2.845	-0.125	1.40	0.081

Table 2. Cont. ...

Statement	Pre-test mean	Post-test mean	Differences*	z-statistic	p-value
13. The ecosystem is resilient – nature is able to deal with environmental problems.	2.080	2.061	-0.019	0.23	0.409
14. Technology will solve eventual problems with energy supply in the future.	2.958	2.608	-0.351	3.33	0.000***
15. Innovations and development of technology will solve problems with environmental pollution and overuse of natural resources.	2.629	2.459	-0.170	1.75	0.040
16. Traffic jams can be solved by building more roads.	2.774	2.505	-0.270	2.97	0.001***
17. Climate change is not caused by human beings.	1.688	1.693	0.005	-0.06	0.476
18. We should sacrifice economic growth for preventing climate change.	3.279	2.982	-0.297	3.19	0.000***
19. Climate change is a very dangerous threat to society.	4.306	4.301	-0.005	0.06	0.476
20. The social responsibility of business is to increase its profits.	2.641	2.696	0.055	-0.55	0.291
21. It is no problem when innovations of a company increase the reliance on high skilled, difficult to find employees.	2.730	2.626	-0.104	1.05	0.147
22. A company should take unlikely disasters into consideration in crisis management.	3.822	4.009	0.187	-2.27	0.012
23. It is no problem when the innovations of a company make it reliant on one or two suppliers.	2.454	2.337	-0.117	1.39	0.082
24. Stocks and buffers, which seem not to be useful, can be eliminated.	2.890	2.675	-0.215	2.12	0.017
<i>A positive number implies that the level of agreement with the statement increased. A negative number implies that the level of agreement with the statement decreased. Note. *** p < .001</i>					

Items 14, 16 and 18 are related to adherence to the technocentric paradigm. During the class, issues involving the confidence of markets, companies and society in general in which technology will help us find solutions to complex problems related to sustainability and directly related to the development and survival of the

species were discussed. However, statement 18 “We should sacrifice economic growth for preventing climate change” underwent an interesting modification. Students reduced their level of agreement with this item when reverse behavior could be expected. This may be due to the fact that during the classes, the balance that is intended to be found between the economic, environmental and social perspective in all strategies and policies for sustainable development is emphasized.

Finally, statements 22 and 24 related to the indicators of fragility show an interesting behavior. The statement "A company should take unlikely disasters into consideration in crisis management" (22) showed an increase in the level of agreement after the intervention while the statement "Stocks and buffers, which seem not to be useful, can be eliminated" (24) presented a reduction in the level of agreement. This may be because during classes and workshops the importance of the systems approach in solving complex problems as well as in low probability events and non-linear effects were emphasized.

4. Discussion and conclusion

First of all, these results should be carefully analyzed since they do not represent the perception of all students. The study was carried out in the engineering faculty of the university which has a specific academic and cultural direction. However, it is interesting to observe the modifications found in the perception of the students.

The results obtained show changes in the students' perception in some of the statements related to functional stupidity, lack of general trust, indicators of fragility and mental models. This means that the conditions for teaching sustainable development and sustainable business in this case of study can potentially contribute to creating in students the cognitive capabilities necessary to generate a non-fragilizing mindset and, consequently, contribute to business sustainability and sustainable development.

The research shown here only represents the case of one university with a very specific academic and cultural context; It is necessary to repeat this experiment in

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different faculties and universities in order to identify if students of different disciplines suffer the same modifications in their perceptions.

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