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Assessing Systems Thinking Skills in Two Undergraduate Sustainability Courses: A Comparison of Teaching Strategies

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Abstract

The purpose of this study was to determine systems thinking skill development among undergraduate students and assess the effectiveness of two different instructional methods for increasing these skills. Undergraduate students from two four-year state institutions, one located in the Midwestern region (n=20) of the United States and one in the Southwestern region (n=16) participated in the study. To accomplish the research object, the study employed a mixed between-within subjects experiment. Employing two different systems thinking teaching interventions, one group of students was exposed to a one-time intervention while the other group was exposed to a more extended and holistic intervention. Data were collected at two points in time: pre- and post-intervention. At the beginning (pre-intervention) and end (post-intervention) of one semester, students read case studies describing apparel firms' sustainability efforts. The students were then tasked to identify sustainability challenges, analyze conflicts between challenges, and offer business recommendations. Using a rubric, the authors scored the students' responses on a scale of 0 to 5 and assessed ability to 1) think holistically and 2) perceive interrelationships and resolve resulting conflicts. T-tests revealed that prior to the teaching interventions, as a whole, the students had unsophisticated skills related to their ability to think in systems. ANOVA revealed that, through instructional methods focused on systems thinking, it is possible to increase students' ability to think in systems. Additionally, the study revealed that, compared to a constrained one-time intervention, a long-term, holistic, and integrated approach is significantly more effective in encouraging students' system thinking competencies. Results of this study support the need for educators to integrate teaching methods designed to increase students' systems thinking competencies holistically throughout course curriculum. Additionally, the study outlines a transferrable approach to assessing systems thinking skills within postsecondary education.

Keywords: systems thinking, assessment, undergraduate, sustainability education

The UN has challenged higher education to reorient education and integrate sustainability across all disciplines (Rode & Michelsen, 2008; UNESCO, 2003). This reorientation has pedagogical implications for advancing skills and attitudes supporting sustainable development (Sterling, 2004). Systems thinking—a problem-solving skill that works to understand the whole by examining multiple perspectives and interrelationships—is considered a fundamental learning outcome for education for sustainable development (Forum for the Future, 2004). The purpose of this study is to explore systems thinking competency among undergraduate students and assess the effectiveness of teaching strategies designed to increase these skills.

Systems Thinking in the Literature

Systems' thinking, borne from systems theory, has its roots in the hard sciences, such as biology, where integration during problem solving is a fundamental concept. Systems thinking evolved to counter mechanistic or reductionist thinking, the notion that it is possible to explain the whole through an analysis of its parts in isolation. Instead, from a systems perspective, the goal is to understand the whole and its many levels of interrelationship that characterize the parts of the system. In fact, what we may perceive as parts are not parts at all, but patterns inherently linked to other patterns or networks, none of which are understandable without contextualization.

Checkland (1981) makes clear that systems thinking is equally applicable to systems or problems more social or cultural in nature, termed soft problems, just as it has been vital to issues in the hard sciences, termed hard problems. However, Checkland does distinguish that the approach to systems thinking in each differs in its purpose. In applying systems thinking to hard problems, components are relatively stable and less dynamic and a finite conclusion may be reached. In the case of soft problems, which are more highly dependent on subjective judgment and perception to sort, systems thinking may be used to simply raise understanding about a system. In this light, systems thinking is an epistemological tool, rather than ontological in nature. Such is indeed the case with sustainability challenges.

Systems Thinking and Sustainability

Most recently, systems thinking was identified as a core competency in sustainability research and problem solving (Wiek, Withycombe, Redman, & Mills, 2011), and has long been considered a key component to the achievement of sustainability literacy (ACPA, 2008; Forum for the Future, 2004; Hulbert, Schaefer, Wacey, & Wheeler, 1997; McKeown, 2006; Svanström, Lozano-Garcia, & Rowe, 2008). Specifically, Dale and Newman (2005) argue that understanding the interrelationship between the human social system and the ecological system is particularly salient in solving problems related to sustainability. Challenges that manifest within these systems are inherently complex, interdisciplinary in nature, and often defy linear, cause-and-effect correlations, making problem solving complicated (Holling, 2001). Clearly, an integrative approach in sustainability education is commanded to prepare graduates, as this skill is currently at a premium in professional practice (Martin, 2008).

LeGrange (2011) describes this needed approach as a shift from arborescent to rhizomatic thinking. Arborescent thinking follows a hierarchy stemming from one system rooted in foundational principles, such as in an academic discipline. Rhizomatic thinking embraces chaos, complexity, and entanglement. As such, rhizomatic thinking is more conducive to addressing sustainability problems, which are rife with unintended consequences ensuing from cascading effects through interconnected and web-like causal chains. LeGrange (2011) describes sustainability as inextricably linked to all other things, about which there are multiple perspectives stemming from a variety of knowledge types. Thus, multiple bodies of knowledge are requisite to problem solving in this vein. In addition, the different value and belief systems of diverse stakeholder groups involved in “wicked” sustainability problems make defining problems and identifying solutions challenging (Skaburskis 2008). Further, the interconnections and perspectives embodied in sustainability are also ever changing and are malleable to many, many alternatives and adaptations. Solutions derived through rhizomatic thinking are endless and permitted to come in many shapes and sizes. On the other hand, solutions to sustainability challenges resulting from arborescent thinking are beholden to foundational principles and neat explanations, lacking in imagination and creativity, and are inherently limited. Responsively, authors among the sustainability education literature have articulated similar elements to guide a conceptual understanding of systems thinking in a sustainability context, which augments Checkland’s (1981) contention that hard and soft problems require different approaches.

Holistic Thinking

A primary element commonly associated with sustainability literacy is the ability to think holistically, putting the learner’s view on a systemic level. A conduit for holistic thinking is the capacity to integrate multiple perspectives into that view (Dale & Newman, 2005; Ellis & Weekes, 2008; Forum for the Future, 2004; Porter and Córdoba, 2008; Svanström et al., 2008; UNESCO, 2003; Warburton, 2003). Cloud (2006) describes multiple perspectives that contribute to a holistic view of a problem as entry points ignited by a series of questions which vary in origin, such as social, environmental, economic, political, and physiological. These highly interrelated and interdependent entry points or perspectives *all* contribute to problem solving, none being mutually exclusive.

Admittedly, a primary challenge from a pedagogical standpoint is how to help the learner organize a seemingly indigestible comprehensive picture. A popular principle emphasized in the sustainability literature is the consideration of a sustainability challenge from social, environmental, and economic perspectives, what Forum for the Future (2004) terms the “at the same time rule” (p. 18). Literature has also referred to this as the sustainability triad (Herremans and Reid, 2002) or, in the business literature, the triple bottom line (Elkington, 2004). This is a useful conceptual tool for understanding interrelationships as each corner of the sustainability triad cannot be viewed in isolation, but only in its relationship to the other two corners (Forum for the Future, 2004; Keough, 1998; Svanström, 2008; Herremans & Reid, 2002; Sipos, Battisi, & Grimm, 2008).

Undoubtedly, underpinning this triad of perspectives are values and beliefs, primary sources of conflict in reaching solutions to sustainability challenges. As such, learners must be able to discern and critically reflect on the values which punctuate these perspectives (Forum for the Future, 2004; Herremans and Reid, 2002; Schlottman, 2008; Warburton, 2003), a key component being to contextualizing problems (Martin, 2008). Porter and Córdoba (2008) contend that the learner’s awareness and appreciation of ethical, emotional, and spiritual undercurrents must be stretched, what Cloud (2005) describes as mental modes dominated by our assumptions, values, and experience; all of which must receive scrutiny in the sustainability context.

Conflict Resolution and Trade-offs

As conflicts among social, environmental, and economic perspectives, agendas, or priorities found in any system can be anticipated, a final element associated with systems thinking for sustainability is the ability to identify and resolve those conflicts or develop trade-offs using sustainability to compass such decisions. (Colucci-Gray, Camino, Barbiero, & Gray et al., 2006; Keough, 1998; Herremans & Reid, 2002; Schlottman, 2008; Svanström, 2008;).

Schlottman (2008) argues that complete resolution of conflicts among various perspectives is often unlikely, but learners should be encouraged to design innovative trade-offs among them. He posits, "How do we choose between sustainability and appreciation, political majorities and deeply held values, fairness of resource distribution and irreversible loss of species?" (p. 211). Arguably, these are just a few of the complicated challenges future generations must be equipped to navigate.

Systems Thinking and Pedagogy

Unlike other types of cognitive activity, systems thinking is not intuitive or innate. When thinking about a problem, we do not *naturally* think about all things connected to it and their interrelationships. Thus, it is necessary to train this skill very explicitly (Hung, 2008). A variety of pedagogical strategies used in the context of higher education related to sustainability content have been proposed, including future-focused visioning projects (Goekler, 2003; Martin, 2008), back casting (Martin, 2008), word games (Goekler, 2003), concept mapping (Warburton, 2003), models and queries (Wang & Wang, 2011) as well as modeling via software applications (Hung, 2008). Porter and Córdoba (2008) introduce multiple approaches which may be taken to achieve different levels of systems thinking: a functionalist perspective in which learners must identify and quantify what is knowable in the system (like inputs and outputs), an interpretive approach in which students are encouraged to better understand the more subjective perspectives in a system (like ethics), and a complex adaptive approach where learners gradually widen their worldview to understand the more complex, non-linear phenomena in a system (like entrenched social systems). Warburton (2003) suggests even broader strategies which may guide the integration of systems thinking at the curriculum level: 1) using a wide range of conceptual and material content, 2) explicitly demonstrating the interconnections and interdependence of that material, and 3) emphasizing the dynamics rather than static nature of material.

However, few studies have focused on the application and assessment of these approaches in higher education. The interrelationship of systems thinking and interdisciplinary problem solving (Svanström et al., 2008; Warburton, 2003) is arguably challenging in institutions of higher education where disciplines are housed in neatly defined silos, and the subjects within those disciplines are often similarly organized (Warburton, 2003). This begs the need to identify effective approaches which various disciplines may use that do not require a reconfiguration of the system in which they are housed to accommodate them.

Therefore, the purpose of this project is to determine systems thinking skill development among undergraduate students and assess the effectiveness of instructional methods for increasing these skills. With this purpose in mind, the study looked to answer three research questions:

1) Prior to interventions designed to increase students' system thinking skills, what is the participants' level of competency in terms of holistic thinking and conflict resolution skills?
2) Is there a significant change in participants' level of systems thinking competency following interventions designed to increase students' systems thinking skills?
3) Which intervention is more effective in improving participants' systems thinking competency?

Method

To answer the research questions, this study employed a mixed between-within subjects ANOVA experiment. Data were collected at two points in time: pre- and post-intervention.

Participants

The sample for the study was composed of undergraduate students from two four-year state institutions, one located in the Midwestern region of the United States and one in the Southwestern region. Specifically, the study utilized students completing one of two courses focused on issues of sustainability.

The students from the Midwestern University (Group One) were apparel and textile majors specializing in either apparel design and production or apparel marketing and were enrolled in a sustainable product development course. In this course, typically taken during the senior year of studies, the students developed a line of apparel from concept through pre-production stage. Throughout the semester the students learned about different sustainable design paradigms (e.g. Industrial Ecology, Biomimicry, Cradle to Cradle) and applied those principles to their product line. The course was the first time most of these students had exposure to concepts related to sustainable design paradigms and systems thinking.

The students from the Southwestern University (Group Two) were general business majors, concentrating in sustainability, and were enrolled in an introduction to sustainability course. The intention of the course was two-fold: (1) to increase students' knowledge of disciplinary concepts from the natural sciences (e.g. first law of thermodynamics) and social sciences (e.g. tragedy of the commons) that are relevant to sustainability and (2) to expose students to systems thinking concepts (e.g. feedback) and problem solving methodologies (e.g. visioning) important to both identifying and solving "wicked" (Skaburskis, 2008) sustainability problems. It was the first sustainability course taken by most of the students in this group and was also their first exposure to concepts related to systems thinking in the context of sustainability.

Materials and Procedure

Assessing internal cognitive processes is inherently problematic, but in the assessment of systems thinking in higher education, an examination of writing samples or case study analysis seems to be the most viable approach (Wang & Wang, 2011; Zulauf, 2007), utilizing a structured rubric to analyze (Hung, 2008; Wang & Wang, 2011; Zulauf, 2007). Therefore, to assess the students' systems thinking competency, two case studies (for pre- and post-intervention) were developed. The case studies, written by one of the authors, embodied some typical sustainability challenges and were based on actual apparel industry firms[1]. Nau, a sustainable outdoor apparel company, served as the basis for the pre-intervention case study. This was a company that entered and exited the market in a relatively short period of time, primarily due to the progressiveness of its business plan related to sustainability initiatives which were, at the time, unappreciated by consumers. The post-intervention case study was based on Talbot's, a women's sportswear company, which recently underwent a transformation in an effort to become more financially stable. Although the participants knew real firms informed the content of the case studies, to limit potential respondent bias, both the pre- and post-intervention case studies replaced the companies' names with pseudonyms.

At the beginning (pre-intervention) and end (post-intervention) of one semester, students read the respective case study. For each case study, the instructions to the students were to:

1. Identify all possible social, environmental, and economic challenges presented in the case study.
2. Prioritize the challenges in terms of the ones they believe most important to achieving sustainability.

[1] Copies of the case studies are available from the authors upon request.

3. Identify the conflicts between the social, environmental, and economic priorities.
4. Identify and critique the values that underline the company's strategies.
5. Identify where the company might have to compromise on values and make a trade-off in order to stay in business.
6. Make recommendations for the company about how the conflicts between the social, environmental, and economic priorities could be resolved while still supporting sustainability.

The students in both Group One and Group Two read the same case studies and responded to the same questions.

The interventions. A goal of this study was to explore the effectiveness of different methods for teaching systems thinking skills. To accomplish this objective, this study employed two different teaching interventions. The students in Group One were exposed to a one-time intervention (Intervention 1) and the students in Group Two were exposed to a more extended and holistic intervention (Intervention 2).

Intervention 1 involved one formal lecture introducing the students to systems thinking and the use of the sustainability triad as a guide in decision making. The lesson also included several small-group learning activities designed to guide the students' exploration of the concepts (McKeown, 2006). The expectation was that the students would then apply the systems thinking framework while completing the remainder of their apparel product development project.

On the other hand, Intervention 2 involved weekly lectures, teaching students the principles related to the earth's fundamental natural and social processes and complex adaptive systems theory. Parallel to the lectures, Group Two students also attended weekly breakout sessions during which they, through small group discussion, deepened their understanding of knowledge acquired during lecture and began to develop the systems thinking skills required for solving "wicked" problems using sustainability science problem solving methodologies (Wiek and Lang, in review).

Analysis of Case Study Responses

To guide the analysis of the participants' responses to the case studies' questions and the assessment of systems thinking competencies, the researchers developed a rubric. Utilizing the previously discussed constructs of systems thinking, they identified two primary thrusts: holistic thinking (HT) and conflict resolution (CR). Furthermore, four elements of HT were defined: 1) the ability to identify social, environmental, and economic perspectives/issues embedded in the case study scenario, 2) the ability to prioritize those perspectives/issues with sustainability in mind, 3) the ability to identify and critically reflect on the values which underpin the scenario, and 4) the ability to communicate ideas descriptively and with reflection. Likewise, three elements for CR were defined: 1) the ability to identify conflicts between the interrelating sustainability priorities (social, environmental, and economic), 2) the ability to identify possible trade-offs among these perspectives, and 3) the ability to formulate realistic strategies for resolving the conflict with sustainability in mind. On a scale of zero to five (0=No skill; 5=Exceptional skill), levels of quality in responses for each element of HT and CR were then designed. The completed rubric used in this study is included as Appendix A.

Due to the subjective component of evaluating the students' responses, two researchers (Researcher A and B) independently analyzed the students' responses to the pre- and post-intervention case studies. Using the rubric, they scored the students' responses to the case study questions and assigned scores corresponding to the four elements measuring HT and the three elements measuring CR. Then, for each participant, Researcher A's scores for the four items measuring holistic thinking were summed and averaged into a single score. Similarly, Researcher A's scores for the three items measuring conflict resolution were also summed and averaged into a single score, as were the scores assigned by Researcher B. Data analysis continued by averaging Researcher A and B's scores, for each participant, for both HT and CR—leaving one averaged score, for each participant, representing the individual's total systems thinking score. The researchers repeated this process of data analysis for the participants' post-intervention case study responses.

Results

Overview of Sample

A total of 36 students participated in the study, 20 from the Midwestern university and 16 from the Southwestern institution. Participating in the study were 12 males and 24 females and the sample included one freshman, six sophomores, six juniors, and 23 seniors. The participants ranged in age from 19 to 26 years, with the mean age being 21.64 years. Table 1 provides a complete demographic summary of the participants.

Table 1
Demographic Overview of Sample

	Midwestern university	Southwestern university	Total (N=36)	Frequency (%)
Sex				
Males	1	11	12	.30
Females	19	5	24	.60
Age				
19	0	1	1	.03
20	0	7	7	.19
21	2	6	8	.22
22	14	0	14	.39
23	1	2	3	.08
24	0	1	1	.03
25	1	0	1	.03
26	1	0	1	.03
Year in School				
Freshman	0	1	1	.03
Sophomore	0	6	6	.17
Junior	0	6	6	.17
Senior	20	3	23	.64

Comparison of HT and CR Skills Pre-intervention

Descriptive statistics of the pre-intervention systems thinking competencies of the participants (as reported in Table 2) reveal low mean scores for holistic thinking skills (μ=2.67), conflict resolution skills (μ=2.23), and overall systems thinking skills μ=2.45). A t-test was conducted to compare the participants' pre-intervention holistic thinking skills with their pre-intervention conflict resolution skills. There was a significant difference in these scores [$t(35)=3.611$, $p=.001$, effect size $\eta^2=.271$], with the participants having a greater ability for holistic thinking compared to conflict resolution.

Table 2
Descriptive Statistics of Pre-intervention Systems Thinking Competencies

	Mean	*SD*	Range
Pre-intervention holistic thinking skills	2.67	.94	.50 - 4.5
Pre-intervention conflict resolution skills	2.23	.85	.33 – 4.17
Pre-intervention systems thinking skills[1]	2.45	.82	.42 – 4.33

[1] Average of pre-intervention holistic thinking skills and pre-intervention conflict resolution skills

Comparison of Overall Systems Thinking Skills Pre- and Post-intervention

A mixed between-within subjects ANOVA was conducted to compare participants system thinking competency at Time 1 (pre-intervention) and at Time 2 (post-intervention), with Group 1 versus Group 2 being entered as the independent between-subject variable, Time 1 and Time 2 being entered as the within-subjects variable, and averaged systems thinking score at each time period being entered as the dependent variable. Table 3 presents the descriptive statistics for these scores.

Table 3
Descriptive Statistics for Systems Thinking Test Scores for Time 1 and Time 2

	Mean	Std. dev.
Pre-intervention		
Group 1	2.14	.80
Group 2	2.84	.69
Post-intervention		
Group 1	1.82	.88
Group 2	3.25	.60

Wilks' lambda was used as a test statistic to interpret the analysis of variance results for the within-subjects effect of time. Overall, there was a significant effect for time [Wilks' Lambda=.773, $F(1,34)=9.983$, $p=.003$; effect size $\eta^2=.227$]. A between-groups analysis of variance was used to explore the effect of the type of intervention on systems thinking competencies. Once again, there was a significant main effect between Group 1 and Group 2 [$F(1,34)=21.87$, $p=.000$, effect size $\eta^2=.391$], with Group 2 increasing their systems thinking skills to a greater degree than Group 1.

Implications for Systems Thinking Curricula

This study examined systems thinking skill development among undergraduate students and assessed the effectiveness of two different instructional methods for increasing these skills. The study utilized a pre/post experiment design to carry out the research.

Increasing Holistic Thinking and Conflict Resolution Skills

The results of the study indicated that prior to the teaching interventions, as a whole, the students had unsophisticated skills related to their ability to think in systems. This finding is understandable given the students' educational backgrounds and limited previous exposure to systems thinking. However, perhaps a more illuminating discovery of the study was that the students were more competent in their ability to think holistically about sustainability issues compared to their ability to identify and resolve conflicts within systems. Therefore, sustainability and systems thinking curriculum should ensure that not only are students capable of identifying the interrelationships between human and ecological systems but that they are equally competent to develop tradeoffs between conflicts among social, environmental, and economic perspectives, using sustainability as a guide.

Need for Holistic Integration of Systems Thinking

Results also indicated that, through instructional methods focused on systems thinking, it is possible to increase students' ability to think in systems. Furthermore, compared to a constrained one-time intervention, a long-term and holistic approach is significantly more effective in encouraging students' system thinking competencies. The implication of this finding is that teaching systems thinking to postsecondary students should not occur as an "add on" within a course. Instead, to maximize students' abilities to think in systems, educators need to explore ways to integrate systems thinking skills throughout a course, or better yet, an entire curriculum.

Limitations and Recommendations for Future Studies

A possible limitation to the study relates to the structure of the case study questions presented to the students. For example, a question in the case study question-set stated, "Identify all possible social, environmental, and economic challenges represented in this scenario. Prioritize these challenges in terms of the ones you think might be most relevant to achieving sustainability." In analyzing the students' responses to this question, it soon became evident that while some of students sufficiently identified the case study's social, environmental, and economic challenges, the same students completely ignored the request to prioritize the challenges—resulting in the researchers assigning low scores for that particular question. Therefore, future research should consider revising the case studies questions to eliminate the lumping together of several questions or tasks. Additionally, the researchers suggest adding a qualitative analysis of data in future studies as a way of furthering understanding of system thinking skill development within students.

An additional impact on the results for consideration is that the fact that Group 2 experienced a more science-related curriculum, while the focus in the curriculum for Group 1 was on creative activities. Even though it seems logical that a holistic, integrative approach to teaching systems thinking would be more effective in increasing student competencies, as systems are inherent in science, and less so in creative contexts, the students in Group 2 may have simply been better poised to develop systems thinking. Additionally, considering that the two groups were in programs in two different universities, demographic differences may have also contributed to differences in systems thinking skills. Therefore, a suggestion for future research is to compare differing systems thinking teaching strategies among two sections of the same course, at the same university.

Finally, it is important to consider effective ways of fostering systems thinking skills among students in more creative environments. For example, teaching strategies suggested in the literature such as future-focused visioning (Goekler, 2003; Martin, 2008) and concept mapping (Warburton, 2003) might be more appropriate techniques for nurturing these skills and helping students with less of a science background learn to make the connections so essential within systems thinking.

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Appendix A: Systems Thinking Skills Assessment Rubric

	Exceptional (5)	Above average (4)	Average (3 2)	Below average (1)	No skill (0)
Holistic Thinking Skills					
HT1 CS Q1	Student identifies all of the social, environmental, & economic challenges represented in the scenario	Student identifies most of the social, environmental, & economic challenges represented in the scenario.	Student identifies some of the social, environmental, & economic challenges represented in the scenario.	Student struggles to understand the tenets of sustainability, and therefore, is able to identify challenges but not necessarily pertaining to sustainability	Student *cannot* identify social, environmental, or economic challenges in scenario
HT2 CS Q1	Student is able to prioritize issues represented in the scenario with sensitivity to sustainability principles	Student prioritizes challenges, but is not necessarily completely focused on sustainability principles	Student prioritizes challenges, but is not considering sustainability	Student struggles to prioritize challenges	Student *cannot* prioritize challenges
HT3 CS Q2	Student can identify & reflect critically on all of the values that underpin the scenario	Student can identify most of the values that underpin the scenario, and *reflect on them critically*	Student can identify some of the values that underpin the scenario, but struggles to *reflect on them critically*	Student struggles to identify the values that underpin the scenario; therefore, *critical reflection is implausible*	Student *cannot* identify the values or reflect critically on the values that underpin the scenario
HT4 CS Q1-4	Conceptions communicated are detailed & reflect depth in thought	Conceptions reflect depth of thought, but thought process is incomplete without more detail	Conceptions are simplistic, lacking both depth of thought and detail	Student struggles to think deeply about concepts; therefore, detail is lacking	Conceptions do not exhibit detail or depth in thought

	Exceptional (5)	Above average (4)	Average (3 2)	Below average (1)	No skill (0)
Conflict Resolution Skills					
CR1 CS Q3	Student identifies many conflicts between the interrelating sustainability priorities (social, environmental, & economic)	Student identifies most of the conflicts between the interrelating sustainability priorities	Student identifies some of the conflicts between the interrelating sustainability priorities	Student struggles to identify conflicts between the interrelating sustainability priorities	Student *cannot* identify conflicts between the interrelating sustainability priorities
CR2 CS Q2	Student can identify several possible trade-offs in values that may be necessary for the viability of the business	Student can identify at least *two* possible trade-offs in values that may be necessary for the viability of the business	Student can only identify *one* possible trade-off in values that may be necessary for the viability of the business	Student struggles to identify where trade-offs in values may be necessary for the viability of the business and can give only a partial or simplistic example	Student *cannot* identify where trade-offs in values may be necessary for the viability of the business
CR3 CS Q4	Student makes multiple realistic strategies for resolving the conflicts between sustainability priorities. Recommendations reflect consideration & incorporation of the economic needs of the business, the health of the ecosystem, and the safety, health, and human rights of people that may be affected	Student's recommendations are realistic but reflect a lopsided focus on one of the three sustainability tenets. Nevertheless, *recommendations evidence an effort to support* more than one tenet of sustainability	Recommendations reflect a lopsided focus on one the three sustainability tenets. *Recommendations are singular and lack an effort to support* more than one tenet of sustainability	Student *struggles to* make recommendations reflective of the tenets of sustainability	Student *cannot* make recommendations reflective of the sustainability tenets

HT = Holistic Thinking; CR = Conflict Resolution; CS Q = Case Study Question