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Abstract Higher education is being confronted with a paradigm shift. Current literature supports the contention that higher education needs to improve their connection with the needs of employers to meet future workforce demands. Higher education is specifically challenged in improving the competency of students in twenty-first century skills that include innovation, creativity, problem solving, critical thinking, communication, collaboration, and self management, among others. To assess the extent to which students are developing twenty-first century competencies, the Environmental Studies program at the University of Nebraska–Lincoln has partnered with Target Training International, Ltd (TTI). to gain insights into the development of professional competencies among its majors. Data collected using TTI's TriMetrix® DNA instrument indicates a statistically significant (p <0.05) improvement in the student's ability to: utilize effective processes to make decisions (decision making); effectively manage resources, systems, and processes (management); demonstrate initiative, self confidence, resiliency and a willingness to take responsibility for personal actions (personal effectiveness); adapt to change (flexibility); and anticipate, analyze, diagnose, and resolve problems (analytical problem solving). This exploratory study supports the conclusion that raising expectations about the development of professional competencies among students and employing pedagogical approaches and educational practices that promote student independence, self-directed learning, self-reliance, and interactions with the community, even on a relatively small scale, can have a significant impact on the development of twenty-first century competencies.

Keywords Assessment · Professional competencies · Soft skills · Twenty-first century skills · TriMetrix · Target training

Introduction

One of the biggest challenges that higher education faces is preparing today's students to meet future workforce demands (Zemsky 2009; Bellanca and Brandt 2010; Arum and Roksa 2011; National Research Council 2012). Business and political leaders are increasingly asking schools, including institutions of higher education, to develop skills such as innovation, creativity, problem solving, critical thinking, communication, collaboration, and self management, among others, which are often referred to as "twenty-first century skills" or twenty-first century competencies (Partnership for 21st Century Skills 2011). Although these competencies are considered to be at the foundation of individual as well as collective success in the work place, employers report substantial deficiencies in these applied skills. As a result, business leaders and educational organizations are calling for new education policies that target the development of broad, transferable skills and knowledge.

In a recent report from the National Academy of Sciences (National Research Council 2012), the Committee on Defining Deeper Learning and Twenty-first Century Skills conducted an assessment of the literature related to the development of these skills. The committee indicated that twenty-first century skills are important dimensions of human competence. Furthermore, they developed an initial classification scheme for the twenty-first century skills consisting of three broad, but overlapping, clusters of competencies that included cognitive, intrapersonal,

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and interpersonal domains. The cognitive domain involves reasoning and memory; the intrapersonal domain involves the capacity to manage one's behavior and emotions to achieve one's goals; and the interpersonal domain involves expressing ideas and interpreting and responding to messages from others (National Research Council 2012). Furthermore, the NRC report supports the fact that young people who both apply and develop intertwined cognitive intrapersonal and interpersonal competencies in the process of deeper learning are better prepared for adult success.

Several recent studies, among others, of the characteristics required in the environmental and sustainability employment sector reinforce the conclusions of the NRC report and the importance of twenty-first century competencies to these growing academic fields. Vincent and Focht (2010) concluded from an examination of studies published prior to 2009 that employers of environmental program graduates most value the skills associated with interdisciplinary teamwork, critical thinking, problem solving, communication, planning, and management. They go on further to say that these skills "may actually be more important than substantive knowledge, though knowledge of environmentally relevant natural sciences and sociopolitical disciplines are undoubtedly important." This conclusion is supported by Crawford et al. (2011) in their study of what is important to new graduates entering the workforce. This study indicated that twenty-first century competencies, for which they use the term "soft skills," are ranked as being more important than discipline knowledge among alumni and employers. Weik et al. (2011) identified five key competency clusters that enable students to successfully engage in sustainability research and problem solving. The five clusters are systems-thinking, anticipatory, normative, strategic, and interpersonal competencies. Interpersonal competencies included the dynamics of collaboration (within and beyond academia); negotiation, mediation, deliberation, constructive conflict management, team development, and teamwork methods; and limits of cooperation and empathy. The foundation of these five competencies are what Weik et al. (2011) refer to as basic competencies that include critical thinking, communication, pluralistic thinking, research, and data management that ought to be conveyed in every quality academic program—and thus serve as the foundation of sustainability education. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career competencies that translate over the changing and cyclical emergence, growth, and decline of environmental careers (Vincent and Focht 2010).

The term "competency," as used in the NRC study and throughout the remainder of this paper, is consistent with its use in the professional human resources literature as a way of talking about what helps people get results in their jobs and refer to skills or knowledge that lead to superior performance. Competencies are measureable characteristics that are used to differentiate levels of performance in a given job, role, or organization. During their career in higher education, students generally focus on the development of competencies related to technical (tools, methodologies, processes) and knowledge skills (concepts, facts, theories). The assessment of the technical and knowledge components is typically measured by standard aptitude tests, the most common of which are standard examination formats. Although the importance of these twenty-first century competencies is recognized, the assessment of the extent to which students have acquired these competencies through their undergraduate programs on their way to being successful environmental and sustainability professionals has been virtually unstudied.

The purpose of this paper is to gain insight into the potential application of a business-based instrument, TriMetrix® DNA to (1) assess the twenty-first century competencies for undergraduate environmental studies majors at the University of Nebraska-Lincoln (UNL), United States and (2) evaluate the extent to which students are developing twenty-first century competencies among program majors.

Methodology

Context The UNL Environmental Studies (UNL-ES) program was established in the early 1990s. Majors in the program took five-credit hours of ENVR course work that consisted of a one-credit hour Sophomore Orientation, a one-credit hour Senior Seminar, and three-credit hour, two-semester Senior Thesis. In the summer of 2008, the lead authors, Gosselin and Cooper, took over the management and facilitation of the program and the five-credit hour course sequence. A new educational philosophy was implemented in the Fall semester of 2008. It was intended to:

- Explicitly emphasize the importance and integration of opportunities to develop twenty-first century competencies;
- Create an educational environment based on how people learn and the United Nation's vision for environmental education;
- Develop students who have the skills necessary to work across disciplines and think about issues and demands of global society in the context of systems;
- Facilitate the concomitant intellectual growth and development of each student; and
- Integrate pedagogical approaches and educational practices that promote student independence, self-directed learning, and self-reliance.

As part of the plan to initiate and implement the educational philosophy, we made an explicit effort to provide

students with voice in terms of the content of the existing three-course, five-credit hour courses. We enhanced the use of student-centered teaching pedagogies that provided students the opportunity to think about and integrate course content. These pedagogies included, but were not limited to: group cooperative learning strategies, and group discussions; free writing and focused questions; maintaining a learning log; open-ended questioning; and online writings.

In the Sophomore Orientation class, we continued the basic introduction to the major and its emphasis areas, but we made three basic changes. First, we explicitly began an exploration of the student's personal attributes as outlined in the TriMetrix® DNA and began to discuss what they needed to be successful in the workforce. We added an introduction to environmental careers. Lastly, we had each student examine the extent to which they individually impact the environment using the analysis of their ecological footprint. In the senior seminar class, we moved from weekly guest lectures on various topics to engaging the students in work with a client from the community. The four learning objectives of the senior seminar were that students would (1) understand the processes environmental agencies and organizations use to develop and implement projects and programs while recognizing that each has their own philosophy and approach that is unique to them; (2) prepare a work plan that reflects both specific requirements (in this case, the course requirements) and the needs of the client; (3) conduct research and implement a project from start to finish; and (4) prepare an information/education piece that serves the needs of a particular audience and client. In the two-part senior thesis course, we changed the focus of the course substantially to address the need for the students to develop their understanding of the inquiry-based research process, the development of a researchable question, and the advancement of their abilities to use relevant methodologies to collect relevant data. The products of the overall thesis process are now known as the five p's, thesis proposal, thesis proposal presentation, thesis poster, final thesis paper, and professionalism.

Data sets This exploratory paper on the assessment of twenty-first century competencies for undergraduate environmental studies majors will present four sets of data. Data set 1 includes information for senior-level students in the senior thesis class during the Fall 2008 and Spring 2009 semesters. These students experienced minimal exposure to the new educational philosophy implemented in Fall 2008. Data set 2 includes a comparison of the seniors in data set 1 with students entering the program in the Spring or Fall semester of 2009 (pre-program). Data set 3 compares students who entered the program through the Sophomore Orientation course (pre-program in data set 1) and completed their senior theses under the new educational philosophy (post-program). Data set 4 includes information about true freshmen entering the UNL-ES program and compares this to data from freshmen from other disciplines.

Instruments The UNL-ES program has partnered with Target Training International LTD (TTI), since 2008. The UNL-ES program used TTI's TriMetrix® DNA instrument to assess the personal attributes of the students using self-reported data (http://www.ttiresearch.com/). The online instrument takes approximately 30 to 45 min. Students accessed the online survey on their own time.

The three-part tool (Fig. 1) assesses the behaviors that people bring to a position; in this case, being a student, the values that motivate them to do a job, and the extent to which people have obtained personal competencies. These assessments can help us understand what makes each student function. The first assessment measures normal behavior or "how" a person carries out decisions and how they want to receive communications that influence them. The second assessment looks at their passion or the "why" behind their actions. The third assessment, which is the focus of this paper, is the Personal Soft Skills Indicator (PSSI). For this study, it measured 23 skills, provided in Table 1, which are using the three domains defined by the National Academy of Sciences (National Research Council 2012). The assessment results define what skills an individual has exhibited in their lives. Through the self-evaluation assessment of an individual's own soft skills, this quantitative measurement tool analyzes each capacity on four levels: well-developed, developed, moderately developed, and needs development. The developed and well-developed levels are defined as scores that fall into the 51st to 75th and 76th to 100th quartiles, respectively, when compared to the work force mean (n=17,000). The needs development and moderately developed levels are scores that fall into the 0 to 25th and 26th to 50th quartiles, respectively, when compared to the work force mean (n=17,000).

Validity, according to the American Education Research Association, is defined as "the degree to which evidence and

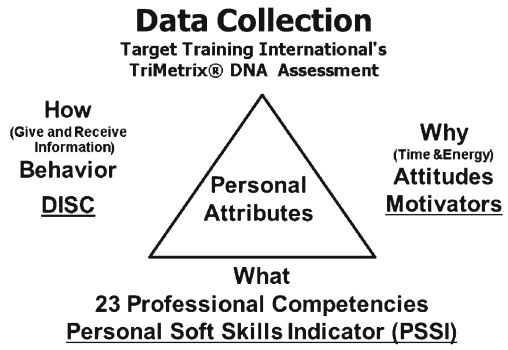

Fig. 1 The TriMetrix® DNA instrument is a three-part tool that assesses the behaviors people bring to a position, the values that motivate them to do a job, and the extent to which people have obtained personal competencies

Table 1 Twenty-three competencies assessed using the TTI TriMetrix® DNA system and categorized using the domains identified by the National Research Council (National Research Council 2012)

Domains from National Research Council (2012)	TTI DNA Competencies
Cognitive competencies: $n=5$	Planning and organizing
	Analytical problem solving
	Decision making
	Creativity/innovation
	Futuristic thinking
Intrapersonal competencies: $n=5$	Continuous learning
	Goal orientation
	Self management
	Flexibility
	Personal effectiveness
Interpersonal competencies: $n=13$	Employee development/coaching
	Presenting
	Diplomacy
	Management
	Customer service
	Interpersonal skills
	Leadership
	Teamwork
	Conflict management
	Empathy
	Persuasion
	Written communication
	Negotiation

theory support the interpretation of the scores." TTI conducts 360-degree feedback surveys to assess the perception of others on an individual's evidence-based competencies. These feedback surveys utilize the variance method to determine the validity of individual questions. The variance method requires that each question in a survey captures the range of responses from the minimum to the maximum choice. In a recent internal audit using the responses from 7,000 respondents, the PSSI survey items had total variance.

Results

For each of the 23 competencies assessed using the PSSI instrument, the maximum score for each item is 10. Spider diagrams are used to present the average score for each data set population (Figs. 2, 3, 4, and 5). On each diagram, an average work force mean is included for reference purposes. The work force mean was calculated using data from 17,000 individuals. These 17,000 individuals represent a random stratified sample from over one million assessments, run annually. Workforce mean in the context of this paper is used as a benchmark for comparative purposes only. It is a database of working adults who take this as part of a business or people who are looking for jobs. Virtually, all the respondents have 4-year degrees.

Data set 1 includes information for 14 senior-level students in the senior thesis class during the Fall 2008 and Spring 2009 semesters (Fig. 2). These students experienced minimum exposure to the new educational philosophy and

Fig. 2 A spider diagram of the 23 professional competencies for 14 senior-level students in the senior thesis class during the Fall 2008 and Spring 2009 semesters. The highest score is a 10. These students experienced minimum exposure to the new educational approach and represent before-program-change seniors. Work force mean plotted for reference. See text for details

Fig. 3 A spider diagram of the 23 professional competencies for the 14 before-program-change seniors and Student 1 who was heavily engaged in a wide range of activities and clearly took advantage of many opportunities to practice and develop these competencies. Work force mean plotted for reference. See text for details

represent what are referred to as "before-program-change seniors." The highest mean score is for continuous learning, which indicates these students are willing to take the initiative in learning and implementing new concepts, technologies, and/or methods. The only other category in which this group of seniors scored above the work force mean benchmark is their ability to be empathetic, in others words, the ability to identify with and care about others. Student 1 in Fig. 3 is distinct from the other 13 senior-level students and, as will be discussed later, took advantage of many opportunities outside the traditional classroom to practice and develop these competencies.

Figure 4 compares the competencies of 29 students who entered the UNL-ES program in the Sophomore Orientation

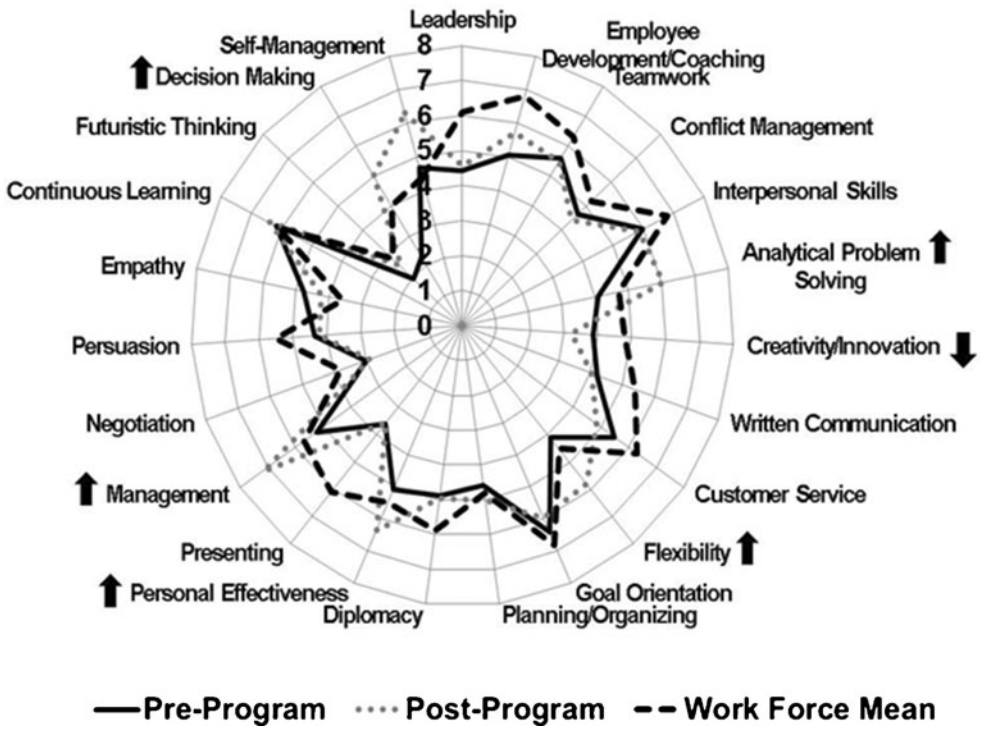

Fig. 4 A spider diagram that compares the competencies of 29 students who entered the UNL-ES program in the Sophomore Orientation Course after the new educational approach was implemented and then went on to complete the Senior Thesis. *Arrows* indicate statistically significant difference between pre- and post-program scores. An *upward arrow* indicates positive change. A *downward arrow* indicates negative change. Work force mean plotted for reference. See text and Tables 1 and 2 for details

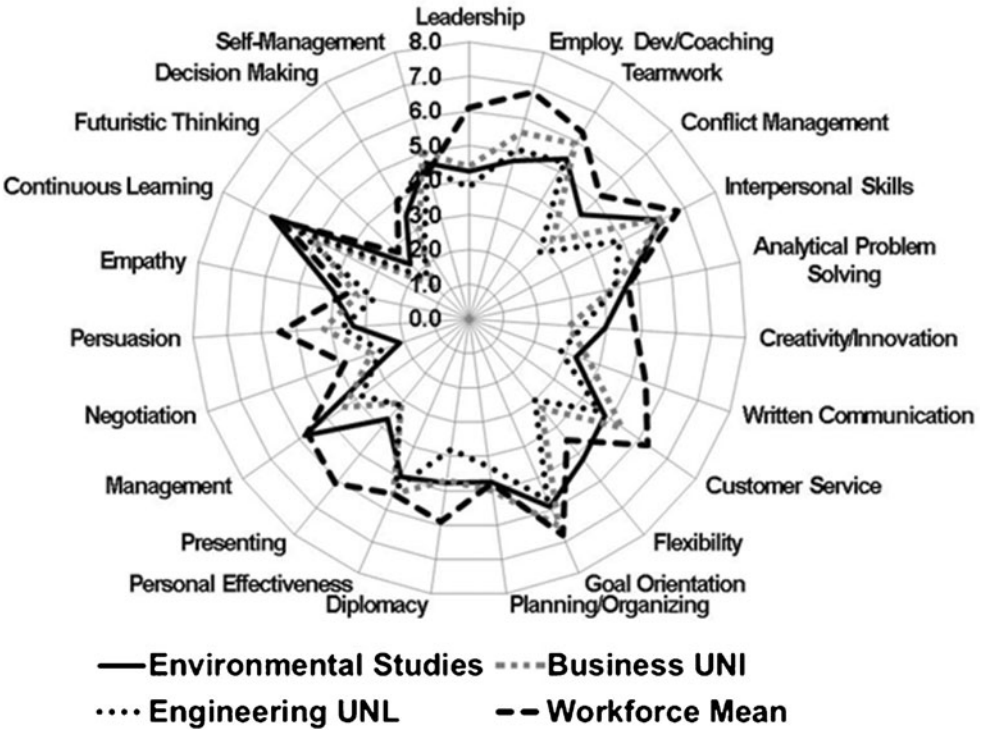

Fig. 5 A spider diagram comparing data for freshmen from College of Engineering at UNL, the Business College at the University of Northern Iowa, and the UNL-ES program who joined the program in Fall 2010 and 2011. Work force mean plotted for reference. See text for details

Course after the new educational approach was implemented and then went on to complete the Senior Thesis. As was the case for the before-program-change seniors, this group of students has a strong desire to take the initiative for their learning as indicated by their continuous learning scores. Using a non-parametric Wilcoxon rank sum comparison, Table 1 indicates a statistically significant (p <0.05) improvement in the student's ability to: utilize effective processes to make decisions (decision making); effectively manage resources, systems, and processes (management); demonstrate initiative, self-confidence, resiliency, and a willingness to take responsibility for personal actions (personal effectiveness); adapt to change (flexibility); and anticipate, analyze, diagnose, and resolve problems (analytical problem solving). Scores for all of these competencies in addition to self management, defined as the ability to demonstrate self control and manage time and priorities, exceeded the work force mean. There was a statistically significant decrease in the student's ability to adapt traditional or devising new approaches, concepts, methods, models, designs, processes, technologies, and/or systems (creativity/innovation) to a problem.

During the Fall semester of 2008, TTI, in collaboration with the College of Engineering at UNL and the Business College at the University of Northern Iowa (UNI), collected data on freshmen students. TTI assessed students in Engineering and Business (Bonnstetter and Bonnstetter 2008). A comparison of the mean values for these two groups and set of freshmen joining the UNL-ES program in Fall semesters 2010 and 2011 suggests some differences in the skill sets that the students bring into each of these majors (Fig. 5). It appears that all three groups have a curiosity and enthusiasm for learning (continuous learning), a belief in their personal capabilities (personal effectiveness), and a willingness to pursue goals (goal orientation) that are similar to the work force mean. Business and engineering students, when compared to the ES students, generally appear to have lower scores overall in terms of their abilities to address and resolve conflict constructively (conflict management), respond to change (flexibility), and manage their resources (management). This is a preliminary assessment that warrants additional investigation, which is a future objective.

Discussion

Applications of a business-based instrument Higher education is being confronted with a paradigm shift (e.g., Arum and Roksa 2011) that is forcing it to collectively reexamine their ability to not only develop graduates who have the professional competencies to be successful, but also to be able to document their ability to enhance the development of these competencies. Through the use of an instrument such as the TriMetrix, the UNL-ES program is taking a page from the business world and partner with it to both identify student needs, and in turn, develop programs of study that include and emphasize opportunities to enhance professional competency.

As is the case with any type of assessment instrument, the TriMetrix has limitations in the context of it being a self-reporting instrument. As outlined in Bedwell et al. (2011),

several particular biases can influence self-report measures: consistency motif, social desirability, acquiescence biases, and self-serving biases. A comprehensive discussion of these influences is beyond the scope of this paper and the reader is referred to Bedwell et al. (2011) and references therein for more details. Briefly, the *consistency motif* suggests that individuals try to remain consistent in their thoughts and feelings and they have an urge to maintain consistency in their responses, or more importantly, what they regard as consistency. People have a need for social approval and acceptance [through] culturally acceptable and appropriate behaviors (*social desirability*). This desire may influence individuals to present themselves in a favorable manner, regardless of their true feelings or tendencies to behave in certain ways. *Acquiescence bias* occurs when respondents generally agree (or disagree) with questionnaires, regardless of the content. This may make some of the dimensions of an assessment seem related, when in fact, they are not. *Self-serving bias* leads people to attribute the positive aspects of their performance to their own individual traits or dispositions and poor performance to external factors. This bias may result in higher self-ratings in terms of their own personal mastery level.

Because the focus of this paper is on the assessment of competency attainment, the consistency motif and self-serving bias may contribute to the scores overestimating the student's abilities to some extent; however, when comparing pre- and post-program data, we are looking for change, not absolute score characteristics, so these biases become neutralized. The social and acquiescence biases most often mask relationships between variables, and we are not concerned at this point with the examination of correlations among variables, so they should have minimal impact on the outcomes or conclusions of the study.

Although there are limitations, these are outweighed by the benefits to the program and instructors. These include: a better understanding of how information may be best delivered to students; explanation of the motivations behind student choices; and a framework that helps opens lines of communication in social settings, classroom interactions, work, and even at home. Furthermore, and in the context of meeting future accountability criteria for higher education, the comparison of pre- and post-program data can be used to document the extent to which the students have grown throughout the program.

Not only does the program benefit, but also, the report that is provided to each student, in and of itself, has six distinct benefits: (1) norm-referenced list of professional competencies that they can use to market themselves to potential employers; (2) unique learning experience that helps them understand better their behaviors and motivators (note—these data will be presented elsewhere); (3) insights that will help them better understand their own perspective as well as others; (4) insights that provide students the ability to communicate their strengths, ideal work environment, and unique personal skill sets; (5) team work insights that provides teams the opportunity to get off the ground faster and are more productive because students see roles, strengths, and potential areas of weakness more clearly; and (6) insights into career matching whereby students understand their own strengths and personal attributes that can help them do a much better job of making matches that result in job satisfaction and more productivity.

Development of twenty-first century professional competencies A first glance at Fig. 2 may draw the conclusion that the before-program-change seniors, as a group, are generally lacking twenty-first century competencies relative to the work force that they will be joining. It is important to recognize that they are being compared to a national workforce and not other college-level seniors. Considering that the extent to which a person has these competencies is not fixed and they are developed by practice, it is probably unrealistic to expect these college-level seniors who have a limited amount of experience to be at or exceed a national work force level of competency development. The key factors to the development of competencies are that they are acquired over time by doing, participating, and actively engaging in activities where they can practice these skills. Data from Student 1 (Fig. 3) supports the contention that the development of twenty-first century competencies well beyond the national work force mean can occur if a student actively engages in activities where they can practice these skills. This student participated in the nationally recognized McNair Scholar program and engaged in a summer research under the guidance of a faculty mentor. Student 1 had the opportunity to travel to national professional conferences and present research. In addition, Student 1 actively engaged and held leadership positions in student government, Ecology Now, and Roots and Shoots, among other activities. These activities provided a range of experiences and networking opportunities that contributed to the development of competencies in leadership, interpersonal skills, and presenting, among others, which far exceeded others in this environmental studies cohort.

Although documenting the student-competency levels when they leave a program is useful, what may be more crucial is identifying the extent to which students gain skills as a result of their program of study. Our relatively small data set suggests that the 29 students, on average, statistically improved their abilities to make decisions; effectively manage resources, systems, and processes available to them; take responsibility for their own actions; adapt to change; and analytically solve problems (Fig. 4) (Table 2). In contrast to the before-program-change seniors, this group of students experienced the required five-credit hour, three-course sequence under the new educational philosophy that was initiated in the Fall semester of

Table 2 Statistical comparison of professional competencies of pre- and post-program students (n=29)

Professional competencies	Non-parametric Wilcoxon rank sum
Leadership	0.8290
Employee development coaching	0.0917*
Teamwork	0.5479
Conflict management	0.4066
Interpersonal skills	0.2300
Analytical problem solving	0.0098**
Creativity innovation	0.0370**
Written communication	0.9031
Customer service	0.0778*
Flexibility	0.0207**
Goal orientation	0.1317
Planning organizing	0.0878*
Diplomacy	0.8911
Personal effectiveness	0.0111**
Presenting	0.6997
Management	0.0007**
Negotiation	0.6202
Persuasion	0.6279
Empathy	0.2741
Continuous learning	0.5055
Futuristic thinking	0.1063
Decision making	0.0013**
Self management (time and priorities)	0.0619*

*significant at p <0.1; **significant at p <0.05

2008. To promote these characteristics, the pedagogical approaches and educational practices used for each course changed.

One of the primary changes to the one-credit hour Sophomore Orientation course was that the expectation or goal through the use and discussion of the TriMetrix instrument was that each student needed to improve their twenty-first century competency skill set to be successful in their career. In contrast to the course meeting for only half of the semester prior to the change of program leadership, all 15 weeks of the semester were used. The weekly classes were designed to create opportunities for students to critically think, reflect, and communicate about their interests and passions as well as pertinent environmental issues. The format of the one-credit hour senior seminar evolved from a traditional speaker-based approach to an environmental engagement in the community class through which groups of three to four students work with clients in the community on a problem of mutual interest. The 1-hour course of the two-semester three-credit hour Senior Thesis course sequence was changed substantially to address the need for the students to develop their understanding of the inquiry-based research process, the development of a researchable question, and the advancement of their abilities to use relevant methodologies to collect relevant data. The products of the overall thesis process are now summarized as the five p's: thesis proposal, thesis proposal presentation, thesis poster, final thesis paper, and professionalism.

The changes to each of the existing courses were intended to promote student independence, self-directed learning, and self reliance. Interestingly, four of the five competencies for which there was a significant change between pre- and post-assessment were in the cognitive and intrapersonal competency domains (Table 1). The improvements in these competency domains support the contention that the changes to the existing courses, albeit relatively small, had an impact. Our results contrast with a longer and more comprehensive assessment of the impact of engineering curriculum and pedagogy on the development of what Pistrui et al. (2012) describes as seven discriminating skills for engineers. These include conflict management, flexibility, goal orientation, persuasion, futuristic thinking, leadership, and employee development/coaching. Pistrui et al. (2012) indicated that in the context of these seven chosen discriminating skills, the current engineering undergraduate experience had no significant impact between freshmen and seniors. However, considering this was only a panel study, not an actual longitudinal study involving the same students Pistrui et al. (2012), implied that this would need to be confirmed.

The notable decrease in the creativity and innovation is worrisome considering its potential importance for success in the future economy (e.g., McWilliam and Dawson 2008; Livingston 2010). To address this trend, we have added explicit activities in our orientation course to promote these characteristics.

The UNL College of Engineering, the UNI College of Business, and the UNL Environmental Studies programs are the first programs to gather these types of data on their students. The Kern Entrepreneurship Education Network has expanded the original application of TTI's instruments at UNL to 21 private engineering schools (Pistrui et al. 2012). Although, considerably, more analysis needs to be completed, the data in Fig. 5 suggest that students coming into each of these disciplinary areas likely bring different sets of professional competencies into their higher education experience. As the NRC (National Research Council 2000) emphasized, it is important to consider prior knowledge and experiences in the educational and learning process. This would imply that these potentially inherent differences in the extent to which these professional competencies have been developed should be considered when developing curriculum in each of these areas.

Lesson learned One of the lessons learned from our experience is that through relatively small changes in curriculum and pedagogy, students can improve their competency levels in areas that are important to employers and help reduce the

dichotomy of expectations between employers and academic programs such as those outlined by Crawford et al. (2011). Another lesson learned is that the development of twenty-first century competencies can occur concomitantly with intellectual growth, the development of content knowledge, and the ability to think about systems. The information collected early in this study documented the use of business-based instruments, such as the TriMetrix® DNA, as part of a formative program-assessment process that led to major curriculum modifications for the UNL Environmental Studies and development of a new 13-credit hour set of core ES courses that is intended to integrate pedagogical approaches and educational practices that further promote student independence, self-directed learning, and self-reliance. This core was initiated in the Fall semester of 2010. Our approach adds to the ongoing conversation in higher education to matching the skills we are teaching with the skills required by employers.

Conclusions

To assess the extent to which we achieve our objectives related to twenty-first century competencies, the UNL-ES program has partnered with Target Training International, Ltd. to gain insights into the development of professional competencies among Environmental Studies majors. This exploratory study supports the conclusion that raising expectations about the development of professional competencies among students and employing pedagogical approaches and educational practices that promote student independence, self-directed learning, self-reliance, and interactions with the community, even on a relatively small scale, can have a significant impact on the development of twenty-first century competencies.

Research on teaching and learning has begun to illuminate how intrapersonal and interpersonal competencies support learning of academic content (e.g., National Research Council 2000) and how to develop these valuable supporting skills (e.g., Yeager and Walton 2011). These competencies are not fixed and they are developed by practice. According to the NRC (National Research Council 2012), research supports the fact that young people who both apply and develop intertwined cognitive intrapersonal and interpersonal competencies in the process of deeper learning are better prepared for adult success. A primary product of deeper learning is the ability to know how, why, and when to use and transfer knowledge, including content knowledge, to answer questions and solve problems.

Higher education is being confronted with a paradigm shift. Current literature supports the contention that higher education needs to improve their connection with the needs of employers. Rising educational costs and requests from the business world for graduates with more than content knowledge is forcing higher education to reexamine their program goals and their graduate skill sets. It seems clear that a deficit exists in the extent to which higher education can track the development of career appropriate competencies. As the pace of new knowledge progresses, a 4-year degree built on content acquisition is no longer adequate. Our future depends on students who possess a set of job-related professional competencies including life-long learning, problem solving, personal effectiveness, and many others. In the context of a growing movement for increased accountability from higher education, it seems that a partnership with an industry recognized leader in human resource development, such as TTI, is important. Through such partnerships, formative and summative assessment data, such as those in this study, can be collected to document the extent to which a student's educational experience has had impact on their overall professional development of career-related competencies.

These data collected as part of this research can be used for a variety of purposes that includes, but is not limited to: assisting students in marketing themselves to employers; assess the extent to which the student's higher education experience has helped the students develop twenty-first century competencies; and contributing to formative assessment to strategically address skill development as a marketable component of a university program.

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ERRATUM

Erratum to: Exploring the assessment of twenty-first century professional competencies of undergraduate students in environmental studies through a business—academic partnership

Dave Gosselin · Sara Cooper · Ronald J. Bonnstetter · Bill J. Bonnstetter

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After this paper was published, the authors discovered that data for 5 of the 29 students compared in Fig. 4 on page 364 had not been processed using the same algorithm as the other 24 students. When data for all 29 students are calculated using the same and appropriate algorithm, there is no statistical difference between the pre- and post-program scores as indicated in Table 2 of the original paper. Figure 4 below provides the correct data. These modified results require a change in one of the conclusions highlighted in the abstract. In addition, the results are now consistent with a longer and more comprehensive assessment of the impact of engineering curriculum and pedagogy on the development of what Pistrui et al. (2012) describes as seven discriminating skills for engineers.

Although these results are no longer statistically significant, we are confident that our approach to the development of twenty-first century competencies can be done concomitantly with the intellectual growth, the development of content knowledge, and the ability to think about systems. This study documents the use of business-based instruments, such as the TriMetrix® DNA, as part of a formative program-assessment process that can lead to major curriculum modifications and the integration of pedagogical approaches and educational practices that further promote student independence, self-directed learning, and self-reliance.

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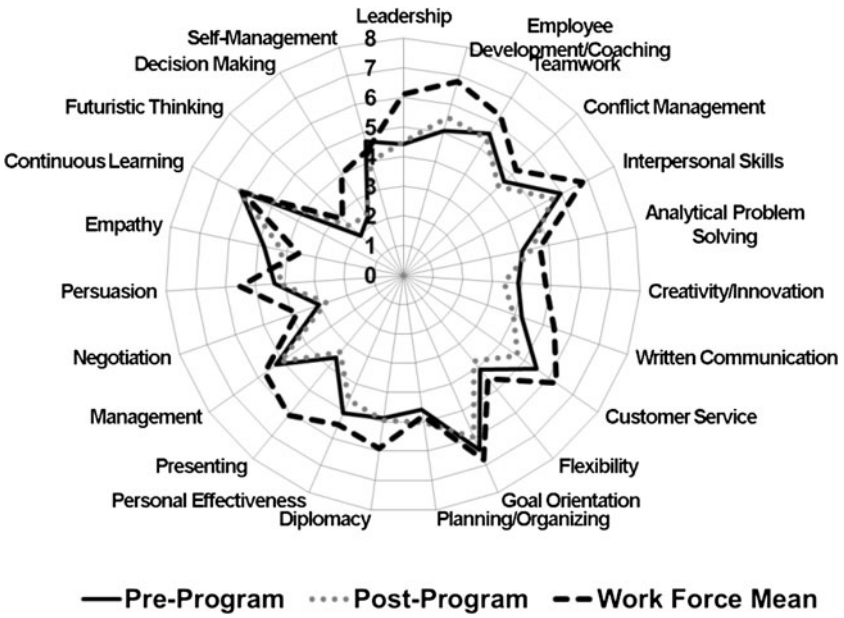

Fig. 4 A spider diagram that compares the competencies of 29 students who entered the UNL-ES program in the Sophomore Orientation Course after the new educational approach was implemented and then went on to complete the Senior Thesis. Work force mean plotted for reference

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