Article

Developing Ill-Structured Problem-Solving Skills Through Wilderness Education

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Abstract

In a society that is becoming more dynamic, complex, and diverse, the ability to solve ill-structured problems (ISPs) has become an increasingly critical skill. Students who enter adult roles with the cognitive skills to address ISPs will be better able to assume roles in the emerging economies. Opportunities to develop and practice these skills are limited in the traditional schooling structures. In contrast, wilderness education is one environment that provides students opportunities to engage with the critical elements that aid in the development of these cognitive skills. The purpose of this study was to measure the effects of wilderness education on students' ability to solve ISPs when compared with peers in a traditional classroom setting. Results of this study suggested that students who were engaged in a wilderness education setting showed significant gains in their ISP skills when compared with their peers.

Keywords

ill-structured problems, outdoor adventure programs, creative problem solving, wilderness education

The Western world is encountering a social and economic revolution where the need for physical labor and services is giving way to a greater need for intellectual labor and services, and as a result of this shift, there is an increasing need for creative, innovative,

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and flexible thinkers. As information is increasingly available via the Internet and repetitive manual labor is rapidly disappearing in developed parts of the world, the skills to navigate, integrate, and synthesize diverse, voluminous information into viable decision paths remain essential. These skills, like others, must be developed and honed through practice. The extant literature on ill-structured problem (ISP) solving posits that practice environments are especially well suited to developing ISP solving skills if they include immediately relevant problems that inherently need resolution (Murgatroyd, 2010), a change in cognitive equilibration (Labouvie-Vief, 2006), and a supportive and collaborative peer-learning environment (Fleming & Alexander, 2001; Johnson, 2006). It is our assertion that wilderness education can provide a rich, experiential, and authentic practice environment to develop these ISP solving skills.

Wilderness education usually occurs in an expedition environment where the primary goal is student learning on a variety of outcomes (cf. Gookin & Leach, 2009) and the pedagogy relies on a diversity of learning strategies for students. Wilderness education requires students to solve problems that do not have definitive right and wrong answers and that inherently include a degree of novelty, instability, and unpredictability. When this environment is intentionally used for programming, students can critically engage in complex problems that are context relevant while supported by an instructor and their peers. In addition, wilderness education programs provide students with the opportunity to engage in real and meaningful context-relevant challenges (Gookin & Leach, 2009). Therefore, the primary aim of this study was to compare the development of ISP solving skills over the course of a semester-long wilderness education/outdoor leadership course with that of students enrolled in a leadership class in a traditional classroom setting, neither of which was taught an academic curriculum about ISP solving.

Background and Theory

ISPs

ISPs, wicked problems, dynamic problems, and naturalistic decision making (NDM) all share common features. ISPs and wicked problems are both resistant to solutions; however, wicked problems, like climate change or world hunger, are often characterized as unsolvable or have an unlimited number of influential factors (Murgatroyd, 2010). ISP solving models are also similar to NDM frameworks in that they share time pressures, group constraints, and changing conditions, and require both critical and creative thinking skills. However, NDM usually assumes a level of expertise within a content domain and a level of risk—conditions that are challenging to replicate. For this study, we used the ISP solving framework because we wanted to study problems that were challenging and dynamic yet could be solved and did not heavily rely on specific domain knowledge. We felt this framework best aligned with the most common wilderness education learning contexts.

Problem structuredness is one of the defining characteristics of problem types, and problems will vary from well structured to ill structured along a spectrum depending on the rigidity of the framework in which any given problem is situated (Jonassen, 2004). ISPs possess elements that are unknown or not known with any degree of confidence (Jonassen, 2004), include multiple solutions or solution paths, and entail multiple criteria for evaluating solutions. ISPs have answers that are context relevant and context dependent (Kitchener & King, 1990) and where the goal states are vaguely defined (Jausovec, 1994). Such problems are less frequently presented in classrooms due to their highly conditional and time-consuming nature. Case analysis, design, and dilemma problems are typically ill structured (Jonassen, 2000). In contrast, well-structured problems have clearly defined boundaries and have clear and well-articulated solutions (Kitchener & King, 1990). These types of problems present all elements of a problem to the learner at the introduction to the problem (Jonassen, 2004). In solving well-structured problems, individuals apply a limited number of domain-specific rules and/or principles. These rules and/or principles are organized and predictable (Jonassen, 2004), and therefore require less cognitive complexity than ISP solving does. Well-structured problems have definitive right and wrong answers that change little over time and context (Kitchener & King, 1990). They have knowable and comprehensible solutions (Jonassen, 2004). Logical, algorithmic, and story problems are generally well structured in nature.

Up until the 20th century, most thinking was regarded in this well-structured way (rational and certain, with stable outcomes; Labouvie-Vief, 2006), and as a result, many educational approaches are still designed to promote this kind of structured thinking. However, well-structured problem-solving skills learned in the classroom do not necessarily guarantee success in solving ISPs in the real world (Choi & Lee, 2008). ISPs require a different set of cognitive processes and resources (see Table 1).

To resolve ISPs, individuals must use creativity, tolerance for novelty, and cognitive flexibility. Creative thinking aids the production of multiple varying solutions (Sternberg, Kaufman, & Pretz, 2002) and is leveraged in the reorganization, restriction, and combination of generated solutions (Mumford, Costanza, Threlfall, Baughman, & Reiter-Palmon, 1993). As ISPs create cognitive disequilibration, tolerance for novelty is needed to ensure that this disequilibration is resolved rather than abandoned (Morra, Gobbo, Marini, & Sheese, 2008). Finally, efficient problem solvers will need to have enough cognitive flexibility to hold multiple pieces of information in their working memory and move fluidly between them (Jonassen, 2004).

Learning to Solve ISPs

Like most skills, ISP solving is learned and developed (Labouvie-Vief, 2006). The literature on learning ISP solving skills points to three essential elements for the development of these skills: (a) immediately relevant environments that encourage the practice of solving actual problems (Murgatroyd, 2010), (b) a change in cognitive equilibration (Morra et al., 2008), and (c) a supportive and collaborative learning environment (Fleming & Alexander, 2001; Johnson, 2006). When these three elements are present, the opportunities for learning and developing ISP solving through experience and practice are enhanced. These three elements are inherently present in most wilderness education programs (cf. Gookin & Leach, 2009).

Table 1. Ill-Structured Problem-Solving Process.

Represent the problem	1. Articulate the problem space and contextual constraints
	2. Identify and clarify alternative opinions, positions, and perspectives
Develop solutions	3. Generate possible problem solutions
Make justifications	4. Assess the viability of alternative solutions by constructing arguments and articulating personal beliefs
	5. Monitor the problem space and solution options (Is the problem solvable?)
Monitor and evaluate solutions	6. Implement and monitor the solution (Will the solution work?)
	7. Be willing to adapt the solution

Source. Adapted from Choi and Lee (2008) and Jonassen (1997).

Wilderness education programs use outdoor settings to afford rich and novel learning environments. The nature of these outdoor settings, routinely shuffling priorities in response to weather and other random dynamics, makes them somewhat unpredictable and nonlinear. Thus, many of the problems encountered in wilderness education have neither singular solutions nor singular solution paths. These contexts are often novel to participants; thus, students are less likely to engage habitual solution paths, which promotes a change in the students' cognitive equilibration. In addition, the inherent small group context common in wilderness education creates supportive and collaborative learning groups where students and instructors live and travel together. The instructors encourage students to collaborate in solving problems (Gookin & Leach, 2009). Such settings urge students to wrestle with group dynamics, objective and subjective hazards, and the task of living in a novel environment (Ewert & McAvoy, 2000; Hattie, Marsh, Neill, & Richards, 1997). Although existing empirical studies have shown that wilderness education can improve students' perceptions of problem-solving and related skills such as resilience and creativity (cf. Hattie et al., 1997), and a number of theoretical papers have linked outdoor programs with learning (naturalistic) decision making, challenging assumptions, and questioning norms (cf. Galloway, 2002; Gookin & Leach, 2009; McKenzie, 2003), there is very little research on actual performance of problem-solving skills.

Emerging Adults

Emerging adults (roughly aged 18-29) are observed in contemporary industrialized cultures where the gap between adolescence and adulthood has broadened (Tanner, Arnett, & Leis, 2008). Some of the cognitive structures and intellectual milestones that an individual needs for solving ISPs are developed during this critical life stage, as a rapid expansion of complex thought structures occurs (Labouvie-Vief, 2006; Tanner et al., 2008). Emerging adults encounter a period where knowledge becomes disequilibrated (Labouvie-Vief, 2006). This helps to move these individuals away from dualist thinking (solutions that are either right or wrong) to relativist or "self-authored" knowledge constructions (where solutions can be right and wrong depending on the context) that allow students to incorporate context as a source of knowledge (see Perry, 1970/1999). The brain is in the critical period for the development and reorganization of the frontal cortex, which includes the neurological centers for reasoning and decision making (Labouvie-Vief, 2006). Thus, the average emerging adult has fewer, but faster, connections when it comes to making decisions involving reasoning and judgment. Most people also experience a peak in creative potential in their early 20s (Kaufman, Kaufman, & Lichtenberger, 2011). For these reasons, emerging adults are primed to learn and develop ISP skills that involve complex thinking, creativity, tolerance for novelty and ambiguity, and cognitive flexibility.

Given the preceding literature related to ISP solving skill development, we hypothesized that students would show significant gains in ISP solving skills after completion of a wilderness expedition compared with students engaged in a leadership curriculum in a traditional classroom setting. Problem-solving skills were characterized as follows: representing the problem (RP), developing solutions (DS), making justifications (MJ), monitoring and evaluating problem space and solutions (ME), and identifying problem-solving stages (PS). These skills were evaluated based on the above problem-solving literature and similar studies from other fields (cf. Bixler, 2007; Chen, 2010).

Method

Setting and Participants

This study involved a comparison group and an experimental group. The experimental group consisted of 91 students who were enrolled in National Outdoor Leadership School (NOLS) semester courses. NOLS semesters are between 75 and 90 days in length and include between 12 and 16 participants who live and travel (hiking, kayaking, or other modes) together for the duration of the semester. NOLS semester courses are similar in both college credits and length to a typical university semester, allowing adequate comparable dosage and incubation of ISP solving process skills. NOLS semesters were chosen for this study because they are long enough that students have sufficient opportunities to practice a variety of problem-solving skills under the guidance of instructors and with peer collaboration.

The comparison group was made up of 65 students who were enrolled in classroom-based leadership courses at two midsized public regional universities in the Southeastern United States. This comparison group was selected because the students were of similar ages to the treatment group and were similarly engaged in college credit earning leadership courses. The students in the comparison group were not engaged in extended field experiences and were not specifically learning problem-solving skills for ISPs. Rather, these students were familiar with similar problem contexts (the scenarios for both study groups are based on college leadership settings) and were learning similar leadership content as the treatment group. Thus, the comparison group was used to control for maturation effects in skill development and was not intended to serve as an "alternative treatment." The collegiate context used for all scenarios, if anything, offered an advantage in gains to the comparison group, which studied on campus that semester. All participants in this study were exposed to leadership curriculum in nationally accredited parks and recreation courses.

Measurement

The instrument used to measure ISP solving skills in this study involved problem-solving scenarios that were developed based on models from previous problem-solving studies (Bixler, 2007; Ge, 2001). Two scenarios (A and B) were developed for this study. As ISPs are best understood situated in context, these scenarios were developed in a leadership context based on the collegiate student experience. This approach best leveraged common domain knowledge among all students in the study.

Scenario A involved solving a problem as a university club president where the club is running at a deficit. In addition to the problem statement and some follow-up questions, the study participants were provided with eight pieces of supplemental material: last year's spending, the current budget, advice from the faculty advisor, advice from a friend, the current list of members, the current list of planned activities, a list of other student clubs, and information on the club budgeting process. Scenario B also involved on-campus leadership and included similar supplemental materials. Given the length of these scenarios (nine pages each), we chose not to include them, but full versions and instructions for use can be found in Collins (2014).

Coding structures for these scenarios were also based on previously published methodologies (Bixler, 2007; Ge, 2001) and were consistent with problem-solving stages outlined in the literature. The scenarios were scored into five subscales aligned with the variables of interest. An a priori scoring rubric was created and refined during a pilot phase when the instrument was beta tested and refined for clarity. The pilot phase involved giving both scenarios to 70 students involved in a university leadership course. These students did not participate in the wilderness education course and were not part of the comparison group; they allowed us to test the utility of the scenarios with a population of college students. This final rubric articulated the description of each ISP stage, the criteria for each point value within each stage, and provided a sample response to exemplify each score.

1. Representing the Problem (RP) evaluated students' abilities to understand the problem space in which the scenario is situated. This section was divided into subsections that include the students' ability to define the problem, generate subgoals, identify relevant information from the problem, and seek any additional information that was needed (maximum score: 10 points).
2. Developing Solutions (DS) evaluated students' abilities to generate appropriate solutions given the problem presented. This section was divided into two subsections that evaluated students' ability to select a solution with explanations and the quality of those solutions (maximum score: 8 points).

3. Making Justifications (MJ) evaluated students' abilities to judge the effectiveness of the generated solution. This section evaluated the students' abilities to construct an argument justifying their solution and the ability to provide supporting evidence (maximum score: 7 points).
4. Monitoring and Evaluating (ME) evaluated students' abilities to evaluate their own solutions and assess useful alternative solutions (maximum score: 7 points).
5. Problem-Solving Stages (PS) was operationalized with a final question that asked students to give advice to someone else presented with the same problem. This evaluated students' abilities to articulate their understanding of the ISP solving processes (maximum score: 7 points).

The lead researcher completed the initial scoring; a random selection of instruments was rescored by a second rater to assess stability of the scoring rubric and coding scheme. The raters had 71% agreement for the five variables that make up the problem-solving process, with each variable ranging between 62% and 83%. All intraclass correlations (ICCs) between the raters' scores were statistically significant ($p < .05$) and ranged between ICC = .48 and ICC = .93.

Procedures

The two leadership scenarios were developed in parallel forms (A and B), so that students were not asked to solve the same problem twice during the study. The order in which students received the two parallel forms was randomly assigned by course. At the beginning of the course, all students read and responded to questions about the first leadership scenario as a part of their course experience before they departed for the field and/or at the beginning of the semester. The follow-up scenario was given at the end of the course experience. Students were given 45 min to complete all the questions in the scenario. Specific questions were not timed, and students were allowed to answer questions in any order they chose (as consistent with real-life ISPs).

Data Analysis

This study used a repeated-measures MANCOVA (Field, 2009) to examine the differences in problem-solving performance for each student over the two testing periods as well as any differences between the two testing groups over time. Three covariates were included in this study as the literature indicates that they are potentially related to these kinds of skills (King & Kitchener, 2002; Strough, Cheng, & Swenson, 2002). These covariates include participant age, years of schooling, and gender.

The dependent variables were the five problem-solving skills outlined above. Each was hypothesized to show greater increases over time for the leadership students engaged in a wilderness education program compared with the students in the traditional classroom experience.

Results

Sample Demographics

This study included 194 students in the pretesting group and 167 in the posttesting group. In total, 156 students completed both pretests and posttests and thus were included in the analysis to ensure consistency of the data across sample times. A full summary of the demographics is provided in Table 2.

Descriptive Statistics

The highest scores overall were in the developing solutions (Grand mean = 3.89) and representing the problem (Grand mean = 3.43) variables. Scores were lower for those variables pertaining to justifying solutions and monitoring and evaluating solutions. Descriptive analysis of all variables is included in Table 3.

Hypothesis Testing

As the main hypothesis was that wilderness education students would perform better on the ISP subscales than the classroom students at the end of the semester, we were primarily interested in the Group × Time interaction. As age, gender, and year of schooling were all hypothesized as viable covariates, each was included in the model. Both gender and year in school were significant covariates in the initial repeated-measures MANCOVA. The Group × Time interaction was significant for both the initial multivariate test, $F(5, 145) = 22.27$, $p < .001$, partial $\eta^2 = 0.434$, and for all five of the subscales with notable effect sizes. Each subscale exhibited the anticipated pattern of similar pretest scores followed by improved posttest scores in the wilderness education group.

To follow up on the significant multivariate interaction, univariate ANCOVAs were performed on each dependent variable. In this analysis, the experimental group improved their scores on each of the five ISP subscales and overall between pre- and posttesting while the comparison group's scores did not significantly change from pretest levels. Effect sizes for the significant interaction results ranged from partial $\eta^2 = 0.106$ for the RP subscale to a partial $\eta^2 = 0.294$ for the ME subscale. A summary of the significant interaction results is found in Table 4. Figure 1 shows the means for each subscale at both pretest and posttest times.

Summary

The students engaged in wilderness education experiences showed significant gains over time in their problem-solving skills as measured by the ISP subscales, while the comparison/classroom group did not show similar gains. Thus, the source of the gains can likely be attributed to participation in the wilderness education course rather than time itself. This pattern held over all five subscales.

Table 2. Study Sample Demographics and Summary Information.

	Classroom	Wilderness	Full study
Participants	65	91	156
Age range[a]	19-29	16-32	16-32
Age average[a]	21	21	21
Females	50	30	80
Males	15	61	76
Average years of school[a]	14	14	14
Pretest—Scenario A	44	47	91
Pretest—Scenario B	21	44	65

[a]Numbers reported in years, all others are raw counts.

Table 3. Means and Standard Errors for ISP Subscales at Pre- and Posttesting.

Subscale	*n*	*M* (*SE*) Pretest	*M* (*SE*) Posttest	Grand mean
RP (classroom)	65	2.75 (1.38)	2.68 (1.95)	3.43
RP (wilderness)	91	3.26 (1.82)	4.69 (2.02)	
DS (classroom)	65	3.48 (1.11)	3.11 (0.94)	3.89
DS (wilderness)	91	3.53 (1.36)	5.15 (1.30)	
MJ (classroom)	65	0.91 (1.04)	0.75 (1.03)	1.28
MJ (wilderness)	91	0.73 (1.04)	2.49 (1.96)	
ME (classroom)	65	2.45 (1.03)	2.00 (0.92)	2.64
ME (wilderness)	91	2.30 (1.02)	3.63 (1.58)	
PS (classroom)	65	1.72 (1.07)	1.85 (1.08)	2.08
PS (wilderness)	91	1.62 (1.29)	2.92 (1.68)	

Note. ISP = ill-structured problem; RP = Representing the Problem; DS = Developing Solutions; MJ = Making Justifications; ME = Monitoring and Evaluating; PS = Problem-Solving Stages.

Discussion

This study found that students who participated in wilderness education showed significant growth in their problem-solving skills at the conclusion of their semester-long experience as compared with peers engaged in a leadership curriculum in a more traditional classroom setting. A survey of the literature finds that wilderness education and adventure education experiences lead to a variety of technical, intrapersonal, and interpersonal outcomes (Hattie et al., 1997). In addition, studies have shown that the intentional scaffolding of problems for students can help in their skill development in problem solving (Bixler, 2007; Ge, 2001) and that outdoor programs specifically can have a positive influence on general problem-solving abilities (Viadero, 1997). However, few studies have explored the development of discrete problem-solving skills in a wilderness education context. We posit that wilderness education is an

Table 4. Summary of Significant Interaction (Group × Time) Effect Sizes by Subscale.

Measure	$F(1, 149)$	p	Partial η^2
RP	17.63	<.001	0.106
DS	53.99	<.001	0.266
MJ	30.87	<.001	0.172
ME	62.08	<.001	0.294
PS	26.73	<.001	0.152

Note. RP = Representing the Problem; DS = Developing Solutions; MJ = Making Justifications; ME = Monitoring and Evaluating; PS = Problem-Solving Stages.

especially well-suited practice environment for learning to solve ISPs for three main reasons: the immediate relevance of the learning, the changes in cognitive equilibration, and the supportive and collaborative nature of the small group expedition common in wilderness education.

Immediately Relevant Environments

Problems experienced as immediately relevant motivate students to engage in the process and to seek solutions (as problems that are immediately relevant do not go away on their own). This immediacy drives motivation, which is highly related to the development of creativity in problem solving (Lubart & Mouchiroud, 2003). This sense of relevance has been shown to heighten content retention and the learning curve of individual students in the wilderness context (Sibthorp & Arthur-Banning, 2004). In a setting where actions can be immediately connected to learning, objects, and others, stronger associations are built (Resnick, 1987) that can be used in future problem-solving scenarios. As students in wilderness education are immersed in a remote and austere experience, they are forced to use only the available resources at hand and to work through a problem-solving process, instead of skipping ahead to an already established solution or adapting a solution generated from an external source. By restricting resources to the immediate environment, a process of cognitive change can occur that shifts the conceptual focus of how an individual understands an object or resource by incorporating more or differing information (Lewis, 2000). That is, the environment naturally suppresses functional fixedness, a cognitive bias that limits a person to using objects in traditional and noncreative ways (McCaffrey, 2012), and supports development of the habit to think outside of the box. For example, a student may come into a wilderness education experience with the functional fixedness that says a piece of webbing is just a tool used in climbing, but during the course of the experience, the student may employ that webbing as a belt, a tool to hang food to protect it from animals, a tool to repair equipment, or any other number of uses. Thus, by changing the environment, and limiting resources, students learn to think more diversely about their options in defining problems and potential solutions. Students who showed improvement in ISP solving skills gave responses that indicated more

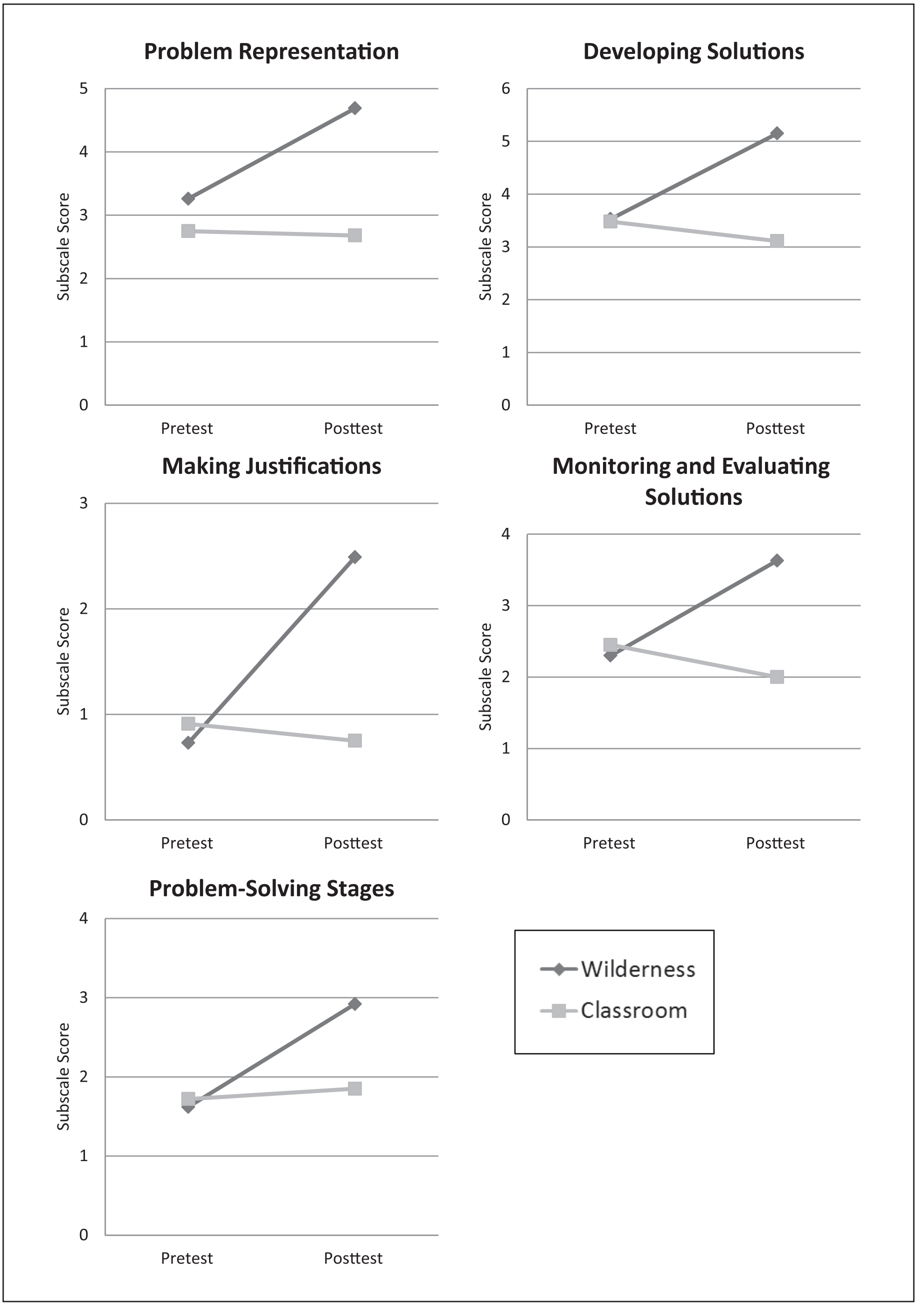

Figure 1. Means for ISP solving subscales by Group × Time.
Note. Any visible decreases observed are nonsignificant, are indistinguishable from error, and are, thus, uninterpretable. ISP = ill-structured problem.

creative solutions that used resources in more diverse ways than those students who did not show improvement.

Meaningful and immediate problems are also present and available in the more traditional school setting; however, these problem types are not as prevalent or attractive to students (Sakofs & Armstrong, 1996), and, as a result, students may not engage in them as readily or often. Wilderness education provides a context where students and instructors are immersed in inherently relevant problems. Therefore, practice solving immediately and contextually relevant problems while in a wilderness education setting could be a factor in the overall development of problem-solving skills observed in this study.

Change in Cognitive Equilibration

Another factor that is related to the development of ISP solving skills is a change in cognitive equilibration. Although the development of cognitive skills is influenced by maturation, the physical environment, and social transmission, these factors alone are not sufficient to promote the development of ISP solving skills. When individuals are forced to disequilibrate, they have to change their cognitive structures to work in a new environment. For many students, wilderness education is novel, and they do not have preestablished frames of reference. When students become disequilibrated, they have the opportunity to modify the cognitive systems to permit integration and embrace novelty (Morra et al., 2008). The practice of this integration and the reapplication of strategies in successive problems could account for the skill growth observed in this study.

In addition, one of the major obstacles to solving ISPs is functional fixedness, where individuals have a blind attitude toward the problem and do not assess the problem based on its merits or component parts (cf. McCaffrey, 2012). Just as the immediately relevant context, constrained by resources at hand, can help students to think of alternative uses, so too can the novelty. Students who are taken out of their routine environments and exposed to new problems with new variables are forced to assess the problem space for its own merits and not jump to conclusions based on past experiences. This break from functional fixedness is not just a matter of circumstance but also a curricular component of most wilderness education experiences. NOLS, for example, encourages the active questioning of norms and assumptions in the field so that students learn to make decisions based on situations, conditions, and evidence gathered from problems, rather than simply from retained rules (Gookin & Leach, 2009).

Supportive and Collaborative Learning Environments

A third factor related to ISP solving skill development is the supportive and collaborative learning environment (Johnson, 2006). Students in wilderness education are living and traveling together daily. This allows them to encounter problems in an immediately relevant context and to collaborate in creative thinking toward problem solving. As a result of the remoteness and necessary group functioning, these small groups frequently tend to build supportive and collaborative networks for accomplishing daily and course goals, where students cite communication, conflict resolution, and group dynamics as some of the critical skills they learn in semester-long wilderness experiences (Jostad, Paisley, & Gookin, 2012). Some studies in other fields have found that question prompting, expert guidance, and peer feedback all improve novices' skills in ISP solving environments (Ge, Chen, & Davis, 2005). This guidance and structure provided by instructors often increases learning in self-directed tasks (Wurdinger & Carlson, 2010) as well as tasks requiring higher order thinking skills (Johnson, 2006).

Students in traditional classroom experiences certainly engage in some group work and receive guidance from instructors, so these aspects are not unique to wilderness education. However, it has been argued that students in the Western world are not often engaged in active knowledge construction, but rather have knowledge handed to them, which can handicap their learning (Rogoff, 2003). In wilderness education, the amount of practice, practical application, and active knowledge construction that students engage in during problem solving helps them to retain knowledge (Sakofs & Armstrong, 1996), thus enabling these students to move toward mature problem-solving schemas. Students who are actively engaged in the decision-making process have greater responsibility for the outcomes and also perceive greater developmental gains (e.g., Sibthorp, Paisley, & Gookin, 2007).

Limitations

This study has several limitations. First, the results of the interrater reliability indicate potential instability of the rubric for this study. Whereas other studies using the same scoring framework were able to find strong interrater reliability (Bixler, 2007; Ge, 2001), this study found that the percent agreement between raters was moderate. The variable for identification of problem-solving skills had relatively low agreement between scorers, and it was challenging to train a second scorer due to the range of potential interpretations. Second, some authors have posited that simply exposure to natural environments, irrespective of curricula, can enhance cognitive skills (e.g., Atchley, Strayer, & Atchley, 2012), and we were unable to detangle wilderness curricula from the wilderness environment in this study. Third, dosage is arguably an issue. Although both groups had comparable doses of curriculum, the wilderness education program students lived together with their instructors for the entire semester. Fourth, with any skill-based assessment, level of participant effort is critical to success. It is possible that the wilderness education students were more invested in their educational experience and, thus, put forth greater effort than the classroom students when completing the second assessment. Finally, while we had participants engage in the ISP via scenarios rather than asking for their self-perceptions, this scenario-based problems approach was limited by the manufactured contexts and logistical constraints of the research study.

Implications for Future Research

Most studies of this nature in the field of outdoor and adventure education ask students to reflect on their own abilities and report their level of comfort or skill via a self-report instrument (cf. Sibthorp et al., 2007). This study asked students to solve an actual problem to assess their skills. We were less concerned with whether or not students *thought* they would/could use all the problem-solving steps to solve an ISP, and more concerned with whether or not students would exhibit these skills in an actual problem. This approach was successful. Future researchers should consider the critical difference between measuring the *self-perception* of having a skill and measuring the actual performance of a skill.

Implications for Practice

Numerous studies have addressed the development of technical, interpersonal, and intrapersonal skills resulting from wilderness education, but fewer studies have explored the cognitive skills that could result from these courses. Although retention and application of learning, or learning transfer, are still being debated in outdoor and adventure education literature (Brown, 2010), this study provides evidence for the development of a skill set that could be transferable to emerging adults' everyday lives and future vocations. Therefore, wilderness education, along with other ill-structured educational interventions, could positively supplement more traditional educational experiences.

Educators who are already using wilderness education, or immersion experiences in other contexts, should recognize that this remains an excellent venue for teaching both content and thinking skills. Adventure and wilderness educators should continue searching for opportunities that foster creative thinking, tolerance for novelty, and exposure to new environments while allowing students the space to navigate these challenges. Educators who do not have access to the resources necessary for immersion or experiential approaches may want to target ISP solving skill development through prioritizing immediate relevance, cognitive disequilibration, and collaborative learning in their classrooms.

Conclusion

As the world is changing, the need for creative, innovative, and flexible thinking remains critical to solve contemporary problems. Emerging adulthood is the time when reasoning and decision making should be developing in the frontal cortex, priming learners in this developmental stage for wrestling with ISPs. However, as with most skills, ISP solving skills must be developed through practice. This study and the related literature support the notion that, for emerging adult students, wilderness education can augment the development of these important cognitive skills. Specifically, we posit that wilderness education programs are well suited to afford abundant practice opportunities where problems are relevant, cognitive disequilibration is common due to the novelty of the wilderness context, and collaborative learning is inherent in the small group expedition model. Educators intent on fostering ISP solving skills would be wise to attend to learning relevance, disequilibration, and collaboration both in and beyond the wilderness classroom.

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