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Levels of cognitive processes in a non-formal science education program: Scouting's science merit badges and the revised bloom's taxonomy

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The United States Boy Scout merit badge program provides non-formal educational experiences for boys from ages 10-17. This study analyzes the objectives of the twenty-three science related merit badges using the lens of the revised Bloom's taxonomy. Merit badges requirements serve as objectives for this program. The verbs in the requirements were classified according to the revised taxonomy. Patterns were then analyzed within the merit badges, within the verbiage of the requirements, and across the entire science merit badge program. Overall, remembering and applying cognitive processes were emphasized the most. Recommendations are made for improving the clarity of merit badge requirements for Scouting and other non-formal educational programs.

Key Words: curriculum analysis, informal education, program evaluation, scouting

Introduction

Non-formal and informal science education experiences can contribute to the education of young people (National Research Council [NRC], 1996; National Science Teachers Association [NSTA], 1999). The merit badge program of the Boy Scouts of America provides opportunities for boys between the ages of 10 and 17 to learn about many fields of study and hobbies. Scouting is a community-based organization in which adults with career or strong interest in a field volunteer to serve as merit badge counselors for the Scouts. Scouts have the opportunity to earn any of 122 merit badges. Twenty-three of the merit badges relate to science topics. One of them, Environmental Science merit badge, is required to earn the organization's highest award, the Eagle Scout award. In 2009, 77,285 Scouts earned Environmental Science merit badge, making it the second most popular merit badge in the program after First Aid (Boy Scouts of America [BSA], 2010a). The Scout must meet a list of requirements provided by the national organization in order to earn the merit badge. These requirements serve as educational objectives for the Scouting program. This study analyzed the requirements of the science merit badges through the lens of the revised Bloom's taxonomy in order to discover what levels of cognitive processing are required of young people in this program.

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Literature Review

Jarman (2005) claimed that worldwide, Scouting is not a well researched science education program. A literature search under the keywords "scouting" and "science education" in ERIC, Education Research Complete, and Academic Search Complete search engines only provided the Jarman article and six other articles that were not about Scouting. Jarmin's study found that adult volunteers in British Scouting reported that Scouting provided an opportunity for "incidental science learning," mostly through participation. Jarmin studied Cub Scout age youth, who are elementary school aged, rather than the Scouting program analyzed in this study that involves middle school and high school youth. Assessment of learning in the British Cub Scouting program mainly took place through participation rather than the explicit requirements requiring explaining, experimentation, and discussion found in the U.S. merit badge program.

Scouting is an example of non-formal education. The binary of formal and informal education has been described as inadequate by Haim (2007). Haim argued that science museum field trips, while often classified as informal learning, are actually formal since the teacher organizes the trip. Haim added a third category of non-formal learning. Informal learning is described as spontaneous and without an authority figure. Non-formal learning is described as planned, but highly adaptable. An authority figure may be present. Both non-formal and informal learning highly depend on the learner's intrinsic motivation (Csikszentmihalyi & Hermanson, 1995). Gerber Cavallo and Marek (2001) defined informal learning as less structured environments in which students have more opportunity to manage their own learning. While Gerber's definition could fit Scouting in the United States, the term non-formal education will be used in this study to differentiate the structured, but voluntary, program of Scouting from the unstructured opportunities that exist when families take their children to science museums. Also, the role of the merit badge counselor is one of an authority on the subject.

The NSTA strongly supports informal science education by community based youth organizations. NSTA states: "Informal science education allows for different learning styles and multiple intelligences and offers supplementary alternatives to science study for non-traditional and second language learners. It offers unique opportunities through field trips, field studies, overnight experiences, and special programs." Scouting's science merit badges include a variety of requirements involving field trips, conducting observations in natural environments, as well as conducting experiments.

Liu (2009) writes that for science literacy to increase in society, both informal and formal education will be necessary to engage people of all ages in science. While lifelong learning may seem to preclude the Scouting program, the merit badge program offers Scouts the opportunity to learn about topics of their own choosing in ways that may not engage them in traditional school settings. The Boy Scouts of America claim that merit badges can "inspire a Scout to develop a lifelong hobby, pursue a particular career, or become an independent, self-supporting adult (BSA, 2010b)." A list of the science merit badges analyzed in this study is given in Table 1.

The merit badges requirements will be analyzed using the revised Bloom's taxonomy. The original taxonomy was developed as a method for evaluating educational goals and objectives (Bloom, 1956). The original six levels in this taxonomy were updated and will be referred to as the revised taxonomy (Anderson & Krathworthl, 2001). The revised taxonomy has six levels of cognitive processes: remembering, understanding, applying, analyzing, evaluating, and creating. The latter three are referred to as higher order thinking skills. The merit badge requirements serve as educational objectives for the Scouting program; therefore, using the revised taxonomy to classify them is in line with Bloom's original intention.

The remembering level focuses mostly on memorization of facts or isolated pieces of information. The understanding level requires that students demonstrate the ability to explain concepts

Table 1. Science Merit Badges

Animal Science
Astronomy
Bird Study
Chemistry
Composite Materials
Electricity
Electronics
Energy
Engineering
Environmental Science
Fish & Wildlife Management
Forestry
Geology
Insect Study
Mammal Study
Nature
Nuclear Science
Oceanography
Plant Science
Reptile and Amphibian Study
Soil and Water Conservation
Space Exploration
Weather

in their own words. Applying refers to situations in which students use knowledge that they have learned in a novel situation, often to solve a problem. This problem solving does require that the student use the knowledge in a new situation since merely memorizing math problem solving steps and repeating them with new numbers would not demonstrate the ability to extrapolate. Analysis refers to the ability to distinguish between concepts or to form comparisons. Evaluation requires that students form a judgment and defend it. Finally, creating involves synthesizing information and the creation of a new product. This creation can be physical or abstract.

By analyzing the cognitive levels addressed by the Scouting merit badges, this study will provide information about the type of knowledge emphasized by non-formal educational programs, such as Scouting. Non-formal educational programs can possibly excite and motivate students in a way that traditional educaitonal systems do not. Therefore, knowing whether such programs place cognitive demands on students higher than merely memorizing information or observing demonstrations will provide information about the value of such non-formal programs. If the cognitive demands of non-formal programs equals or is higher than K12 programs, then it may be suggested that K12 programs reach out and include such non-formal programs.

Amer (2006) published a critical analysis of both taxonomies. The original hierarchy has been reported to be misleading and overly simplistic since many higher order thinking skills require basic skills such as memorization as a prerequisite or use understanding concurrently (Furst, 1994; Anderson & Krathworthl, 2001; Krietzer & Madaus, 1994). Amer also notes that the original taxonomy was based upon a behaviorist philosophy and not a constructivist philosophy. This study seeks to avoid oversimplifying the educational objectives of the merit badge program by classifying portions of requirements rather than the entire requirement in only one category.

Conceptual Framework

The conceptual framework for this study involves using the revised Bloom's taxonomy to classify the requirements found in Scouting's 23 science merit badges. The requirements serve as objectives for the merit badge program. The Guide for Merit Badge Counselors states that "Insist that the Scout do exactly what the requirements specify. Many of the requirements involve hands-on activities that call for a Scout to show or demonstrate; make; list; discuss; or collect, identify, and label—and he must do just that (BSA, 2010b)." Therefore, these requirements serve as the performance benchmark for Scouts. All six cognitive processes listed in the revised taxonomy (remembering, understanding, applying, analyzing, evaluating, and creating) are used as the categories for classifying the merit badge requirements. This analysis will allow Scouting and other non-formal educational programs to analyze and improve their science education experiences by allowing them to evaluate the level of cognitive processes emphasized by their programs and the clarity of their objectives.

Methodology

This study uses document analysis to analyze the levels of cognition involved in the Scouting science merit badges. While it has been acknowledged that qualitative research often prefers to analyze talk or actions rather than documents produced by an organization, analysis of documents and text can still provide important information about ideas that exist in a socially constructed space (Miller & Alvaradeo, 2005; Altheide, 1996). Content analysis is one of three methods described by Miller and Alvaradeo for performing document analysis. Content analysis views documents as resources for understanding a particular social practice. Content analysis involves identifying patterns, themes, and categories using several philosophical approaches (Patton, 2002). The document analysis of the Scouting science merit badge requirements compares the philosophical approach used by the Boy Scouts of America authors through their use of specific verbs in their requirement with the philosophical approach of the revised Bloom's taxonomy. The social practice being analyzed is the non-formal science education promoted by the Scouting merit badge program.

Twenty-three Boy Scout merit badges were included in this study. They were purposefully selected because the topic of the merit badge related to science or technology. Merit badge requirements are publicly available from the Boy Scouts of America webpage (BSA, 2010c). The authors of this paper performed all coding. The public nature of the merit badge requirements allows the authors' coding to be checked. Each merit badge requirement was analyzed for what verb was used to describe the action that Scout had to take to fulfill that requirement. Frequency counts of the verbs were made. Further, each merit badge requirement was analyzed for how many "elements" were contained in it. Elements are defined in this study as individual incidences that a Scout needs to perform a skill. For instance, identifying ten leaves involves ten elements. Each requirement was also coded for the level of the revised Bloom's taxonomy needed to complete the requirement.

For example, in Geology merit badge, requirement 5d(4) says to "collect 10 different fossil plants or animals OR identify 15 different fossil plants of animals." The verbs collect and identify were each counted once for their respective frequency counts. Collect was coded as the revised taxonomy level of applying because the Scout is required to perform a task to gather the fossils. An element count of 10 was added to the collect verb's element category. Identify was coded as analyze since the Scout had to use an identification guide to differentiate between fossils. An element count of 15 was added to the identify verb's element category.

The purpose of creating two frequency counts, verb and element, was to help triangulate the types of reasoning featured in the science merit badges. The verb frequency count only allows for analysis of how many requirements use specific verbs at certain levels of the revised taxonomy. The element frequency count allows the researcher to further analyze how many different tasks the Scout actually performs at each level of the taxonomy. Since a Scout would be identifying 15 samples and only collecting 10, the element count allows the identifying verb to be weighted accordingly.

Coding for the level of the revised taxonomy for each verb in the merit badge requirements was done by comparing the wording of the requirement to the following functional definitions of the levels of the taxonomy. Remembering: the Scout is asked to report facts, figures, or definitions without elaboration. Understanding: the Scout is asked to explain a concept in detail or give reasons why a phenomenon occurs. Applying: the Scout is asked to use the knowledge from the merit badge in a new way; this includes making collections, completing projects using knowledge from the other requirements, or doing service projects using the knowledge. Analysis: the Scout is asked to differentiate between two or more concepts, to identify an object or phenomenon using a key, or perform mathematical or graphical analysis. Evaluating: the Scout is asked to justify a position or decision. Creating: the Scout is asked to construct a new project, field notebook, or creatively think of new ideas. Projects that were models were classified as creating since the Scout had to bring ideas together practically in the creation of their product.

When the two researchers compared their independent coding, initially only 40 percent of the coding was the same. The researchers then refined the descriptions of the categories until consensus was reached. The initial differences in classification were largely found in three areas: classification activities, reporting evidence after a lab or project, and the expectations involved with "telling". It was determined that all classification activities were to coded as analysis because this was likely to be done by using a dichotomous key or identification guide which would require comparison. Reporting evidence was coded as analysis because the Scout would be bringing together their work, demonstrating what they learned, and comparing it to the core concepts taught in the merit badge. Many requirements that involved the verb "tell" were coded as understanding if the Scout was to explain the importance of a concept or relationship of ideas to each other. They were coded as analysis if there was comparison.

To validate the analysis about the types of reasoning used in the science merit badges, the data will be analyzed several different ways to provide for triangulation. First, frequency counts of the level of the revised taxonomy addressed by requirement verbs will be analyzed. Frequency counts of the level of revised taxonomy addressed by requirement elements will also be analyzed. This will provide information on the levels of emphasis per requirement as well as per actual task that the Scout must accomplish. Second, an analysis of the levels of the revised taxonomy addressed by individual science merit badges will be addressed in order to view the data at a smaller grain size. Finally, an analysis of the levels of the revised taxonomy used for the major requirement verbs will be conducted, both at the verb and element level. This analysis will show how consistently the merit badge authors use certain terms in the requirements.

A limitation of this study is that many of the merit badges contain options. In the geology example given, a Scout would either collect 10 samples or identify 15 samples. Because there were so many different options throughout each merit badge, this study limits itself to cataloging all options that Scouts have equally in order to analyze the types of reasoning promoted by the merit badge requirements overall.

Results

The results of this study are presented in three sections. As explained in the methodology section, the data were analyzed in three different ways to provide for triangulation. First, an overall analysis of the levels of the revised taxonomy addressed by the science merit badges is presented. Then, an analysis of the levels of the taxonomy at the merit badge level is presented to allow readers to see the results at this smaller grain size. Finally, an analysis of the levels of the taxonomy addressed by the different verbs used in the requirements is shared.

Overall Science Merit Badge Analysis

The level of the revised taxonomy addressed per requirement verb in the 23 science merit badges is reported first. In order of emphasis, the requirements focused on applying, understanding, analysis, remembering, creating, and evaluating. The unclassified category actually had the third highest frequency. Nine percent of the requirements focused on the remembering level of information, 20 percent focused on understanding, 30 percent focused on applying, 14 percent focused on analysis, and only a few requirements focused on evaluating or creating. Eighteen percent of the requirements were not classified due to the nebulous nature of the verb used in the requirement, such as discuss or visit. These results are displayed in Table 2.

When analyzing the number of elements in each requirement, the order of importance is similar. Applying received the most emphasis in terms of the number of elements, then understanding. This is the same order as when analyzing the frequency of verbs in the requirements. Many of the requirements involved defining terms. For example, Environmental Science requirement 2 (Environmental Science-2) asks the Scout to define 19 terms. One researcher originally categorized all defining as remembering; however, after the researchers discussed their classification, it was decided that some of these requirements did involve understanding, application, or analysis since the terms were related to each other or a model. The uncategorized elements ranked fourth in proportion; close to the same rank as when only analyzing verb frequency. Remembering was the focus of 12 percent of the elements, understanding was the focus of 17 percent of the elements, applying of 37 percent, analysis of 16 percent, and a small amount of evaluating and creating. Twelve percent of elements of science merit badge requirements were not related to a level of the revised taxonomy. All of the percentages are reported in Table 3.

When comparing the merit badge requirements by both overall verb frequency and element frequency, understanding and applying were the most emphasized levels of the revised taxonomy. While the merit badges do not necessarily promote strict memorization of facts, the requirements categorized as remembering focused on information that was retrievable from the merit badge book, the internet, or other sources and required no further analysis or interpretation by the Scout. Nevertheless, the researchers coded requirements as understanding even if some information was available in the book, because they felt that the requirements verbiage implied comparisons and explanations in the Scout's own words. The large proportion of requirements related to applying demonstrates that the science merit badges support the Scout performing tasks and completing projects that use the knowledge and skills of a subject area to accomplish a task, many times a task that involves community service.

The percentage of requirements not related to a level of the revised taxonomy was between 12 and 18 percent under both methods of analysis. While requirements such as visiting a location where people use the scientific knowledge and skills of the field engage the Scout and should not necessarily be changed, the requirement to "discuss" items really leaves the intent of the requirement to be quite vague. If the requirements are attempting to provide a standard for Scouts to meet to show competence in a field of study, the discuss requirements should be reworded to

Table 2. Percentage of Merit Badge Requirements by Level of the Revised Taxonomy

	Remembering	Understanding	Applying	Analysis	Evaluating	Creating	Unclassified
Animal Science	26	21	12	16	2	6	17
Astronomy	8	23	27	27	2	6	8
Bird Study	5	19	36	21	0	17	2
Chemistry	13	25	10	23	0	3	25
Comp. Mat.	3	10	17	7	7	3	53
Electricity	0	27	33	7	0	27	7
Electronics	13	22	35	4	0	22	4
Energy	2	8	16	41	2	14	18
Engineering	8	10	28	14	6	8	26
Environ. Sci.	1	3	40	12	3	6	34
Fish & Wild	8	11	30	11	0	30	11
Forestry	3	38	10	19	2	3	24
Geology	5	9	23	15	2	4	41
Insect Study	5	9	36	32	5	5	9
Mammal St.	6	23	35	6	0	13	16
Nature	10	8	44	31	0	8	0
Nuclear Sci.	7	31	21	7	1	6	25
Oceanography	12	21	38	13	0	8	8
Plant Science	6	27	45	6	1	4	12
Reptile & Amp	15	20	41	15	0	0	10
Soil & Water	20	32	39	5	0	2	2
Space Exp.	0	30	38	2	0	11	19
Weather	8	14	43	11	0	0	24
Total	9	20	30	14	1	8	18

define whether the purpose of discussion is to merely share facts, to demonstrate understanding, to analyze the information, or to form a judgment about the information gathered.

Individual Merit Badge Analysis

The results for the individual science merit badge requirements coverage of the different levels of the revised taxonomy is also found in Table 2. The merit badges with the largest number of requirements related to the remembering level were Animal Science (26 percent), Soil and Water Conservation (20 percent), Reptile and Amphibian Study (15 percent), Chemistry (13 percent), Electronics (13 percent), and Oceanography (12 percent). The merit badges with the largest number of requirements related to understanding were Forestry (38 percent), Soil and Water Conservation (32 percent), Nuclear Science (31 percent), Space Exploration (30 percent), Electricity (27 percent), Plant Science (27 percent), and Chemistry (25 percent). In terms of applying knowledge, Plant Science had the most requirements (45 percent), followed by Nature (44 percent), Weather (43 percent), Reptile and Amphibian Study (41 percent), and Environmental Science (40 percent). Analysis was featured in the most requirements for Energy (41 percent), followed by Insect Study (32 percent), Nature (31 percent), Astronomy (27 percent), and Chemistry (23 per-

cent). Engineering involved evaluating in 6 percent of its requirements and Composite Materials used it in 7 percent of its requirements. Creating was used most in Fish and Wildlife Management (30 percent), Electricity (27 percent), then Electronics (22 percent), Bird Study (17 percent), Energy (14 percent), Mammal Study (13 percent), and finally Space Exploration (11 percent). These merit badges involved making working electrical projects, a functional model rocket, and natural conservation projects that served a functional purpose.

A great variety of emphases in terms of the levels of the revised taxonomy are found in the science merit badges. While merit badges like Geology and Bird Study involve very little of the remembering level, Animal Science and Soil & Water Conservation have more than one-fifth of their requirements asking for only factual recall. Applying was found to be important in almost all merit badges. The Environmental Science and Nature merit badges especially featured a lot of application, at least 40 percent of the requirements were classified in this way. This is notable since Environmental Science is required for Scouts to earn the Eagle Scout award, this showing an emphasis on application of this core knowledge. The individual science merit badges were also analyzed at the element level by level of the revised taxonomy. This was done to compare the amount of tasks that a Scout had to complete with the overall number of requirements. A summary is found in Table 3. The merit badges with the most amount of remembering at the element level were Animal Science (35 percent), Reptile and Amphibian Study (22 percent), and Oceanography, Composite Materials, Bird Study, and Chemistry (all 19 percent). Animal Science, Reptile and Amphibian Study, and Chemistry were all in the top five merit badges for the most remembering at the verb level as well. In terms of understanding, Science (45 percent), Electricity (44 percent), Space Exploration (41 percent), Chmiestry (30 percent) and Electronics (29 percent) had the greatest number of elements in this category. Space Exploration, Nuclear Science, and Electricity were also ranked in the top five by the verb count. For applying knowledge, Soil and Water Conservation (76 percent), Fish and Wildlife Management (54percent), Mammal Study (50 percent), Plant Science (50 percent), and Nature (48 percent) had the most elements. Plant Science and Nature both were also ranked in the top five for applying at the verb level. Energy (57 percent), Insect Study (47 percent), Nature (42 percent), and Forestry, Bird Study, and Astronomy (each 10 percent) had the most elements for analysis. Energy, Insect Study, and Nature were the in the top five for analysis under both frequency counts. Engineering ranked as the highest merit badge in terms of evaluating (5 percent) while it was second in rank when analyzing by verb. Composite materials (2 percent) were ranked lower by element count than Forestry and Environmental Science for evaluating. For creating, Electricity (21 percent), Electronics (14 percent) , and Bird Study (13 percent), Fish and Wildlife Management (12 percent), and Animal Science (12 percent) were notable. Fish and Wildlife, Electricity, Electronics, and Bird Study were also notable about the verb level.

Analysis at the verb and element levels did not produce identical ordering patterns, but there was overlap in the top ranking merit badges in each level of the taxonomy. This form of triangulation suggests that the merit badge requirement authors were emphasizing the same levels of cognition both in overall scope of the content as well as in terms of individual components.

Analysis of Requirement Verbs

Finally, an analysis of the levels of the revised taxonomy addressed by each common verb in the requirements was conducted. When counting the verbs in the science merit badge requirements, the most common verbs were explain, tell, describe, discuss, identify, show, visit, and list. Frequency counts for each of the verbs are found in Table 4. For the verb “explain”, 56 percent of the requirements were rated as understandingm but 30 percent were rated as analysis. Thus, while

Table 3. Percentage of Merit Badge Elements by Level of the Revised Taxonomy

	Remembering	Understanding	Applying	Analysis	Evaluating	Creating	Unclassified
Animal Science	35	17	18	8	2	12	9
Astronomy	7	26	28	30	1	4	3
Bird Study	19	5	33	30	0	13	0
Chemistry	19	30	10	20	0	2	20
Comp. Mat.	19	4	14	8	2	2	51
Electricity	0	44	26	5	0	21	5
Electronics	12	29	29	2	0	14	14
Energy	1	4	18	57	1	7	11
Engineering	17	11	36	10	5	4	18
Environ. Sci.	14	2	37	20	3	3	22
Fish & Wild	8	16	54	6	0	12	4
Forestry	1	26	23	30	3	3	13
Geology	3	10	41	22	0	2	23
Insect Study	1	4	42	47	1	1	3
Mammal St.	7	20	50	5	0	10	8
Nature	6	2	48	42	0	2	0
Nuclear Sci.	6	45	16	5	1	4	23
Oceanography	19	18	37	16	0	4	6
Plant Science	13	22	50	6	0	4	5
Reptile & Amp	22	25	34	4	0	0	15
Soil & Water	9	12	76	1	0	1	1
Space Exp.	0	41	28	1	0	8	22
Weather	9	22	45	7	0	0	17
Total	12	17	37	16	1	5	12

the word explain may be typically associated in objectives as relating to understanding, when it has students comparing different ideas, it moves up to the analysis level. For the verb "tell", 18percent of the requirements were remembering, and 48 percent were understanding. Initially, one researcher coded this primarily as remembering, but during the consensus building phase of research, it was decided that telling promoted understanding when the Scout was required to explain how a concept worked. "Discuss" was too vague of a verb to determine what level of knowledge the Scout was expected to use. "Identify" was used in 55 percent of requirements to indicate analysis, mostly in terms of using analytic skills to identify the type of plant, animal, rock, or other specimen. "Show" was used in 73 percent of requirements at the applying level, which relates well to the everyday meaning of the verb show. "List" was used in 54 percent of requirements to indicate remembering, and 27 percent to indicate applying. "Visit" was not classified for a level of the revised taxonomy since it only required the Scout to actually go to a location. Most of the visit requirements were followed by requirements to tell, describe, or discuss what was observed or learned at the visit. A summary of the coding of these verbs is found in Table 5.

When frequency counting by the total number of elements in the merit badges, the most common verbs were explain, describe, tell, identify, discuss, list, plant, label, collect, record, and find out. Frequency counts for the verbs by the number of elements is found in Table 6. At the element level, "explain" requirements are 67 percent at the understanding level. "Describe" is split between understanding (34 percent) and aplying (31 percent). "Tell" is 49 percent under

Table 4. Most Common Verbs in Science Merit Badge Requirements

Verb	Frequency Count
Explain	165
Tell	140
Describe	120
Discuss	85
Identify	51
Show	45
Visit	41
List	37

standing. "Identify" is 68percent analysis and 18 percent applying. "List" is 61percent remembering. "Label" is 57 percent applying and 34 percent analysis. "Finding out" was 70 percent applying. A summary of the coding of these verbs by level of the revised taxonomy is found in Table 7. "Plant" was high in this frequency count since many requirements requiring planting of trees or other plants require large numbers to be planted. Examples of requirements from the various science merit badges are now examined. The name of the merit badge is followed by the requirement number being referenced.

Table 5. Most Common Verbs by Requirement vs. Revised Taxonomy Level (Percentages)

Verb	Remembering	Understanding	Applying	Analysis	Evaluating	Creating	Unclassified
Describe	5	47	25	23	1		
Discuss							100
Explain		56	8	30	5		
Identify	4	22	18	55			2
Show	2		73	13		2	9
Tell	18	48	18	8	4		5
Visit							100
List	54	11	27	5			3

Remembering level verbs. Verbs such as tell, list, and define are mostly classified at the remembering level of the revised taxonomy. These verbs ask the Scout to find information and then relay it to the counselor. A deep understanding is not required to fulfill requirements with these verbs. For instance, Oceanography-1 says, "Name four branches of oceanography. Describe at least five reasons why it is important for people to learn about the oceans." "Name" is classified as remembering since this requires only finding the factual information and reporting it. Describe is not classified as remembering since Scouts are asked to give reasons why rather than just reporting facts. For another example, Electronics-4b states in part "Tell about the basic principles of digital techniques." No interpretation is required, just a listing of principles. A final example comes from Environmental Science-2: "Define the following terms: population, community, ecosystems, etc." Nineteen terms in all were to be defined. This requirement is classified

as remembering since Scouts only need to give a definition for each term, not relate them to each other or other concepts.

Table 6. Most Common Verbs in Science Merit Badge Elements

Verb	Frequency Count
Explain	351
Describe	324
Tell	323
Identify	226
Discuss	222
List	179
Plant	124
Label	122
Collect	117
Record	111
Find out	100
Explain	351
Describe	324

Table 7. Most Common Verbs by Element vs. Revised Taxonomy Level (Percentages)

Verb	Remembering	Understanding	Applying	Analysis	Evaluating	Creating	Unclassified
Collect		17	83				
Describe	13	34	31	20	2		
Discuss							100
Explain		67	6	24	3		
Find out	4	22	70	2			2
Identify	3	5	18	68			15
Label		8	57	34			
List	61	7	29	2			1
Plant			91			9	
Record			100				
Show	2		75	11		2	10
Tell	14	49	17	14	3		3

Understanding level verbs. Explaining is mostly completely classified at the understanding level of the revised taxonomy. These requirements prompted the Scout to show an understanding of how something works. Bird Study-1 asks Scouts to "explain the need for bird study and why birds are useful indicators of the quality of the environment." Chemistry-4a involves an experiment with cooking onions. It ends with "Explain what happens to molecules in the onion during the cooking process.". Space Exploration-3 has a list of nine rockets parts that must be

identified and explained. By splitting this requirement into the two verbs, it is clear that the Scout is expected to do more than just point out or define what each part of a model rocket is. A final example is from Bird Study-7b, which states "By using a public library... find the name and location of the Christmas Bird Count nearest your home... Explain what kinds of information are collected during the annual event." All of these examples show that the Scout is being asked to demonstrate a personal understanding of the concepts in the merit badge.

Some of the merit badges more clearly demonstrate the intent of "explain" being used at the understanding level. For example, Electricity-10 states, "Explain the following electrical terms: volt, ampere, watt, ohm, resistance, potential difference, rectifier, rheostat, conductor, ground, circuit, and short circuit." While this requirement uses the verb "explain," it is not fully clear how this requirement is different than asking the Scout to give definitions for each of the terms. The authors of the merit badge requirements may want to consider clarifying this verbiage. However, in Mammal Study-1, Scouts are asked to "Explain the meaning of 'animal,' invertebrate,', 'vertebrate', and 'mammal.'" While the Scout could just give definitions, this requirement is slightly clearer than the electricity example in that the Scout is expected to show an understanding of these words rather than just define them due to the addition of "explain *the meaning*".

Applying level verbs. The verb "show" was one of the most used verbs at the requirement level analysis in terms of requiring the Scout to apply knowledge. The verb "demonstrate" was not used as frequently, but it was used clearly for this purpose. For example, Bird Study-3b asks Scouts to "Show how to adjust the eyepiece and how to focus for proper viewing." The Scout is being asked to apply his knowledge of how binoculars work in order to focus them. Electronics-3b states, "Show how to avoid heat damage to electrical components." Once again, the Scout is asked to demonstrate the skill, not just explain or talk about it. Plant Science-7, Option 2-C3 states, "Demonstrate good pruning techniques..." Here it is clear that the Scout must show how to do pruning on plants.

Analyzing level verbs. The verb "identify" was classified frequently as analysis since it required the Scouts to differentiate between different specimens or objects in order to make the correct identification. For example, in Weather-5, Scouts must "Identify and describe clouds in the low, middle, and upper levels of the atmosphere. Relate these to types of weather." The Scout is being asked to differentiate the different types of clouds from each other. Forestry-2a asks Scouts to "identify wood samples of 10 species of trees." While the Scout will probably use an identification guide as a resource, the Scout still uses analysis to differentiate species.

Mathematical requirements also were classified as analyzing. For instance, Environmental Science-3b states, "Using the idea of trip chaining, determine how many miles and gallons of gas could have been saved in those seven days." Electricity-9a says, "Read an electric meter and ... determine the energy cost from the meter readings."

Finally, many requirements ask Scouts to perform comparisons. Some directly use the verb "compare", such as Insect Study-6: "Compare the life histories of a butterfly and a grasshopper." Others imply the comparison. For example, Nuclear Science-5d involves an experiment comparing irradiated and non-irradiated food over a period of two weeks. In Oceanography-3, Scouts are to "Explain the difference between sea, swell, and surf." This requirement does involve analysis as the Scout differentiates between sea, swell, and surf.

The verb "explain" was also occasionally classified as analysis when Scouts were asked to form a comparison in their explanation. For instance, in Astronomy-7d Scouts are ask to do the following: "With the aid of diagrams, explain the relative positions of the Sun, Earth, and Moon at the times of lunar and solar eclipses, and at the times of new, first-quarter, full, and last-quarter phases of the moon". Also, in Nuclear Science-1a asks Scouts to "Explain the difference between deterministic and stochastic effects. In your explanation, discuss the nature and magnitude of

radiation risks to humans from nuclear power, medical radiation, and background radiation." This requirement not only asks for an understanding of the different effects of radiation, it clearly lays out the areas for a Scout to explore. The requirement also requires analysis to differentiate the terms, even though the discussion portion shows how the requirement mainly revolves around understanding the effects of radiation on humans, the environment, and wildlife

Evaluating level verbs. Evaluating was not the focus of most of the requirements; however, several examples are still found. "Explain", "tell", and "evaluate" were the verbs used in the science merit badges. The verb "evaluate" is self explanatory. Composite Materials-5 requires Scouts to complete two composite materials projects. It ends with requirement c: "With your counselor, determine how the finished projects will be evaluated." The verbs "explain" and "tell" are used at the evaluating level when the Scouts are asked to explain their reasoning for a decision. In Engineering-5a, Scouts use the engineering approach to design plans for their next campout. At the end of the requirement, it says "Tell why you made the choices you did and what improvements were made." This is asking the Scout to evaluate his plan. Environmental Science-6 requires Scouts to "Find out about three career opportunities in environmental science." After picking one to research in depth, Scouts have to "explain why this profession might interest you." While this is a matter of personal judgment, it is asking the Scout to defend his reasoning.

Creating level verbs. "Build", "make", "construct", and "design" were the verbs most commonly coded as creating. Creating was distinguished from just making a model of a concept, which was classified as applying. Examples include Chemistry-3, which states, "Construct a Cartesian diver." Nuclear Science-5a says to "Build an electroscope." Nature-4a requires Scouts to "Make and set out a birdhouse OR a feeding station OR a birdbath." Weather-8a states, "Make a weather instrument such as a wind vane or anemometer." Charting results were also classified as creating because it required the Scout to synthesize the information or data he gathered. For example, Energy-6 requires the Scout to prepare pie charts for five different energy related topics (such as showing the share of energy resources used by the United States that comes from other countries).

The verb "discuss". Discuss is a verb that is poorly defined in these merit badge requirements. The intent of the merit badge requirement authors is not clear in terms of the level of knowledge that the Scout is expected to demonstrate. For example, Weather-1 asks Scouts to "Discuss how the weather affects farmers, sailors, aviators, and the outdoor construction industry." Scouts are asked to connect weather to these other human pursuits; however, it is not clear whether a Scout is expected to merely state facts about how weather affects these people or to demonstrate a personal understanding. Worded differently, this requirement could actually involve the Scout in analysis of weather and industries.

Chemistry-1d asks Scouts to "Discuss the safe storage of chemicals. How does the safe storage of chemicals apply to your home, your school, your community, and the environment?" The follow up question for this requirement does give the Scout a prompt from which to develop an understanding of the safe storage of chemicals. If this pattern were followed in other requirements, it would help clarify the intent of the discussion requirements, but the level of discussion is still vague.

The Environmental Science merit badge has many optional experiments for Scouts to perform to learn about topics such as ecology, air pollution, land pollution, and water pollution. The other options often involve writing a report. After completing the optional experiments, Scouts are asked to "Discuss your observations/conclusions with your counselor." While this discussion has the potential to talk about experimental design, inferences, and the environmental issues, the nebulous character of these requirements leaves the objectives of the experiments in doubt. The

merit badge pamphlet does include suggestions for conclusions as well as questions, but these are not mandated parts of the requirements.

Written reports. Several science merit badges require Scouts to make written reports. While the verbiage is quite clear in terms of writing, a Scout could fulfill many of these requirements by only using remembering level knowledge rather than demonstrating understanding, application, or analysis. For example, Mammal Study-4c states, "Write a life history of a native game mammal that lives in your area." This could be nothing more than a summary of facts about a local game mammal. Oceanography-8 says, "Write a 500-word report on a book about oceanography approved by your counselor." OR "Visit a oceanographic research ship or oceanographic institute and write a 500-word report about the visit. While the length of the essay is prescribed, further indication as to whether the Scout should analyze the information in the book or compare it to other sources are not made. If the desire is for Scouts to demonstrate higher level reasoning, these requirements could be strengthened.

Discussion

The Scouting science merit badges require Scouts to use many different types of cognitive processes as defined by the revised Bloom's taxonomy. The science merit badges require a variety of tasks that involve factual recall, personal understanding, and application of the material. In terms of higher level thinking (analysis, evaluating, creating), analysis is involved in a few requirements of almost all but one of these badges. Evaluating and creating are the two levels of the taxonomy that do not receive much emphasis overall. Future revisions of these merit badge requirements should consider adding more evaluating and creating requirements. Since evaluating includes defending personal decisions or judgments, this seems apropos to an organization with "character building" as an aim. Scouts could be asked to explain why they feel a certain decision or action in each field is helpful or harmful to the community, nation, or world.

If the verbs are being purposefully chosen by the authors of these merit badges, then they are helping Scouts to meet the desired end result. However, if verbs such as "explain" are being chosen to promote Scouts showing an understanding of a concept, then the wording of several of the requirements should be modified. This suggestion is not so much that verbs should only have a singular meaning in terms of the taxonomy, since several "explain" requirements involved analysis and evaluating. The suggestion is that authors of these and other requirements for formal and non-formal science education, should avoid using the verb "explain" in objectives and requirements to refer to factual recall implicitly by their wording. While this analysis is of the Scouting program, these requirements are objectives that could be found in many formal and non-formal educational situations.

The verb "discuss" should also be modified in requirements and objectives. Discussion can take many forms. While this does empower a volunteer counselor or teacher, it makes an unclear objective. If the purpose of a requirement is to set a clear standard for competence in a field, then the requirement should use a verb that clearly defines at what level a Scout should demonstrate understanding or knowledge. "Discuss" does allow for an open ended dialogue that a counselor could continue until he or she felt confident that the Scout had fulfilled the intention of the requirement, but it is vague for an objective.

Although it would be more cumbersome, the authors could chose to reword requirements involving discussion as follows. In Geology-5d,(3), Scouts are asked to "Discuss the following terms and explain how animals from each habitat obtain food: benthonic, pelagic, littoral, lacustrine, open marine, brackish, fluvial, eolian, protected reef." Discussion of those terms is a very vague requirement; however, the portion to "explain how animals... obtain food" is an example of

how to make the requirement more specific. If the intention is for Scouts to define these aquatic terms, then the requirement could be changed to only require definitions. The discussion could require higher level thinking for Scouts by asking them to connect these terms to each other, differentiate the terms, or provide examples of each in a geographical situation. The modified requirement could read,

> In a discussion with your counselor, do the following:
>
> (a) Explain the differences between each of the following terms: benthonic, pelagic, littoral, lacustrine, open marine, brackish, fluvial, eolian, protected reef
> (b) Give an example of the each terms in (a) found in nature
> (c) Explain how animals from each habitat in (a) obtain food

By making discussion requirements into a list of more specific objectives, the standard for Scouts and learners to achieve becomes clearer. Another alternative is to include questions as was done in Chemistry-1d. While the use of questioning changes the requirements from objectives into assessment, it would still provide a more defined standard for the merit badges. For example, the modification of this same geology requirement could read,

> Define each of the following terms: benthonic, pelagic, littoral, lacustrine, open marine, brackish, fluvial, eolian, protected reef. Then, have a discussion with your counselor about the following questions:
>
> (a) What are the differences between these terms?
> (b) What are examples of geographical places where these terms apply?
> (c) How do animals in each of these habitats obtain food?

Finally, it is recommended that authors of these requirements and other educational objectives evaluate the number of requirements that involve merely defining terms. While knowledge of the definition of terms is not an unacceptable goal, it is somewhat limited, especially for a non-formal learning situation where young people are choosing to participate in the experiences and requirements. A good example to follow in modifying these requirements could be Mammal Study-1, which states “Explain the meaning of 'animal,' 'invertebrate,' 'vertebrate,' and 'mammal.' Name three characteristics that distinguish mammals from all other animals.” This requirement involves four vocabulary terms, but the Scout is asked to explain their meaning rather than just copy the definitions from the merit badge pamphlet or an internet dictionary site. While the follow up requirement of naming characteristics is a remembering level objective, it still requires the Scout to compare mammals to other animals.

Conclusion

This study of science merit badge requirements from the program of the Boy Scouts of America provides a method of analyzing the objectives of non-formal educational situations. By using the revised Bloom's taxonomy, the level of knowledge understanding and use is elucidated. Since non-formal educational organizations such as Scouting use volunteers to conduct their program with young people, clear requirements that specify a standard of performance are important in terms of giving young people learning experiences that go beyond learning terms and facts. Further analysis of the actual application of the educational programs such as the Scouting merit badge program are needed to study how the requirements are actually applied in different situa-

tions, with counselors that range from seasonal summer camp staff to professional scientists volunteering their time to work with young people outside of the formal education systems.

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Formal olmayan bir fen eğitim programında bilişsel süreçlerin düzeyi: Scouting fen değer nişanı ve gözden geçirilmiş bloom taksonomisi

Birleşik devletler erkek değer nişan programı 10-17 yaş arası erkekler için formal olmayan eğitim tecrübeleri sağlamaktadır. Bu çalışma tekrar gözden geçirilmiş bloom taksonomisini kullanarak yirmi üç fenle ilişkili değer nişanlarının amaçlarını analiz etmektedir. Değer nişanı gereksinimleri bu program içim amaçları sağlamakladır. Gereksinimlerdeki fiiller gözden geçirilmiş taksonomiye göre sınıflandırıldı. Modeller daha sonra değer nişanları içinde, gereksinimleri ve tüm fen değer nişanı programı boyunca analiz edildi. Genel olarak hatırlama ve bilişsel süreçleri uygulama en fazla vurgulandı. Scouting ve diğer formal olmayan eğitsel programlar için değer nişanı gerekliliklerinin netliğini geliştirmek amacı ile öneriler yapıldı.

Anahtar kavramlar: müfredat analizi, informal eğitim, program değerlendirme, Scouting.