

On Teaching and Assessing Engineering Innovation*

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Abstract

This paper details data, analysis, and evaluation of one facet of innovation: ideation. Over the past six years college and high school students were exposed to several idea generation methods in an engineering problem solving course at Florida Atlantic University entitled: “Inventive Problem Solving in Engineering” (EGN 4040). Two different problems were given to the students in the beginning and towards the end of the semester, about which they were asked to generate ideas.

They used different methods to solve the problems, some of which they learned in class, including the *Eight Dimensional Methodology for Innovative Thinking* that was developed and taught by the first author. This method focuses on idea generation and is a unified approach that builds on comprehensive problem solving knowledge from different disciplines. The different dimensions, namely *Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, and Experimentation* provide problem solvers with new directions for solving problems.

The paper starts with a brief overview of the methods that were taught in the class, and later focuses on assessment, including method, data, analysis, and interpretation of results. The analyzed results are based on the average number of solutions per student, the standard deviation, and the total number of different solutions. The results clearly indicate a consistent and significant improvement in idea generation. They show an average increase in the number of ideas by a factor of nearly two and a half produced by about 130 participants.

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Introduction

Creative thinking, innovations, and inventions are a part of everyday life. Finding effective ways to teach students to be creative and solve problems requires as much creativity and innovation in itself. Currently, there are many different kinds of thinking methods and methodologies that stimulate creative cognitive processes. Sometimes, however, it is hard to define creativity. As defined by Grossmon, Rogders, and Moore, “Creative thinking involves the ability to find solutions to problems by changing your point of view”¹.

One way to teach innovation is to develop a systematic way of thinking or controlling patterns of thought. There are many different kinds of such methods. Some examples include TRIZ^{2,3}, Lateral Thinking⁴, Mind Mapping⁵, and the Eight Dimensional Methodology for Innovative Thinking^{6,7,9}. Another option is to have hands-on activities such as 3-D puzzles and group projects which encourage students to be more open-minded and to experience joy in their learning and ideas. All of these methods are part of the curriculum in the course “Inventive Problem Solving” taught at Florida Atlantic University (FAU). The goal of the course is to enhance the inventive thinking of students that they can use in all aspects of their careers. One partial measure of success is the ideation, or number of solutions that students can develop to solve a given problem.

This paper describes a study of ideation performed over the past four years. The college and high school students involved were evaluated before and after learning several techniques of problem solving, as well as many other activities and ideas. The results and analysis of these evaluations are described in detail.

Overview of Course

The course “Inventive Problem Solving in Engineering” (EGN 4040) has been taught at FAU for the past eight years. While most students who enroll are engineering majors, some students majoring in the sciences, arts and humanities have participated in the course. In addition to college juniors and seniors, high school students have taken the course over the past five years. These students were either enrolled in the Advanced Academic Institute (AAI) or Engineering Scholars Program (ESP), both of which are intense summer programs.

Methods Taught

A large portion of the in-class teaching is devoted to teaching systematic ways of thinking. Students are exposed to TRIZ, Lateral Thinking, Mind Mapping and the Eight Dimensional Methodology for Innovative Thinking. Multiple methods are taught since some are not necessarily suited for everyone or for every problem.

TRIZ, a Russian Acronym that translates into the Theory of Inventive Problem Solving is quickly becoming very popular and is being used by major corporations throughout the world. After studying over two million patents, the method’s creator, Altshuller, identified the main principles and knowledge that define the process for solving inventive problems. TRIZ makes use of this global patent database by providing specific steps for solving the problems^{2-3,7}.

Lateral thinking involves changing one's perception. This method “. . . is concerned not with playing with the existing pieces but with seeking to change those very pieces. Lateral thinking is concerned with the perception part of thinking. This is where we organize the external world into the pieces we can then 'process'.”⁸ This method is practiced by having the students as a class come up with a list of items taken for granted at a restaurant, eliminating one item at a time, and then brainstorming ideas for a “new restaurant” that exploit the lack of the items .

Mind mapping involves using words, phrases and pictures to branch from a central idea or problem to many solutions or related ideas. The result is a central core that has branches that break off as more detailed ideas are generated. Using this method, students are asked to solve a variety of problems including how to deal with a hungry mosquito in the room. Here students are introduced to a problem, e.g., “There is a mosquito in the room and it bothers you.” They list ideas, and then collectively come up with a category-based pictorial mind-map of the different solutions. Ideas range from the initial idea of slapping the mosquito to less obvious solutions such as burning down the house (with the mosquito inside).

The Eight Dimensional Methodology for Innovative Thinking is a combination of many types of problem solving techniques. This unified approach is quick to learn and can easily generate many unique and high-quality ideas in a short period of time. “You explore solutions in eight different thinking directions, one at a time. In each direction, or dimension, you are guided through multiple questions or suggestions that stimulate your mind and that may lead to solutions.”⁶ The dimensions are 1) Uniqueness, 2) Dimensionality, 3) Directionality, 4) Consolidation, 5) Segmentation, 6) Modification, 7) Similarity, and 8) Experimentation. A major portion of the lectures is devoted solely to this method, which include solving 3-D puzzles and engaging in team-based games and tasks that relate to each dimension. Students use this method to solve several problems, including “how to improve a sprinkler system” and “create an ideal neighborhood”. For more information on this method, readers are encouraged to refer to a previous paper written by the first author⁹.

Class Activities

Besides simply teaching creatively, there are many activities designed to encourage self-exploration and interpersonal skills. To do this, the class includes many team-based and hands-on activities.¹⁰ These activities help to enhance the concepts taught and put into practice what the students have just learned, as well as providing new experiences. In addition, students frequently are required to move about the room and enjoy thinking in a non-lecture environment.

Students participated in individual and group activities designed to stimulate their minds (Figure 1). While they consider problems and explore solutions, they are learning new concepts in thinking. These activities include solving mechanical 3-D puzzles, each of which emphasizes one or more problem solving techniques. Throughout the class, students solve brainteasers, which allow them to use methods they just learned in class and help to maintain interest and concentration during the lectures. Occasionally, activities allow students to leave the classroom. In one such activity, groups of two to three students are charged with the task of measuring the height of a tall building using only a 12-inch ruler, a sheet of paper, a pencil and an 8 by 8-inch flat mirror. The teams then present their solutions to the class so students can appreciate the

wide range of ideas and innovations. This activity also emphasizes that many problems have more than one solution and that there are more solutions than “one right solution”.

Daily, “Puzzlebusters”¹⁴ are given as homework. These brainteasers allow students to work individually or in small groups on a daily basis outside of the scheduled class time. Questions such as “How can you distribute six pennies in three paper cups so that each cup contains an odd number of pennies?” reinforce inventive thinking by continuously stimulating students’ minds. Other assignments include performing Internet or patent searches to find inventions, products or advertisements that utilize each sub-strategy of the Eight Dimensional Methodology for Innovative Thinking. After these, students come up with their own solutions to new problems using all eight dimensions and the relevant sub-strategies.

The integration of several methods and activities are included with the so-called “Speed Bump Problem”. First, student groups use mind mapping to brainstorm the problems that speed bumps cause (i.e., spilled drinks and suspension wear). After doing this, students find many solutions to improve speed bumps using the Eight Dimensional Methodology. Finally, the groups pick solutions and actually design, build and implement them. (Usually they build scaled down versions with RC cars.) This takes the students through the entire process of innovative problem solving from observing and defining the problem to evaluating the solution.



Figure 1: Students participating in group exercises

Personal discovery and appreciation of diversity are important in allowing students to communicate and work with one another to develop ideas. Students “discover” themselves through Myers-Briggs testing to determine their own personality type and then see the variety within their own class. In another activity, Nedd Herrmann’s Diversity Game¹¹, students individually negotiate for cards that describe themselves with three adjectives, and then share their adjectives with their classmates to get a different perspective on the wide variety of personalities. These activities lead students to become more appreciative of the diversity of

different kinds of thinkers. The latter example, in particular, also helps encourage students to appreciate diversity in a fun, hands-on manner.

Teaming and risk-taking are also important components of the course. Three LegoMindstorm® robot competitions help to develop teaming skills. Here, students work in groups of three to four to design robots to complete a specific task such as get out of a maze (Figure 2) or climb a rope. In these competitive events, some teams create creative, risky designs in order to gain an edge. This concept is iterated throughout the class by encouraging different ideas to be heard. It encourages students to be more creative, rather than following unspoken rules.

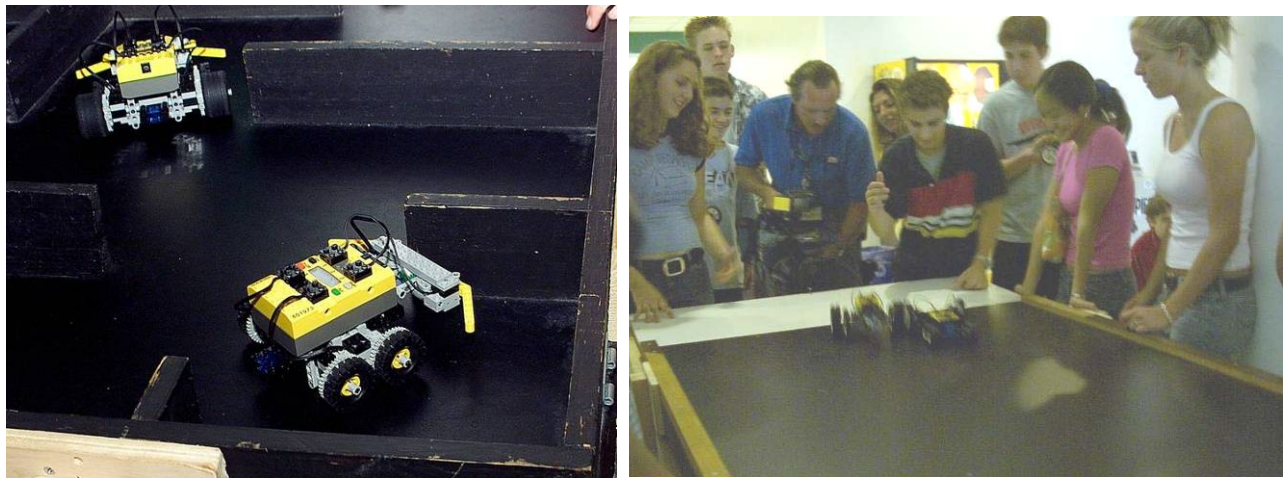


Figure 2: LegoMindstorm® competitions

The activities in the course provide students with skills important in areas such as engineering and business. Working in teams, communication, and creative thinking are all encouraged. Many of the activities during the class are the medium used to teach new concepts in thinking. These activities enhance the learning experience in the course, and most likely increase the creativity of the students. A paper published by the first author will be of interest for readers wanting more details about some of these class activities¹⁰.

Evaluation Method

The ideation results are generated from responses from two questions given to students in the Inventive Problem Solving course. The first, “Where Are You?”, states “You are somewhere in the USA. How would you find your location? List ideas.”¹² The second, “The Jumping Problem,” states “JJ lived in an apartment located on the sixth floor of a building. He opened the window, looked down and ... OH NO! ... Jumped! His friend ZZ ran to the scene, and was surprised to discover that JJ was NOT hurt! Can you explain the mystery?”¹³ The question sheets given to the students are in Figures 3 and 4.



Figure 3: "Where Are You?" problem sheet

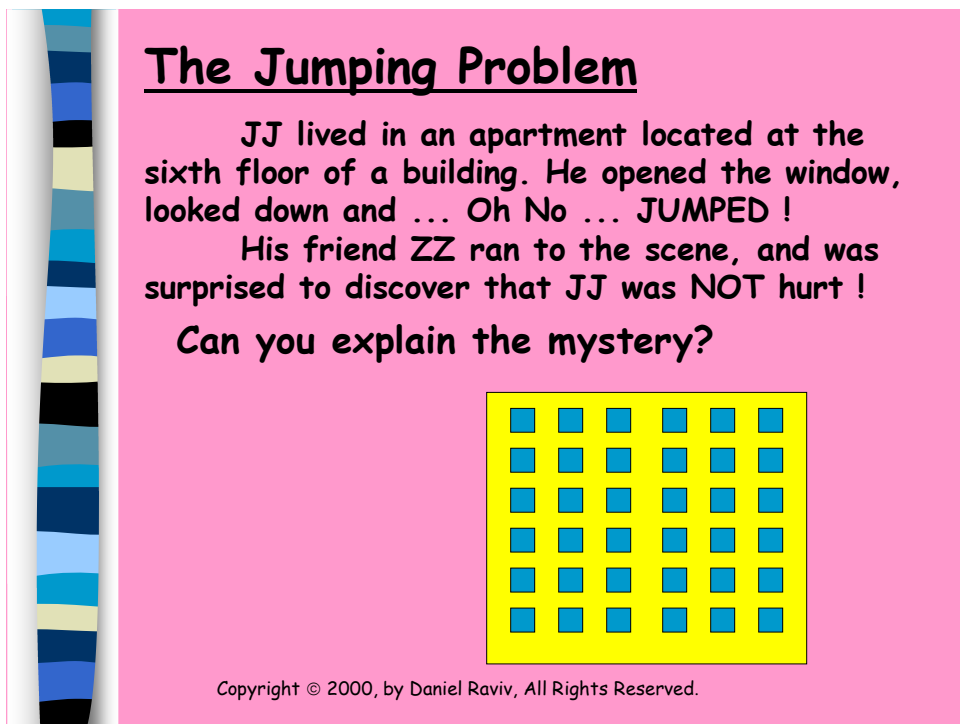


Figure 4: "The Jumping Problem" problem sheet

As an interesting exercise for the reader, write down as many solutions to these problems as you can before continuing. Then compare with the student's solutions described in this paper and in the Appendix.

The evaluation data was collected in two stages during each course. During the first day of class, the students were split evenly into two groups, *A* and *B*. Group *A* was given the "Where Are You?" problem and Group *B* was given "The Jumping Problem." Towards the end of class, after being taught several of the problem-solving methods and being involved in various activities, these questions were given again. However, Group *A* was given "The Jumping Problem" and Group *B* was given the "Where Are You?" problem.

During both evaluation periods, the students worked individually, and were told to generate as many ideas as they could. They were not told to use any specific method for generating their ideas. It was emphasized that the number of solutions produced would have no impact on the students' grades. They were also told that there were no "right or wrong" answers. In addition, the students were given the time they needed to generate their ideas, generally about 15 to 20 minutes. Every effort was made to insure that the students did not feel that they were under pressure during both periods. After the students had finished, their answers and problem sheets were collected. To avoid sharing of ideas after the first evaluation, the students were immediately given other assignments to work on.

Results

It should be noted that the results were collected and compiled by the teaching assistants of each class. In order to avoid any identification of participating students, the data given in this paper has been combined from all classes. However, the pattern of the overall data closely matches that of the individual classes. The number of solutions per student, the standard deviation, and the total number of different types of solutions were determined for each set of questions. As can be seen in the Appendix, some solutions were very similar. It was sometimes difficult to define a "different" solution. Some seemed too similar and were combined, while others were left as different solutions. It is up to the individual to decide if jumping into a (presumably, stationary) pile of feathers is really different than jumping onto the back of a (presumably, mobile) truck filled with feathers. In this respect, the actual number of different solutions can not be known for sure, but the results show a clear pattern despite a few uncertainties.

There was some difficulty in determining the exact number of students participating. This is because in some cases, a student was absent or not registered in the course on one of the two days that the evaluation was conducted. This did not occur frequently, however, and has little impact on the overall trend shown by the results. According to our data, it is about six students out of about 130 participants.

Summary of Results

The detailed listing of all of the students' responses can be found in the Appendix. It should be referred to in order to note the creativity and variety that was produced by the students. Tables 1

and 2 summarize the results for each question. “Before” refers to the evaluation given towards the beginning of the class and “after” refers to the evaluation given near the end of the course.

Where Are You?

Average Number of Students	Total Number of Different Solutions (Before)	Total Number of Different Solutions (After)	Average Number of Solutions Per Student (Before)	Standard Deviation (Before)	Average Number of Solutions Per Student (After)	Standard Deviation (After)
63	79	166	5.742	1.78	12.781	2.23

Table 1: Overview of results from “Where Are You?” question

The Jumping Problem

Average Number of Students	Total Number of Different Solutions (Before)	Total Number of Different Solutions (After)	Average Number of Solutions Per Student (Before)	Standard Deviation (Before)	Average Number of Solutions Per Student (After)	Standard Deviation (After)
64	94	220	4.969	1.34	12.25	1.63

Table 2: Overview of results from “The Jumping Problem” question

The following table depicts the number of students from each individual class that answered the given questions. The different numbers of students between “before” and “after” in a given class result from students being absent during one of the evaluation days.

Number of Students From Each Class

Class	Before	After	Question
ESP 2001	10	10	Where Are You?
ESP 2001	10	10	The Jumping Problem
AAI 2001	7	7	Where Are You?
AAI 2001	6	6	The Jumping Problem
ESP 2003	11	11	Where Are You?
ESP 2003	12	11	The Jumping Problem
AAI 2003	9	9	Where Are You?
AAI 2003	9	8	The Jumping Problem
College 2004	14	15	Where Are You?
College 2004	15	17	The Jumping Problem
ESP 2004	11	12	Where Are You?
ESP 2004	12	12	The Jumping Problem

Table 3: Breakdown of participants by question and class

Analysis of Results

The data shows a definite trend of an increase in ideation. On average, students generate more than twice as many solutions after completing the course. The quality of the answers were not considered in this study. It was the case that some students produced fewer, but more thoughtful or elaborate answers, while others had many short solutions. Each student interpreted the questions individually. One interesting note about the resulting solution is that one student described the location of the man to the buildings given as the image on the handout. This means that the use of only text, only pictures, or both to present the problem could alter the number and type of results produced. All of the students involved here, however, were given identical sheets on the same color paper as shown previously.

The increase in average number of solutions per student was 2.23 fold for the average number of solutions generated by the students for the “Where Are You?” problem. In addition, a total of 87 new solutions were generated by our classification. This means that the number of independent ideas doubled. There was a similar trend for “The Jumping Problem.” On average, 2.47 times more solutions per student were generated between the first and second evaluation periods. Similarly to the first problem, the number of new solutions doubled with an increase of 126 ideas. Even with somewhat of a large variance in deciding what is a “different” solution, there is clearly an increase in the number of different solutions produced as a whole. Overall, the results show a doubling in ideas generated.

Conclusion

Although we can be certain that students create more solutions in general, what causes this change is only speculated. Many diverse factors including the exposure to idea-creation methods, increased confidence, reduction in the need to please the professor, possible increased cognitive reasoning due to hands-on activities, team and communication exercises and the particular classroom environment that the course creates are all possible reasons for this trend. We believe that the combination of these may be the main factor.

This research shows a clear indication that it is possible to enhance ideation through some type of classroom instruction. The number of unique ideas produced as a whole doubled, and the number of ideas per student on average more than doubled. While the exact ingredients for such instruction that led to the meaningful increase can not be clearly determined by the evaluation conducted, we believe that the described environment was very beneficial.

The atmosphere and freedom to think freely were likely conducive to this increase. At the start of class, students were focused on trying to please the teacher in order to obtain high marks. The students generally asked a lot of questions and looked for specific directions. In addition, they tried to “follow the rules” and looked for the “right” answer. When specific rules and directions were not provided in nearly all cases, they gradually began to think more openly and came up with ideas that they would have previously considered as “unacceptable” solutions.

As the class progressed, students were observed to be more open-minded. They developed better teaming and communication skills. In addition, they began to think more independently, learned how to work at their own pace, and produced work pleasing to themselves rather than work to please the professor. Overall, the students were joyous and excited to see what would be next. Not only did they learn to develop more ideas, but they also developed important interpersonal skills and how to have fun in the process.

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Appendix

There are eight detailed tables included in this appendix. The four large tables list the individual responses and how many students generated a specific response. There are two tables for each question – one for “before” and one for “after”. The “before” table of each question shows the responses from the students during the beginning of the class. The “after” tables show the responses to the questions towards the end of the class. Preceding each of these large tables is a small summary table showing pertinent numerical data.

Data from “Where Are You?” Question Given at the Beginning of the Course

Where Are You? (Before)			
Number of Students	Number of Solutions	Solutions per Student (Mean)	Standard Deviation
62	356	5.742	1.78

	Solutions	Number of Students With This Solution
1	Ask someone	45
2	Look around for popular landmark	19
3	Use GPS	19
4	Listen to the accents and dialects	17
5	Look for street signs	17
6	Look at the newspaper	14
7	Observe the weather	12
8	Ask a policeman	11
9	Look in the phone book	11
10	Look at a map	10
11	Look at the license plates on cars	10
12	Ask the telephone operator	8
13	Look around	8
14	Look at the structure of the buildings around you	8
15	Look for a national monument	8
16	Look at the arrangement of the sun and stars	7
17	Open a mailbox and look at the address	7
18	Ask the navigation system in the car	5
19	Observe the kinds of trees and vegetation	5
20	Determine if rural or urban	4
21	Look at name of shopping plaza / store	4
22	Look at the type of clothing people are wearing	4
23	Look for "Welcome to ..." sign	4

24	Look for any signs	4
25	Observe local wildlife	4
26	Observe the weather	4
27	Ask for the area code	3
28	Ask the post office	3
29	Find the border / ocean and determine how far you traveled	3
30	Identify latitude and longitude	3
31	Look at a compass	3
32	Look for local business	3
33	Look for police car / school bus with location on side	3
34	Observe landforms	3
35	Remember where you are going	3
36	Use a computer to find out where you are	3
37	Watch the news on TV	3
38	Ask a government official	2
39	Call 911	2
40	Look at the culture around you	2
41	Look at the different types of festivals or parties that people throw	2
42	Look for a "You are here" sign	2
43	Look for a billboard	2
44	Look for a public building for a "City of ..." sign	2
45	Look for a state flag	2
46	Look for the closest airport	2
47	Look for the zip code	2
48	Look in a local magazine	2
49	Use phone to call friend and ask for area code on caller ID	2
50	Ask a real estate agent	1
51	Ask a taxi driver	1
52	Describe the location to other people	1
53	Eat at a local restaurant	1
54	Find out what time zone it is	1
55	Go back in time and see the founder	1
56	Guess	1
57	Identify from a relative place	1
58	Know where you are	1
59	Listen to the radio	1
60	Look around	1
61	Look at a directory	1
62	Look at an emergency vehicle sign	1
63	Look at the kind of money people are carrying	1
64	Look at the library	1
65	Look for a national park	1

66	Look for religious symbols	1
67	Look for saltwater or freshwater	1
68	Look for the social security number of people	1
69	Look for tourism item for the name of city	1
70	Observe the driving behavior	1
71	Observe the wind direction	1
72	Report yourself as a missing person and watch the news for the last known location	1
73	Sacrifice an animal for an answer from the gods	1
74	See what people eat	1
75	See what type of industry is going on	1
76	Start a fire so the firemen can tell you where you are	1
77	Threaten people until a sheriff comes and ask him/her	1
78	Use a spy satellite	1
79	Use boyscout/girlscout survival skills	1

Data from “Where Are You?” Question Given Towards the End of the Course

Where Are You? (After)			
Number of Students	Number of Solutions	Solutions per Student (Mean)	Standard Deviation
64	818	12.781	2.23

	Solutions	Number of Students With This Solution
1	Ask someone	64
2	Look at any street signs	40
3	Look for any familiar monuments or buildings	38
4	Buy a map	34
5	Look at the license plates of cars	26
6	Use GPS	26
7	Watch television	26
8	Listen to the peoples' accent around you	24
9	Call someone and have them look at your area code on caller ID	20
10	Look at the temperature / climate	20
11	Look for a police car that displays the name of the city	20
12	Look in a phonebook	18
13	Open a mailbox and look for the address	16
14	Look for the closest airport	15
15	Check the Internet to see where you are	14
16	Listen to the radio	13
17	Look at a newspaper	13
18	Look at the wildlife and vegetation	13
19	Look around for popular landmarks	12
20	Call the information center	11
21	Find the border or ocean and trace back how far you went	11
22	Look at the scenery / landscapes	11
23	See what type of clothing people are wearing	9
24	Explore until you know where you are and recognize things	8
25	Go up high in plane or helicopter to determine the type of land around you	8
26	Look at the stars	8
27	Look in an atlas	7
28	Use the Onstar system	7
29	Look at the telephone area code	6
30	Look at your plane ticket	6
31	Use a compass	6
32	Call the operator	5
33	Eat at a restaurant to see what food the city is known for	5
34	Get arrested and go to the county jail	5
35	Guess	5
36	Look for a "You are here" sign	5
37	Look for a highway or interstate	5

38	Look for a local taxi	5
39	Look for a post office	5
40	Look for a public building for a "City of ..." sign	5
41	Look for a satellite image of the area	5
42	Look for saltwater or freshwater (Water characteristics)	5
43	Send a letter to your home and check the postmark	5
44	Take the local public transportation to be able to recognize certain areas	5
45	Watch the weather channels	5
46	Cross into a new state and look at the sign	4
47	Find out the zip code	4
48	Find the city limit sign and read it	4
49	Look at local businesses	4
50	Look for a "Welcome to ..." sign	4
51	Look for a billboard	4
52	Look for the state flag	4
53	Retrace your steps	4
54	Compare the time difference from home	3
55	Look at how people drive	3
56	Look at the names of shopping centers and stores	3
57	Look at the sun positions	3
58	Look at the tourist information at a hotel	3
59	Look for business cards	3
60	Look for someone's ID	3
61	Look for state colleges	3
62	Look for tourism item for name of city	3
63	Observe local crops	3
64	Observe technology usage	3
65	Observe the other side of the earth	3
66	Observe the season and sun location	3
67	Start a fire and ask fire rescue	3
68	Use dog senses	3
69	Wake up from dream	3
70	Ask an alien	2
71	Buy a house and look at the papers	2
72	Buy something from a store that indicates the address	2
73	Call the FBI	2
74	Determine if the area is rural or a city	2
75	Do something crazy - then watch the news and find out where you did it	2
76	Find the nearest hospital	2
77	Fly to outer space and observe	2
78	Go to the next town	2
79	Locate the latitude and longitude of the area	2
80	Look for a national park	2
81	Look for a police or fire department	2
82	Look for a sport logo	2
83	Look for a train station	2
84	Look in a local magazine	2
85	Observe anthropology threats	2

86	Observe the local culture	2
87	See how many casinos there are	2
88	Use time machine to back a few days before	2
89	Wait for someone to look for you	2
90	Walk along the railroad track	2
91	Ask a bus driver	1
92	Ask someone in a local house	1
93	Ask someone on a CB radio	1
94	Ask someone on a HAM radio	1
95	Ask the children	1
96	Ask the friend who drove you	1
97	Attach a sign "Remind me where am I" on your back	1
98	Be smarter and realize by yourself	1
99	Become a secretary and look at addresses in files	1
100	Become a taxi driver	1
101	Become telepathic / psychic	1
102	Call 911	1
103	Call a movie theater and get directions	1
104	Compare the similarities and differences from your hometown	1
105	Determine the types of local industries	1
106	Find a congressman name to indicate district	1
107	Find a friend	1
108	Find out where you are not	1
109	Find the state capital	1
110	Flush the toilet	1
111	Follow clues like a scavenger hunt	1
112	Get a ticket and look at that	1
113	Go home	1
114	Go to a gathering	1
115	Go to concert and let singer tell you	1
116	Have Homeland Security pick you up - they will tell you during the interrogation	1
117	Hold up a sign "where am I?" until someone tells you	1
118	Hurt yourself and go the hospital	1
119	Identify from the unique characteristics	1
120	Just stay (Don't worry about where you are)	1
121	Knock on someone's door and ask	1
122	Know where you are going	1
123	Let local people know that you don't know where are you	1
124	Listen the local music	1
125	Listen to zip-code at store cash register	1
126	Look at the economic status of the city	1
127	Look at the power on the wall outlet	1
128	Look at the state lottery in gas station	1
129	Look at the type of people that are around you	1
130	Look at your feet	1
131	Look for a car dealership	1
132	Look for a city park	1
133	Look for a sports stadium	1

134	Look for a state dog tag	1
135	Look for a subway station	1
136	Look for a tourist attraction	1
137	Look for farm animals	1
138	Look for local ads	1
139	Look for pay-phone booths	1
140	Look for the county that you are in	1
141	Look for the school district	1
142	Look for theme parks	1
143	Look in gift shops that might attract tourists	1
144	Look when someone fills out an application form	1
145	No Solution	1
146	Observe structures	1
147	Observe the distance between two cities	1
148	Observe the hobbies of local people	1
149	Observe the kinds of cars	1
150	Observe the local history	1
151	Observe the local law	1
152	Observe the population density	1
153	Observe the soil	1
154	Observe the wind	1
155	Pray	1
156	Report yourself as a missing person	1
157	Send a signal to ask	1
158	Shoot a laser and observe the angle of reflection	1
159	Take a train and look at the map inside	1
160	Trade something for someone to tell you where you are	1
161	Use a hot-air balloon	1
162	Use a pedometer and walk to Canada - find your location	1
163	Use a satellite phone	1
164	Walk around until you figure it out	1
165	Wave down a car	1
166	You know you are in the USA	1

Data from “The Jumping Problem” Question Given at the Beginning of the Course

The Jumping Problem (Before)			
Number of Students	Number of Solutions	Solutions per Student (Mean)	Standard Deviation
64	318	4.969	1.34

	Solutions	Number of Students With This Solution
1	JJ was a stuntman and jumped on something soft	27
2	JJ jumped down with a parachute	21
3	JJ landed in his pool that was very deep	15
4	JJ didn't stay in his apartment	13
5	JJ jumped from inside and landed on his balcony	13
6	JJ landed on a trampoline	13
7	JJ jumped onto the fire escape	12
8	JJ was bungee jumping	9
9	JJ jumped from someone else's apartment	7
10	JJ jumped up and landed in his apartment	7
11	JJ was a bird	7
12	JJ was a cat	7
13	JJ was able to safely land on his feet	7
14	JJ was caught by a fireman	7
15	JJ didn't open the window	6
16	The building was on the moon	6
17	JJ didn't jump out of window	5
18	JJ jumped down to the trees	5
19	JJ jumped from the first floor	5
20	JJ landed on ZZ and ZZ is dead	5
21	No Solution	5
22	The building was an underground building	5
23	JJ fell on an overhang	4
24	JJ jumped in place	4
25	JJ jumped to a rope or ladder and slid down	4
26	JJ landed in a garbage dumpster	4
27	JJ landed on a bush	4
28	JJ thought he was superman and could fly	4
29	JJ had a hang-glider	3
30	JJ jumped to an awning	3
31	JJ was caught by superman	3
32	The floor numbers were reversed	3
33	There was no gravity, so he could not be hurt	3
34	Gravity in that area was very low	2
35	JJ grabbed the window	2
36	JJ jumped back into the apartment	2
37	JJ jumped on another building	2

38	JJ jumped to the next window across from him	2
39	JJ landed onto a fire blanket	2
40	JJ lives in the matrix and there is no apartment	2
41	JJ was a superhero	2
42	JJ was killed	2
43	The building was on a hill and he did not have far to fall	2
44	ZZ caught him	2
45	He jumped to a flag pole	1
46	JJ fell on a truck of marshmallows	1
47	JJ fell to a painters stand	1
48	JJ fell to a pile of leaves	1
49	JJ flew down to the ground	1
50	JJ had a cable to hold him	1
51	JJ had a miracle happened to him	1
52	JJ had an experience to protect himself	1
53	JJ had internal bleeding	1
54	JJ had on loose fitted clothes which guided him to the ground	1
55	JJ is a hologram	1
56	JJ jumped but he felt no pain	1
57	JJ jumped closer to the window	1
58	JJ jumped from the sixth floor to the fifth floor	1
59	JJ jumped in his imagination	1
60	JJ jumped in spirit	1
61	JJ jumped next door	1
62	JJ jumped out 1 floor, but climbed down the rest	1
63	JJ jumped sideways	1
64	JJ jumped to his patio	1
65	JJ jumped to the outside of the door	1
66	JJ just acted like he was going to jump	1
67	JJ landed on a giant eagle	1
68	JJ landed on a thick layer of grass	1
69	JJ landed on bail or straw	1
70	JJ landed on open truck full of feathers	1
71	JJ landed on people	1
72	JJ landed on someone	1
73	JJ landed on ZZ	1
74	JJ lived on a midget apartment so he was not hurt when he jumped	1
75	JJ opened a different window	1
76	JJ used bed-sheet as parachute	1
77	JJ was a ball of energy	1
78	JJ was a flying squirrel	1
79	JJ was a freak of nature	1
80	JJ was a kangaroo	1
81	JJ was a toy and cannot get hurt	1
82	JJ was an ant	1
83	JJ was an exoskeleton man	1
84	JJ was an orangutang	1
85	JJ was caught by a big balloon	1

86	JJ was wearing clothing that protected him from the fall	1
87	JJ who jumped was not the same JJ that ZZ knew	1
88	JJ wore spring shoes	1
89	JJ's building sucked him back in	1
90	JJ's room is connected to a lower level window	1
91	Someone caught JJ before he fell	1
92	ZZ thought JJ jumped but he did not	1
93	ZZ was dreaming	1
94	ZZ was hallucinating	1

Data from “The Jumping Problem” Question Given Towards the End of the Course

The Jumping Problem (After)			
Number of Students	Number of Solutions	Solutions per Student (Mean)	Standard Deviation
64	784	12.250	1.63

	Solutions	Number of Students With This Solution
1	JJ used a parachute	47
2	JJ landed in water	29
3	JJ landed in something soft	25
4	JJ was lying and didn't really jump	25
5	JJ was bungee jumping	21
6	JJ jumped to a lower floor	17
7	JJ landed on a trampoline	17
8	JJ was a bird	17
9	JJ was a cat and landed safely on his feet	17
10	JJ was a stunt man	17
11	The window was a fire escape	16
12	JJ could fly	14
13	JJ had a jet pack or rocket	14
14	JJ tied a rope around himself and lowered himself to the ground	14
15	The building was underground so the sixth floor was at ground level	14
16	JJ was a superhero	13
17	JJ was already dead	13
18	JJ landed on a garbage truck	12
19	JJ landed in a net	10
20	JJ lived in a midget/dwarf apartment that was half the size as a normal building	10
21	JJ had a hang-glider	9
22	JJ used a ladder to climb down	9
23	JJ grabbed onto the water drain pipe	8
24	JJ jumped to helicopter	8
25	JJ jumped to next building	8
26	JJ was on the first floor and jumped	8
27	JJ caught his shoe lace on the side of the window	7
28	JJ jumped backwards	7
29	JJ landed on trees	7
30	JJ landed on ZZ	7
31	JJ was Spiderman and climbed down safely	7
32	There was a slide on the side of the building and JJ went down it	7
33	ZZ thought he saw JJ jump out of the window	7
34	JJ jumped in his own apartment	6
35	JJ jumped out of an indoor window	6
36	JJ landed on a window on a lower floor	6
37	JJ was immune to gravity	6

38	Someone caught JJ	6
39	Superman saved JJ	6
40	The building was on the moon	6
41	A fireman caught JJ	5
42	Each floor was only one foot high	5
43	JJ fell in the bushes	5
44	JJ is invincible	5
45	JJ was a set of twins	5
46	JJ believed he was a god and could not get hurt	4
47	JJ held onto the ledge	4
48	JJ jumped back inside	4
49	JJ jumped down onto the balcony below one by one	4
50	JJ jumped to a flying car	4
51	JJ jumped to helium balloon	4
52	JJ landed on someone	4
53	JJ was a cartoon character	4
54	JJ was using suction cups to walk down the side of the building	4
55	JJ was ZZ's imaginary friend	4
56	The building was built on a hill and JJ did not have far to fall	4
57	JJ had an experience to protect himself	3
58	JJ jumped into a pile of clothes	3
59	JJ jumped into his spaceship	3
60	JJ jumped to scuffling	3
61	JJ landed on an open truck full of features	3
62	JJ was hurt, but by the time ZZ got there he was OK	3
63	JJ was in a bubble and bounced back up	3
64	JJ's building is a dollhouse and JJ is a doll made of plastic	3
65	ZZ caught JJ	3
66	Angel saved JJ	2
67	Doctor on the ground fixed JJ immediately	2
68	It was a video game and JJ was an animated character	2
69	JJ fell onto a tent	2
70	JJ had a blast of air so strong it blew him back into his apartment	2
71	JJ had an anti-gravity belt	2
72	JJ had something to slow his descent	2
73	JJ had wings	2
74	JJ is a robot that cannot be hurt	2
75	JJ is in a movie and there is no such thing as a 6th floor apartment	2
76	JJ jumped onto large construction equipment	2
77	JJ landed in an ocean	2
78	JJ landed in an opened sewer	2
79	JJ landed in the arms of some cheerleaders	2
80	JJ landed on a carnival moonwalk	2
81	JJ landed on a flying carpet	2
82	JJ landed on a giant eagle	2
83	JJ landed on a hay stack	2
84	JJ landed on a pile of feathers	2
85	JJ landed on an open truck with full of hay	2

86	JJ opened the window in the corridor	2
87	JJ threw a dummy out of window	2
88	JJ used an umbrella to hover down	2
89	JJ was lucky	2
90	JJ was wearing a special suit that not let him get hurt	2
91	JJ wore spring shoes	2
92	JJ's building had burned to the ground so the 6th floor was the first	2
93	The building was sideways and all the floors were at ground level	2
94	The story is not complete	2
95	Wind helped him to fall slowly	2
96	Both JJ and ZZ were in virtual reality game	1
97	Both JJ and ZZ were insane people	1
98	Building had a lot of snow to 5th floor	1
99	Building had only one floor	1
100	Building was an underwater building	1
101	Building was flooded	1
102	Building was in space station	1
103	Building was not very high	1
104	Demon saved JJ	1
105	Ground was bounding rubber	1
106	His apartment was 6 stories high	1
107	It was a dream	1
108	It was not time for JJ to die	1
109	JJ can walk on air	1
110	JJ changed the charge of his body	1
111	JJ didn't hit the ground yet	1
112	JJ dove into a glass water cup	1
113	JJ drank a "Red-Bull" and it gave him "wings"	1
114	JJ fell just right	1
115	JJ floated down	1
116	JJ glided his way down	1
117	JJ grabbed an overhang	1
118	JJ had a blimp	1
119	JJ had a cushion	1
120	JJ had a mutant power	1
121	JJ had a new flying machine	1
122	JJ had a super watch	1
123	JJ had bouncing shoes	1
124	JJ had on anti-gravity boots	1
125	JJ had on special gear	1
126	JJ had strong bones	1
127	JJ had telekinetic power	1
128	JJ hovered in air	1
129	JJ is a ghost	1
130	JJ is a gymnast	1
131	JJ is an electronic airplane	1
132	JJ is like Rudolph the Red Nosed Reindeer	1
133	JJ jumped and grabbed 2nd floor escape	1

134	JJ jumped from a tied blanket to ground	1
135	JJ jumped in freight	1
136	JJ jumped in the room	1
137	JJ jumped into a hot air balloon	1
138	JJ jumped into the stairwell	1
139	JJ jumped on a windowsill	1
140	JJ jumped onto a crane	1
141	JJ jumped onto an elevator and rode it all the way down	1
142	JJ jumped sideways	1
143	JJ jumped to a cherry picker	1
144	JJ jumped to clothesline	1
145	JJ jumped to flagpole	1
146	JJ jumped to light-post	1
147	JJ jumped to log	1
148	JJ jumped to pipe and slide down	1
149	JJ landed in a manhole full of water	1
150	JJ landed in a pile of dirt	1
151	JJ landed in a river	1
152	JJ landed in snow	1
153	JJ landed in the arm of person	1
154	JJ landed on a baby carriage	1
155	JJ landed on a bed	1
156	JJ landed on a big bird	1
157	JJ landed on a big bird nest	1
158	JJ landed on a big pile of dust	1
159	JJ landed on a big umbrella	1
160	JJ landed on a car	1
161	JJ landed on a cart of pillows	1
162	JJ landed on a cloud	1
163	JJ landed on a convertible car	1
164	JJ landed on a group of cats	1
165	JJ landed on a group of chickens	1
166	JJ landed on a horse carriage	1
167	JJ landed on a jello pool	1
168	JJ landed on a laundry cart	1
169	JJ landed on a mayonnaise pool	1
170	JJ landed on a pile of boxes	1
171	JJ landed on a pile of dead people	1
172	JJ landed on a pile of wigs	1
173	JJ landed on a plane	1
174	JJ landed on a sandbox	1
175	JJ landed on a soft sofa	1
176	JJ landed on a soft spot	1
177	JJ landed on a some balloons	1
178	JJ landed on a tank of water	1
179	JJ landed on an open truck full of lettuce	1
180	JJ landed on Dumbo (flying elephant)	1
181	JJ landed on fish underwater	1

182	JJ landed on fuzzy fertilizer	1
183	JJ landed on giveaway	1
184	JJ landed on his feet	1
185	JJ landed on his friend	1
186	JJ landed on street dogs	1
187	JJ landed on tarps	1
188	JJ landed on the back of an elephant	1
189	JJ landed on the back of horse	1
190	JJ looked like he was alive	1
191	JJ opened the car window	1
192	JJ played a game	1
193	JJ slowed down time and was not hurt	1
194	JJ trained himself to jump out of 6th story buildings	1
195	JJ tried to clean the window	1
196	JJ was a Batman	1
197	JJ was a computer graphic	1
198	JJ was a doll	1
199	JJ was a flying squirrel	1
200	JJ was a kangaroo	1
201	JJ was a lizard	1
202	JJ was a monkey and swung down	1
203	JJ was a pain-free person	1
204	JJ was a stuffed animal that came to life and landed without getting hurt	1
205	JJ was an alien	1
206	JJ was blind	1
207	JJ was committing suicide	1
208	JJ was deep sea diving	1
209	JJ was disabled and could not jump	1
210	JJ was grabbed by alien	1
211	JJ was jumping in bed	1
212	JJ was on a pogo stick	1
213	JJ was six stories tall	1
214	JJ was stuck at the window	1
215	Someone else was disguised as JJ	1
216	The numbers on the floors were backwards: Biggest to Smallest	1
217	There were two JJs	1
218	ZZ called for help	1
219	ZZ did not think JJ was hurt	1
220	ZZ misidentified JJ	1