A comparison of problem solving strategies in gifted versus regular students during a small group computer activity.

Nancy Walthall

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A COMPARISON OF PROBLEM SOLVING STRATEGIES
IN GIFTED VERSUS REGULAR STUDENTS DURING
A SMALL GROUP COMPUTER ACTIVITY

A Project Submitted to
The Faculty of the School of Education
In Partial Fulfillment of the Requirements of the Degree of
Master of Arts
in
Education: Elementary Option
By
Nancy Walthall, M.A.
San Bernardino, California
1984

APPROVED BY:
[Signature]
Advisor

[Signature]
Committee Member
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>LITERATURE REVIEW</td>
<td>1</td>
</tr>
<tr>
<td>PURPOSE</td>
<td>6</td>
</tr>
<tr>
<td>SAMPLE</td>
<td>7</td>
</tr>
<tr>
<td>METHOD</td>
<td>7</td>
</tr>
<tr>
<td>METHOD OF ANALYSIS OF DATA</td>
<td>10</td>
</tr>
<tr>
<td>RESULTS</td>
<td>14</td>
</tr>
<tr>
<td>CONCLUSIONS AND DISCUSSION</td>
<td>19</td>
</tr>
<tr>
<td>IMPLICATIONS</td>
<td>21</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>23</td>
</tr>
<tr>
<td>APPENDIXES</td>
<td></td>
</tr>
<tr>
<td>A. INTERACTION DATA PROFILE</td>
<td>26</td>
</tr>
<tr>
<td>B. PROBLEM-SOLVING STRATEGIES</td>
<td>29</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>33</td>
</tr>
</tbody>
</table>
ABSTRACT

Problem-solving skills were examined as small groups of elementary students interacted during a computer problem-solving activity. Academically superior students ("gifted") were compared to students who were less than academically superior ("regular") on the following variables: the elaboration and use of ideas that pointed to the development of specific problem-solving strategies, completion of task, and interaction patterns. The procedure involved arranging the students in groups of three. All triads were given the same problem to solve on the computer. Think-aloud protocols were gathered as the students interacted. The data was analyzed regarding interaction and problem-solving strategies. The results indicated that the "gifted" students were apparently better equipped for solving problems than the "regular" students on a more frequent basis. Two possible reasons for these results were: greater cooperation among group members and more frequent and elaborate use of problem-solving strategies.
The decor of various educational settings has changed in the past decade. Counter tops have been cleared, tables and chairs sought after, and corners reconstructed, all in preparation for the invasion of advanced technology, the microcomputer. Invasion may be an understatement for some educators. Teachers are hesitant to use the computer due to unfamiliarity (Kulik, 1983). Those who see their primary role as that of lecturer-information giver feel threatened, and one of the greatest concerns is that of job security (Clement, 1981). Actually, there is no evidence that a computer has replaced or will replace a human being in education. Findings support that the computer does not replace traditional instruction: rather, it simply supplements it (Anderson, Klassen, Hansen, et al., 1981).

In what manner does computer-assisted instruction (hereafter abbreviated CAI) supplement traditional instruction? Bracey (1982) notes that achievement outcomes are what most people think of when CAI effectiveness is considered. However, social outcomes are of equal significance. According to Bracey, the opinion of many educators is that more collaborative, cooperative, and problem-solving behavior is present during group-computer activities than in almost any other school activity. Students tend to
focus on the computer-related goals rather than on their own personal need for attention. The interaction is stimulating. The fear of computers "dehumanizing" society because of the "isolation effect" is not well grounded. Bracey states that more and more "group oriented" computer programs are being written to encourage student interaction.

The value of computers in enhancing group interaction and problem-solving behavior has gone beyond opinion. Research is supporting the theory also. Two studies (Stodolsky, 1979, and Hawkins, Sheingold, Gearhart, et al., 1982) examined the effects of the computer in these areas and produced similar findings.

Stodolsky's purpose was to facilitate interaction between four-member problem-solving teams through the use of a computer mediation system. Male undergraduate students were tested and labeled as highly assertive, moderately assertive, moderately shy, and highly shy. Homogeneous groups of four were formed according to personality type and were given instructions to talk aloud while solving problems during a computer activity. Group members could only speak if the computer mediation system allowed the opportunity. The operation was set up so the shiest person in the group was given the most opportunities to speak. In conclusion, the computer-experimental system had an effect on enhancing interaction in some groups.

Hawkins, Sheingold, Gearhart, et al. observed the level of interaction among children who were learning to program LOGO on a computer. The elementary students were
placed in two settings: programming LOGO on the computer, and participating in teacher, non-directed activities such as math, language, and map-making activities. An observation system was used to code the types of student interaction during the stated activities. The results found that there were more frequent occurrences of task-related talk and collaborative episodes around the computer than at any other time. The study was a little weak in that the excitement of working at the computer and doing the other activities was an unbalanced comparison. Nevertheless, the computer activity was successful in enhancing student interaction.

Studies have also shown that the computer can encourage problem-solving skills with individuals as well as groups. Reynolds and Simpson (1980), and Johnson, Willis, and Danley (1982) discovered the value of using computer simulation as an instructional tool in teacher education programs. The purpose for both studies was to research the effectiveness of teachers solving problems while working with the simulated classes. The use of the computer in teaching the problem-solving skills proved to be very effective.

Ellinger and Frankland (1976) used college students in a geography course to further examine the value of computer simulation in teaching problem-solving skills. The students were divided into two groups receiving either CAI or traditional, lecture-exercise instruction. The results revealed that CAI as well as traditional instruction
were of value in teaching problem-solving skills.

According to Gallini (1983), the implementation of computers into the classroom can provide a broad range of experiences in the area of problem solving.

1. They can provide structure which allows students to select, discover, and test alternative strategies for solving problems.

2. Motivation and experimentation are enhanced due to lack of fear in making mistakes.

3. Interaction between the tutor (computer) and the student provides continuous feedback.

It appears, then, that the computer has been proven to be a resourceful tool for encouraging both group interaction and problem-solving behavior. Because the study presented in this paper is interested in comparing "gifted" and "regular" students in group problem-solving processes, a computer activity serves as an ideal stimulus.

Group Interaction: A Stimulus for Problem-solving Behavior

Numerous researchers have found the interaction of groups to be closely linked to product and performance during problem-solving situations. For instance, group cohesiveness (Courtright, 1976), brain-storming (Gallicchio, 1976), and semantics (Hebert, 1982) are elements of interaction that have been proven to affect final problem solutions. Additionally, Pendergrass and Hodges (1976) examined the interaction processes and problem-
solving behaviors of a group of deaf students. The results found the deaf students to be weak in the area of group problem solving due to lack of maturity in the area of questioning skills and positive social skills such as encouragement of the ideas of others.

**Problem Solving Strategies**

The use of computers and the analyzing of group interaction are of value in the present study due to their impact on problem-solving behavior. The primary focus in this research is aimed at the possible development of strategies as "gifted" and "regular" students solve problems. The methods and patterns behind problem-solving behaviors, therefore, are of great interest.

According to Nash (1975), it has been historically assumed that the products of creative thinking were chance occurrences, the dynamics of which were so mysterious that any attempt to gain scientific understanding would prove meaningless. In recent years, however, research has suggested that discoveries, inventions, and other products of divergent thinking do involve systematic idea generation. Nash states that studies of the creative problem-solving process have led to numerous methodologies and activities aimed at training and enhancing creative production.

Studying the thought patterns of creative students with high aptitudes was the purpose behind Bloom and Broder's research (1950). One group of college students was divided
according to aptitude scores. High achievers were compared with low achievers as they worked individually on a problem-solving activity. They were asked to talk aloud as they attempted to logically sequence a list of historical events. Their statements were recorded. The results found that four behaviors determined successful problem solution:

1. Understanding of the nature of the problem;
2. Understanding of the ideas contained in the problem;
3. General approach to the solution of the problem;
4. Attitude toward the solution of the problem.

**PURPOSE**

The purpose of the present study is to examine the problem-solving strategies that develop as small groups of elementary students interact while working on a computer assignment. Academically superior students ("gifted") will be compared with students who are less than academically superior ("regular") on the following variables: interaction patterns, elaboration and use of ideas that point to the development of specific problem-solving strategies, and completion of task.

The hypothesis is that the "gifted" students will differ in comparison to the "regular" students on the computer task in the following areas:

1. Positive and cooperative interaction (Nash, 1975);
2. Development of more elaborate and original ideas that point to the use of specific problem-solving strategies due to inherent creativity and cooperative interaction (Nash, 1975, and Pendergrass and Hodges, 1976);

3. Completion of task due to success in the two areas listed above.

SAMPLE

The setting was a public school in a small community in southern California. The subjects consisted of thirty-six elementary students between the ages of nine and ten. A variety of ethnic and socio-economic backgrounds was represented, with the greatest percentage of students coming from low-income families. Students were divided into two groups of eighteen each according to their academic ability, "regular" and "gifted." The "regular" group consisted of volunteers from a regular fourth-grade class. The "gifted" group consisted of volunteers participating in an adjunct fourth grade Gifted and Talented Education Program, having been previously admitted to same on the basis of teacher recommendation and high scores on the Wechsler Intelligence Test for Children - Revised, previously administered by the school psychologist. The "gifted" group was composed of ten girls and eight boys. Seven girls and eleven boys made up the "regular" group.

METHOD

Both groups were called together to observe a film before the experiment began. The film was a videotape that demonstrated pairs of people working together on
a computer. They were talking aloud and problem-solving while playing a game called "Artillery." The subjects who were watching were told that they would also be working on a computer to solve another type of problem in a similar manner. They were offered a candy treat if they chose to volunteer for the experiment. Each group of eighteen students was then subdivided into six groups of three students each. The students were allowed to choose who they would like to work with in the small groups of three.

Over a two-week period, each group was assigned one twenty-minute session for working on an Apple IIE computer. During that time they would be working with LOGO, an educational graphics computer language, invented by Seymour Papert. Specifically, the students would be using "turtle graphics." The "turtle" refers to a small arrow on the screen that is made to move using simple vocabulary words: "forward," "backward," "left," and "right." As the turtle moves, it leaves a trail that creates drawings and designs (Waddington, 1977, and Goldberg, 1984).

The students were given the specific assignment of deciding how to draw a six-pointed star such as this:

Before each group of three students began, they were given the following information.

1. They were shown the picture of the star which was removed from their sight after one minute.

2. They were told that they had twenty minutes
to draw the star using the following instructions which were listed on the computer screen and could be referred to at any point in the problem-solving activity:

F - "Forward"
B - "Backward"
R - "Right"
L - "Left"
C - "Clear"
S - "Stop"
? - "Print instructions"
E - "Erase the last thing you drew."

3. They were allowed to play with the "turtle" to gain familiarity.

4. They were instructed to think aloud as they performed the task so their actions and reasons for the actions would be recorded.

5. The tape recorder was turned on and students were reminded to speak clearly so their voices would be heard, as the tape was the only record of data besides the teacher viewing the finished product.

The classroom setting proved to have limitations in that there was a certain amount of background noise and interruption. Also, there was no opportunity for visual observation of the group interaction. The only non-verbal clues that could be examined were those that were picked up by the tape recorder, and included sighs, laughter, and tone of voice.
Analysis of Group Interaction

Several interaction profiles were selected for analyzing group interaction. Pendergrass and Hodges (1976) used the Interaction Process Analysis (IPA) as the method for developing an interaction profile. This research used the IPA also because it was designed specifically to study the interactions of persons involved in small group settings. The IPA, developed by Bales (1970), has a standardized set of twelve categories including: solidarity, tension release, agreement, suggestion giving, offering of opinions, information giving, asking for information, asking for opinion, asking for suggestions, disagreement, show of tension, and show of antagonism. These categories can then be grouped into four major sections for another level of analysis. They include: positive social-emotional area, neutral task area (answers), neutral task area (questions), and negative social-emotional area. All of these areas were evaluated, including a few added categories: organizational behaviors, competitive behaviors, and signs of boredom.

Analysis of Problem-solving Strategies

The general approach to the solution of a problem is the focal point for this research. Numerous problem-
solving strategies have been defined and labelled. This study has chosen ten strategies from various sources to serve as a foundation for understanding patterns of thought used by the subjects as they perform the computer assignment. The strategies include:

1. **Lateral Thinking** — The process of getting rid of dominant ideas and searching for new ways of looking at a problem; the production of new ideas that are simple, sound, and effective (DeBono, 1967).

   Example: Instead of looking at the walls of a house as support for the roof, the walls may be considered as suspended from the roof.

2. **Vertical Thinking** — The careful construction of a theory by logical means; a step-by-step process; high probability thinking determined by past experiences and present needs (DeBono, 1967).

   Example: A computer proceeds in a line of vertical thinking as it carries out the commands step-by-step that it has been programmed to follow.

3. **Means-ends Analysis** — The assessing of the difference between the current state of knowledge required for solving the problem and the knowledge necessary for solution, and then selecting an action that will reduce the difference and so on until the problem is solved (Tuma and Reif, 1980).

   Example: In solving an unknown equation, one can assess the difference between an unknown equation and a known equation and take steps to reduce the difference.
4. **Planning Strategy** - The replacement of the original problem with an abstracted version while retaining central features. That is, form a solution using the simplified version of the problem and then return to the original problem using the same basic solution to solve it (Tuma and Reif, 1980).

Example: In solving math word problems, change the numbers to simple figures and then decide the method necessary for solution. Return to original numbers and use same method.

5. **Goals and Subgoals Strategy** - Break the problem into subgoals. Achieve the subgoals and apply knowledge to achievement of the main goal (Tuma and Reif, 1980).

Example: In reducing the fraction 16/18, one could list the factors of 2 as a subgoal.

6. **Abstract Coding** - Represent the problem in terms of abstract codes, attempting to state it as verbal or mathematical symbols or analyzing it into attributes and recombining the attributes (Anderson, 1980).

Example: One thinks differently about the names of things than the things themselves, therefore the expression of a problem in written or spoken word is a technique for coding the problem in different terms, i.e., verbal terms.

7. **Concrete Coding** - Represent the problem in terms of concrete codes, translating it into actions,
pictures, or analogies (Anderson, 1980).

Example: Solving of a problem in terms of your own actions, such as writing the letters of an anagram on slips of paper and moving the slips of paper around with your fingers.

8. **Working Backwards** - The best place to start solving a problem is at the point of highest constraint, a point that narrows down the search as much as possible. Sometimes this point is at the "end" of a problem (Anderson, 1980).

Example: In the game of chess, there is a point where one can consider possible checkmate positions. This is a time when working backwards is appropriate.

9. **Classification Strategy** - The selection of important attributes for initial consideration. The breaking down of the problem into sub-problems in order to learn something about the final solution (Anderson, 1980).

Example: In the game of chess, classification can be helpful in the elimination of alternatives. For example, if one of your pieces is being attacked by a knight, you can eliminate the consideration of placing a piece between the knight and the attacked piece because knights can jump over other pieces.

10. **Hillclimbing** - The consideration of where you are and where you would like to be, and then deciding upon the action that will move you the closest to where you want to be (Anderson, 1980).
Example: Similar to a person climbing a hill in the fog. He climbs to the point he can see. He looks up again and climbs to the next visible point until he reaches the top.

Though these ten strategies overlap in some cases, they each hold interesting designs that will be looked for in the interaction of the groups of students in this study as they problem solve.

RESULTS

Comparison of Interaction Profiles

The data was analyzed in a subjective manner. One person listened to the recordings several times. During the final listening session, interaction profiles were recorded (Appendix pp. 26-23). For each student comment a mark was tallied in one of the twelve categories in Bale's IPA or in one of the three separate categories added by the researcher, including organizational matters, competitive inclinations, and signs of boredom. Records were not kept of who was making the comments. The comments from the twelve categories were then divided into four major sections and added up to form another section of the profile. Separate groups were analyzed. Averages of the six "gifted" groups and six "regular" groups were compared.

The results revealed that both "gifted" and "regular" groups had similar averages in the area of
positive social-emotional responses and the number of questions asked. However, the "regular" groups did have a higher average in the area of negative social-emotional responses and answering behavior. Groups 2 and 3 in the "regular" groups appeared to have the most difficulty with tension, anxiety, and disagreement. Group 3 in the "gifted" groups also scored high in the negative category.

"Regular" groups generally spent more time worrying about turn taking. Anxiety and frustration was apparent in groups 2, 3, and 6 over this matter. Group 1 spent a great deal of time organizing the turn situation, but they did so in a polite manner.

"Gifted" groups 1 and 3 were also concerned with turn taking, but in a light-hearted fashion.

A spirit of competition was not obvious in any of the "regular" groups, as no mention of the progress of any of the other groups was made, whereas three of the "gifted" groups (1, 3, and 5) were concerned with the success of other groups.

All "regular" groups were very serious about the task of drawing the star. They gave full attention to the job at hand with the exception of arguing over organizational matters. Two "gifted" groups were as serious (1 and 2). However, "gifted" groups 3, 4, 5, and 6 were aware of the task and wanting to complete it, but carrying on other activities and conversations at the same time.
For example, group 4 mentioned the need for two triangles in the beginning of the task and accomplished the goal very quickly while mentioning very little about what they were doing during the task. The task appeared to be very simple and boring to them. They read bulletin boards, planned schemes for getting candy out of the cupboard, discussed the meaning of the "turtle" on the computer, and acted very silly. Group 6 sang songs. Group 5 had light-hearted name-calling contests and plenty of silly behavior for gaining personal attention. Group 3 read bulletin boards and talked to others in the room. Yet, all "gifted" groups except group 5 completed the task.

Problem-solving Strategies

Most comments were not written down word for word, but were recorded for their frequency under an interaction category with a tally mark. However, verbal responses that appeared to have a strategy or logical pattern were copied down word for word in order to detect a tendency toward any of the ten problem-solving strategies that were under investigation (Appendix pp. 29-32). More specifically, responses were verbally recorded if they indicated a series of actions that led to a goal or sub-goal, if a move and the reason for the move was stated, or if more elaborate and original ideas were mentioned, such as the seeing of the triangles or mention of new ideas in the exploration of the problem. Comments such
as "Go left" or "Go up" with no reason for the direction were not recorded word for word. Evaluative statements without a solution (such as "That looks crooked," or "It shouldn't do that." ) also were not recorded word for word. The listing of the statements does not reveal who the speaker is, nor does it indicate if any of the statements are in response to one another.

The groups that spotted the two triangles ("regular" 2, 4, and 6, and "gifted" 1, 2, 3, 4, and 6) were showing hints of using elements of the following strategies:

1. Goals and Subgoals - The drawing of each triangle was a subgoal that generally led to the final goal of drawing the star.

2. Classification - Seeing the triangles in the star indicated the ability to break a problem down into important attributes in the process of reaching the final goal.

3. Abstract Coding - Seeing the star in terms of two triangles represents the ability to break down the larger picture into symbols that are easier to understand.

"Regular" group 3 and "gifted" group 1 evidenced the use of Concrete Coding in their mention of wanting to draw the star. Putting the star on paper other than just keeping it in their mind demonstrated the element of translating the problem into pictures, a new form.

Some Lateral Thinking was used in "gifted" groups 2 and 4. Group 2 was the only group to come up with a
solution for making the lines of the triangles more even. Their Lateral Thinking, or new way of looking at the problem, led then to the idea of counting the number of button pushes for one line and using the same number of pushes on the other lines. Group 4 looked at the project in a new manner by trying to formulate a scheme for uncovering the instructions on how to make the star. They typed in "LIST" on the computer, hoping it was the secret password to success.

The use of Means-ends Analysis was hinted at when "gifted" group 3 was discovering the method for getting from the step of having made one triangle to the step of beginning the next one. The discussion was on how to connect the two triangles, a step-by-step idea formulation on the way to the final goal of completing the star.

**Task Completion**

The groups that completed the task included "regular" groups 4 and 6, and "gifted" groups 1, 2, 3, 4, and 6. All groups that formed the star saw the two triangles and used more than one problem-solving strategy in completing the task. "Gifted" groups 1, 2, and 3 appeared to be the most elaborate in their approach to problem solution, as they each had numerous statements that demonstrated a purposeful series of thought. "Gifted" group 4 also elaborated in their use of the Lateral-
Thinking strategies.

All of the successful groups tended to be more cooperative in comparison to other groups by having lower scores in the negative social-emotional area and more fairness in turn taking. "Gifted" group 3 was an exception, as they demonstrated a high level of unfriendly behavior and disagreement. "Regular" group 6 was also an exception because of unfair turn-taking practices.

"Regular" group 2 was the only group that mentioned the triangles but was unsuccessful in drawing the star.

**CONCLUSIONS AND DISCUSSION**

Due to the nature of the topic under investigation, the methods of data collection and analyzation were very subjective. The observations and evaluations of one researcher are the foundation for the results of the study. Also, the sample size was very small, consisting of only thirty-six subjects. With these limiting factors in mind, one can draw the following informal conclusions.

The "gifted" students tended to demonstrate more cooperative behavior. For instance, they had fewer problems in the organization of turn taking. Possibly they felt more confident in the ideas of other group members, so there was less need to take over and manage the project alone. Also, the "gifted" students averaged fewer responses in the negative social-emotional area. This could imply a like-mindedness among these creative
students that allowed the group to be more unified in their direction. Another point that represented cooperation was the strong competitive spirit within some of the "gifted" groups. The concern over the success of other groups could have created greater unification in group purpose. Last of all, the fact that four of the "gifted" groups were engaged in a great deal of entertaining and silly behavior could indicate that the task was rather boring and simple for them. If this is the case, an easier task could further group cooperation because it would involve less frustration in achieving success.

The "gifted" groups were better equipped in using problem-solving strategies. Possibly inherent creativity could have contributed to their success. Also, "gifted" students have usually had more exposure and training in the area of problem-solving due to participation in special education programs for academically superior students. The one "gifted" group that did not complete the task appeared to have let their silly behavior interfere with their progress.

Success in group cooperation and use of problem-solving strategies probably were the two important factors that led to success in task completion for the "gifted" groups. Five out of six "gifted" groups were successful compared to two out of six "regular" groups.

All "gifted" and "regular" groups that were suc-
cessful had one basic factor in common. They all saw the two triangles in the star, thus evidencing the use of problem-solving strategies. All of the unsuccessful groups did not see the triangles except for "regular" group two. Two reasons may have interfered with task completion in this group. The subgoal of forming the triangles was mentioned, but little else was said about how to form them, connect them, and reach the final goal. A step-by-step process was not clearly understood. Additionally, the group had high marks in the negative social-emotional areas of tension, disagreement, and unfriendly behavior.

IMPLICATIONS

Though "teaching for thinking" has been a commonly-stated goal in American education, there is substantial evidence that it has not been widely achieved by our schools (Feldhusen and Treffinger, 1977). As the world is confronted by an increasing number of critical problems, the need for students to become educated in the area of creativity and problem solving becomes increasingly necessary.

What can be done? First of all, instructors can provide students with more opportunities that encourage problem-solving behavior. Students can be placed in special environments that stimulate creative thought. For example, some computer activities have
been proven to be a catalyst for enhancing the development of problem-solving skills. Group activities can provide the same stimulus.

However, providing a proper setting is not enough. Students need some tools. They need to learn specific strategies for solving problems. The "gifted" students who tend to have an inherent ability in this area can be given a greater understanding of the strategies and more practice in using them. Possibly these creative students could serve as models or tutors for encouraging creativity in other students. Students also need tools for improving group problem-solving skills. Organizational skills (e.g., turn taking) and social skills (e.g., encouragement of other group members) are two areas in which instruction is necessary.

Thinking can be improved. Anderson (1980) states that intelligence is a matter of methods, techniques, and procedures. Intelligence is as much a matter of what we do as of what we have.
BIBLIOGRAPHY


### APPENDIX A

Interaction Data Profile

Group Category - Gifted
Number of Groups - 6
Groups that Demonstrated Successful Task Completion - 1, 2, 3, 4, and 6

#### Interactions of Groups

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#### Interactions of Groups by Major Categories

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**EXPLANATION OF TABLES**

- 1 and 2 were taken from Bale's Interaction Process Analysis (1950).
- 12 categories in Table 1 are grouped into four major sections from Table 2. Table 3 was designed by the researcher of the present study.
Interaction Data Profile

Group Category - Regular
Number of Groups - 6
Groups that Demonstrated Successful Task Completion - 4 and 6

Interactions of Groups

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<tr>
<th>INTERACTION CATEGORIES</th>
<th>NUMBER OF COMMENTS</th>
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Interactions of Groups by Major Categories

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Interactions of Groups: Additional Categories

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Interaction Data Profile

Group Categories - Regular and Gifted
Number of Groups - 12
Group Averages for 6 Gifted Groups in Comparison with Group Averages for 6 Regular Groups

Interactions of Groups

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Interactions of Groups by Major Categories

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Interactions of Groups: Additional Categories

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PROBLEM-SOLVING STRATEGIES - DATA PROFILE AND ANALYSIS

Verbal Statements | Possible Strategies
---|---
**REGULAR GROUP 1 - UNSUCCESSFUL IN TASK COMPLETION**
"Move it down so we can go higher."
"Go like this, then this, then this." | Both statements seem to indicate that steps are being formulated for reaching a goal, but no goal is mentioned. A strategy is not clearly deciphered.

**REGULAR GROUP 2 - UNSUCCESSFUL IN TASK COMPLETION**
"We need a triangle."
"We need two triangles."
"A Jewish star has six points."
The discussion of star and the mention of the triangles indicates that the following strategies could have been used:
- Goals and Subgoals
- Abstract Coding
- Classification
Smaller steps for making the triangles are not verbalized.

**REGULAR GROUP 3 - UNSUCCESSFUL IN TASK COMPLETION**
"Hey, let's write this down."
"I'm just turning this around so you can go like that."
"The edge is supposed to do like that."
"You need to go right to make the edge go up."
A few small steps are verbalized. No goal is mentioned. In the suggestion for copying the star on a piece of paper, there is some evidence of Concrete Coding.

**REGULAR GROUP 4 - SUCCESSFUL IN TASK COMPLETION**
"No, we are going to try to go this way and then that way."
"We are trying to make a triangle that way and then that way."
"Right there, make a little point and then go that way."
Triangles and their positions are verbalized. Possible strategies:
- Goals and Subgoals
- Abstract Coding
- Classification
Small steps in making the points are used.
**Verbal Statement**

**Possible Strategies**

**REGULAR GROUP 5 - UNSUCCESSFUL IN COMPLETING TASK**

"Yeah! Now make it go up there and come back down like that and we'll have it."

"Connect it."

"Go like that, that and that."

"If we could get it to go across here and here, we'd have it."

"This is a five point star. It's wrong. We need a six point."

The goal of the six-point star was mentioned but never attained. This group made three 5-point stars. They never saw the relationship of the triangles. They possibly used some Hill-climbing as they recognized the goal and used some small steps, but their steps were in the wrong direction.

**REGULAR GROUP 6 - SUCCESSFUL IN TASK COMPLETION**

"OK. Keep on going up and we'll make an upside-down triangle."

"Now you go back. Manuel will go there, and I'll make the line."

The upside-down triangle was verbalized. Possible strategies:

**Goals and Subgoals**

**Abstract Coding**

**Classification**

Little was said as to how the triangles were made or connected.

**GIFTED GROUP 1 - SUCCESSFUL IN TASK COMPLETION**

"Go right and get it at an angle down here."

"Left, to get it straight."

"Now we have to get it pointed this way instead of down."

"We have to get it up here."

"Have to point it this way more so it will go down."

"Go down and then up."

"We've got to see that star."

"See to point it that way, we have to get it down."

"Make two triangles. One up. One down."

"Try to make it so it will go straight up there, one back and one down."

Numerous statements that demonstrate elaborate use of small logical steps in arriving at the subgoals and goal. Triangles and positions were verbalized. Possible strategies:

**Goals and Subgoals**

**Abstract Coding**

**Classification**

Some indication of the use of Concrete Coding in the mention of wanting to see the star.
### Verbal Statement

<table>
<thead>
<tr>
<th>GIFTED GROUP 2 - SUCCESSFUL IN TASK COMPLETION</th>
</tr>
</thead>
</table>
| "That's the top of the star."
| "To make the star you go blank, blank, and blank."
| "You would have turned it that way to make an upside-down triangle. Then you would have moved it back, back, and back."
| "I think I've got an idea."
| "If we go down, we'll have a triangle."
| "I'll see how many times we push the button for one line, and then we'll push the button that many times to make the other lines. Then it will be straight."

### Possible Strategies

Numerous statements that demonstrate the elaborate use of small logical steps in reaching the subgoals and goal. Triangles and positions were verbalized. Possible strategies:

- Goals and Subgoals
- Abstract Coding
- Classification

The original concept of counting the button pushes for each line could indicate the use of Lateral Thinking.

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<table>
<thead>
<tr>
<th>GIFTED GROUP 3 - SUCCESSFUL IN TASK COMPLETION</th>
</tr>
</thead>
</table>
| "Hate to say it but I'm a genius. We have a triangle."
| "I've got a plan."
| "Go up two more, then down."
| "I'd go up one more because you look like you're going to come down like that."
| "It's supposed to have six points."
| "You need two triangles."
| Let's try something else. Clear it."
| "What happens when we make a triangle like this and then like that? What is so hard? Getting them hooked together?"

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<table>
<thead>
<tr>
<th>GIFTED GROUP 4 - SUCCESSFUL IN TASK COMPLETION</th>
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</table>
| "Need an upside-down triangle and a regular triangle."
| "I wonder where she hid the instructions?"
| "I know. Type in LIST to see if we get them. (instructions)"
| "We're making a Jewish star."

---

This group was not as elaborate in their aloud ideas. They seemed to find the task to be quite easy as they pin-pointed the need to make the triangles and then solved the problem while acting silly and bored. Strategies used:

- Goals and Subgoals
<table>
<thead>
<tr>
<th>Verbal Statement</th>
<th>Possible Strategies</th>
</tr>
</thead>
</table>
| **GIFTED GROUP 4 - CONTINUED** | **Abstract Coding**  
|                      | **Classification**  
|                      | **Some Lateral Thinking**  
| could have been involved in the creative hunt for the instructions on how to make the star. |
| **GIFTED GROUP 5 - UNSUCCESSFUL IN TASK COMPLETION** | **No goal or subgoal was mentioned and there was no apparent strategy.**  
| "I'm making one corner of the star." | **This group was not real serious about the task.**  
| "We are already going that way." | **It was the only "gifted" group that did not complete the task or use problem-solving strategies."  
| "We have to go forward. How many times?" | |
| "Go right so we can go right up that line." |
| **GIFTED GROUP 6 - SUCCESSFUL IN TASK COMPLETION** | **Discussion of Jewish star and triangles indicates the use of the following strategies:**  
| "Are we making a Jewish star?" | **Goals and Subgoals**  
| "We have half of the star - an upside-down triangle." | **Abstract Coding**  
| "We have one triangle done now." | **Classification**  
| Elaboration of small steps is not spoken aloud. This group tended to be silly and distracted by outside influences. |
ACKNOWLEDGEMENT

The student wishes to gratefully acknowledge the encouragement, support and guidance of her teacher and advisor Dr. Alison King, and the helpful recommendations of the Department of Education Chair, Dr. Adria Klein.