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## **The Effect of Verbal Scaffolding on the Complexity of Preschool Children's Block Structures**

Reports of play with blocks can be traced back to 4<sup>th</sup> century BC (Gura, 1992). Today, most preschool and kindergarten classrooms have an area in the classroom which is designated for block play. Over the past one hundred years or so, play with blocks has repeatedly been reported as an important medium to enhance the development of young children. Forman (1982) makes a strong case for block play as a way to view children's representational thought in action. In addition, block play has also been advocated as a way to enhance children's development of cognition (Cuffaro, 1995; Franklin, 1975), language (Donnelly, 1985; Isbell & Raines, 1991), and socialization (Rogers, 1985; Meckley, 1994). Some claims of the benefits that block play can provide for children are well documented, while others have been reported and accepted as "social wisdom". The area with the least amount of information, either research based or otherwise, is on the methods that adults can utilize to support children's block play (Conrad, 1995). This is ironic given the current popularity in early childhood education of Vygotsky's theory which calls for the active involvement of adults in supporting children's learning. Most practitioners set up a block corner in their classrooms, stepping in to assist only with conflict resolution or behavior issues. However, if the use of blocks in play does provide so many positive effects on children's development, is there a need for more active involvement on the adult's behalf to assist children?

Prior research suggests that merely including an adult in the block area increases the amount of time children spend there (Halliday, McNaughton, & Glynn, 1985). One would wonder if added time for children in the block corner reaps significant benefits or if more intervention is needed to derive the greatest results. Vygotsky's theory would advocate that adults take a more active role in the block corner. According to Vygotsky's theory of sociocultural learning, mental functions are shared first between others and then become part of the individual's thinking process. Higher mental functions are always first social, in the form of spoken language before they become internalized thoughts (Berk, 1995). In the social situation, an adult or "expert" other is the ideal partner. The challenge provided by the expert partner is the key to the child's internalization of the information and experiences (Stone, 1993). In reference to blocks, if children's representational thinking is displayed through their constructions, can the child's level of representational thought, as a higher mental function, be increased? Using Vygotsky's theory in practice, one highly effective method of presenting a challenge which is at a level just above a child's current ability in order to increase children's level of thinking is known as scaffolding (Wood, Bruner & Ross, 1976; Wood, 1989).

The present study had three goals. The first was to investigate Vygotsky's theory in action in the area of block play. Specifically, to determine the effect of adult's use of verbal scaffolding on the structural complexity of children's block constructions. The second goal was to establish a more comprehensive measure for the complexity of children's block structures. The third goal was to establish further support for the levels of complexity reported on Stages, Arches, and Dimensionality. To establish the grounds for these goals, a brief look at the history of the measurement of block constructions is discussed below.

## Historical Overview of the Measurement of Block Constructions

*Stage Complexity.* In the 1900s, with the burgeoning use of blocks in preschool classrooms in the United States, a group of researchers attempted to document the common uses of blocks by children. The three main researchers, Hulson (1930), Johnson (1933) and Guanella (1934) shared some commonalities in their findings. Hulson (1930) proposed that children used blocks for four types of activities: knocking them down, carrying them, jumping from blocks and dramatizing with them. Johnson's (1933) study seemed to elaborate on Hulson's types and reported seven stages:

- 1). Carrying blocks around;
- 2). Making rows or stacks;
- 3). Bridging: two blocks with a space between and a third on top;
- 4). Enclosures: blocks placed to enclose a space;
- 5). Decorative patterns with symmetry;
- 6). Naming of structures;
- 7). Reproducing or symbolizing what is familiar in what is built accompanied often by dramatic play.

Guanella's (1934) work was the most extensive of the three and continues to be cited by nearly every block researcher since its inception. Although based only on twelve children from upper middle class families, the stages that she identified have held true in subsequent studies. Guanella noted four stages of block building with unit blocks. Each stage consists of multiple categories. The first stage is *Preorganized* or Non-structural stage. Second is the *Linear* stage, which is piles and rows. Third is the *Bidimensional* stage, includes solid areal forms (wall like and floor like arrangements), enclosed, spaces and arches. The fourth and final stage, *Tridimensional stage* incorporates solid tridimensional structures and enclosed tridimensional structures. Guanella concluded that as children mature, their block constructions become more complex.

At about the same point in time, Bailey (1933) devised a scale, using blocks as the medium, to measure and evaluate the constructive and manipulative ability of children preschool through kindergarten. The scale consists of 10 items for *plan and achievement of plan* and 10 items for *symmetry of design*. Pictures of actual block constructions were used to establish the scale.

### Blocks as Evidence of Representational Thinking

In the late 1970s and the early 1980s, the next wave of interest in children's block play and its structural complexity began. The research emphasis was on the contribution of block play on cognition. According to Forman (1982), one can see children's structures of thought by observing block play. While his work did not cite Guanella's the stages he described were very similar. His stages begin with infants. First, the child *grasps* the block with two hands. Next, the child *bangs the blocks together* at the midline. Later, the child *stacks* them (forming a vertical line). Still later they are in a *horizontal line touching* each other, and finally in a *horizontal line with spaces* between.

*Arch Complexity.* Goodson observed children's mental representations for block models, developing a hierarchy of structures of arches in children's block building (1982). She proposed four levels of developmental progression in arch structure. See Figure 2 for a description. Goodson's research concluded that children in the higher levels of arch building also had better levels of planning and perception.

*Dimensionality and Integration Complexities.* Reifel and Greenfield (1982) concluded from their review of the literature and their own research that the hierarchical complexities of construction increase with age and suggest that cognitive structures also become more complex with age. In their study, they defined levels of integration in block building as well as levels of dimensionality. Comparing four-year-olds to seven-year-olds, they found that the older children utilized greater levels of both integration and dimensionality. See Figure 2 for description of dimensionality levels.

*Spatial Complexity.* Stiles-Davis (1988) is the most recent person to study spontaneous block play in relation to its developmental progression in spatial grouping. She used the previously discussed studies to devise a method of examining the complexity of block play based upon six measures: spatial products, spatial loci, directions, and number of relations, types of relations and processes. Her results are consistent with other research on the developmental progression of block structures; older children construct more spatially complex structures than do younger children.

Overall research findings thus far have supported a sequential developmental progression in various types of complexity of block structures, with predominately more complexity the greater the age of the builder. Each of the studies looked at only one or two aspects of complexity at a time. Other than Guanella, these complexity components were each individually assessed. While useful, this provides only part of the picture of a child's ability. In the current study, complexity was considered with each of the following individual components: stage, arches and dimensionality. A complexity composite component was then developed and utilized using all three aspects simultaneously.

In each of the prior studies, the child was working without adult assistance. Using Vygotsky's theory as a framework, it is hypothesized that adding an adult to the block area to actively use verbal scaffolding will positively impact the complexity of children's block structures.

According to Vygotsky's theory, it is possible for adults to work jointly with children on mental activities to support their movement from their present level of independent activity to their level of *potential* development through the process of verbal interaction (Vygotsky, 1962). The key is to work with the child within their *zone of proximal development*, which is the area between where the child is performing independently and where they work with assistance (Bodrova & Leong, 1998). To do this, the child's present level of development on the given task must be assessed. The adult or knowing other, then actively works to assist the children in achieving the next level using some type of external mediator. This process is known as scaffolding. External mediators may take many forms. In this current study, the adult's use of language serves as the external mediator during the scaffolding process. While naturally occurring gestures, such as smiles when a child added a block to the construction did happen, gestures were not the focus of this investigation. The verbal interaction that the adult structured in the situation with the intent of moving the child to higher levels of block complexity was the focus.

This study attempted to answer the main question: Does verbal scaffolding by adults while children are playing with blocks increase the complexity of their block structures in four areas: stage, arches, dimensionality and composite complexity? In addition, the role that age plays in the varying complexities of structure was investigated. Gender was explored individually and as an interaction factor with scaffolding for each of the four areas.

## **Method**

### **Sample**

The research sample consisted of 85 preschool children from four classes in a University Laboratory Preschool in the Midwest United States whose parents gave written permission for their participation in the study. No parents denied permission from any of the classes. Both the morning and afternoon sessions from two classrooms participated. The four classes serve families from ethnically and economically diverse backgrounds. Of the 85 children, a subsample of 50, 22 female and 28 male between the ages of 38 and 71 months was used for analysis. The reduction was due to the necessity of including in the analysis sample only those children who participated in

block play at least once during each time segment in the study (baseline, intervention, and follow-up). This subsample included 22 children in the control group and 28 children in the treatment group. As the children were assigned to the classes prior to the onset of the study, their classes were randomly designated as control or experimental groups.

### **Materials**

Unit blocks were the only blocks available to the children during the course of the study. Each classroom had equivalent amounts of various types of unit blocks that are commonly found in early childhood classrooms. In addition, each block area had 10 vehicles, 10 animals, and 10 human figures available for the children from which to select during their time in the block area. Floor measurements were made of the block areas in both classrooms before the study began to ensure the availability of the same square footage for the block play. Two open shelves were provided in each classroom for the storage of blocks and accessories.

### **Data Collection**

*Design.* To control for the variable of time of day, the two classrooms, each with a morning and afternoon session, were randomly assigned control and experimental groups with each receiving the opposite treatment during the morning and afternoon sessions. One classroom functioned as the control group in the morning and the experimental group in the afternoon. The other classroom was the experimental group in the morning and the control group in the afternoon. Each session in each classroom had its own set of student teachers who were primarily responsible for interaction in the block play as well as overall classroom function. This greatly reduced the opportunity for contamination between the control and experimental groups in both classrooms. The control and experimental groups were observed before the intervention (baseline), during the intervention and after the intervention (follow-up).

*Intervention.* The intervention was carried out four days a week, Monday through Thursday. Three of the classes did not attend on Fridays and the fourth class did not open the block area on Fridays. The study occurred during the Winter Semester for a 10-week period (3 weeks of baseline, 3 weeks of intervention, one week off and 3 weeks follow up).

In both the experimental and the control groups, an adult, who was a student teacher majoring in Child Development, was located in the block area, verbally interacting with the children. There were specific directions regarding the type of verbal interactions that the student teachers were expected to have with the children in their area, depending on their class' assignment of experimental or control. See Figure 1 for specific details. The adults for both the experimental and the control groups were each trained at the conclusion of the baseline and prior to the intervention. At this training, group specific directions were explained and demonstrated when appropriate.

All student teachers in both the experimental and control groups were instructed during their training on the following common points.

- Always intervene for safety, rights of others and property issues.
- Entice children to enter the block area by placing blocks on the floor.
- Refrain from building structures, demonstrating how to build, or taking over the child's play.
- Allow children to choose their own blocks.

All of the student teachers had been trained in their prior coursework on using behavior reflections and asking open ended questions and were strongly encouraged to do so when the children were in the block area.

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Insert Figure 1 about here

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The control group's adults were instructed that their goal for the next three weeks in the block area was to encourage and support block building. They were not trained in any of the complexities of block structures and reported at the end of the study no prior knowledge of these, nor were they trained in the process of verbal scaffolding. While all had heard of the term

scaffolding during prior coursework, non reported knowing how to accomplish this. In addition, as all were observed throughout the course of the study, none showed evidence of attempts at scaffolding.

The experimental group's adults were instructed that their goal was to increase the complexity of children's block play through verbal scaffolding. Training began with teaching the adults to recognize the various levels of complexity of stages, arches and dimensionality. They were given copies of Figure 2, which was then fastened to the back of their nametags for easy reference. The adult participants who would work with the experimental group practiced building each level in the three areas of complexity and recognizing various examples of these levels of complexity in block structures built by the researchers. The concept of verbal scaffolding was explained to them. They received a modified version of Figure 1, which gave them suggestions to assist in their verbal scaffolding. They viewed a role-play of one researcher scaffolding another researcher while she built with blocks. They then watched a video of an adult doing this with a child, and finally practiced on each other.

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Insert Figure 2 about here

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The student teachers in both the control and experimental groups were monitored on a daily basis by the research team and their classroom head teachers to ensure that they were implementing their given intervention correctly. Immediate intervention by the research team members or classroom head teacher was made if something was occurring in the block area which was outside of the intervention. In addition, members of the research team were available to all student teachers in both the control and experimental groups to answer questions that arose throughout the entire study period.

During each of the three time segments, baseline, intervention, and follow up, the children were strongly encouraged to go to the block area at least once during their free choice time and build. Individual structures were also encouraged. Group structures did occur, but were only coded if it was blatantly clear what the continuous contribution of individual children was, could be separated from the rest of the structure, and could be coded according to the given complexity categories.

## Measurement

The block areas in both classrooms were continuously observed by the research team and recorded by video for the entire duration of the study. Ten constructions from the video tapes were randomly selected and independently coded by members of the research team in each of the four areas: stage, arches, dimensionality, and overall complexity composite. These initial block construction ratings were compared. An interrater reliability of .95 was computed. The subsequent coding was identical to the initial coding and completed by the same members of the research team. Each child's most mature structure during every block play session was assessed using the three categories: stage, arches and dimensionality using a scale of 1-4. If there was no observation of a particular component, it was left blank. See Figure 2 for a complete description of each area and level. In addition to these three categories, a fourth category, the block composite, was created. It was used to assess the overall complexity of the structure.

*Stage.* The measurement scale for stage was based primarily on a combination of Johnson's (1930), Guanella's (1934) and Forman's (1982) stages of block construction. As each stage represented a higher level than the one before, the data was treated as parametric data. The stages received the following numerical ratings:

Tower	1
Row	2
Row-Tower	3
Enclosure	3
Covered Enclosure	4
Covered Enclosure	4

with Tower

*Arches.* The arches scale was taken directly from Goodson's work (1982). See Figure 2.

*Dimensionality.* The dimensionality scale, also found in Figure 2, was directly taken from Reifel and Greenfield's 1982 description of dimensionality in block play. The numerical values are the dimension level plus one point due to the fact that a zero dimension does not mean lack of presence of dimension (ex. Zero dimensions is a 1 on the scale). Again, the levels of dimensionality represent a true hierarchy, with each level more advanced than the previous one, therefore the data was treated as interval data.

*Composite.* A composite score was created to look at the overall complexity of a given block structure. This appeared to be a logical combination as each of the three areas to be combined occurred simultaneously in the structure, not in a linear fashion. To create this composite, each of the three complexity areas: stages, arches, and dimensionality, had to possess an equal number of stages, which they did. Each had four levels. In addition, the data had to be parametric. Given that the areas met these criteria for combination, the numerical values for stages, arches and dimensionality from the most complex block structure of each observation period were averaged. The resulting number was the complexity composite structure score. If one of the areas was not able to be coded (such as the non existence of an arch) that score was not included in the average.

## Results

An Analysis of Covariance was conducted on the dependent variables (stage, dimensionality, and complexity composite) using SPSS. The baseline measurements for each dependent variable were used as the covariates to control for the differences in the children's original block building abilities. Table 1 depicts the description of the data for both groups. It includes the baseline and follow up data on all component areas: stage, arches, dimensionality, and complexity composite. In all of the analyses, there were no significant effects of practice, which was the number of times during the study that a child played with the blocks. Therefore the practice factor was eliminated from the analyses. A significance level of  $p < .05$  was set.

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Insert Table 1 about here

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## Baseline Analyses

To obtain information regarding the children's prior block building structural complexity and to assess comparability across groups, the control and treatment groups' scores for the baseline for all four components (stage, arches, dimensionality and complexity composite) were examined using a T test. No significant differences were found between the groups on any component.

## Stage Complexity Results

Age is a factor which predicts  $F(1, 37) = 5.659, p < .05$  and was significant. See Table 2. Older children built more complex structures according to the stage complexity criteria. This finding is consistent with previous work.

The baseline for stage complexity  $F(1, 37) = .400$ , gender  $F(1, 37) = 2.093$ , and scaffolding  $F(1, 37) = 2.279$ , did not significantly influence the stage complexity, nor did the interaction of gender and scaffolding  $F(1, 37) = .004$ . Considering the adjusted R squared is so low (.092), the combination of these variables do not account for much of the variance in the model as related to stage complexity. The hypothesis that verbal scaffolding would increase the stage complexity of children's block structures was not supported.

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Insert Table 2 about here

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## Arches Complexity Results

No statistical analyses were run on the complexity of arches due to the low number of children who built arches both at the baseline and at the follow up time segments (n=13).

### **Dimensionality Complexity Results**

The ANCOVA for dimensionality revealed significant effects for scaffolding  $F(1, 44)= 30.455, p<.05$  (Table 3). Age  $F(1, 44)=1.131$ , baseline for dimensionality  $F(1,44)=2.748$ , gender  $F(1,44)=2.619$  and the interaction between gender and scaffolding  $F(1,44)=1.267$  were not significant. The Adjusted R squared = .427, indicated that these variables account for nearly 43% of the variance in this model of dimensionality complexity. The hypothesis that verbal scaffolding would increase the dimensionality complexity of children's block structures was supported.

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Insert Table 3 about here

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### **Complexity Composite Results**

The ANCOVA for the composite revealed a significant effect for gender  $F(1,44)=4.165, p < .05$ , and for scaffolding  $F(1,44)=4.788, p<.05$  (Table 4). The baseline for composite  $F(1,44)=3.161$  and the interaction between gender and scaffolding  $F(1,44)=2.053$  was not significant. The Adjusted R Squared (.183) indicated that the variables in this model, gender and scaffolding, accounted for nearly 18% of the variance in the complexity composite. The hypothesis that verbal scaffolding would increase the composite complexity of children's block structures was supported.

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Insert Table 4 about here

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### **Discussion**

The first goal of this study was to investigate the effect of verbal scaffolding on the complexity of children's block structures in the areas of stage, arches, dimensionality and complexity composite. For the overall complexity composite and for the dimensionality component, specific adult verbalization in the form of verbal scaffolding did positively impact the complexity of children's block structures. It did not impact the stage complexity when considered alone. Not enough data was present to infer its impact on arch complexity. Further research is recommended in this area.

The second goal of this study was to provide a more detailed description of the complexity of children's block structures than is currently used. First, the components of stages, arches, and dimensionality progressions supported by empirical research in prior studies, were used to assess block structure complexity, then the three separate components were combined. This resulted in the creation of the complexity composite. Future research is warranted to further examine the ongoing feasibility of the complexity composite.

The third goal of the study was to gain further support for scales of block complexity discussed in previous research studies. Results of this study confirm findings of previous studies that there is a progression in stage complexity (Guanella, 1934; Forman, 1982) and dimensional complexity (Reifel & Greenfield, 1982). There was not enough data to confirm or refute previous findings on the Arches scale by Goodson (1982).

Guanella's (1934) and Forman's (1982) findings that stage complexity of children's block play was primarily due to the age of the child did hold true in this study. Age was the significant factor in the children's stage complexity of block structures, with older children building more stage-complex structures. However, age was not a significant factor with the other components of structural complexity examined (dimensionality and overall complexity composite). This is contrary to Reifel and Greenfield's (1982) conclusion that maturation leads to more complex dimensionality in block structures.

Contrary to popular belief, gender did not play a role in the complexity of the children's block structures when the complexity components of stage and dimensionality were examined individually. However, when these components were combined into the complexity composite, gender did make a difference. Boys did build significantly more complex than girls did overall. Other studies have found that boys choose to play in the block area more often than girls (Beeson

& Williams, 1979; Varma, 1980). This suggests a need for further research into whether more exposure is the advantage for boys or if there are other factors at work.

This study provides support for Vygotsky's proposition that learning leads performance and perhaps may lead development (Berk & Winsler, 1995). When paired with a more knowing adult, children were able to use higher levels of complexity in their block structures overall (complexity composite) and in the area of dimensionality. During the intervention, the adults were able to successfully work with children in their zone of proximal development to consciously assist them to attain their potential level of development through the use of verbal scaffolding. This later became their new independent level, as evidenced in the follow up data. There was no difference between the control groups and the experimental groups in the areas of complexity during the baseline data collection. Following the intervention, there was a significant difference in overall complexity and in dimensionality.

There are some areas to consider in this study. While the student teachers in both groups were observed during the baseline, intervention and follow up periods to ensure that they were following the prescribed intervention, the level of skill between the student teachers in each of the classrooms varied. This could have had an impact on the study. The counter balanced design, utilizing the two classrooms at two separate times of the day should have helped account for this. This study should be replicated over the course of an entire school year, spreading out the baseline, intervention and follow up periods to see if the same outcomes are achieved. It would also be interesting to conduct another study using hollow blocks instead of unit blocks to compare complexity when the size, shapes, and variety of blocks are limited. Finally as most play that occurs in block areas is cooperative building, a study designed to look at the complexity of group play and adult verbal scaffolding would be useful.

## **Implications**

These results have implications for early childhood classrooms. The mere act of placing an adult in the block area to facilitate play is not sufficient. Both the control group and the experimental groups had adults stationed in the block area. The difference in overall complexity of structure and in the dimensionality complexity is whether or not the child experienced active verbal support (in the form of verbal scaffolding) that assisted in generating structures of increased complexity. This is a dynamic factor. It involves not only the adult's ability to recognize and identify the current level of complexity of block play by children, but also his/her knowledge of the entire sequence of the components of block structure complexity as well as the ability to use this information in a verbal scaffolding process. While this is an intellectually complex task, this study demonstrates it can be successfully accomplished.

To do this, adults working with young children must first be taught the three complexities of block play (stage, arches, and dimensionality) and their developmental progression. They must also be given opportunities to practice verbal scaffolding and receive feedback to gain skill with this practice.

In conclusion, if in fact block structures are our window to children's logical thinking processes and a direct view of children's developing representational thinking capacity, as Forman (1982) suggests, then learning about the complexities of block structures and how to scaffold these could accomplish at least three important things. First, it could strengthen adults' abilities to effectively work with children. Second, it could help adults better understand individual children's levels of cognitive development. Third, as adults scaffold children up to the next level of complexity in their constructions, the potential exists that they can simultaneously increase the children's representational thinking abilities.

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Figure 1: Directions for Adult Interactions with Children in the Block Area

- Intervene for safety, rights of others, and property issues
  - When no children are in the block area, pull out blocks and place them on the floor to entice children into the block area, but DO NOT construct a structure.
  - Verbally talk with children, but DO NOT build with or assist with building blocks.
  - Allow children to choose the blocks with which they will build.
  - Stay in the block area at all times, unless an emergency occurs.
  - Support children’s play, DO NOT direct it.
  - Use behavior reflections.
  - Ask open ended questions.
  - ❖ Pose problems (ex. What would happen if..., How could...)
  - ❖ Make leading statements (ex. Sometimes people use a block to join as structure...)
  - ❖ Think of possibilities out loud (ex. I wonder if... )
  - ❖ Continually work to encourage children to build at the next level of complexity (keeping the three types of complexity from Figure 2 in mind...Evaluate where the child is and the next level to move him/her to).
  - ❖ Accept the child's choice in the matter. Your suggestion(s) may or may not be accepted. This is OK.
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- Directions for both the control group adult interactions as well as the experimental group adult interactions.
  - ❖ Directions for only the experimental group adult interactions.

Figure 2: Three Methods of Evaluating the Complexity of Block Structures

<b>Stages Complexity*</b>	
Tower	Blocks one on top of another in vertical fashion.
Row	Row of blocks, one next to the other
Row-Tower	Combination of tower and row, also includes adding flooring and/or walls.
Enclosure	Blocks form an enclosure with “walls” on all sides.
Covered Enclosure	A “roof” is added to the enclosure.
Covered Enclosure with Tower	Tower is constructed on top of a covered enclosure

\*Adapted from Guanella, 1934

<b>Arches Complexity**</b>	
Arch – level One	Two blocks parallel with third block on top of both
Arch – level Two	Two or more arches side by side or on top of each other or a tunnel.
Arch – level Three	Three arches with at least one on top of the other.
Arch – level Four	More than three arches on top of each other or in a variety of combinations.

\*\*Adapted from Goodson, 1982

<b>Dimensionality Complexity***</b>	
Zero Dimension	Single block or scattered blocks forming single points.
One Dimension	At least two blocks forming one line.
Two Dimension	At least three blocks forming two lines or forming one plane.
Three Dimension	More than three blocks forming one line AND one plane.

\*\*\*Source: Reifel & Greenfield, 1982.

Table 1: Descriptive Data of Block Study

No Scaffolding	N	Mean	Standard Deviation
Control Male age	11	57.9091	8.348
Stage Baseline	10	3.2	1.6193
Stage Follow Up	11	3.0	1.4832
Arch Baseline	5	1.6	.5477
Arch Follow Up	2	2	1.4142
Dimensionality Baseline	11	3.5455	.8202
Dimensionality Follow Up	11	2.4545	.5222
Complexity Comp. Base.	11	2.3	.4584
Complexity Comp. Fol.	11	1.9	.543

No Scaffolding	N	Mean	Standard Deviation
Control Female age	12	59.3636	10.5667
Stage Baseline	12	2.9167	1.1645
Stage Follow Up	10	2.7	1.4944
Arch Baseline	4	2.25	.9574
Arch Follow Up	4	1.75	.9574
Dimensionality Baseline	12	3.5	.7977
Dimensionality Follow Up	12	2.3333	.6513
Complexity Comp. Base.	12	2.3681	.5897
Complexity Comp. Fol.	12	1.833	.6317

Scaffolding	N	Mean	Standard Deviation
Experimental Male age	17	55.1176	5.3722
Stage Baseline	17	3.3529	1.147
Stage Follow Up	13	3.5385	.9674
Arch Baseline	8	1.3750	.5175
Arch Follow Up	9	1.7778	.9718
Dimensionality Baseline	17	3.2941	.7717
Dimensionality Follow Up	17	3.5882	.7123
Complexity Comp. Base.	17	2.1765	.4876
Complexity Comp. Fol.	17	2.4902	.6193

Scaffolding	N	Mean	Standard Deviation
Experimental Female age	11	58	3.8471
Stage Baseline	11	3.1818	.7508
Stage Follow Up	10	3.2	.9189
Arch Baseline	4	1.75	.5000

Arch Follow Up	6	1.1667	.4082
Dimensionality Baseline	11	3.5455	.6876
Dimensionality Follow Up	11	3.1818	.7508
Complexity Comp. Base.	11	2.5606	.5541
Complexity Comp. Fol.	11	2.0606	.3963

Table 2: Effects of Age on Stage Complexity

Source	Degrees of freedom	F Ratio	Significance
Baseline Stage	1	.4000	.531
Age	1	5.6959	.023
Gender	1	2.093	.156
Scaffolding	1	2.279	.140
Gender*Scaffolding	1	.00440	.953

Adjusted R squared = .092  
Mean Square Error = 1.308  
Alpha = .05

Table 3: Dimensionality Complexity

Source	Degrees of freedom	F Ratio	Significance
Baseline Dimensionality	1	2.748	.104
Age	1	1.131	.293
Gender	1	2.619	.113
Scaffolding	1	30.455	.000
Gender*Scaffolding	1	1.267	.266

Adjusted R Squared = .427  
Mean Square Error = .409  
Alpha = .05

Table 4: Complexity Composite

Source	Degrees of freedom	F Ratio	Significance
Baseline Composite	1	3.161	.082
Age	1	.108	.744
Gender	1	4.165	.047
Scaffolding	1	4.788	.034
Gender*Scaffolding	1	2.053	.159

Adjusted R Squared = .183  
Mean Square Error = .266  
Alpha = .05