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SOLO and solid geometry: Interpreting upper primary students' representations of the three-dimensional geometrical shapes and their development of three-dimensional visualization

by

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Doctor of Education

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Certificate of Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis have been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Table of Contents

Certificate of Originality ii

Acknowledgement iii

Table of Contents iv

Abstract x

CHAPTER 1 Introduction 1

1.1 How the Study Emerged 1

1.2 Teaching and Learning Three-dimensional Geometry in Schools 2

1.3 The Purposes of the Study 4

1.4 The Significance 5

1.4.1 The Geometry Curriculum 6

1.4.2 Concerns in Teaching and Learning 3D Geometry 7

1.4.3 Assessment in Mathematics 8

1.5 Contextual Information 8

1.5.1 Basic Education System 9

1.5.2 Contents of Geometry in the Primary Mathematics Curriculum 9

1.6 Terminology 10

CHAPTER 2 Literature Review 13

2.1 Defining Spatial Ability 13

2.1.1 Some Descriptions of Spatial Ability 13

2.1.2 Components of Spatial Ability 14

2.2 The Teaching of Spatial Ability 19

2.2.1 The van Hiele Model 20

2.3 The Problematic Issues 23

2.3.1 Evidence of IFI-ability in Literature 23

2.3.1.1 The Influence of Standard Diagrams 23

2.3.1.2 The Prototype Representations 24

2.3.1.3 Limitation of the 2D Representation of the Solid 25

2.3.1.4 Conventions of Diagrams 26

2.3.1.5 The Influence of the Drawing on Students' Spatial Conceptions 27

2.3.1.6 Difficulties in Basic Geometrical Concepts 28

2.3.1.7 Cultural Differences 30

2.3.2 Evidence of VP-ability in Literature 30

2.3.2.1 Coordination and Integration 31

2.3.2.2 Accuracy of Mental Image 33

2.3.2.3 The Presence of the 3D Shape 34

2.3.2.4 Difficulty in Thinking Aloud About Visual Image 35

2.4 Piaget's Two-factor Cognitive Theory of Symbolic Meaning: VP- and IFI-Abilities Revisited 36

2.5 The Representation as an Assessment Tool 37

2.5.1 Internal Representation and External Representation 38

2.5.2 Internal Representation as Students' Personal Representation System 38

2.5.3 The Dynamic Nature of Internal Representations 39

2.6 Conclusion 39

CHAPTER 3 In Search of a Theoretical Framework 43

3.1 Looking Back 43

3.2 The SOLO Model 46

3.3 Ontological and Epistemological Assumptions Underpinning the Study 50
3.3.1 Vygotsky's Theory of Scientific Concepts 51
3.3.2 The Epistemological Assumption 53
CHAPTER 4 Research Design and methods 57
4.1 General Nature 57
4.2 Research Methodology: The Interpretive Approach 58
4.3 Sample Selection and Collection of Data 59
4.4 The Methods: Working with the Data and the Software Tool 61
4.4.1 Grounded Theory Approach 61
4.4.2 Use of ATLAS.ti in This Study 62
4.5 Data Analysis and Interpretation 68
4.6 Conclusion: The Research Design 71
CHAPTER 5 INTERPRETIVE DATA ANALYSIS 72
5.1 Coding as an Analysis Process 72
5.2 Tasks of Data Analysis 74
5.2.1 The Cyclic Process of Coding 75
5.2.2 Coding Scheme 78
5.2.3 Co-occurrence Query 88
5.2.4 Writing Memos 90
5.2.5 The Changes in Selecting and Naming Segments of Data 92
5.2.6 Linking Concepts 95
5.3 The Data Sources 98
CHAPTER 6 The Scene of Cubes 100
6.1 Description Patterns about Cubes 100
6.2 Drawing Patterns of Cubes 107
6.3 Identification of P-U-M-R levels of the SOLO Model for Cubes ... 111
6.3.1 The P-U-M-R levels of the SOLO Model for Cube Descriptions 111
6.3.2 The P-U-M-R levels of the SOLO Model for Cube Drawings 113
6.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model 115
6.4 Vignettes in Responses about the Descriptions about and Drawing of Cubes 116
6.4.1 The Influence of the Drawing on Students' Spatial Conceptions 116
6.4.2 Lack of Coordination of the Edges and Faces of Cube 118
6.4.3 The Use of 2D Mathematical Terms in Description 118
6.4.4 Descriptions Reflecting How a Cube is Formed 119
6.5 Summary 120
CHAPTER 7 The Scenes of Triangular Prisms, Pyramids and Cylinders 123
7.1 The Scene of Triangular Prism 123
7.1.1 Description Patterns about Triangular Prisms 123
7.1.2 Description Patterns about Triangular Prisms 129
7.1.3 Identification of the P-U-M-R levels of the SOLO Model for Triangular Prisms 132
7.1.3.1 The P-U-M-R levels of the SOLO Model for Descriptions about Triangular Prism 132
7.1.3.2 The P-U-M-R Levels of the SOLO Model for Drawings of Triangular Prism 135
7.1.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model 135
7.1.4 Vignettes in Responses about the Descriptions about and Drawing of Triangular Prisms 136

7.1.4.1 Descriptions Based on the Meaning of the Name 137
7.1.4.2 Association with Chocolate Bar in Descriptions 137
7.1.4.3 The Use of 2D Mathematical Terms in Description and Drawing in 2D Scenario 138
7.2 The Scene of Pyramids 138
7.2.1 Description Patterns about Pyramids 138
7.2.2 Drawing Patterns of Pyramids 145
7.2.3 Identification of P-U-M-R levels of the SOLO Model for Pyramids 149
7.2.3.1 The P-U-M-R levels of the SOLO Model for Pyramid Descriptions 149
7.2.3.2 The P-U-M-R levels of the SOLO Model for Pyramid Drawings 153
7.2.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model 153
7.2.4 Vignettes in Responses of the Descriptions about and Drawing of Pyramids 155
7.2.4.1 The Influence of the Drawing on Students' Spatial Conceptions 155
7.2.4.2 Drawing Tetrahedrons as Pyramids 155
7.3 The Scene of Cylinders 156
7.3.1 Description Patterns about Cylinders 156
7.3.2 Drawing Patterns of Cylinders 161
7.3.3 Identification of P-U-M-R levels of the SOLO Model for Cylinders 165
7.3.3.1 The P-U-M-R levels of the SOLO Model for Cylinder Descriptions 165
7.3.3.2 The P-U-M-R levels of the SOLO Model for Cylinder Drawings 168
7.3.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model 168
7.3.4 Vignettes in Responses of the Descriptions about and Drawing of Cylinders 169
7.3.4.1 Influenced by Solid Shapes with Edges and Faces 169
7.3.4.2 Perpendicular Edges 170
7.4 Summaries 170
CHAPTER 8 Conclusions and implications 172
8.1 Conclusions 172
8.2 Summary and Discussion of Findings 175
8.2.1 The Diversity in the Response Patterns 175
8.2.2 The Stereotyped Descriptions 176
8.2.3 The Social Practice in the Descriptions and Drawings 176
8.2.4 The Chinese Names of the 3D Shapes 177
8.2.5 Describing Only with the 2D Mathematical Terms 178
8.2.6 Drawing Solid Shape as 2D Drawing 178
8.2.7 The Spontaneous Concepts in Descriptions 179
8.2.8 Consistent Errors in Drawings 179
8.3 Implications for the Teaching and Curriculum Design 180
8.3.1 The 3D Geometric Vocabulary 181
8.3.2 Conventions in the 3D Geometry Drawings 181
8.3.3 The Static Nature of 2D Representational Drawings on Papers 182
8.3.4 Building Up the Coordination Views in VP-ability 182
8.3.5 The Partial Occlusion Technique 183
8.3.6 Hands-on Activities 183
8.3.7 Relating 3D Objects in the Real World 183
8.3.8 SOLO Levels for the 3D Geometrical Shapes 184
8.4 Limitations of the Study 184
8.5 Implications for Further Research 185

Reference 185

Appendices

Appendix A: Code List 199
Appendix B: Cooccurring Codes for Cube Descriptions 202
Appendix C: Cooccurring Codes for Cube Drawings 226
Appendix D: Cooccurring Codes for Triangular Prism Descriptions 241
Appendix E: Cooccurring Codes for Triangular Prism Drawings 255
Appendix F: Cooccurring Codes for Pyramid Descriptions 261
Appendix G: Cooccurring Codes for Pyramid Drawings 268
Appendix H: Cooccurring Codes for Cylinder Descriptions 273
Appendix I: Cooccurring Codes for Cylinder Drawings 280
Appendix J: IFI-ability about the Four 3D Geometrical Shapes 287
Appendix K: Difficulties in IFI-ability about the Four 3D Geometrical Shapes 289
Appendix L: Difficulties in VP-ability about the Four 3D Geometrical Shapes 291
Appendix M: The Network View of the Social Practice about the Shapes 292
Appendix N: The Network View of Unaware of the Drawing Conventions of the Shapes 293

List of Figures

Figure 1.1 The geometrical shapes, commonly found in primary mathematics 5
Figure 1.2 A student's idiosyncratic representation of a cube 7
Figure 1.3 Perspective projection drawing of a cube 11
Figure 1.4 Oblique projection drawing of a cube 11
Figure 2.1 Entities in spatial ability 16
Figure 2.2 Components of spatial abilities based on IFI-VP dichotomy 18
Figure 2.3 The amalgamated model 22
Figure 2.4 Representation of a cube 24
Figure 2.5 Close and distant representations 26
Figure 2.6 Representation of planes 28
Figure 2.7 Misconception because of the representation 28
Figure 2.8 How many unit cubes does it take to make this rectangular solid? 31
Figure 2.9 Coordination and integration of arrays of cubes 33
Figure 2.10 Necker cube illusion 34
Figure 2.11 Line-segments on cubes 34
Figure 2.12 Cognitive symbol created by copying picture 36
Figure 2.13 Cognitive symbol created by the interaction of two mechanisms 37
Figure 3.1 In search of a theoretical framework 45
Figure 3.2 Diagrammatic representation of levels associated with the Concrete Symbolic Mode 47
Figure 3.3 Spontaneous and scientific concept (Wellings, 2003) 52
Figure 3.4 The theoretical frame work of the study 55
Figure 4.1 Families of scanned worksheets (three classes are shown) 64
Figure 4.2 Segments of student's drawing and description are coded 65
Figure 4.3 Families of codes (family of codes about drawing is shown) 66
Figure 4.4 Sample of a network view 66
Figure 4.5 Samples of co-occurring codes with cube description at levels of prestructural (level 1) and unistructural (level 2) 68
Figure 4.6 The research design 71
Figure 5.1 Drawing of pyramid 74
Figure 5.2 Description of pyramid 74
Figure 5.3 The main tasks of data analysis 76
Figure 5.4 The coding interface 77
Figure 5.5 Coding a data segment 78
Figure 5.6 Data segments which are labelled "# 6 faces (cube)" 78
Figure 5.7 The code family manager 87
Figure 5.8 The network view of code family 87
Figure 5.9 Memo manager 91
Figure 5.10 An example of memo 92

Figure 5.11 Examples of merging codes 94
Figure 5.12 Examples of spitting codes 95
Figure 5.13 Example of segment of data that is embodied multiple interpretations 95
Figure 5.14 The linking between codes 96
Figure 5.15 The visual view of the linking between codes 97
Figure 6.1 The description influenced by the drawing 117
Figure 6.2 Description influenced by the drawing 117
Figure 6.3 Lack of coordination of the edges and faces 118
Figure 6.4 The use of 2D mathematical terms 119
Figure 6.5 Descriptions reflecting how a cube is formed 119
Figure 7.1 Triangles and prisms for triangular prism 137
Figure 7.2 Associations with chocolate bar 137
Figure 7.3 Description and drawing in 2D scenario 138
Figure 7.4 The description influenced by the drawing 155
Figure 7.5 Drawing tetrahedrons as pyramids 155
Figure 7.6 A pyramid or tetrahedron 156
Figure 7.7 Drawings and descriptions influenced by solid shapes with edges and faces 169
Figure 7.8 Perpendicular edges 170
Figure 8.1 Steps in a pyramid 176

List of Tables

Table 3.1 Descriptors of Students' Response 49
Table 4.1 Response patterns about upper primary students' representations of the three-dimensional geometrical shapes and their development of three-dimensional visualization: 69
Table 5.1 Code list for cubes and triangular prisms in the first-pass coding process 81
Table 5.2 Modified code list for cubes and triangular prisms 82
Table 5.3 Final code list for cubes and triangular prisms 84
Table 5.4 An Example of Code Family 86
Table 5.5 Co-occurring Codes for the P-U-M-R levels about the descriptions of Cubes 89
Table 5.6 Data from "Rose" School 98
Table 5.7 Data from "Siu" School 99
Table 5.8 Data from "Wu" School 99
Table 6.1 Frequency of Description Patterns about Cubes Found in Three Samples (schools) 102
Table 6.2 Frequency of Drawing Patterns of Cubes Found in Three Samples (schools) 108
Table 6.3 Frequency of Description Patterns of Cubes Rated as at P-U-M-R levels of the SOLO model 112
Table 6.4 Frequency of Drawing Patterns of Cubes Rated as at P-U-M-R levels of the SOLO model 114
Table 6.5 Descriptions about Cubes across Different Years of Students 115
Table 6.6 Drawings of Cubes across Different Years of Students 116
Table 6.7 Students' Response Patterns of 3D Geometrical Shapes 120
Table 6.8 Selected Cases: Students' Response Patterns of 3D Geometrical Shapes 121
Table 7.1 Frequency of Description Patterns about Triangular Prisms Found in the "rose" School 124
Table 7.2 Frequency of Drawing Patterns of Triangular Prisms Found in "rose" School 129
Table 7.3 Frequency of Description Patterns of Triangular Prisms Rated as at P-U-M-R levels of the SOLO model 133
Table 7.4 Frequency of Drawing Patterns of Triangular Prisms Rated as at P-U-M-R levels of the SOLO model 134
Table 7.5 Descriptions about Triangular Prisms across Different Grades of Students 136
Table 7.6 Drawings of Triangular Prisms across Different Grades of Students 136
Table 7.7 Frequency of Description Patterns about Pyramid Found in the "siu" School 140
Table 7.8 Frequency of Drawing Patterns of Pyramids Found in "siu" School 146

Table 7.9 Frequency of Description Patterns of Pyramids Rated as at P-U-M-R levels of the SOLO model 151
Table 7.10 Frequency of Drawing Patterns of Pyramids Rated as at P-U-M-R levels of the SOLO model 152
Table 7.11 Description about Pyramids across Different Grades of Students 154
Table 7.12 Drawings of Pyramids across Different Grades of Students 154
Table 7.13 Frequency of Description Patterns about Cylinders Found in the "wu" School 157
Table 7.14 Frequency of Drawing Patterns of Cylinders Found in "wu" School 162
Table 7.15 Frequency of Description Patterns of Cylinders Rated as at P-U-M-R levels of the SOLO model 164
Table 7.16 Frequency of Drawing Patterns of Cylinders Rated as at P-U-M-R levels of the SOLO model 167
Table 7.17 Descriptions about Cylinders across Different Grades of Students 168
Table 7.18 Drawings of Cylinders across Different Grades of Students 169

Abstract

Within the study of the three-dimensional (3D) geometry in the primary school curriculum is the development of students' spatial visualization, the ability to visualize the 3D geometrical shapes. Both the National Council of Teachers of Mathematics in the States and the Curriculum Development Council in Hong Kong emphasis that all students should have opportunities to visualize and work with 3D shapes in order to develop spatial skills fundamental to everyday life and to many careers.

This research is a study about how a sample of 297 upper primary students in Hong Kong describe in (Chinese) words about, and draw on papers, the 3D geometrical shapes. These shapes include cube, triangular prism, pyramid and cylinder. The focus is on the interpretation of the diversity of the responses used in students' descriptions and on the exploration of students' development of visualization by their drawings of the four 3D shapes. It raises issues about upper primary students' spatial ability and the need to conceptualize 3D spatial ability within board theoretical frameworks in the literature. The theoretical models of different aspects are explored: Bishop's IFI and VP spatial abilities be adopted to define the scopes of spatial abilities; Van Hiele's levels of geometry learning be the basis of the macro stages of cognitive development; and the Prestructural-Unistructural- Multistructural-Relational (P-U-M-R) sequence in the SOLO model be the micro levels of cognitive development growth.

Epistemologically, the view of knowledge in this study is based on Vygotsky's socialcultural perspective. The grounded theory approach and the interpretive approach are adopted for the research methodology.

A fundamental finding is that the response patterns about the descriptions and the drawings of the 3D geometrical shapes are rich and diverse. Also, the findings support the P-U-M-R levels of the SOLO model and provide a set of descriptors of students' developmental representation patterns for the four levels both in

descriptions and drawings underpinned by the theoretical framework achieved in this study.

This study concludes with recommendations for explicit instructions on the 3D geometrical shapes such as the 3D geometrical vocabulary, 3D drawing conventions, the static nature of representational drawings on papers, building up the coordination views, the partial occlusion technique, hands-on activities with real objects and relating 3D objects in the real world.

Key words: 3D geometry; spatial ability, SOLO model

CHAPTER 1 INTRODUCTION

1.1 How the Study Emerged

My interest in this study evolved because I had been a mathematics teacher over 15 years. First, my undergraduate study in mathematics followed by further studies in teaching and then in mathematics education, stimulated my interest in mathematics teaching. Second, over many years during my teaching in three-dimensional trigonometry in junior secondary school, there were always students who could not read and draw three-dimensional drawings for they did not know the drawing conventions of how solid shapes are represented on two-dimensional paper. For instance, students could not recognize that two planes can be perpendicular to each other and they used plane-figure names instead of three-dimensional names for solid shapes. My thought about these difficulties turned to the child psychology.

> "The literature on drawing development has emphasised a main transition between 4 and 7 years of age, from a stage at which children draw "what they know" about scenes or objects to a stage at which they draw "what they see" from a specific viewpoint" (Picard & Durand, 2005, p. 49)

"What they know" means that there is a mental model or internal representation of the solid shape between students' observations and their drawings (See Section 1.4.2 and Section 2.4). Students' knowledge on these internal mental representations might influence or intrude students' drawing process and ultimately their three-dimensional drawings on papers. For instance, children below the age of 8 years might include in their drawings of parts of the solid shapes that could not be seen from their viewpoints. On the other hand, I also made reference about the primary mathematics curriculum in Hong Kong (Hong Kong Curriculum Development Institute, 1998) for what students learned about geometry before they came to secondary schools. I found that three-dimensional geometry was excluded though volumes and properties of solid shapes such as cubes, cylinders, pyramids and triangular prisms (Figure 1.1) were taught and such solids are displayed on primary mathematics textbooks. My interest then became focusing on exploring how upper primary students describe and draw from their memory about these solid shapes. In the context of mathematics

teaching. I looked for students' mental representations about these solid shapes (Kosslyn, Hedelmeyer, & Lockear, 1979). How do students interpret cubes, triangular prisms, pyramids and cylinders by descriptions? What are the most common wordings they would use? How do primary students demonstrate by drawing that cubes, triangular prisms, pyramids and cylinders are solid on a two-dimensional surface of a paper? What are the students' canonical interpretations about the solid shapes? Are there any developmental growth or levels that I can figure out? The study results can provide teachers with useful level descriptors to interpret students' understanding, their internal mental models, about the three-dimensional geometrical shapes.

1.2 Teaching and Learning Three-dimensional Geometry in Schools

The interpretation of two-dimensional (2D) drawings back to three-dimensional (3D) real space is very important in our modern world, in which we obtain a great part of the information in our 3D world via various 2D media. Ben-Haim, Lappan and Houang (1985) stated "although we live in a 3D world, most of the visual mathematics materials presented to students are 2D". Mitchelmore (1980) also argued that "it is of great value to be able to visualize and represent 3D configurations and to comprehend the geometrical relations among the various parts of a figure". In other words, drawing an acceptable representation of a 3D solid, students need to recognise the relationships among the parallels, perpendicular lines, edges and faces on the solid. Thus, they learn a great deal about geometrical properties by drawing geometric shapes. "So, even now, being able to do a drawing that is suitable for problem solving is not obsolete" (Parzysz, 1991, p. 587).

In Hong Kong, the primary mathematics curriculum (The Curriculum Development Council, 2000) requires students to understand the properties of 3D shapes, group and make 2D and 3D shapes. The main tool for teaching these topics is still textbooks or paper based worksheets. The 3D world of these geometrical shapes is presented through 2D drawings and pictures. Although the computers are common in modern classrooms, graphics on the computer screen are still of a 2D nature.

Students face the problem of reading spatial objects or pictures on books and graphics on computer screen during their learning life. Interpreting 2D representations of 3D shapes is a very important part of mathematics and science curricula. These skills are essential and indispensable when students study science subjects such as Earth science, Physics, Biology and Chemistry in their high schools (Baartmans & Sorby, 1996; Ehrlen, 2008; Lege, 1999; Patrick, Carter, & Wiebe, 2005). For instance, Ferk, Vrtacnik, Blejec, & Gril (2003, p. 1242) in their study about students' understanding of molecular representations suggested that primary school teachers should guide students to draw their 3D observations in two dimensions and thus facilitate students' understanding different kinds of 2D molecular structure representations.

Geometry and spatial ability are major parts of the school mathematics curriculum (Geddes, 1992; Lappan, 1999). Through activities and spatial experiences such as drawing 2D representations of 3D solids, students develop spatial sense and visualization skills necessary to function effectively in a 3D world. That a student could describe and draw a 2D representation of a 3D geometrical shape implies that the components of the shape are better understood because they are formed by the student who knows what they should include (Koester, 2003; Qin & Simon, 1995, p.404). Yet, it is well known that the teaching of solid geometry is rather neglected (Clements, 2003; Webb, Lubinski, & Benbow, 2007) and that is often limited to the topics in measurement: surface area, volumes and names of simple solids (Howson, 1991). Hong Kong is not exceptional in this aspect referring to the recent curriculum (Hong Kong Curriculum Development Institute, 1998).

In an ICMI (International Commission on Mathematical Instruction) study, Villani (1998) suggested that the attention to 3D reality in which we live should continue even in later grades together with a focus on the relationships between 3D space and its 2D representations. Therefore, students' representations of 3D geometrical shapes and their development of 3D visualization are problematic issues that are worthy of study.

Furthermore, 3D or spatial visualization is part of the human general intelligence (Shea, Lubinski, & Benbow, 2001; Webb, et al., 2007). Howard Gardner (1993) has

created a theory of "multiple intelligences" and spatial intelligence is one of the seven intelligences. Accepting Gardner's Theory has the implication for teaching representations of 3D geometrical shapes. 3D space and its 2D representation may be may be subsumed under the spatial intelligence. Campbell, Campbell, & Dickinson (2004, p. xx) defines that "spatial intelligence instils the capacity to think in three-dimensional ways as do sailors, pilots, sculptors, painters, and architects. It enables one to perceive external and internal imagery, to navigate oneself and objects through space, and to produce or decode graphic information".

Gardner (1993, p. 192) agrees that "it is skill in spatial ability which determines how one will progress in the sciences". Visual spatial intelligence is also a characteristic of many intellectually gifted children (Webb, et al., 2007). Thus, teaching 3D geometrical shapes is teaching for spatial intelligence and would be part of the process identifying visually gifted children (Fredette, 1993).

1.3 The Purposes of the Study

This is an explorative study on spatial ability of students in upper primary geometry. In this study, spatial ability is concerned with 3D geometrical shapes commonly found in primary mathematics (See Figure 1.1) and their descriptions by words.

A primary purpose of this study is to extend and develop the theoretical models to inform research and development about upper primary students' response patterns to the descriptions about and drawing of 3D geometrical shapes both within and beyond the contexts of this study. These theoretical models, to be elaborated in the next chapter, include the levels of responses in SOLO model (Biggs & Collis, 1982; Pegg & Davey, 1998), van Hiele's Level Model of geometry learning (Clements & Battista, 1992) and Bishop's IFI and VP spatial abilities (Bishop, 1983).

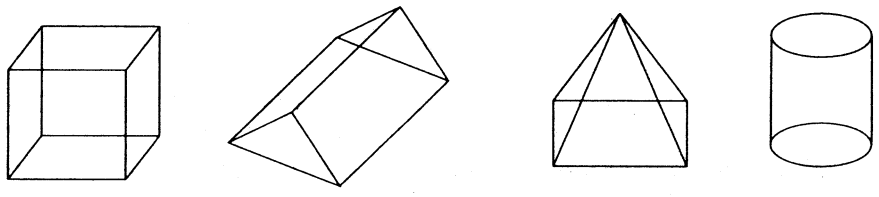


Figure 1.1 The geometrical shapes, commonly found in primary mathematics

A second primary purpose of this study is, based on the response patterns of 3D geometrical shapes obtained across different grades of primary students, to provide teachers with the cognitive development level descriptors to interpret students' understanding about the 3D geometrical shapes. Hence, the level descriptors provide a means of considering the quality of understanding about the 3D geometrical shapes.

In other words, this study will try to supply information for answers to the questions: What does understanding of 3D geometrical shapes mean? Is it a measurable phenomenon? What does a view of understanding mean for assessing the quality of students' work in 3D geometrical shapes? How do students acquire spatial abilities in the case of 3D geometrical shapes? What are the optimal instructional sequences in lessons on 3D geometrical shapes?

To acquire the information to answer the above questions, a large number of students' drawings and descriptions of the 3D geometrical shapes will be collected, examined and analysed in order to discover and identify the diversity and patterns in students' descriptions about and drawing representations of 3D geometrical shapes.

1.4 The Significance

We are living in a 3D space. Learning about solid objects begins when a baby is born. Babies visualize and explore the objects around them. They have the experiences with solid objects such as putting toys into the containers and taking them out and

learning the language used by adults. These experiences assist the students to develop their initial knowledge about space before they go to school (Owens, Leberne, & Harrison, 1999).

1.4.1 The Geometry Curriculum

Geometry and spatial ability are major parts of the school mathematics curriculum. As the renowned British mathematician, Sir Michael Atiyah writes:

> "... spatial intuition or spatial perception is an enormously powerful tool and that is why geometry is actually such a powerful part of mathematics - not only for things that are obviously geometrical, but even for things that are not. We try to put them into geometrical form because that enables us to use our intuition. Our intuition is our most powerful tool..."(Atiyah, 2001, p.50)

Also, the Principles & Standards for School Mathematics (National Council of Teachers of Mathematics, 2000) states the requirements in the Geometry standard for Grades 3-5 and Grades 6-8:

> "Much of the work students do with 3D shapes involves visualization. By representing 3D shapes in two dimensions and constructing 3D shapes from 2D representations, students learn about the characteristics of shapes." (p.168)

> "Students' skills in visualizing and reasoning about spatial relationships are fundamental in geometry. Some students may have difficulty finding the surface area of 3D shapes using 2D representations because they cannot visualize the unseen faces of the shapes. ... Interpreting or drawing different views of buildings, such as the base floor plan and front and back views, using dot paper can be useful in developing visualization. Students should build 3D objects from 2D representations; draw objects from a geometric description; and write a description, including its geometric properties, for a given object." (p.236)

So, an important part of growth in insight for 3D geometry is visualization. However, "many teachers do not consider geometry and spatial relations to be important topics, which gives rise to feelings that geometry lacks firm direction and purpose" (Pegg & Davey, 1998, p.109). Many mathematics educators (Ben-Chaim, Lappan, & Houang, 1988; Hazama & Akai, 1993; Hidaka, 1994; Kwon, Kim, & Kim, 2002) have voiced the importance of promoting the teaching of geometry in the development of students' spatial ability, including visualization, visual representation and visual

reasoning.

On the other hand, a geometry curriculum is not just a collection of contents and students' activities. It must be supported by effective pedagogy. Teachers must develop the pedagogical knowledge they need to teach their students. However, there has been insufficient research into the teaching and learning of geometry with a theoretical framework to underpin the research (Pegg & Davey, 1998).

1.4.2 Concerns in Teaching and Learning 3D Geometry

"Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well." (National Council of Teachers of Mathematics, 2000, p. 370). Learning 3D geometry, students often use perceived images or idiosyncratic representations in drawing geometric shapes. For example (Mitchelmore, 1974), one of students' idiosyncratic representations of a cube as requiring horizontal edges might lead to a "stable" image only if two edges are drawn horizontally (Figure 1.2)

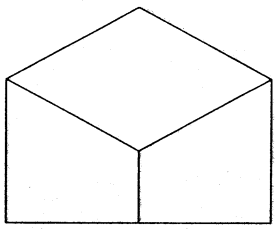


Figure 1.2 A student's idiosyncratic representation of a cube

Students' construct of images suggests that although pictures can support geometric reasoning, they bring their own problems. "Idiosyncratic representations are both inevitable and necessary for learning mathematics" (Smith, 2003). This study starts from students' internal representations both in drawings and descriptions, and explores their creation and use of idiosyncratic representations. Understanding students' idiosyncratic representations might help students progress from idiosyncratic to conventional and general representations. Accordingly, teachers can

explore their students' understanding of the role of representations in learning geometrical shapes.

1.4.3 Assessment in Mathematics

Another area of concern in this study is the assessment in 3D geometry in the mathematics curriculum. It is a concern for the formative nature of assessment: the teacher wants to monitor student progress and adapts lessons to have more appropriate levels of understanding in 3D geometrical shapes; the curriculum analyst has a means to redesigning the topics to take account of how students grow; and the mathematics researcher has a means of identifying appropriate descriptions of the various categories of development in visualization of 3D geometrical shapes.

Biggs and Collis (1982) examined a large number of student responses across a number of content areas. Their analysis dealt with the *Structure of the Learned Outcomes* (SOLO) of student responses. SOLO was concerned with the cognitive development of students from analysing and interpreting student responses (See Section 3.2). "For particular content areas, certain idiosyncrasies peculiar to the area need to be taken into account" (Collis, Romberg, & Jurdak, 1986). In this study, a set of structured levels of students' responses in the context of 3D geometry will be investigated. Instruction is most successful if it is directed at the student's level of understanding.

Hence, the quality of geometric knowledge that students develop could have a powerful effect on their idiosyncratic representations and subsequent use of that knowledge. The next chapter reviews researches and theories that affect students' spatial abilities, in particular, students' 3D geometric knowledge, ideas on 3D geometric shapes and other issues of teaching and learning in 3D geometry

1.5 Contextual Information

Situated at the south-eastern tip of China, Hong Kong is positioned at the centre of East Asia. Hong Kong became a Special Administrative Region (SAR) of the People's Republic of China on July 1, 1997, after a century and a half of British administration. Under the 1984 Sino-British Joint Declaration, the existing

economic, legal and social systems will be maintained for at least 50 years after 1997.

The educational system in which the study is set and the primary mathematics curriculum that is currently adopted are briefly described below.

1.5.1 Basic Education System

The Hong Kong Special Administrative Region Government provides nine years of free basic education from the ages of 6 to 15. There are three main types of schools: government schools that are wholly operated by the Government; aided schools, which are fully aided, by the Government but run by voluntary bodies; and private schools, some of which receive financial assistance from the Government.

While the medium of instruction in schools are Chinese and English, the Government has been promoting the use of trilingual, that is, speak fluent Cantonese, Putonghua and English. Primary schooling starts at the age of 6 and there is 6 years of schooling at the Primary level. Currently, secondary schools except for international schools offer three-year basic and two-year senior secondary courses leading to the Hong Kong Certificate of Education Examination (HKCEE), to be followed by a two-year sixth-form course leading to the Hong Kong Advanced Level Examination (HKALE) for admission to tertiary institutions.

It is the above examination system that exerts a powerful influence on pedagogy and assessment with the result that didactic teaching and rote learning are very common in classrooms of Hong Kong schools (Morris, et al., 1999). The purpose of assessment is for grading and selection students within this highly competitive educational system. Morris and his project team (1999, p. 2) criticized the prevailing curriculum in Hong Kong's schools as primarily academic, teacher- and textbook-centred, and driven by competitive, norm-referenced examinations.

1.5.2 Contents of Geometry in the Primary Mathematics Curriculum

The existing mathematics curriculum (The Curriculum Development Council, 2000) for Hong Kong primary schools was adopted in 2000. It is divided into five learning dimensions, namely, Number, Shape and Space, Measures, Data Handling and

Algebra. In designing the dimension (strands of contents) on Shape and Space, below is the learning targets set up for primary year 1 to 3:

- identify, describe and group 2D and 3D shapes
- recognize intuitively the elementary properties of 3D shapes;
- make 2-dimensional and 3 dimensional shapes from given information;
- recognize, describe and appreciate shapes;

and for year 4 to 6:

- understand the properties of 2D and 3D shapes;
- group and make 2D and 3D shapes; (p. 8)

In general, the contents of geometry are arranged across all years of primary education from simple to complex and from concrete to abstract. The curriculum guide suggests that students should be allowed to learn and master the properties of shapes through intuitive and hands-on activities such as grouping, paper folding, shape cutting and dissecting, drawing and model making. Teachers are advised to let students learn the relationships between relative positions of shapes through observation in order to help develop students' spatial sense.

1.6 Terminology

In the discussion of children' drawing the word, *perspective*, is likely to be troublesome that it means different things to different people. In our daily communications, perspective means a realistic graphic display of an object on paper. In technical drawing, there is a perspective projection system to represent a 3D object. In perspective projection (Frantz, Crannell, Maki, & Hodgson, 2006), the edges (or rays) of the object converge to a vanishing point on the paper . Figure 1.3 below is a perspective drawing of a cube.

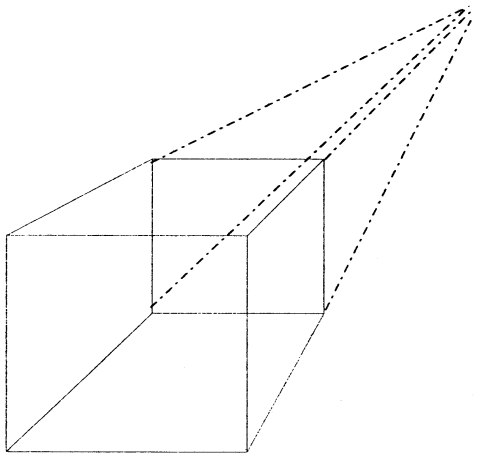


Figure 1.3 Perspective projection drawing of a cube

In our mathematics texts, we usually use the *oblique* projection system to represent 3D geometrical shapes. In oblique projection, the projection rays, the edges of the shape, are parallel in the picture. Thus, a rectangle and a square become a parallelogram in oblique projection system. From a glance at the picture, the solid shape looks like more 'realistic' than 'perspective'. In this study, a perspective view is preferred to this oblique projection view. Figure 1.4 is an oblique projection drawing of cube.

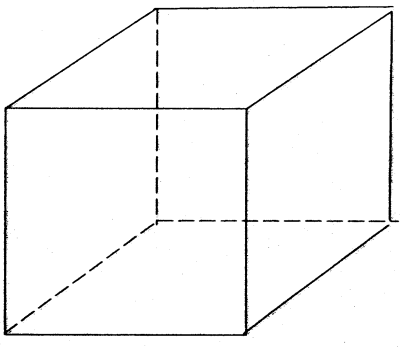


Figure 1.4 Oblique projection drawing of a cube

The figure also shows a technique called the partial occlusion technique in which all the hidden-lines are in dotted lines. This is the most commonly used solution in solid geometry to represent those lines obscured by the faces from the observer's view.

CHAPTER 2 LITERATURE REVIEW

This study will look for the diversity and patterns that occur in upper primary students' drawings and descriptions of 3D geometrical shapes. The first part of this chapter will review the meaning of spatial ability and its annotations for the drawings, the 2D representation of 3D geometrical shapes, and the descriptions, the interpretations of 3D geometrical shapes, within some board theories in the literature of the teaching and learning of geometry. The second part of this chapter will identify the problematic issues related to students' spatial abilities and misconceptions in learning 3D geometrical shapes. As drawings and descriptions of 3D geometric shapes are one aspect of mathematical representations, the third part of this chapter focuses on the representation as an assessment tool (Cuoco & Curcio, 2001).

2.1 Defining Spatial Ability

Historically, spatial ability has long been of the interest to psychologists and a large number of experiments have been done to test its various components. Terms such as "visual perception", "spatial cognition", "spatial perception", "spatial visualization" and others appear to have been used in the psychological literature interchangeably with "spatial ability"(Wiley, 1990). It is also recognised that no agreement on the definition of each of these terms has been reached in the literature (Guttierez, 1996).

2.1.1 Some Descriptions of Spatial Ability

Spatial visualization in general can be considered as being the ability to represent information consisting of spatial, non-arbitrary (i.e., "picture-like" qualities resembling actual shapes or events), and continuous (i.e., an "all-in-oneness" quality) characteristics (Paivio, 1990). Guttierez (1993) supported this idea from the viewpoint of mathematics education. He noted "spatial visualization refers to a set of elements related to the generation and use of mental representations (mental images) of mathematical information"(p. 24). Lean and Clements (1981) gave a more general definition that by 'spatial ability' we mean the ability to formulate mental images and

to manipulate these images in the mind. National Council of Teacher of Mathematics defined spatial visualization as "building and manipulating mental representations of 2D and 3D objects and perceiving an object from different perspectives" (2000, p. 41). McClintock, Jiang, and July (2002) described 3D spatial ability including "both the ability of interpreting figural information in the context of 3D objects and the ability for visual processing of these objects". Thus, these researchers have identified the ability of representation and manipulation of spatial information as major components in spatial ability.

2.1.2 Components of Spatial Ability

Though there are still debates over problems of the definition, nature and components of spatial ability, to mathematics educators there can never be a "true" nature. For practical reasons as well as teachers' concern, knowledge about the components of spatial ability would help the teachers to address the teaching and learning problems associated with spatial representation and interpretation problems.

From a plethora of factor analytic studies, McGee (1979) identified the existence of at least two types of spatial abilities:

1. *Spatial visualization* which is the "ability to mentally rotate, twist two- and 3D stimulus shapes"(p. 909); and
2. *Spatial orientation* which is "the comprehension of the arrangement of elements within a visual stimulus pattern, the aptitude to remain unconfused by the changing orientations in which a spatial configuration may be presented, and an ability to determine spatial orientation with respect to one's body"(p. 909).

To help mathematics educators focus on the significant learning process and relevant teaching research, Bishop (1983) followed up on McGee's analysis and proposed these two alternative components of spatial ability:

1. *The ability for Interpreting Figural Information* (hence referred to as IFI). This ability involves understanding the visual representations and spatial vocabulary used in geometric work, graphs, charts, and diagrams of all types. Mathematics

abounds with such forms and IFI concerns the reading, understanding, and interpreting of such information. It is ability of content and of context, and relates particularly to the form of the stimulus material.

2. *The ability for Visual Processing* (hence referred to as VP). This ability involves visualization and the translation of abstract relationships and non-figural information into visual terms. It also includes the manipulation and transformation of visual representations and visual imagery. It is an ability of process, and does not relate to the form of the stimulus material presented.

Separating the ability of Visual Processing from that of Interpreting Figural Information, Bishop (1983, p. 185) argued that the IFI-VP dichotomy is more extensive and refined than McGee's. Bishop's IFI-VP dichotomy also shows that though there is a close relation between the stimulus material involved in IFI-ability and the mental image involved in VP-ability, these entities are distinct when considering factor analysis of spatial abilities (Hershkowitz, Parzysz, & van Dormolen, 1996). The mental image in Figure 2.1 is a mental representation of a mathematical concept or entity containing information based on pictorial, graphical or diagrammatic elements (Guttierez, 1996). The mental image is sometimes referred to as the visual imagery. Visualization is a kind of reasoning based on the corresponding mental image.

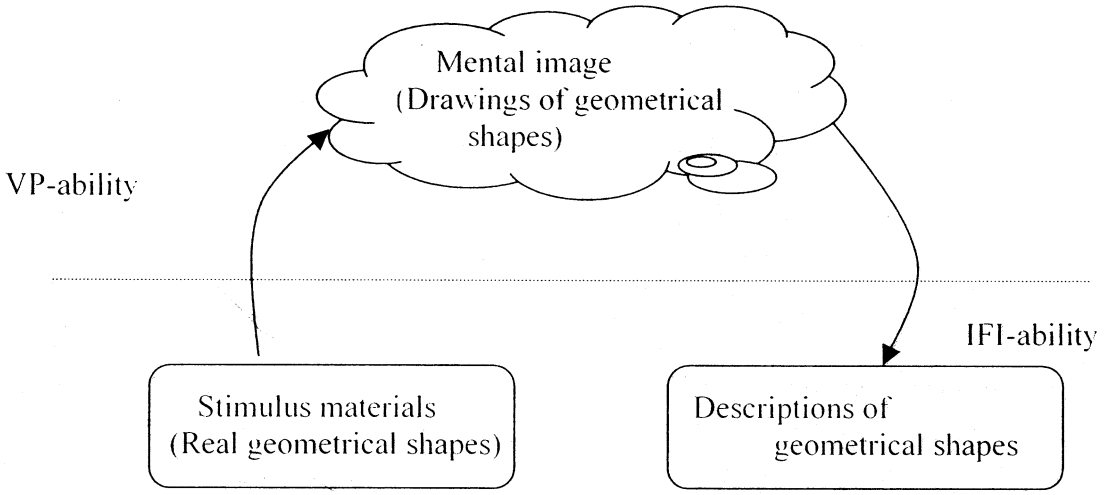


Figure 2.1 Entities in spatial ability

IFI-ability almost invariably uses figural stimuli or the physical geometric shapes. It also links students' understanding of the figural representations used to describe geometric and spatial concepts. Students should have the ability to interpret the language or conventions used to represent the geometric figures otherwise concepts related to spatial ability will not have much meaning for the students. Bishop's IFI-ability relates directly to geometric and graphical conventions emphasizing the interpretation demanded by those mathematical representations.

In a later review, Bishop (1989) further commented that VP-ability and the use of mental imagery are very personal or idiosyncratic matters. Teachers have to give time to their students to let them develop or construct their own mental images. There seems no way for teachers expecting identical images from different students due to the results from such personal activities. Bishop's comment is in fact in line with the constructivist paradigm that students have reconstructed anew their individual mental images.

> "This IFI-VP dichotomy also conveyed the possibility of testing spatial ability. Bishop states that "whereas it is possible to test the ability for Interpreting Figural Information (IFI) in a group mode, it seems much more necessary to use individual clinical procedures to test the ability for VP. IFI ability seems much easier to train and develop than VP, if only because of the public, communicable nature of IFI in comparison with the private, personal nature of VP. " (Bishop, 1983, p. 185)

A remark from Zimmermann and Cunningham (1991, p. 1) is useful to make VP-ability more operational for mathematics educators. The term "visualization (is) to describe not only the representation as an outcome, whether hand drawn or computer generated, but also the process of producing it by using mathematical principles or concepts". The ability to draw 2D representations of 3D shapes is subsumed within VP-ability for the process of producing the drawing certainly involves the manipulation of the visual images of the 3D shapes.

However, Guttierez (1996) criticized the IFI-VP dichotomy. She felt it was only a classification of processes to be performed. "The description of ability should include information about the way it can be performed or the skills to be used" (p. 8). Furthermore, school teachers are only interested in what components of the spatial visualization ability they are able to teach, what are the methods they can assess students' learning outcome and what way they can overcome students' 3D visual obstacles.

The researcher believes that these specific definitions can provide a basic framework that can be translated into measurable skills and observable processes. If drawings of 3D shapes were affected by students' own mental images, then there should be a diversity of drawings. This IFI-VP dichotomy can also provide a foundation for the specifications of tasks for teaching about the representation and interpretation abilities of 3D shapes. The learning, assessment and improvement of learning in 3D geometrical shapes are the key areas in this study.

As a first step towards this framework, the researcher proposes a preliminary refinement of IFI-VP dichotomy in a figurative form from Figure 2.1 to that in Figure 2.2. The IFI- and VP- abilities will be further factorised into components later after an extensive review of factors affecting students' learning in spatial geometry in literature and be further elaborated in my future study. As a major achievement of this review, components of IFI- and VP-abilities will be established in order to facilitate the exploration and interpretation of students' descriptions and drawings of 3D shapes.

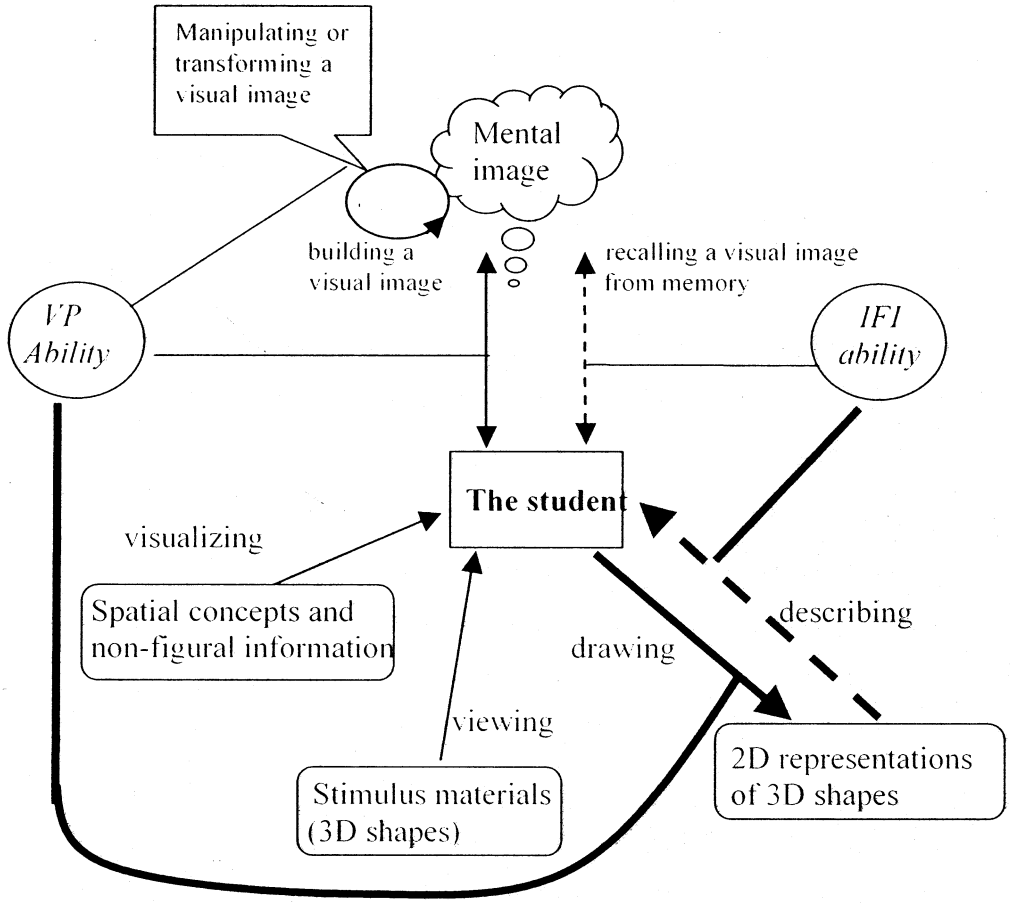


Figure 2.2 Components of spatial abilities based on IFI-VP dichotomy

1. *The IFI-ability.* When the student interprets the 2D representation of a 3D shape, he or she would mentally recall the visual image that relates with his or her experience in viewing the corresponding physical shape and in the interpretation of spatial vocabulary, convention or concepts. It is because the human eye is not a camera-like instrument for recording an object. Rather, it serves as an "optical interface" between the external stimulus material and the human neural system (Hubona, Shirah, & Fout, 1997). So, the accuracy of the mental image depends on the student's understanding of the drawing conventions, specific concept and vocabulary used in 3D geometry. The most essential factor is that he or she has to distinguish the 2D *representational* nature of the drawing from the *physical* 3D geometric shape. Even though the students had an accurate mental image as well as a

correct interpretation of the physical shape, they might draw bad representations not in accordance with the conventions. This inability to draw the 3D figures may be due to some obstacles in students' drawing skills. That is, students may have the relevant spatial ability but not the related drawing skills to represent the 3D shapes. Drawing skill is part of the IFI-ability.

2. *VP-ability*: When a student is asked to draw the 2D representation of a 3D shape from memory, a mental image will be generated based on the information of the given shape in order to "observe" mathematically by rotation the position and the other unobservable parts or elements of the geometrical shape. It is also quite common in mathematics that many mental images do not have a pictorial base such as point, line and plane. Their representations are based on other visual ways or conventions when solving mathematical problems. Thus, the VP-ability is involved in the drawing of 2D representation as the manipulation of the mental image is needed. VP-ability is involved in order to build visual images when visualizing the non-figural mathematical spatial concepts. The major function of the VP-ability is the manipulation and transformation of a mental image by rotating, translating, scaling or decomposing it.

2.2 The Teaching of Spatial Ability

Numerous studies have reported that spatial visualization ability can be improved through teaching (e.g. Clements & Battista, 1992). However, to what extent can a direct intervention by instruction improve spatial abilities? Del Grande (1987, 1990), Lean and Clements (1981), Bishop (1983, 1989) commented that these various skills involved in Interpreting Figural Information (IFI) are trainable given the appropriate experience. However, Lean and Clements (1981) did not find any evidence showing the success of training in VP-ability. As shown in previous reviews, it is likely that the difficulty lies with assessment of Visual Processing (VP) as much as with students' development (Bishop, 1983). This necessarily leads to an examination of the relationship between students' spatial ability and their development in geometry

learning.

2.2.1 The van Hiele Model

The van Hiele model (Fuys, Geddes, & Tischer, 1988) suggests a progression in geometric thinking through taxonomy of levels. The model provides the role of instruction in assisting students to acquire knowledge and raise their levels of geometric thinking (Lehrer, Jenkins, & Osana, 1998). The following are a short description of the levels (Clements & Battista, 1992) and some major characteristics of the model (Fuys, et al., 1988):

Level 1: Visual. The student perceives and operates on shapes according to their appearance. Figures are identified by their shape as a whole, not by the characteristic traits of the class of figures represented.

Level 2: Descriptive/analytic. The student can identify the properties of figures. These properties are discovered and generalized from the observation of a few examples.

Level 3: Abstract/relational. The student can reason figures in terms of properties. Thus, simple deduction can be followed, but a whole proof is not understood. Relationships between different figures are also understood.

Level 4: Formal deduction. The student can establish theorems within an axiomatic system and distinguish between necessary and sufficient sets of conditions for a concept.

Level 5: Rigor/meta-mathematical. The student can work formally in a mathematical system and operate between formal constructs.

As Pegg, Gutierrez & Huerta describe (1998), the theory of van Hiele offers an important addition, the learning cycle of five teaching phases by which the learner may be assisted to develop to higher level. Five such cycles are specified:

Phase 1: *Information (Inquiry).* Learners get acquainted with the studying area. Teachers know the learners' previous knowledge.

Phase 2: *Directed orientation.* Learners are guided by the teachers to complete

certain tasks. Teachers' role is to direct the classes to explore the area of study.

Phase 3: *Explicitation.* Learners become conscious of the subject matters. Teachers have to ask the learners to try to express them in words and talk about what has been learned. They gradually learn the technical language of the subject matter.

Phase 4: *Free orientation.* Learners are expected to find their own way to solve general tasks. Teachers' role is to encourage learner seeking for alternative solutions to the tasks

Phase 5: *Integration.* Learners build an overview of all they have learned of the subject and are prepared to reach the next level.

These teaching phases are significant in providing a framework for instruction aimed to develop understanding of geometric concepts and skills to be learned

In summary, the major characteristics of the van Hiele "levels" are that (a) the levels are sequential; (b) each level has its own language, set of symbols, and of relations; (c) what is implicit at one level becomes explicit at the next level; (d) material taught to students above their level is subject to reduction of level; (e) progress from one level to the next is more dependent on instructional experience and is not age-dependent; and (f) one goes through various "phases" in proceeding from one level to the next (Fuys, et al., 1988).

The van Hiele model in plane geometry has been the subject of important research but as regards 3D geometry there has been little research. Only recently have there been several isolated and incomplete approaches to 3D geometry based on the van Hiele model (Guillen, 1996; Guttierez, Jaime, & Fortuny, 1991). In a recent study (McClintock, et al., 2002) about 3D visualization, both the van Hiele model and Bishop's IFI-VP dichotomy on spatial ability were used as the research framework. Subjects' levels of geometric thought were measured as evidence of the effectiveness of the teaching experiments.

Of particular reference to the researcher proposed study are the first three van Hiele levels for categorising upper primary students' cognitive levels in learning 3D geometrical shapes. Note that learning 3D geometrical shapes does not involve the abilities for Level 4 and 5. A linking between Bishop's IFI- and VP- abilities and van

Hiele Model is proposed (See Figure 2.3). It illustrates that there are relationships between level 1, 2 and IFI-ability and between level 3 and VP-ability. Previous research (Burger & Shaughnessy, 1986) has shown that in 2D geometry students at these two levels cannot form mental image, see the 2D shapes as a whole, and recognize the shapes by their properties.

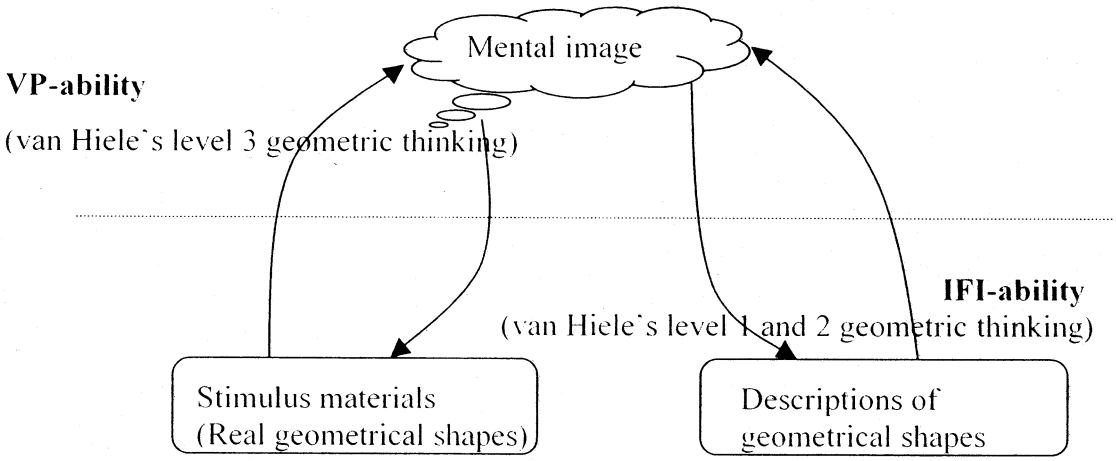


Figure 2.3 The amalgamated model

Now that Bishop's IFI-VP dichotomy provides the scope of spatial ability and van Hiele's provides a cognitive development path in levels. However, the path is uni-dimensional. Pegg, Gutiérrez & Huerta (1998) points out that "(i) learners may be on different van Hiele levels for different concepts, and (ii) the van Hiele levels are not particularly suited for fine-grained analysis of a learner's understanding." (p.280). This study needs a more local and micro cognitive development. Such micro refinement is referred to SOLO Taxonomy which will be discussed in Chapter 3.

Before searching for a refined model to assess students' 3D spatial ability, a review in literature on students' misconceptions and difficulties in learning solid geometry is necessary in order to show that the study really resolves some problematic issues in the teaching of solid geometry.

2.3 The Problematic Issues

There is increasing evidence that many students have severe misconceptions concerning a number of important geometric ideas. During the past two decades, mathematics educators have identified students' difficulties in learning geometrical shapes and in particular the 3D shapes. Following are the research literature showing the existence of the Interpreting Figural Information (IFI) ability and the Visual Processing (VP) ability in Bishop's model as well as the evidence of the refinements of the IFI- and VP- abilities in a proposed model developed by the researcher (Figure 2.2).

2.3.1 Evidence of IFI-ability in Literature

Some of difficulties with visualization apply generally to all kinds of geometric figures and some of them are actually related to difficulties in the teaching problems. These difficulties or can be grouped around the following categories in the following sections but all are due to the obstacles in IFI-ability:

1. The Influence of Standard Diagrams
2. The Prototype Representations
3. Limitation of the 2D Representation of the Solid
4. Conventions of Diagrams
5. The Influence of the Drawing on Students' Spatial Conceptions
6. Difficulties in Basic Geometrical Concepts
7. Cultural Differences

2.3.1.1 The Influence of Standard Diagrams

Mariotti (1993) reported a research study in which students at three different age levels were asked to count the number of faces, vertices and edges after a regular tetrahedron was shown (without rotation) and then hidden. A very common and persistent performance was observed: the mental image of a square pyramid frequently replaced that of the tetrahedron. Mariotti explained that the perceptual

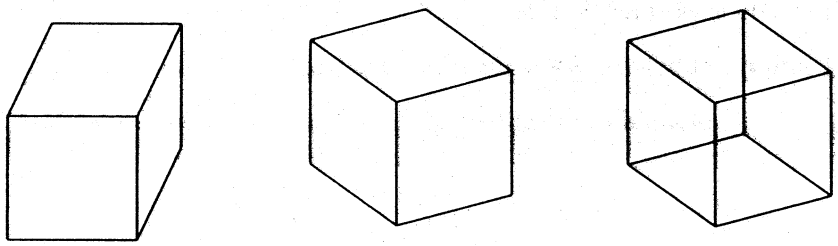
stimulus was interpreted according to a prototypical image: few critical attributes presented in the shape drew the pupils' attention and this caused the image to be assimilated to a prototype.

This phenomenon was probably due to the fact that shapes such as square pyramids were shown to pupils as a popular example of solid shape in geometry by teachers or textbook writers. Therefore, it led to the inconsistencies between the mental image and the real shape presented and hence, the students unduly generalize the properties of an example as the properties of the whole class of solid objects.

Yerushalmy and Chazan (1990) in a review on overcoming visual obstacles in geometry also pointed out that "students' definitions may include an irrelevant characteristic of the standard diagram, causing difficulties in creating or interpreting diagrams." Presmeg (1986) referred to this case as "one-case concreteness" and "the persistence of uncontrollable image"(pp. 44-45)

2.3.1.2 The Prototype Representations

The previous case shows that students mistake a special category of solids for all kinds of solids. Yet, even for a category, one diagram is intended as a prototype -canonical representation of the type. For example, textbook writers tend to use Figure 2.4(a) as the only representation of a cube but not others such as Figure 2.4(b) and 2.4(c). The diagram is meant to be understood as representative of a class of situations.



(a) (b) (c)

Figure 2.4 Representation of a cube

Every representation has characteristic that is individual and not representative of the class (Yerushalmy & Chazan, 1990). Here, students were also trapped by the

one-case concreteness of an image or diagram which may tie thought to irrelevant details, or may even introduce false data (Presmeg, 1986). In other words, students cannot realize static nature of all geometrical diagrams in the textbooks and thus cannot identify the particularity of the drawing that can only represent one case.

Lowrie and Diezmann (2007) also found that many students become confused when exposed to visual representations of diagrams and pictures that are different to those that they frequently encounter in school contexts which generally are standardised prototypes.

2.3.1.3 Limitation of the 2D Representation of the Solid

Any kind of 2D representations of solid shapes, such as those usually presented in textbooks, have some limitations and fail to inform the basic characteristic that a solid can be rotated and moved at a distance away from or close to the viewing position. So, there's more than one right way of drawing a 2D representation of any 3D solids. Viewing a solid irrespective of the viewing conditions such as the viewing position and the distance from the viewing position always incurs a certain loss of information. Thus, students may have difficulty drawing a 3D solid (model) on paper once the viewing angle is changed. It is an obstacle that Yerushalmy and Chazan (1990) related to an inability to see a single diagram in different way.

Parzysz (1988) illustrated the level of loss of information of representation by the table below where

level 0: the term "figure" here is referred to as a concept, a definition, a creation of the imagination or an idea in geometry (for instance, a vector, a point, a line and etc.). It cannot be drawn with all the attributes or characteristics represented;

level 1: the representation looks like the geometrical figure – same dimension, apart from the move from abstract to concrete;

level 2: the dimension of the representation is strictly inferior to that of the figure.

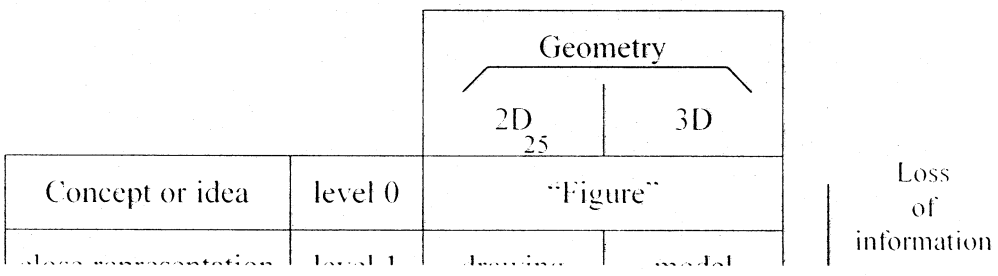


Figure 2.5 Close and distant representations

Geometrical concepts or ideas are typified by their mathematical definitions, which distinguish from their representations that are concept-examples. Bishop (1983) observed that one problem with geometry was that it is impossible to represent geometric concepts by a generalized drawing. When a 3D geometrical concept is represented by a drawing, the representation is insufficient in terms of structures and dimensions. In Figure 2.5, the loss from level 0 to level 2 is greater than that from level 0 to level 1. Parzysz (1988) further illustrated that the perpendicularity of the height of a regular pyramid to the diagonals of its square base is much less evident to imagine other than using a model.

2.3.1.4 Conventions of Diagrams

Studying the problems of the plane representation of solid figures in the teaching of geometry, Parazysz (1988) highlighted students' unconscious tendency to transfer the geometrical properties of the shape represented to the graphical representation, and vice versa. When given the 2D drawing of a cube represented by parallelograms for its side faces, Parzysz (1988) noted that:

> "... although all the pupils knew that it (the side of a cube) was indeed a square, and although the teacher several times laid stress on recalling that it was a matter of a quadrilateral in space, and not its drawing, however several pupils gave the answer 'parallelogram'." (p.79)

Parzysz commented that the drawings of these kinds of figures that appear in most textbooks were stereotyped and contained many implicit conventions, which caused difficulties in interpretation. To avoid this difficulty, Parzysz (1991) suggested that the conventions of geometrical diagrams should be taught explicitly. That is, the drawing of 2D representation should make use of the conventions such as parallel perspective and receding lines, dotted lines as hidden lines and shading to indicate depth. Parzysz contended, "as long as these conventions are not known and mastered, it cannot be expected that students have "sound" relations with the geometrical

shapes themselves". (p. 586)

Using dynamic 3D software programs in the investigation of young children's spatial reasoning, Lowrie (2002, p. 314) also found that some of the subjects had difficulty interpreting the spatial elements on the computer screen because they had not been specifically taught the mathematical conventions to construct ideas about links between 2D and 3D representations.

2.3.1.5 The Influence of the Drawing on Students' Spatial Conceptions

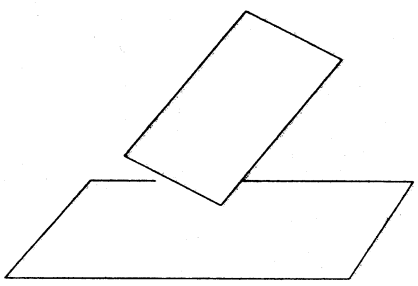
The formation of a geometric concept sometimes has to be based on verbal descriptions to convey a number of critical attributes of the concept such as planes and lines that extend indefinitely in space. Where concepts are introduced by diagrams for illustrative purpose, students' knowledge of a concept is constrained by the illustration or drawing presented.

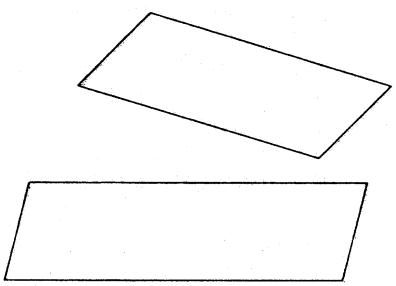
Parzysz (1991) in a study how the senior high students in France would represent planes asked students the following questions:

> "Can two (distinct) planes have: - more than one common point ?
> - one common point, and one only ?
> - no common point?"

The students consistently answered:

- for two planes having only one common point, they belong to the type shown in Figure 2.6(a);
- for two planes having no common point and not being parallel, they belong to the type shown in Figure 2.6(b).





(a) (b)

Figure 2.6 Representation of planes

The underlying misconception of a plane seems to be of the "limited plane". Parzysz's test clearly showed that the convention implicit in the drawing (eg., the parallelogram to represent an "infinite" plane in this case) engendered a serious misconception in the students' interpretation of the topic. The situation is summarized by the diagram below:

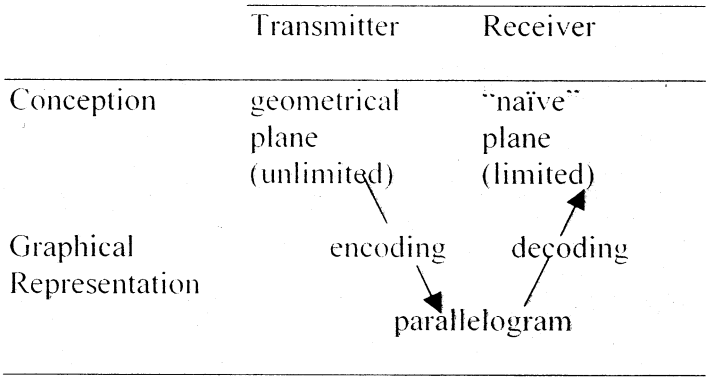


Figure 2.7 Misconception because of the representation

The parallelogram lies between the two communication actors (transmitter and receiver) as an interfering factor. The parallelogram is encoded as the graphical representation of a geometrical plane but the outlook of the parallelogram, when decoded, favours a misconception of a limited "naïve" plane. Sometimes, the two actors might be a single person, at two different moments.

2.3.1.6 Difficulties in Basic Geometrical Concepts

To interpret a 3D representation, it is necessary for students to understand the concepts and the drawing of angles, parallel lines and perpendicular lines since most of the drawings of regular shapes in the curriculum are composed of these components. Gal and Vinner (1997) found that students had difficulties in identifying

a right angle in diagrams.

Mitchelmore (1983, 1993) also gave many examples of the difficulties that students have in representing and drawing angles, parallels and perpendiculars. He found that even Year 4 university students had not formed a general concept of angle. He reminded readers "the ideas of parallels, perpendiculars and angle in general are fundamental to an educated understanding of space". (Mitchelmore, 1993) Similar cases were reported in the study of Ben-Chaim, Lappan and Houang (1989).

Recently, some of the above difficulties were confirmed by Diezmann (1993). In the study of a model of levels of mastery of representation in 3D geometric shapes, she reported evidence of various difficulties in diagram interpretation. The responses of students in grades 2 and 5 showed different difficulties in their interpretation: (a) confusing some properties of the referent and diagram, (b) representing shapes by only some features of 2D representations of 3D shapes, (c) overcoming perceptual/conceptual conflict but not being considered expert in diagram interpretation. She concluded that a curriculum of diagram literacy in geometry should cover the transition from a diagram of a 3D shape being interpreted as a re-presentation of a referent, to a diagram of a 3D shape being interpreted as a representation of a referent.

To conclude, students' difficulties in interpretation of 2D representation of 3D geometrical shapes are due to their inability in understanding the visual representation and spatial vocabulary and convention or in Bishop's term, an inability in Interpreting Figural Information (IFI). The major obstacle arises from the conflicts between what they know and what they see (See also Section 2.4).

Problem in "standard diagram" concerns only about the ways of presenting diagram to students. For "Prototypes of Diagram" and "Limitation of the 2D representation of the solid", students have to understand the static nature of drawing. Students should understand and master not only the specific meaning of spatial concepts and vocabulary but also the significance of drawing conventions to avoid confusing and mixing some properties of the shape with those of the diagram.

2.3.1.7 Cultural Differences

Mathematical activities are set in cultural contexts (Miura, 2001, p. 53). Languages and symbol systems are the most important culturally developed tools. These tools differ by cultural groups and restructure the mental activities in thinking about mathematical concepts.

There are many cross-cultural studies that show cultural differences in geometric concepts. For instance, Mitchelmore (1980) administered his Solid Representation Test to students in Kingston (Jamaica), Columbus (Ohio), and Bristol (England). His report showed significant differences between the samples. On average, the Bristol students were ahead of the Columbus students, by the equivalent of 3 years of development, and a similar gap existed between Columbus and Kingston students.

Questioning what are the factors that influence the description and interpretation of drawings of 3D shapes, Hershkowitz (1990) observed that there is evidence of the culture factor that is related to the spatial ability. Hershkowitz quoted an experiment that 8- to 12-year old students in an isolated India village that was supposed to be in a convention free situation produced their visual representation much related to their family occupation (their culture). For instance, potters students, who worked with 3D solids, produced more complex representations of 3D solids than weavers' or farmers' students. Thus, it is quite likely that culture might affect the ability of VP-ability.

Though these researchers did not cite the Vygotsky's sociocultural theory (Vygotskiĭ & Cole, 1978), their finding is coincident with the current conceptualizations of that theory. Vygotsky contended that learning is embedded within social events and occurs in terms of students' confrontation with the cultural environment, their own exploration, and their reactions to with people and objects. From this theoretical point of view, students' drawings and descriptions of 3D geometrical shapes contain sociocultural factors (See Section 3.3).

2.3.2 Evidence of VP-ability in Literature

The ability to carry out Visual Processing (VP) places emphasis on the process and

not on the nature of the stimulus. The stimulus does not have to be figural to be processed visually and is not always needed. However, the 'versatility' of VP also complicates its classification and the description in students' mind. As the following sections indicate, the factors affecting students' Visual Processing (VP) ability are diverse.

1. Coordination and Integration
2. Accuracy of Mental Image
3. The Presence of the 3D Shape
4. Difficulty in Thinking Aloud About Visual Image

2.3.2.1 Coordination and Integration

When the concept of volume is introduced, Figure 2.8 is a stereotyped representation in most mathematics textbooks forcing students, as early as grade 3, to visualize unit cubes within the drawings of rectangular solids.

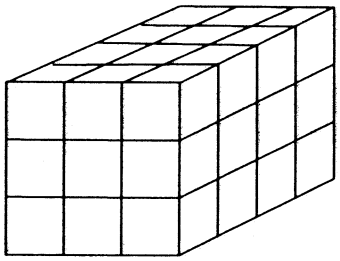


Figure 2.8 How many unit cubes does it take to make this rectangular solid?

The study from Ben-Haim Lappan and Houang (1985) showed there were four types of errors those pupils from 5th to 8th grades made in interpreting this type of drawings:

type 1- counting the cube faces show in the diagram;

type 2- counting the cube faces shown in the diagram and doubling that number;

type 3- counting the number of cubes showing in the diagram; and

type 4- counting the number of cubes showing in the diagram and doubling that number.

Ben-Haim et al. suggested that counting the faces was dealing the picture as a 2D shape while counting the visible small cubes was indicating an awareness of the 3D attribute of the pictures.

Battista and Clements (1996) extended the research in this area by investigating students' solution strategies and errors in dealing with 3D cube arrays. Their data suggested that many students cannot enumerate the cubes in a 3D array because they were unable to coordinate orthogonal views (top, front and side in Figure 2.9) of the rectangular prism from different perspectives and to construct an integrated mental model of the array. To coordinate the side views means to recognize how they should be placed spatially in proper position relative to each other. Many students seemed unable to recognize that edges of the cube are parts of the edges of other views as shown in figure 10. This coordination and integration construct is strikingly similar to the study of the three-mountain task by Piaget and Inhelder (1967, p. 211) in which students have difficulty in co-coordinating different viewpoints. Piaget and Inhelder found that the mastery of this ability begins to appear after 11-12 years of age.

When reviewing students' understanding graphics, Diezmann argued (2008) that the comprehension of graphics is related to the spatial relationships among the visual elements such as shapes that represent the object. In other words, students' cognitive processes of visual representations involve the shapes used and how the shapes are spatially related in the graphics. Interestingly, the coordination and integration processing ability in Figure 2.9 is similar to this argument of spatial relationships among shapes used in graphics.

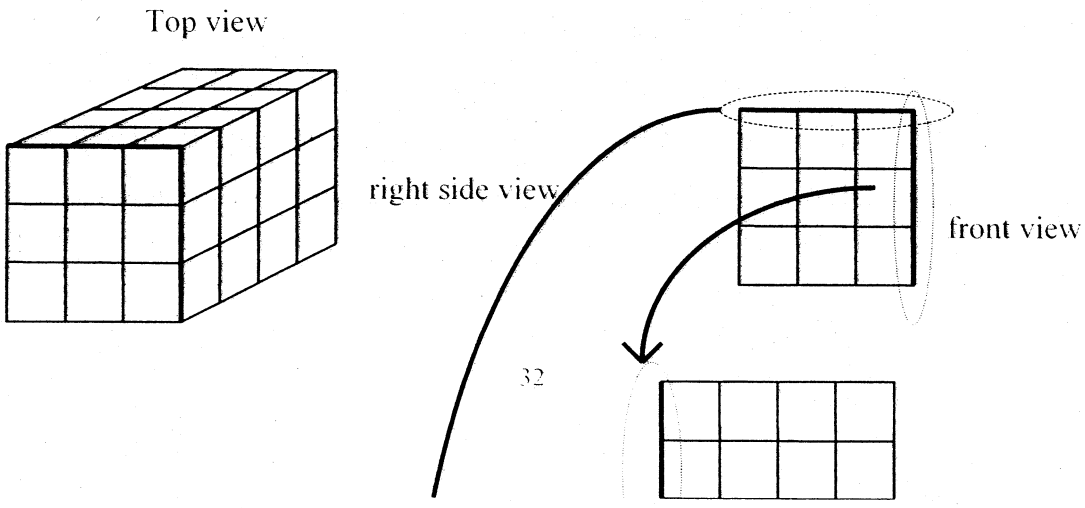




Figure 2.9 Coordination and integration of arrays of cubes

In a study about student teachers' transformation of a solid to its net, Cohen (2003) also found that many student teachers often confused the perspective drawing of the solid with its net. They showed some static, incomplete aspect of the action in drawing the nets of 3D shapes. "This process of folding and unfolding solids belongs to the VP, because it involves the manipulation and extrapolation of visual imagery, and the transformation of one visual image to another" (p.2-203). When lacking experience, student teachers sometimes behave as young students are unable to coordinate different viewpoints.

2.3.2.2 Accuracy of Mental Image

As Metzler and Shepard (1974) pointed out, a mental image of a 3D shape does not have all the structural features of its 2D drawing. A true "mental image" is an analogue representation of the actual 3D shape (Ellis & Hung, 1999, p. 124). It is due to this incompleteness of structure of the 2D drawing that a student's mental image is not accurate. For example, consider Figure 2.10. The Necker cube illusion is a classic representation problem that the human perceptual system tries to resolve this ambiguity by "seeing" one of two possible faces of the cube as being "in front". That is, Figure 11(a) can be alternatively perceived as (b) or (c) (Hubona, et al., 1997).

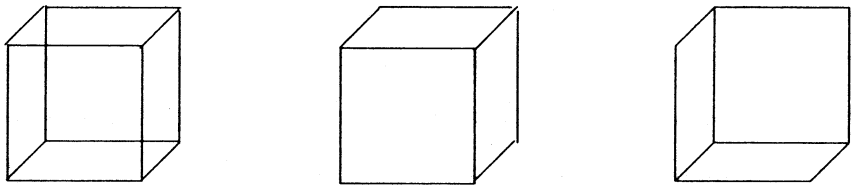


Figure 2.10 Necker cube illusion

Accordingly, difficulties in Visual Processing (VP) arise because the students manipulate or transform an inaccurate image. Gorgorio (1998) in exploring students' visual strategies in solving rotation problems stated that "the most frequent (error) consisted of not knowing how to draw a part of an object which was behind, in front of, over or under another one which has already been drawn" (p. 207).

In other words, it is also a problem of "knowing" vs "seeing" (Parzysz, 1988). The result of inaccurate "seeing" affects a student's Visual Processing (VP) ability of "knowing" the accurate image of the geometric shape

2.3.2.3 The Presence of the 3D Shape

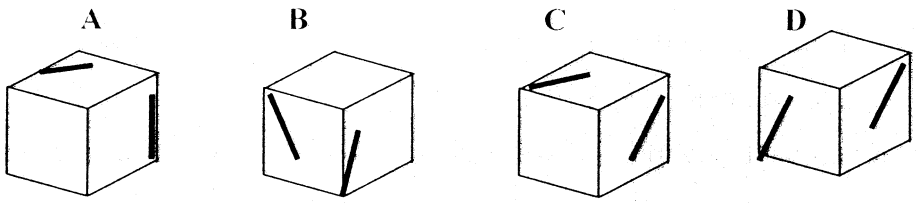


Figure 2.11 Line-segments on cubes

Kopelman and Vinner (1994) administered a spatial test on school students, teachers and professionals. The test consisted of two questions for each of four figures (Figure 2.11): two line segments are drawn on two faces of each cube (1) Do the lines intersect in space? (2) If not are the lines parallel in space or not?

Results were then analysed based on several research questions one of which is "Do

3D models help to solve spatial problems?". The study revealed that the substitution of the picture representation by the 3D model in spatial task was not necessarily helpful to most of the subjects. Again, it shows that Visual Processing (VP) is independent of the stimuli presented. In other words, VP is an idiosyncratic process.

2.3.2.4 Difficulty in Thinking Aloud About Visual Image

Study of thinking, to some extent, can be relatively easily investigated by simply asking subjects to talk out loud. However, the nonverbal process such as Visual Processing of 3D shapes is very special. "Nonverbal mediating representations including mental images and mental transformations on such images, by contrast, are much more difficult to externalize." (Metzler & Shepard, 1974, p.197)

Burton, Martin and Gilah (1986) found that in interpretation, pre-service teachers, prefer visual descriptions of 3D structures to verbal description. There were some subjects who were unable to construct the 3D block from the description provided from another subject.

Cooper and Sweller (1989) investigated secondary students' ability to interpret representations of simple 3D shapes. They used verbal descriptions, descriptions based on coordinates, graphical representations, and actual prototypes. From their studies, they concurred with Metzler and Shepard's (1974) belief that perspective drawings of 3D shapes are internalised in the same way as the shapes themselves applies to students as well as to adults. Of the real life representations, perspective drawings and the actual solid models were more easily interpreted than verbal descriptions.

Ben-Chaim, Lappan and Houang's study (1989) is a further example of this kind of work. Owens (1990, 1991) investigated primary level students' use of visual imagery and other mental processes. The study also revealed that the students seemed to be unable or unwilling to elaborate on their thinking, especially when it concerned visual imagery.

Therefore, to classroom teacher, it is difficult to establish what the students think about the mental images and the manipulations of them since any accurate overt

expressions of students' mind are nearly impossible.

2.4 Piaget's Two-factor Cognitive Theory of Symbolic Meaning: VP- and IFI-Abilities Revisited

Bringing together the various aspects of Piaget's work, Cowan (1978) explored Piaget's two-factor cognitive theory of symbolic meaning. According to Piaget, symbolic function is the essence of human intelligence, human beings using images, pictures or drawings to bring back (*re-present*) shapes or events, so that they can think about or communicate about events in the past or in the future. Piaget questioned the common assumption that cognitive symbols were created from picture-copies and that perception in knowledge can provide an accurate or true picture of the external world (Figure 2.12).

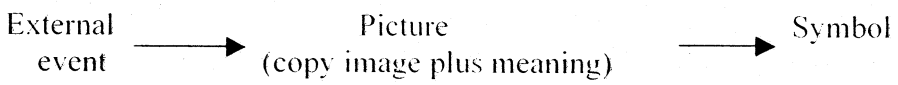


Figure 2.12 Cognitive symbol created by copying picture

He argued that symbolic meaning was based upon a combination of perceptions, action, and emotion, structuring and transforming events. While perception is an essential mechanism of symbolic meaning for keeping human in contact with the physical world, it is never free from distortion. Piaget attributes this distortion to an ability to draw what the child knows instead of what the child actually sees (Golomb, 2004, p. 109). Thus, most if not all difficulties reviewed in Section 2.3.1 conceived with IFI-ability are related to the insufficiency of this picture-copy theory.

> "In Piaget's model, each task is accomplished by a separate mechanism (see Figure 2.13). The representation mechanism brings back images of sights, sounds, tastes, smells, and kinaesthetic movements, but these images are not meaningful until they are structured by a conceptualisation mechanism. In the interaction between the two mechanisms, symbolic meaning is constructed, not simply copies." (Cowan, 1978, p. 42)

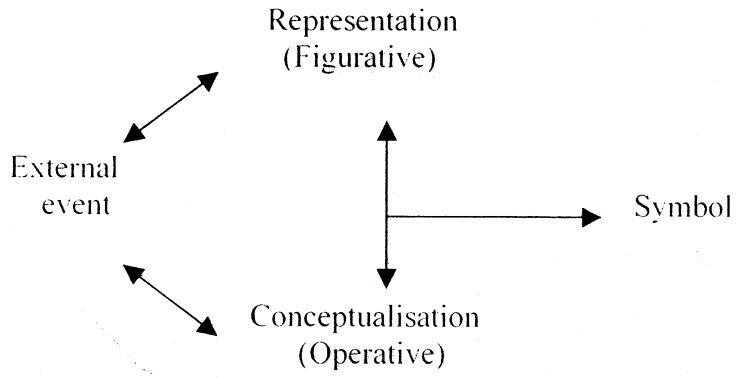


Figure 2.13 Cognitive symbol created by the interaction of two mechanisms

It is the conceptualisation process that contributes the development of children's VP-ability. If spatial ability is subsumed as part of cognitive ability, then the IFI-ability deals with the figurative aspect while VP-ability deals with the operative aspect. Thus, before it becomes meaningful, children's ability on the interpretation and representation of 3D geometrical shapes must be incorporated in a figurative representation as well as an operative conceptualisation. Teaching the child some "rules" to copy 3D drawings without operative understanding does not speed up the spatial ability on 3D geometrical shapes (Bremner, Morse, Hughes, & Anderson, 2000, p. 621). In other words, the teaching and learning of spatial abilities cannot be separated into two isolated units of pure IFI-ability and VP-ability.

2.5 The Representation as an Assessment Tool

The importance of the roles of representations in teaching and learning mathematics are widely acknowledged (Cuoco & Curcio, 2001). Mathematical representations help students to develop, share, preserve mathematical thoughts and extend a mathematical idea by focusing on its essential features (National Council of Teachers of Mathematics, 2000, p. 206). Drawing or constructing representations of 3D geometrical shapes are integral aspects in recent curriculum documents (e.g., National Council of Teachers of Mathematics, 2000) in mathematical education. Such curriculum documents, however, leave open what the representation is and how the representation of 3D geometrical shapes can be accomplished by the students. This explorative study on spatial ability considers students' response patterns drawn

from their descriptions about and drawings of 3D geometrical shapes. The results of study pertain broadly to students' mathematical growth and development as well as the classroom teaching of mathematics.

Descriptions are verbal representations while drawings are visual representations (C. M. Diezmann & English, 2001). Both representations are important tools for thinking and communicating mathematically (G. A. Goldin, 1998, p. 143). This study utilizes these two mathematical representations as assessment tools to measure students' spatial understanding as well as their development in visualization of the 3D geometrical shapes. The justifications follow:

2.5.1 Internal Representation and External Representation

In the classroom, there are internal and external representations that affect students' understanding of mathematical concepts or ideas. Reviewing about the role of representation in school mathematics, Goldin and Shteingold (2001, p. 2) held that it is important to note the difference the external systems of representation to the internal one. External systems include the conventions, symbols or notations and rules in mathematics that are knowledge delivered by teachers to students. They can be learned and memorized mechanically without much conceptual understanding having taken place in students' minds. Internal systems range from students' personal symbolization constructs, assignments of meaning to mathematical notation, their natural language, their visual imagery and spatial representation. In other words, internal systems are psychological representational systems of individuals and external systems are instructional representations.

2.5.2 Internal Representation as Students' Personal Representation System

To teach mathematics, not only it is important to ask questions about content and pedagogy of a mathematical topic but also to ask how students learn that topic. The last question requires us to look into the minds of the students (students' VP-ability) and that we need to think about the mathematics concepts from their perspectives. However, it is hard for a teacher with rich knowledge and experiences in mathematics to imagine the ways that the students learn mathematics. Cuoco and

Curcio (2001) opined in the 2001 Yearbook of NCTM that one aspect of understanding how students learn mathematics from their perspective is to study about how students build their mathematical representation of phenomena. Reading students' internal representations may also be a way of seeing and thinking about mathematical ideas in students' minds (WGBH Educational Foundation, 2003).

2.5.3 The Dynamic Nature of Internal Representations

Internal representations of different individuals are not static for they capture the personal process of constructing concepts or relationships (Woleck, 2001, p. 215) about students' developing representations and understanding of the mathematical phenomena. This is consistent with Bishop's (1989) comment that the student's mental imagery is very personal or idiosyncratic (see also Section 2.1.2 and Section 2.4). In this study, students' description and drawings of pictures provide information about their understanding mathematics and can be a window into the minds of the students. Therefore, interpreting students' internal representations is a way of assessing students' understanding of 3D geometrical shapes.

2.6 Conclusion

To conclude from previous sections, this section synthesizes this literature review and outlines the refined components of the IFI-VP dichotomy within the framework of Piaget's two-factor cognitive theory and the description of IFI-VP dichotomy is slightly modified from that of Bishop (1983) presenting in the context of the present study for 3D geometry. The purpose is to provide more information about the ways that spatial abilities can be developed in the processes in upper primary students' interpretation and representation of 3D geometrical shapes as well as the justifications of using these verbal and drawing representations as assessment tool. They are based on the previous theories and pieces of studies about students' difficulties in learning spatial abilities.

IFI-ability involves understanding the visual representations, spatial vocabularies and conventions used in three-dimensional geometric work. IFI concerns the reading, understanding, and interpreting of such information. It is the ability of content and of

context. and relates particularly to physical models and two-dimensional representations of the geometrical shapes. It consists of (but is not limited to) the following figurative representation skills:

The student

1. distinguishes 2D representational drawings from the 3D geometric shapes:
2. understands the static nature of 2D representational drawings on papers:
3. understands the drawing conventions in 3D geometry drawings: and
4. understands the specific geometrical concept and vocabulary used in 3D geometric drawings.

IFI-ability relates external stimulus materials that include the real 3D shapes and the drawing representations. It is an ability of interpretation of external stimulus to generate information. As shown in Section 2.3.1.2 and 2.3.1.3. the child should have the first two skills in order to avoid any misconception of the external representations. To have an accurate interpretation the child should also have the next two skills from findings in Section 2.3.1.4. 2.3.1.5 and 2.3.1.6.

VP-ability involves visualization and the translation of abstract relationships and non-figural information into visual terms. It also includes the manipulation and transformation of visual representations and visual imagery of 3D geometrical shapes. It is an ability of process, and does not relate to the form of the stimulus material presented. It consists of (but is not limited to) the following operative conceptualisation skills:

The student

1. builds up the visual image and the relationships between different parts of the image by imagining the shape from geometric concepts and other nonfigural (including verbal) information:
2. performs spatial rotation of the visual image:
3. performs spatial transformation of the visual image from another viewpoint (at different angles and distance):

4. "sees through" to the hidden faces and edges of the visual image: and

5. uses conventions and encode the visual image by drawing its two-dimensional representation.

A visual (mental) image is the basic entity in VP-ability in all the literature reviewed. Visual interpretation of information creates visual images. The first three VP-skills require that the children can coordinate and integrate different parts of a visual image (see Section 2.3.2.1). To have these skills the child should have the ability to coordinate comprehensively different viewpoints in the space.

The above two sets of spatial skills are derived from different categories of learning difficulties in the literature. They provide a perspective of what should be designed for the teaching and learning environment of spatial ability of 3D geometrical shapes.

Now that this literature review has shown that verbal descriptions and drawings of 3D shapes are included as components of spatial ability in Bishop's IFI-VP dichotomy. Since drawings of 2D representations of 3D shapes involve the manipulations of mental image, drawings of 2D representation is one kind of VP-ability in students' minds and the use of mental image is very personal. Drawings from different students are hardly identical due to this very personal activity, the conceptualisation process. Descriptions also vary due to different connections between students' natural language and how they think about the 3-D geometrical shapes (C. M. Diezmann & English, 2001). Therefore, there should be diversity in students' drawings and descriptions of geometrical shapes. Reviews on students' difficulties and misconceptions in the research literature have also confirmed this diversity. Since descriptions of 3D shapes involve the use of spatial vocabulary in geometry, descriptions of 3D shapes belongs to one kind of IFI-ability. The description of 3D geometrical shapes is easier to teach than the drawing of 3D shapes because IFI-ability is of the communicable and cultural nature and VP-ability is of the personal nature in students' minds. Linking with van Hiele's theory, the researcher conjectures that the first three levels: visual, descriptive and relational might provide a framework of study about students' cognitive development in their drawings and descriptions of 3D shapes.

CHAPTER 3 IN SEARCH OF A THEORETICAL FRAMEWORK

A theoretical framework consists of a selection of concepts and relations among these concepts. For any research, first of all it is important to provide a theoretical framework so as to enable the reader or users to easily see the structure of the study. This chapter provides the process how the theoretical framework is developed.

3.1 Looking Back

At the start, the literature review in the last chapter adopts a theory-based approach. The first focus of interest is the board theoretical framework, Bishop's IFI- and VP-abilities (Figure 2.2). A review of the research literature has shown the existence of such spatial abilities. Previous chapter concluded that drawing of 3D shapes is subsumed in VP-ability while description of 3D solids is subsumed in IFI-ability (Figure 3.1). Second, the theoretical framework is to be put into teaching practice by relating van Hiele's levels of geometric thinking to IFI- and VP- abilities in the proposed amalgamated model (Fig 2.3). Third, while research literature has showed the evidences of IFI- and VP- abilities it also shows that students do have learning difficulties and problems in 3D solids.

By observing upper primary students' responses to the drawing and description of 3D geometrical shapes. The researcher aims at finding a micro view within the Bishop's IFI-VP dichotomy and it is expected that this theoretical model will form a basis to explain any findings from the students' responses and the developmental growth of upper primary students' spatial ability related to representation and interpretation of 3D geometrical shapes.

There are micro views in the research literature which shows various factors affecting students' learning in 3D geometrical shapes. In particular, this research proposal is looking for a finer or micro framework in order to outline the structural cognition of students' drawings and descriptions of the four 3D geometrical shapes, cube, triangular prism, pyramid and cylinder. As Pegg, Gutiérrez and Huerta (1998)

proposed. the cognitive development provided by the SOLO Model offers the flexibility and versatility in categorising these responses. This chapter will review and conclude such a micro framework (Figure 3.1).

The geometrical contents and the study tasks are to be developed in the next chapter. the research design. in order to test the fitness of the proposed micro framework in this chapter.

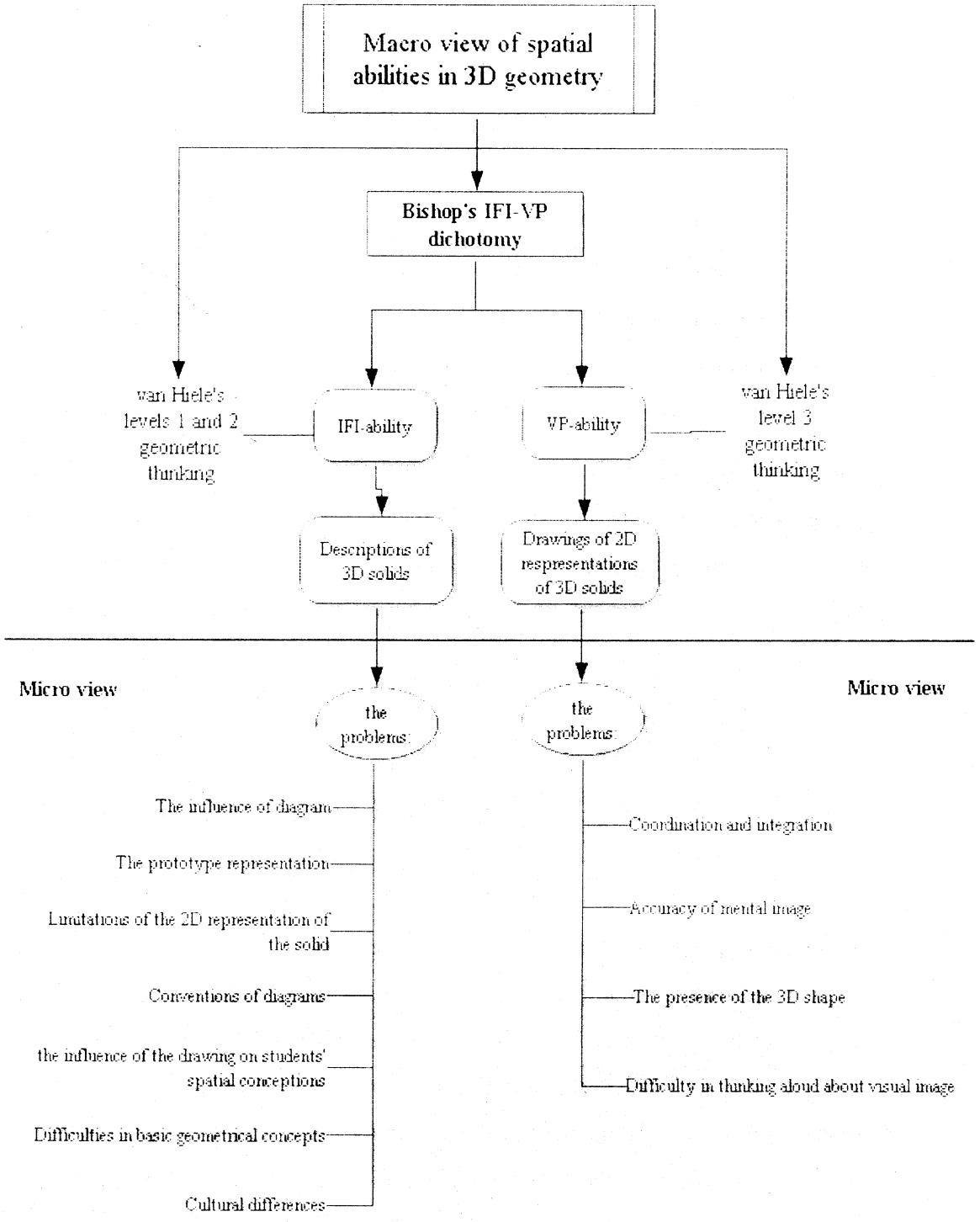


Figure 3.1 In search of a theoretical framework

3.2 The SOLO Model

Biggs and Collis (1982) examined a large number of student responses across a number of several curriculum areas, such as mathematics, English, history, geography, economics, and foreign languages. Their analysis dealt with the *Structure of the Learned Outcomes* (SOLO) of student responses. The SOLO Model was in fact concerned with the cognitive development of students on a theoretical basis from analysing and interpreting student responses in doctoral theses for the past 20 years. SOLO specifies the qualitative rather than quantitative nature of student learning. It is used to evaluate learning quality. A SOLO classification combines two aspects.

Firstly, the Model, like Piaget's stage theory, suggests that learning occurs in one of five modes: (1) sensori-motor (reactions to the physical world), (2) ikonic (making use of imaging and imagination), (3) concrete symbolic (using a symbol system such as written language and number systems), (4) formal (engaging in abstract thought), and (5) post formal (able to challenge and extend theories). Differing from Piaget's stage theory, the SOLO Model is not sequential or in one-way direction. That is, later modes do not replace earlier modes and continue to evolve without any reference with ages. Persons can function in more than one mode to support their learning.

Secondly, the Model is a series of levels that measure an increasing sophistication in handling certain tasks within a particular (or targeted) mode. The growth can be described in terms of levels. A level refers to a pattern of performance or responses of the learner. The levels are structural in the sense that "there is a pattern or consistency to what the learner thinks" (Pegg, 2003). These five levels are Prestructural, Unistructural, Multistructural, Relational (P-U-M-R) and Extended abstract. Of main interest in this study are the three levels that form local cycles of development (Pegg & Tall, 2002) within the concrete symbolic mode and the progression from Ikonic mode, Concrete Symbolic Mode up to Formal Mode (Figure 3.2). The first cycle is represented by the terms U_1, M_1, R_1 standing for the levels unistructural, mutlistructural, and relational, respectively. It is built up by the R_2 in Ikonic mode. A response more advanced than R_1 becomes a new unistructural level in the new second cycle of levels, U_2, M_2, R_2. Following from the R_2 in the second cycle of the concrete symbolic mode is the U_1 in the formal mode. Therefore, the

SOLO model has the strength in linking of the cyclical nature of learning and the hierarchical nature of cognitive development.

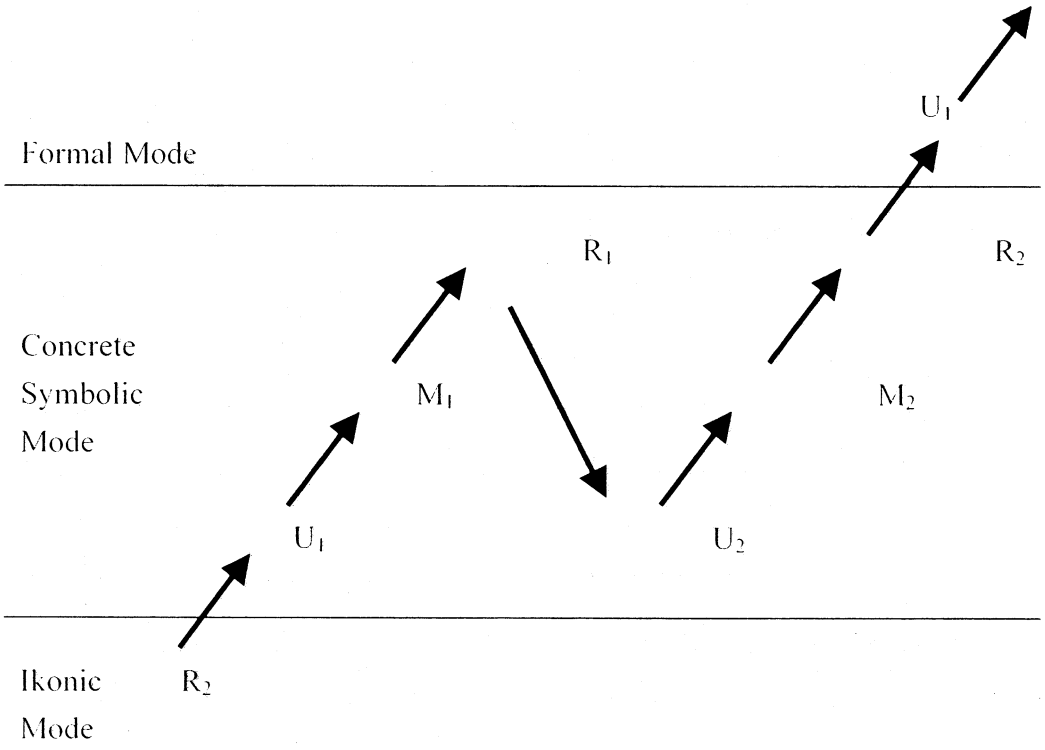


Figure 3.2 Diagrammatic representation of levels associated with the Concrete Symbolic Mode

Of main interest in this study are the three levels in the table below and they are called local cycles of development (Pegg & Tall, 2002). These levels have several properties (Levins & Pegg, 1994) which include:

- a growing complexity in understanding;
- an increased ability to consider more information;
- an increased ability to accept complexity; and,
- an increased ability to delay in providing an answer.

Other features of the model include: the levels are sequential and students progression through the levels is thought to be fixed, i.e., they cannot jump or skip levels; the language used by students changes as they proceed through the levels and modes; and, there are characteristic ways of responding at different levels.

The table (Table 3.1) considers the cases of the responses from upper primary students in drawing of 3D geometrical shapes. Each of these cases is called a descriptor of students' representation pattern in the level. Since the SOLO Model has not been addressed to visual responses, the researcher has to develop and validate a set of descriptors of students' representation patterns in the cases of drawing 3D geometrical solids. So, all the descriptors in the right-most two columns (shaded) of the table, for the time being, are the researcher's descriptions and based on the properties suggested by Levins & Pegg (1994). They are subject to change upon obtaining the results from the data analysis of this research.

Numerous studies (Biggs & Collis, 1982, 1991; Collis et al.1986; Pegg, 1992, 2003; Pegg & Currie, 1998) on SOLO model are on areas of arithmetic and algebra. Similar information on 2D geometry can be found in Pegg and Davey (1998). However, there seem very few studies found in the literature in the application of SOLO in 3D geometry (Everett & Mulligan, 2000; Lawrie & Pegg, 2000).

SOLO Taxonomy has been identified by several researchers (Pegg & Davey, 1998) as having strong similarities with the van Hiele Theory. The two models are mutually supportive. Visualization skills can only be traced by the individual's response to stimuli. The van Hiele model may be regarded as a theoretical construct for an overall macro view of the spatial ability in geometry. Bishop's VP- and IFI- ability provide two aspects of spatial ability where as the SOLO model may better describe the variances in individual behaviour. As a micro theoretical framework, the table below is being developed based on these three models:

Table 3.1 Descriptors of Students' Response

SOLO levels for measuring students' quality of responses or performance within the Concrete Symbolic Mode in the SOLO model (Pegg, 2003)	**Van Hieles' levels** for interpreting students' understanding of 3D geometry (modified by Lawrie & Pegg, 2000), and only the first three are given here)	Students' response patterns of 3-dimensional geometrical shapes (*to be investigated, validated and/or confirmed in this study*)	
		VP-ability: about drawing	**IFI-ability:** about describing
Prestructural (P) The response is below the Concrete symbolic mode. The student is frequently distracted or misled by irrelevant aspects of the situation and is there operating in Ikonic mode.	**Level 1** A solid is seen as a total entity and as specific shape. Students are able to recognize solids and to distinguish between different solids. Properties play no explicit part in the recognition of the shape, even when referring to faces, edges or vertices.	**(P)** *No response, graffito or just a 2D shape*	**(P)** *Unable to describe any features of the solid shapes or describing with incorrect properties*
Unistructural (U) The student focuses on the domain/problem, but uses only one piece of relevant data and so may be inconsistent.	**Level 2A** A solid is identified now by a single geometric property rather than by its overall shape.	**(U)** *Unaware of the drawing conventions; maintaining the properties of 2D drawings(that is no indication of awareness of the perspective view)*	**(U)** *Identifying and describing solid shapes based on one part of visual information of the solid;*
Multistructural (M) Two or more pieces of data are used without any relationships perceived between them. No integration occurs. Some inconsistency may be apparent.	**Level 2B** A solid is identified in terms of its individual elements or properties. These are seen as independent of one another. They include side length, angle size, and parallelism of faces.	**(M)** *Aware of different orientations and different parts of the same solid shape but no coordination in drawings*	**(M)** *Identifying and describing solid shapes with several properties but there are no mathematical terms used to relate these properties*
Relational (R) All data are now available, with each piece woven into an overall mosaic of relationships. The whole has become a coherent structure. No inconsistency is present within the know system.	**Level 3** Properties are ordered logically and relationships between the properties are recognized. Families of solids can be classified.	**(R)** *Building, drawing, making, putting together, and taking parts of solid shapes together in a coordinating manner to form a perspective view of drawing*	**(R)** *Describing solid shapes with correct properties and using mathematical terms to relate these properties*

In conclusion, this study is expected to support the hypothesis of Pegg and Davey (1998) that there exist unistructural-multistructural-relational cycles within the Concrete Symbolic Mode. It would provide further empirical evidence about structural responses in the case of primary students' drawings and descriptions of 3D geometrical shapes. As a result, the SOLO model helps teachers understand students' progress and match appropriately the readiness of students in learning. This section concludes with the research questions for this research proposal:

Research Questions:

(1) What diversity and patterns can be identified in upper primary students' drawing representations of and descriptions about 3D geometrical shapes?

(2) Upon the identification of diversity and patterns in (1), are there prestructural-unistructural- multistrutural- relational (P-U-M-R) levels of the SOLO model in the case of the upper primary students' drawing representations of and descriptions about 3D geometrical shapes?

SOLO is relevant to areas: assessment of student performance, curriculum analysis and providing a mechanism for enriching teaching processes (Pegg, 2003). Teachers become aware that many student errors are due to the natural development phenomena, rather than carelessness. Teachers, armed with this knowledge, would focus their instruction in 3D geometry to be directed more accurately at the students' levels of understanding and their learning needs. Study results of this research question might offer empirical evidences to further extend the SOLO Taxonomy to subject area of 3D geometry.

3.3 Ontological and Epistemological Assumptions Underpinning the Study

So far, the researcher has proposed the macro as well as micro theoretical frameworks that frame this study. However, any educational study or practice is not value-free. The adoption of the underlying philosophical beliefs about the nature and

acquisition of knowledge might result in different understandings of the research questions above and different explanations of the results to be acquired in this study. This section begins with a brief discussion of Vygotsky's sociocultural theory, focusing in detail about Vygotsky's spontaneous concepts and scientific concepts (Kozulin, 2003; Vygotskiĭ & Cole, 1978). Then, after a brief description of the geometrical properties of the 3D shapes in this study, the researcher describes how an adoption of this theory has provided this study an epistemological background in understanding children's drawings and descriptions of the 3D geometrical shapes.

3.3.1 Vygotsky's Theory of Scientific Concepts

Epistemologically, the view of knowledge in this study is based on a socialcultural or socialhistorical perspective which can be traced back to the ideas of Vygotsky (1978). Sociocultural theory emphasises that learning always involves more than one human. Children co-construct knowledge with each other, their teachers as well as their social context. Social contexts influence children's attitudes, beliefs, and thinking processes. "Vygotskians suggest that the achievement of a concept is not an individual mastery, but that it is outcome of socially embedded and socially facilitated activity" (John-Steiner, 1993). "In particular, it challenges traditional views of mathematics as value free, objective and divorced from everyday personal concerns." (Crawford, 1996, p. 44). Accordingly, knowledge is recontextualised in schools and a major role of instruction is to create social contexts.

Vygotskians also stress that the role of teachers is not only to provide students discussions via social mediations but also structural and systematic concepts. Vygotsky called this "scientific" concept differentiating from what he called the "spontaneous knowledge". Vygotsky held that the primary outcome of instruction in school is the development of conscious awareness and voluntary control of scientific concepts. It is through the use of spontaneous concepts that children make sense of the definitions and explanations of scientific concepts. Spontaneous concepts are those concepts formed by the children through everyday interaction with the social and cultural activities and in some cases, might be used incorrectly by children. They also provide the "living knowledge" for the development of scientific concepts in

school learning (Moll, 1990, p. 10). The strength of scientific concepts is in the child's ability to use these concepts voluntarily. "The weak aspect of the child's use of spontaneous concepts lies in the child's inability to use these concepts freely and voluntarily and to form abstraction. The difficulty with scientific concepts lies in their verbalism, i.e., in their excessive abstractness and detachment from reality"(Vygotskiĭ & Kozulin, 1986, p. 148). Mathematical concepts are characterised by highly abstractness and formal decontextualised structures. In this study, mathematical concepts will be used as an example of Vygotsky's scientific concepts.

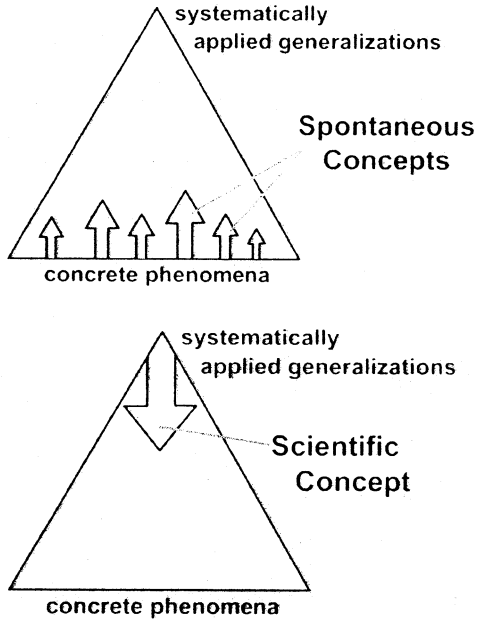


Figure 3.3 Spontaneous and scientific concept (Wellings, 2003)

Spontaneous and scientific concepts are interdependent. The upward development of spontaneous concepts and the downward development of scientific concepts are required to facilitate the child's absorption or attainment of scientific concepts. Vygotsky states that

> "The child becomes conscious of his spontaneous concepts relatively late; the ability to define them in words, to operate with them at will, appears long after

> he has acquired the concepts. He has the concept (i.e. knows the object to which the concept refers), but is not conscious of his own act of thought. The development of a scientific concept, on the other hand, usually begins with its verbal definition and its use in nonspontaneous operations – with working on the concept itself. It starts its life in the child's mind at the level that his spontaneous concepts reach only later." (Vygotskii & Kozulin, 1986, p. 192)

3.3.2 The Epistemological Assumption

For the 3D shapes in this study, for example, when defining properties of prisms, there are two 'tops' (or 'upper surface and lower surface'). Prisms have 'thickness'. The side edges of a prism are straight and equal in length. Cylinder is a special case where the two 'tops' are circles and there are no side edges. The structure of triangular prisms has 9 edges, 5 faces and 6 vertices. It is made up of 2 triangles and 3 rectangles. These are scientific concepts which are well-defined terminologies in primary mathematics. These scientific concepts or mathematical concepts are in fact abstract generalizations of 3D shapes. These shapes in reality exist in physical objects such as cubes in packaging boxes, triangular prisms in chocolate bars (Toblerone), cylinders in canned foods in supermarkets and pyramids as the shape of tombs or tents. The students' spontaneous concepts about these 3D shapes are usually associated with their immediate encounter with these objects in their daily lives through social communication with their families and friends, or the scenes on TV advertisements and videos (in the cultural aspect). In describing these 3D shapes, children might express them through their own words and might use them in their ways of thinking without conscious awareness of the mathematical definitions. At school the children might be faced with learning the properties of these geometrical 3D shapes. However, teaching using verbal definitions of these concepts does not penetrate below the surface meaning. As a result, their descriptions might consist of everyday words which are not connected to mathematics but are connected to their peer's or family's language.

In drawing 3D geometrical shapes, children might begin not with the mathematical conventions that the drawing of 2D representation should make use of parallel perspective and receding lines and dotted lines as hidden lines but with the subjectivity of their images about these shapes. Literature about children's IFI-ability

on 3D shapes (See Section 2.3.1) has shown that drawings of these shapes are affected by context and culture revealing children's perception of reality or their understandings of what they see (Meadows, 2006, p. 140). It is envisaged in this study (Figure 3.4) that children's problems in IFI-ability are due to the unconsciousness of the spontaneous concepts of these 3D geometrical shapes and their problems in VP-ability are due to the abstractness of the scientific concepts (Schmittau, 1993).

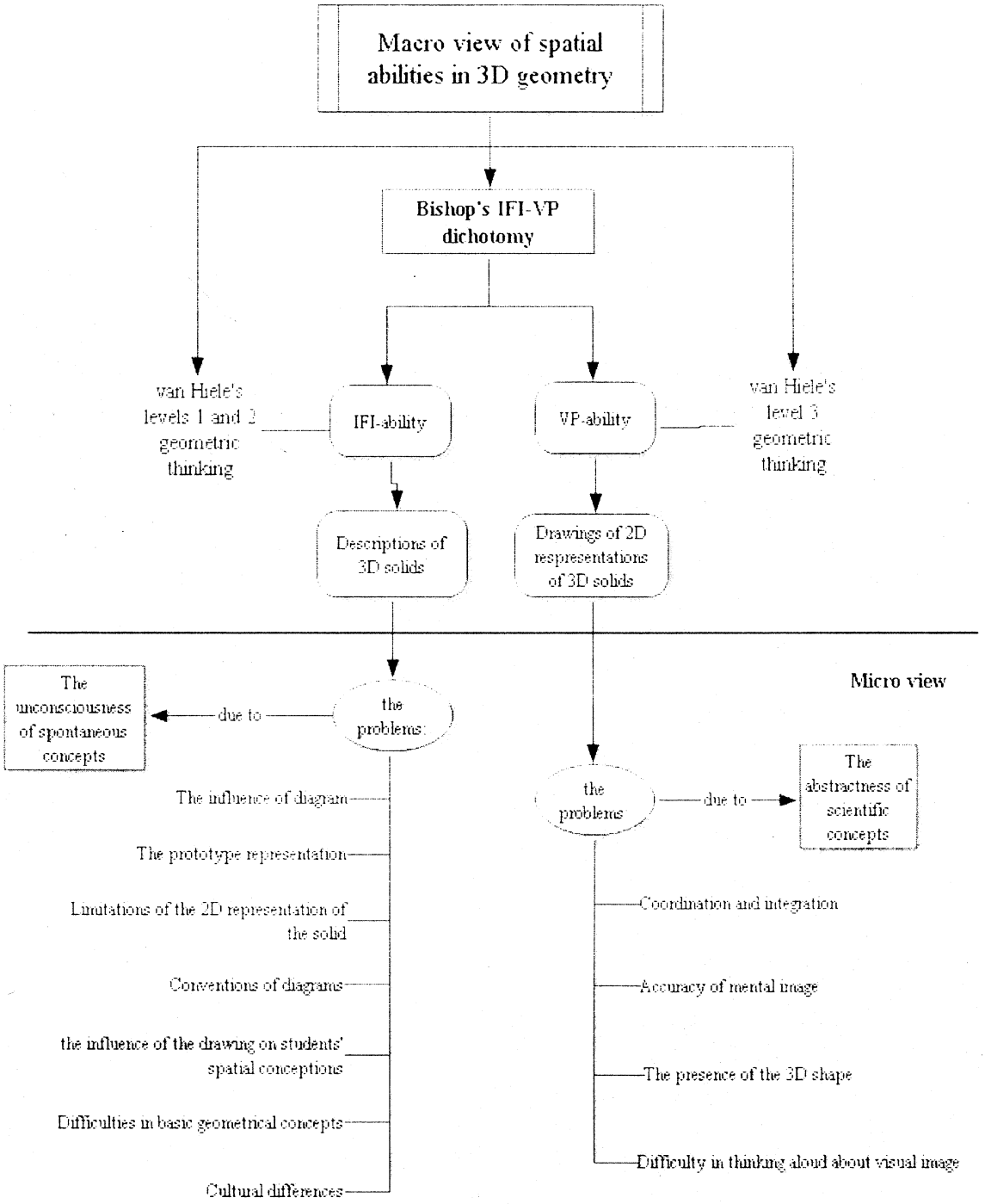


Figure 3.4 The theoretical frame work of the study

In conclusion, developmental categorization of drawings and descriptions in SOLO levels is an individualistic development framework. The researcher suggests that

based on Vygotsky's socialcultural theory an interpretive approach that examines the relational properties between "drawing", "description" and "meaning" might provide better explanations of the results to be acquired in this study about young children's idiosyncratic representations about 3D geometrical shapes.

Therefore, methodologically, the study adopts an interpretive approach which aims to "understand the subjective world of human experience"(L. Cohen, Manion, & Morrison, 2000). Sociocultural theory emphasises the fact that students actively construct knowledge drawing on what they already know and believe (Vygotsky 1978). In this study, the teacher and students work within a classroom culture that is influenced by the 3D shapes shown in the text books and TV videos, teachers' and students' daily use of words about shapes and any other cultural activities involving 3D shapes.

CHAPTER 4 RESEARCH DESIGN AND METHODS

4.1 General Nature

The research interest of this study is in the discovery of the diversity and patterns of students' drawings and descriptions of the four specified 3D geometrical shapes. All data to be acquired are qualitative. There are two major types of data: students' drawings are graphic type and students' descriptions are in Chinese words. Skills in discerning of patterns among the graphics and in categorisation of these patterns are needed for graphic data while the comprehension skill in understanding the meaning of Chinese words is needed for text data. As the researcher was an experienced mathematics teacher, the researcher is equipped with the above skills and is qualified for the judgements on reviewing students' patterns of responses in this study. However, the researcher cannot detach from his understandings of these 3D geometrical shapes and his own mathematics knowledge. Also, the researcher cannot detach from his Chinese cultural background when data involve the Chinese language in this study. The researcher is affected by what he hears and observes from teachers and schools in Hong Kong. Broadly speaking, the primary methodology in this study is qualitative, the approach to data analysis is interpretive in local school context and the findings are descriptive.

The data capture adopts the technique of open-ended item, one of the well-established SOLO assessment procedures (Collis1992, p. 23). This technique allows free responses to fairly open questions. There are three stages for obtaining outcomes from students: setting the questions or collecting learning outcomes from students' assignments: devising a component table (such as Table 3.1): and interpret the individual responses. The researcher uses no pre-established instruments in order to avoid any "external information" preset in the instruments to affect students' drawings and descriptions but instead collects relevant students' worksheets for class assignments when teachers require them to draw or describe 3D geometrical shapes in classes. So, from time to time during an academic year, the researcher will be told to collect such students' worksheets whenever there are such assignments from the

sample schools.

4.2 Research Methodology: The Interpretive Approach

This study was conducted in the interpretive approach. Interpretation of each student' drawing and description of a particular 3D geometrical shapes is a major data analysis work in this study. There is no predefined dependent or independent variables and no test instruments. The goal is to see patterns and draw conclusions from the sample of students' work on drawing and description of the 3D shapes. Quantitative approaches "focused on behaviour only, whereas interpretive research studies the actions of participants. An action is the observable behaviour, plus the meaning attached to it by the actor" (Vrasidas, 2001). Based on the research questions developed, this study works with text and drawing rather than numbers. It focuses on the meaning in students' representations of solid geometrical shapes and how the researcher uncovers and interprets the meanings. The researcher argues that quantitative research is not an appropriate methodology for this study. It is qualitative research with an interpretative approach. This interpretive approach in methodology not only follows the epistemological assumption in the previous chapter but also provides a richness and depth descriptions for such a hermeneutical nature of the research questions in this study.

While the researcher has made clear the epistemological assumption (Section 3.3.2), the uncertainty of the outcomes or results of this study also confirms the adoption of an interpretative approach in methodology. For example, there was little prior research investigating 3D geometry within the SOLO model. The researcher argues further that for the extension of the SOLO model to the 3D geometry and providing empirical evidence to support P-U-M-R levels in the responses to the representations of the 3D geometrical shapes grounded research is better able to account for the phenomenon under investigation. The outcome is not just a theory testing but it might be theory building, that is, building theory of students' understanding of the 3D geometrical shapes based on the P-U-M-R levels. This uncertainty from the research questions influence the researcher to choose further an inductive approach and grounded theory techniques for data analysis (Section 4.4).

There is no bias-free point of view in interpretive research. Interpretivists assume that reality is not objectively determined but is socially constructed and there are many truths and many meanings to one event (Erickson, 1986; Rowlands, 2005). The researcher is part of the context. His experiences in mathematics education and teaching influence the validity of inference from the results. On the other hand, we are living in a 3D world and students encounter, interact or communicate in speech various forms of 3D shapes in their living in addition to those appearing in the real world as well as in their mathematics text (written in Chinese). Students socially and symbolically construct their own meanings of the solid shapes. The researcher thus attempts to understand the meanings that the students assign to their descriptions and drawings of the solid shapes. The researcher's interpretation of the phenomenon about upper primary students' learning of 3D geometry can only confine to local meanings, that is, it is only meaningful to the mathematics educators in Hong Kong. The meaning and knowledge acquired in this study are socially constructed by mathematics teachers, curriculum designer, the textbook writers, the students as well as the researcher. The emphasis in this study is on interpreting how students understand the mathematical meanings of the 3D geometrical shapes from their descriptions and drawings. In conclusion, the resulting theory at least fits the dataset in this study and gives mathematics educators insights and understanding about students' understanding of 3D geometrical shapes. The quality of the theory is determined by its ability to explain other similar data or new data.

4.3 Sample Selection and Collection of Data

As stated in the next section, this study uses the grounded theory approach for data analysis. In this method of theory building, sampling tends to be more purposeful and looks for events or incidents that are representative of relevant concepts, properties and dimensions (Strauss & Corbin, 1998). In this method of theory building, samples are the scripts about upper primary students' descriptions of and drawings about the specified 3D geometrical shapes.

The study is carried out in three different urban, public primary schools in Hong Kong. The targeted students are those studying in primary/grade 4 to primary/grade 6.

Upon the approvals of the principals and the mathematics teachers, each school nominates one class in primary 4, primary 5 and primary 6, for the researcher to collect their class assignments. Thus, there are three classes involved in each school. Class size is usually of 28 to 35 and thus, there are about 250 target students.

The three schools are purposely selected. They are located in different areas of Hong Kong. One is in the north part where most of the residences are public houses. One is in the middle part and the remaining one is in the down town area. Therefore, this sample should include students with various socioeconomic statuses.

Ages of these students range from 9 to 12 years that provide not only a wider spectrum of intellectual and spatial developments but also a sample of students which are in the concrete symbolic mode as in the SOLO model (See Figure 3.2). In that functioning mode, students are supposed to be able to use a symbol system such as written language and mathematical symbols.

As the cubes are the most common 3D geometrical shapes in primary mathematics classes, all word descriptions and drawings on cubes are collected from all sample students. For data on triangular prisms, pyramid and cylinder, the researcher has to ask one of these schools to collect the drawing and description of one of these three shapes. In other words, there are three groups of data: word descriptions and drawings about (1) cubes and triangular prisms; (2) cubes and pyramid; and (3) cubes and cylinders; each group collected from one of the three sample schools. All these provisions are to ensure there is a wide diversity of patterns of drawings and word descriptions in the data set.

The researcher is not in direct contact or face-to-face to students neither in their classes nor at their schools. Scripts or worksheets with their drawings and word descriptions are collected from the hands of the principals and their mathematics teachers. The teachers are advised not to arrange any particular lessons to collect these data but only whenever the topics are taught, whenever they need to make some revisions or whenever they need to draw 3D shapes from memory to illustrate other mathematical concepts, say the measurement of volumes of 3D shapes. Since those upper primary students have studied about the four 3D geometrical shapes:

cube, triangular prism, pyramid and cylinder when they were in lower primary years (Section 1.4.2), they all have their own ways to draw or to describe these shapes.

Furthermore, the teachers are requested to ask their students from their memory to draw or sketch with pencils the 3D shapes in transparency so that the structure of the shapes can be seen. Rulers are not to be used. When students describing their 3D shapes, they have to use other words or mathematical terms but not the name of the shape just like talking to their friends on the phone and asking their friends to think about what the shape is.

All the student worksheets or scripts are scanned as picture files and stored in researcher's computer. Segmentations or the whole of the drawings and terms or words in the descriptions are coded. With the help of a qualitative data analysis software tool (see Section 4.4.2), the relations among codes are built and any other attributes for each levels of SOLO both in students' drawings and descriptions are categorized and patterns are discovered. Finally, a theory in terms of SOLO levels about students' understanding of 3D geometrical shapes is built.

4.4 The Methods: Working with the Data and the Software Tool

This section justifies the use of the grounded theory (GT) approach and the qualitative data analysis software package, ATLAS.ti, to analyse students' scripts of descriptions and drawings.

4.4.1 Grounded Theory Approach

Grounded theory is a qualitative approach that generates theory from data. Using this approach, researchers do not try to control any variables but to discover them (Strauss & Corbin, 1998, p. 281) The grounded theory method was introduced by Glaser and Strauss (1967). The initial stage of GT method is to read and re-read a dataset (such as a corpus of textual scripts and graphics in this study) to identify categories and their properties. This process of naming phenomena found in the dataset is called "coding". "Coding means categorizing segments of data with a short name that simultaneously summarizes and accounts for each piece of data. Your codes show how you select, separate, and sort data to begin an analytic accounting of

them" (Charmaz, 2006, p. 43). During coding, the researcher has to jot down any ideas, concepts, relationships and assertions that stimulate him. This understanding of certain aspects of the study becomes a theoretical write-up which is called memo in GT method (Glaser, 1978, p. 83).

Then, categories are to be integrated to reflect patterns and to reveal significant similarities and differences within and between categories (Dey, 1999, p. 7). Finally, an emerging theory is developed providing an explanation of categories, their properties, and the relationships among them. Strauss & Corbin (1998, p. 22) holds that a theory is "a set of well-developed categories (e.g. themes, concepts) that are systematically interrelated through statements of relationship to form a theoretical framework that explains some relevant social, psychological, educational, nursing or other phenomenon". Since this study works with an established framework, the SOLO theory, the researcher sticks to the P-U-M-R levels of this theory in coding the data in a deductive way to look for the expansion of this existing theory. Though the coding is in this focus way, it is open to new incidences and themes arising from the dataset.

The researcher chooses the GT methods because it is in the same line of thought that the research questions in this study focus on contextual interpretations of students' learning outcomes and developing theoretical propositions from them. Other than the research questions that lead to the use of GT method, it is appropriate in this study because it requires a constant comparison between concept and data as well as a steady movement between conceptual levels of coding and the emerging theory, that is, the expansion of the SOLO levels to 3D geometry.

4.4.2 Use of ATLAS.ti in This Study

The drawings and descriptions are analysed with the support of the software ATLAS.ti V5.0 (http://www.atlasti.com). ATLAS.ti (http://www.atlasti.com) has been developed for more than a decade to support the analysis of qualitative data. It is a software tool for qualitative data analysis of large amount of text, graphic, audio, and video data. It offers a variety of tools for systematic analysis of unstructured data, e.g., data that cannot be meaningfully analysed by formal, statistical methods.

While the researcher also analysed NVivo (http://www.qsrinternational.com), another popular software package in the market before data analysis took place. ATLAS.ti is chosen as best fit for the study as the development of ATLAS.ti closely and firmly reflects the GT method.

In general, the advantage of using a software tool is that it simplifies and speeds the mechanical aspects of data analysis without sacrificing flexibility thereby freeing the researcher to concentrate to a greater extent on the more creative aspects of theory building. More specifically in this study, the reasons are:

The nature of data type. There are two major types of data in this study: students' drawings are graphic type and students' descriptions are in Chinese words. In this data capture process, all data are in fact scanned pictures which are of unstructured type and can only be analysed by qualitative methods. Atlast.ti is the one that can handle large amount of computer graphics files.

The design of the software. The fundamental design objective in ATLAS.ti is to develop a tool that effectively supports the human interpreter (Muhr, 2004). There are two modes of data analysis within ATLAS: firstly, the 'textual level' which focuses on the raw data and includes activities such as data (graphics in this study) segmentation and, coding and memo writing; and secondly, the 'conceptual level' which focuses on framework building activities such as interrelating codes, concepts and categories to form theoretical networks (Muhr, 2004, p. 26). In general, the researcher found the procedures within ATLAS.ti to be both efficient and firmly based on the principles of grounded theory approach. It was reported that Strauss was once asked to help to test the usefulness of ATLAS.ti in qualitative analysis (Strauss & Corbin, 1998, p. 276).

The query tool to explore the complex phenomena hidden in the data. The query built from operators (e.g. AND, OR, WITHIN, etc) is also very helpful for retrieving quotations using the codes they are associated with. The output of co-occurring codes helps to do cross-case analysis. By selecting codes, operators, various filters, a query can be built and the output helps to develop complex exploration about the data. Also, the query results can be saved, printed or undone at will.

Ease of management of data. There is the advantage that the software frees the researcher from those tasks that a computer program can do much more efficiently like retrieving coded data segments, the hyperlinks between codes, memos and comparison of patterns across different scripts and the avoidance of duplicated codes and redundant codes. Thus, it allows the researcher more freedom to play with ideas and to write in different places in the software such as comments and ideas attached to the scripts and the codes for detailed definition and additional information.

The following sequence of steps describes a common procedure for working with the dataset of this study in ATLAS.ti 5.0:

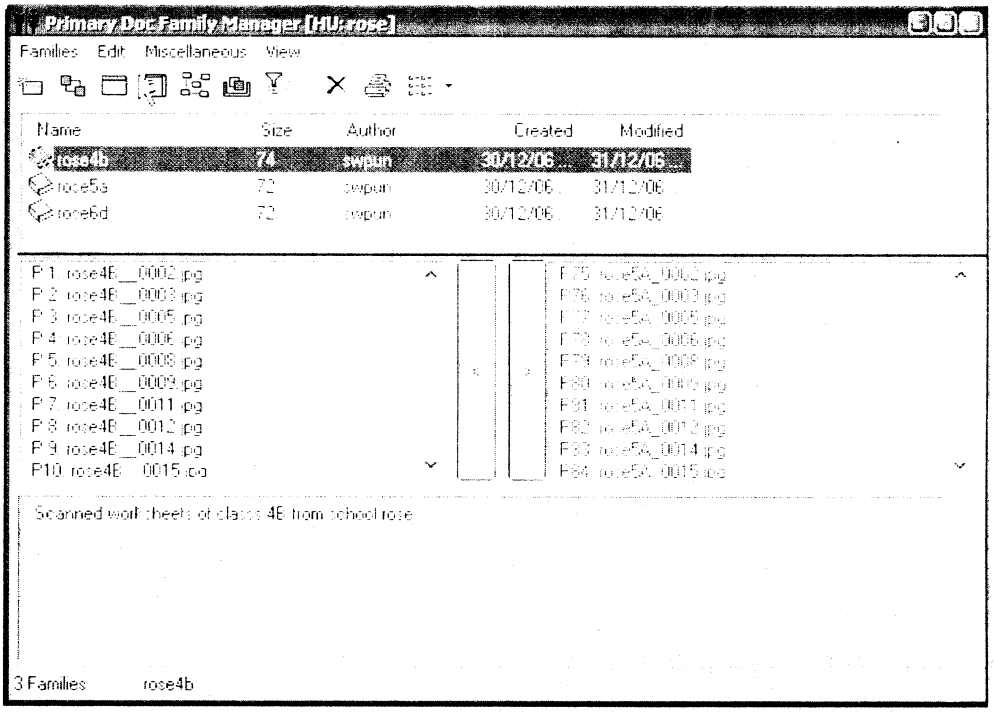


Figure 4.1 Families of scanned worksheets (three classes are shown)

(1) The first step is to open a hermeneutic unit, a computer project that contains all the data, codes, memos and diagrams belonging to the analysis under a case. All scanned worksheets are imported to this hermeneutic unit as primary documents.

computer picture files. Then they are grouped as families of documents (e.g., Figure 4.1) on a class basis, that is, each group of documents consists of all worksheets done by students of the same class.

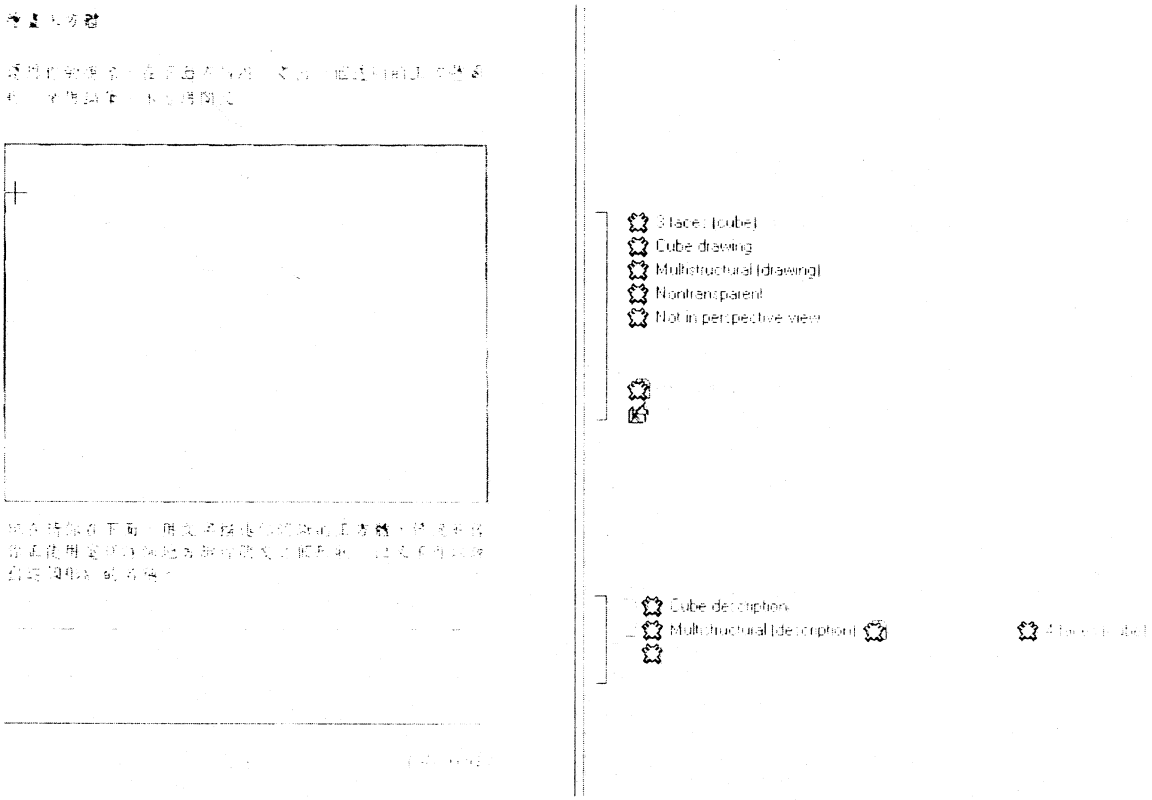


Figure 4.2 Segments of student's drawing and description are coded

(2) The researcher reads and identifies areas in the images (scanned worksheets) that are of further interest. Then codes are assigned for specific occurrences in the data as well as comparison purpose. This is a step called open coding (e.g., Figure 4.2), "the analytic process through which concepts are identified and their properties and dimensions are discovered in data" (Strauss & Corbin, 1998). Memos are written containing the researcher' interpretations, questions, thoughts, and ideas for further data analysis about the data segments (in this case, the captured areas of images).

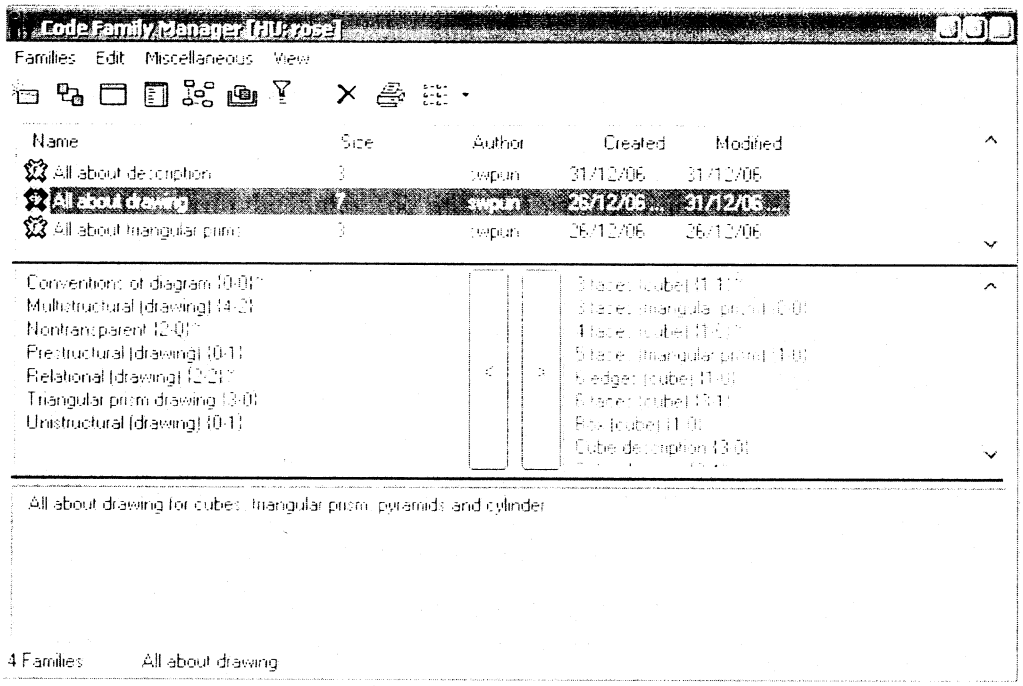


Figure 4.3 Families of codes (family of codes about drawing is shown)

(3) The data segments based on the codes that the researcher has assigned are compared. For classification purpose, codes and memos are grouped as families (e.g., Figure 4.3) if they are of one type of attributes.

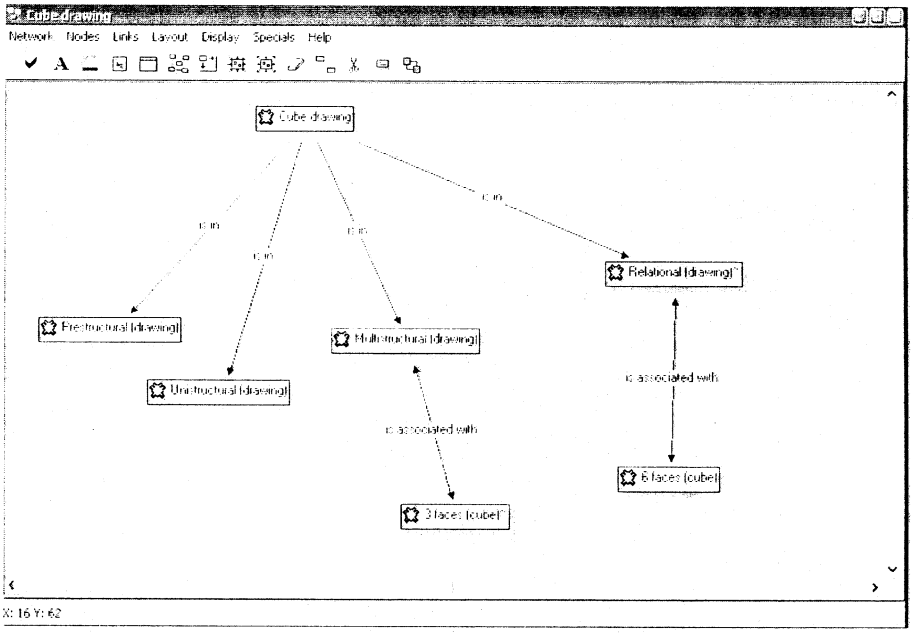


Figure 4.4 Sample of a network view

(4) To conceptualize and visualize an emerging structure, semantic networks are built from the codes of similar or related elements. These networks (e.g., Figure 4.4) together with the codes and memo, form the framework for emerging theory.

(5) To identify the emerging theory of the P-U-M-R levels of the SOLO model for students' understanding of 3D geometrical shapes, the co-occurrence explorer (e.g., Figure 4.5) can list all codes that co-occur with the levels of P-U-M-R classified by the researcher. Figure 4.5 shows part of the codes that has been used to code quotations that are simultaneously coded with cube description at levels of prestructural (level 1) and unistructural (level 2). These co-occurring codes with descriptions or drawings at the levels of P-U-M-R constitute the learning outcomes of the P-U-M-R levels of understandings of the 3D geometrical shapes in the present study. This process is a method, called axial coding suggested in Strass Corbin (1998, pp. 123-142). The purpose of axial coding is to synthesize and organize large amounts of codes around the "axis" of a category. Now that, the co-occurrence task in this study collects the codes that occur around the axis of a category, linking all the codes to one of the P-U-M-R levels in this study. "Strauss and Corbin content that linking relationships between categories occurs on a conceptual rather than descriptive level" (Charmaz, 2006, p. 60). Thus, axial coding is a method to build the theory of P-U-M-R levels for 3D geometrical shapes in this study.

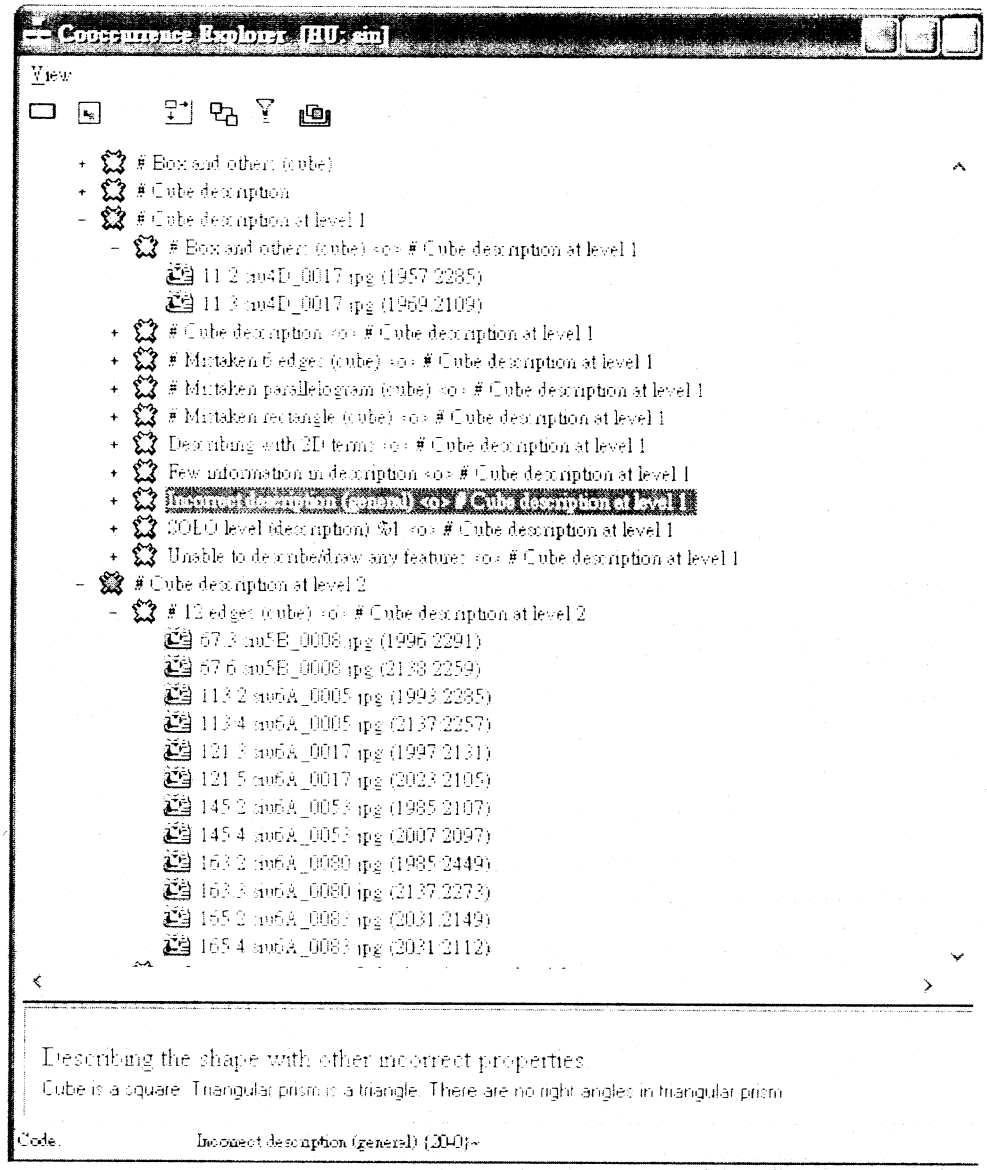


Figure 4.5 Samples of co-occurring codes with cube description at levels of prestructural (level 1) and unistructural (level 2)

(6) Finally, compile a written report about an emerging theory based on the memos that the researcher has written throughout the process of the segmentation of the images and codes assigned, and the networks formed.

4.5 Data Analysis and Interpretation

Data analysis actually commences in literature review. Preliminary patterns about

students' drawings and word descriptions of 3D geometrical shapes are related to the literature, that is, they are developed basing on the findings of the evidence of IFI-ability and VP-ability about students' learning 3D geometrical shapes (see Section 2.3) as well as the criteria drawn from the SOLO levels (see Table 3.1). In other words, these preliminary patterns are based on theoretical concepts. Below (Table 4.1) are the patterns that serve as a theoretical list to guide the data analysis when starting the coding process with ATLAS.ti 5.0. Coding is an on-going process during data interpretation. There are more patterns acquired upon reviewing more data. Codes will change. Some codes do not work; others fade out. Some codes flourish. As there might be several data segments getting the same code, codes have to be split into subcodes (Miles & Huberman, 1994, p. 61). So, coding is not limited to the following patterns. Finally, elaborated criteria for each of the P-U-M-R levels will be obtained and supported by the sample of data from this study (See Section 5.2.1).

Table 4.1 Response patterns about upper primary students' representations of the three-dimensional geometrical shapes and their development of three-dimensional visualization:
Pattern 1: Just a 2D shape in drawing
Pattern 2: Unable to describe/draw any features of the solid shape (See Section 2.4.4) Cases 2.1 Having difficult to write what they think about the mental image of the solid shape. Cases 2.2 Drawing an incorrect or other solid shape
Pattern 3: Describing with incorrect properties (See Section 2.3.7) To describe a solid shape, it is necessary for students to understand the properties of the solid shape and the angles (vertices), parallel lines and perpendicular lines (edges) since most of the regular shapes in the curriculum are composed of these components Cases 3.1: Describing shape with incorrect mathematical terms Cases 3.2: Describing with incorrect number of faces, vertices or edges

Pattern 4: Inaccurate images/unaware of the drawing conventions (see Section 2.3.2 and 2.3.5) To draw a solid shape in a perspective convention, it is necessary for students to understanding the drawing of angles, parallel lines and perpendicular lines are different from those in 2D. Students' unconscious tendency transfers the graphical representations as the geometrical properties of the shape, and vice versa. Cases 4.1: In description of cube, the square is mistaken as rectangle Cases 4.2: In description of cube, the square is mistaken as parallelogram Cases 4.3: In description of triangular prism, the rectangles in triangular prism are mistaken as trapezium Cases 4.4: In description of triangular prism, the rectangles in triangular prism are mistaken as parallelogram
Pattern 5: Describing the shape with few information that one cannot identify what it is. Cases 1: Describing the shape using only one mathematical property out of others Cases 2: Describing the shape using only two mathematical properties out of others
Pattern 6: Difficulties in coordination and integration (see Section 2.4.1) Students seem unable to recognize that edges of the solid shape are parts of the edges of other faces from other views. They cannot complete a perspective drawing of the solid shape Cases 6.1: Hidden lines not in coordination Cases 6.2: Representational drawing is not in perspective view Cases 6.3: Drawing a non-transparent solid shape Cases 6.4: Incomplete drawing of the hidden lines
Pattern 7: Describing the solid shape with several properties which are mathematical terms related to 2D properties only
Pattern 8: The spontaneous concepts (See 2.3.8) The students' spontaneous concepts about these 3D shapes are usually associated with their immediate encounter with these objects in their daily lives through social communication with their families and friends, or the scenes on TV advertisements and videos (in the cultural aspect) As a result, their descriptions might consist of everyday words which are not connected to mathematics but are connected to their peer's or family's language.

Cases 8.1: Cube is associated with box, ice cube and dice Cases 8.2: Triangular prism is associated with the chocolate bar (Toblerone) Cases 8.3: Students want the shape to be in a stable manner based on their spontaneous concepts rather than mathematical convention on drawing 3D shapes
Pattern 9: Building, drawing, making, putting together, and taking parts of solid shapes together in a coordinating manner to form a perspective view of drawing
Pattern 10: Describing solid shapes with correct properties and using mathematical terms to relate these properties

4.6 Conclusion: The Research Design

The research design for this study is illustrated in detail in Figure 4.6. The design is divided into three phases: phase 1 defines the particulars of the initial SOLO levels from the literature and the data collection; phase 2 involves the coding and analysis process, while phase 3 entails the theory building that is based on identification of patterns and relationships.

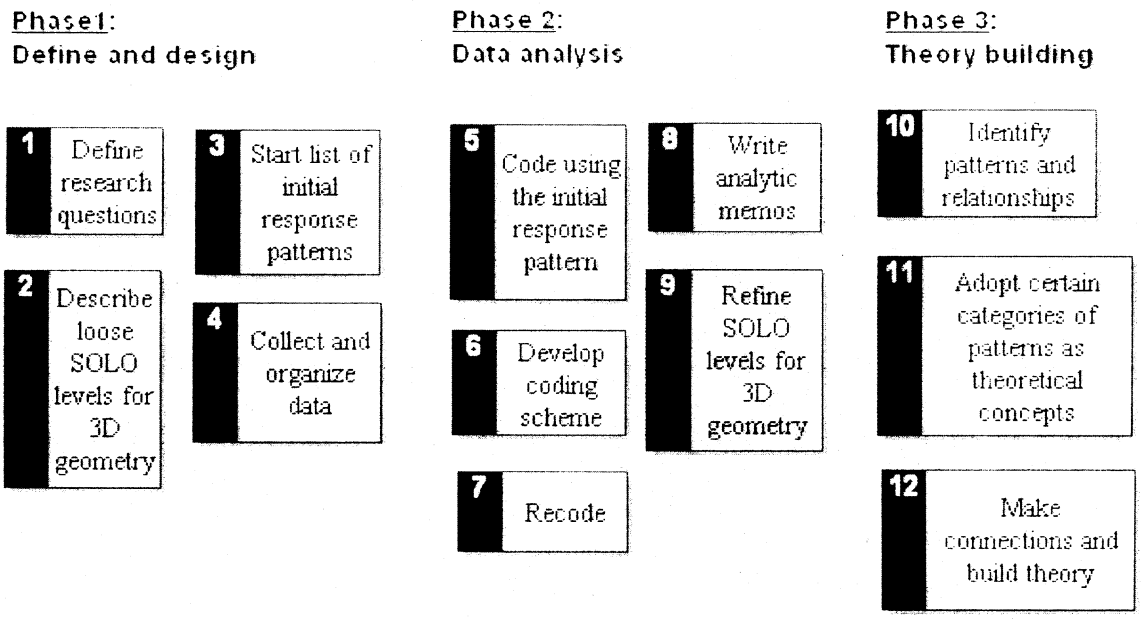


Figure 4.6 The research design

CHAPTER 5 INTERPRETIVE DATA ANALYSIS

The first research question of this study focuses on how students understand and make sense of their visual experiences about 3D geometrical shapes through reviews of students' drawings of and descriptions about the shapes. The work in analysis is to develop thorough and comprehensive descriptions of the diversity and patterns of students' drawing representations of and descriptions about 3D geometrical shapes.

Therefore, to review these datasets is the major stuff of analysis. For the first research question, the analysis adopts the grounded theory approach (Charmaz, 2006; Strauss & Corbin, 1998). The analysis involves how the researcher differentiates and combines patterns found and the memos made about the data acquired. The analysis started with open coding which is to identify a coding taxonomy that might capture the full range of upper primary students' responses in their drawing representations of and descriptions about 3D geometrical shapes. Codes acquired in open coding are key words or categories that the researcher interprets the piece of information (segments of text and drawings) in students' responses. In interpretative data analysis, it is not the key words themselves but for the interpretations associated with the words that matters.

For the second research question, the researcher is interested not only in how many individuals exhibit various drawing and description patterns but also in how the theory of P-U-M-R levels of the SOLO model emerges from these patterns and what it looks like in 3D geometrical shapes. Deductive approach was used in the analysis for the study that intends to test the existing theory of SOLO model. It investigates the transferability of that theory to 3D geometrical shapes (Lewins & Silver, 2007, p. 93). The theoretical framework (See Chapter 3) and the theoretical patterns (See Section 4.5) guide the code development and the interpretation of the data set is subject to the professional judgement of the researcher.

5.1 Coding as an Analysis Process

Codes acquired in the coding process are the building blocks of the analysis. Without

categorization and coding, there is no way of knowing what are being analysed because "coding is an integral part of analysis: it lays the conceptual foundations upon which interpretation and explanation are based." (Dey, 1993, p. 40). Strauss and Corbin (1990, p. 61) defines coding as "the process of analysis". Thus, coding and analysis proceed simultaneously.

In this study, the first set of codes is descriptive and open. The researcher attributes a pattern of phenomena to segment of students' text descriptions and drawings. That is, codes are first generated inductively from salient pattern identified in the dataset. With the reference to the descriptive and open coding acquired inductively, the second coding is to establish incidents and to accumulate supporting evidence for the existence of P-U-M-R levels of the SOLO model. That is, coding for P-U-M-R levels is deductively drawn from the research framework (Chapter 3). Thus, codes make the researcher think about the phenomena that are being analysed. All in all, codes need to be meaningful in the sense that they indicate the nature of the data and research questions. Below are some illustrations how coding is an integral part of the analytic process in this study.

Figure 5.1 is the drawing of pyramid from a grade 4 student. This segment was (open) coded "No structure of square base" and "Some or all faces (including hidden) are drawn in a 2D format". These are in fact descriptive and entail little interpretation. However, the drawing could be coded more interpretively; the drawing was classified in the category of Unistructural level (SOLO model) as the student only displayed the triangular structure of the pyramid with no perspective view.

[siu4D_0066.jpg]

Figure 5.1 Drawing of pyramid

Figure 5.2 is the description of pyramid from the same year 4 student. The text was (open) coded "Few information in description" which indicates that the description does not provide sufficient information to let other persons to recognize it as a pyramid. It was interpreted as in the Prestructural level.



[siu4D_0066.jpg]

Translation: *I draw a transparent cone with the same four faces*

Figure 5.2 Description of pyramid

5.2 Tasks of Data Analysis

Figure 5.3 shows the main tasks of the data analysis process in this study (Lewins & Silver, 2007, p. 9). Datasets are organized in three families (or batches) from three schools with coded names: "rose", "siu" and "wu". The scanned computer file of each script is named with the convention:

[familyname + class__xxxx.jpg]

where familyname = rose, siu or wu, class = class name assigned by the school, xxxx = numerals assigned by software when scanning, jpg = a computer picture format

Segments of pictures are marked and coded with one or more key words with reference to the initial patterns derived from the literature (Section 4.5). Data analysis proceeds initially from "open" or "free" coding. Open coding involves coding the data in every way possible for as many patterns that might fit.

5.2.1 The Cyclic Process of Coding

The researcher realized that he was unfamiliar with the first dataset and so he carried out the coding in a detail way so that all patterns found were coded. However, after the first set of data (the school "rose" was coded, the researcher became concerned whether he had double coded, overlooked some patterns, coded inconsistently and misinterpreted some patterns (see Section 5.2.3). As suggested by the constant comparative method (Charmaz, 2006, p. 54), existing codes are compared and contrasted to find similarities or differences from time to time during the coding process. In other words, emerging codes have to reveal significant differences from existing codes. Key words have to be modified or amended for accuracy and codes are needed to be split or merged for any inconsistency. Thus, coding is a cyclic process as indicated at the centre of Figure 5.3. The process needs working back and forth between existing codes and emerging codes. It only stops when codes are combined and/or connected so that an adequate theory has emerged and is support by a set of codes.

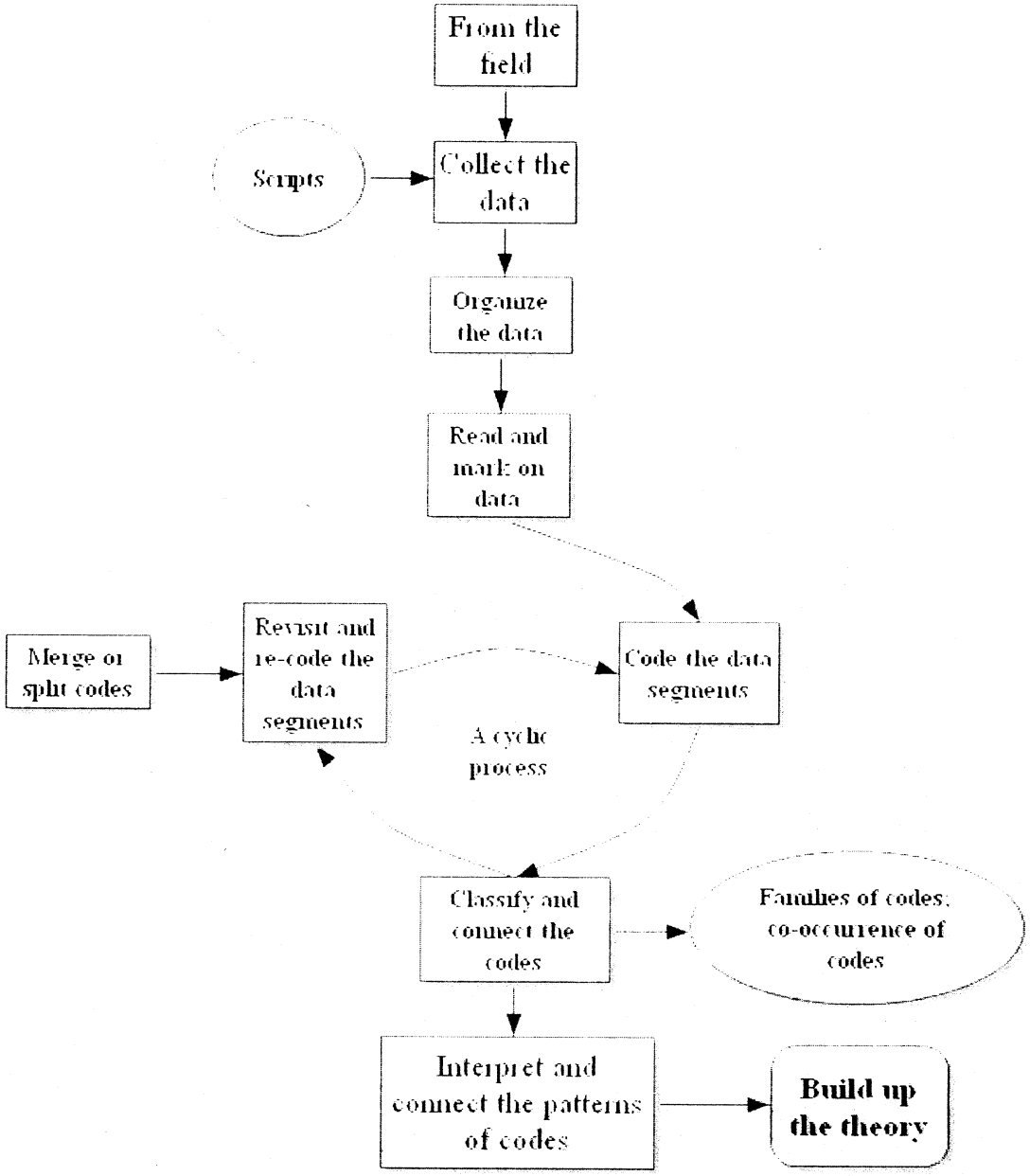


Figure 5.3 The main tasks of data analysis

Figure 5.4 below shows the ATLAS.ti interface with a coding view. The data (scanned from the scripts of the worksheets) is displayed on the left side of the screen, the applied codes on the right side in the margin area. A visible window at the left is the code manager which contains the code list. The major task of the data analysis

process involves retrieving each picture file, selecting part of the picture and labelling this segment of picture with existing code (See Figure 5.5 below) or new code. Note that when part of the segment of picture is selected, the software superimposes some straight lines on the picture.

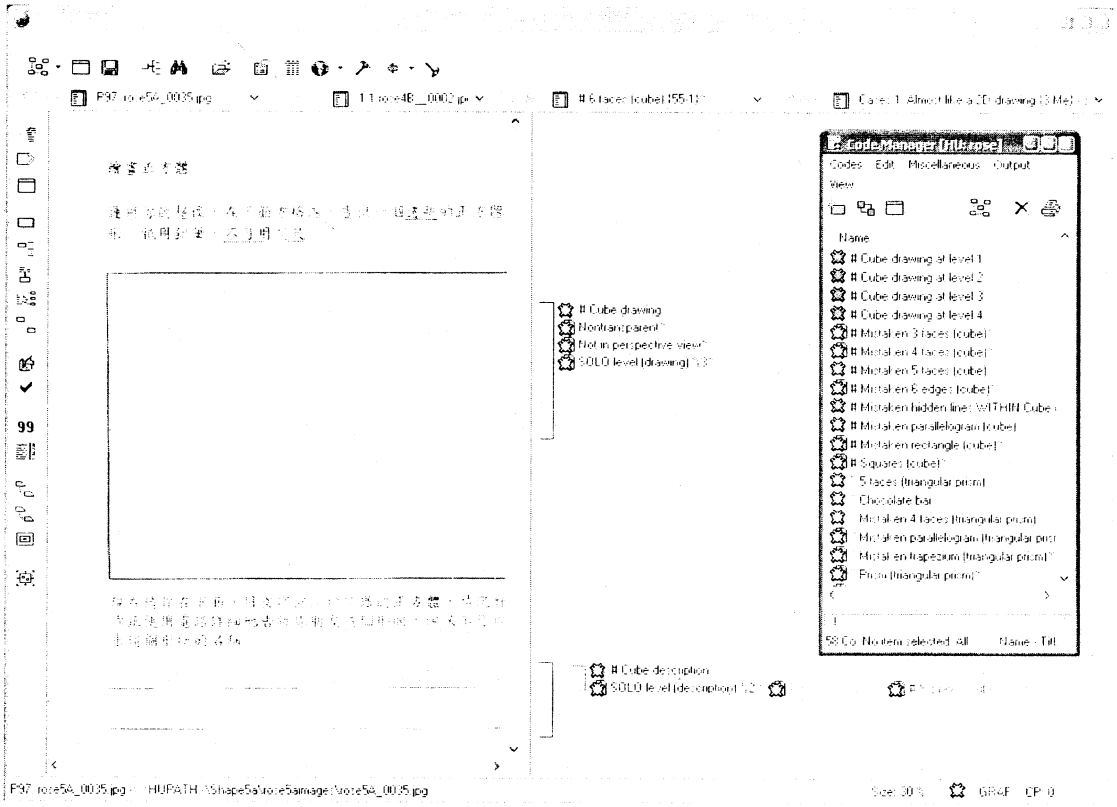


Figure 5.4 The coding interface

ATLAS.ti provides easy ways to retrieve coded data. By clicking a particular code in the code list window, the software prompts a window (Figure 5.6 below) showing all the segments of picture files or quotations that are labelled by that code. Thus, the researcher can browse all these coded segments in their original source context. This retrieval and browsing process can help the researcher to identify gaps or inconsistency and to think about whether the code label adequately captures the concept or category.

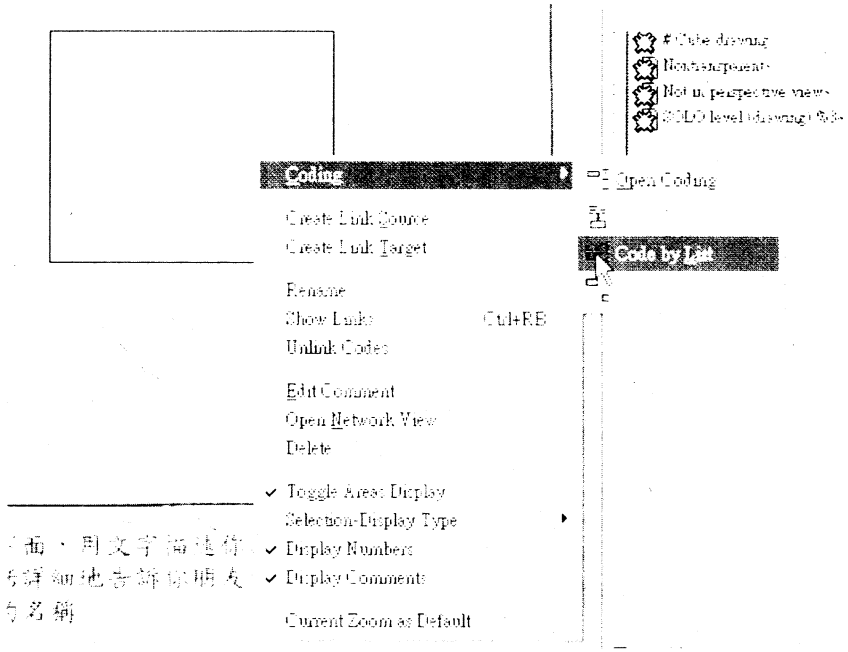


Figure 5.5 Coding a data segment

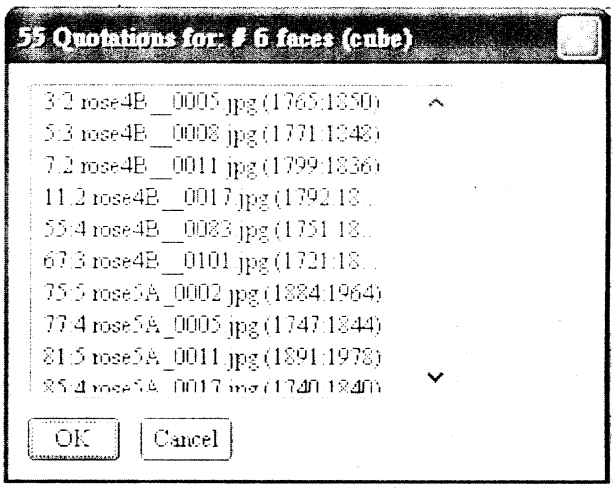


Figure 5.6 Data segments which are labelled "# 6 faces (cube)"

5.2.2 Coding Scheme

Now that codes are generated but the ways of grouping codes are critical to proceed further in data analysis. Codes have to be reorganized in order to build up a theory. Coding scheme is the manifestation of the way codes are listed or organized (Lewins

& Silver, 2007, p. 93). This section reports how the coding scheme was developed and how codes were grouped in order to build the P-U-M-R levels of the SOLO model for 3D geometrical shapes.

At the start, coding scheme (see table 5.1 and 5.2) was non-hierarchical, that is, codes were listed in the same level without any subcodes or supercodes. At the later stage of analysis, codes were grouped to build higher-level codes or codes at a higher level of abstraction. In other words, codes are created in a bottom-up approach. In this study, the higher-level codes are related to IFI- and VP- abilities in visualization of 3D geometrical shapes. They are also theoretical codes, codes created based on theoretical concepts which are related to the literature.

In order to build higher-level codes as well as avoiding mistakes in coding, codes are labelled using meaningful prefixes so that the lists are more systematic and organized to facilitate grouping of codes in families and building higher level codes. For example, in Table 5.1 and Table 5.2, # was used to indicate codes for cube and ^ was used to indicate codes for triangular prism. Table 5.3 shows the final coding scheme which has a more sophisticated prefixing for codes about cubes and triangular prisms:

#_des - a code for the description about cube;

#_draw - a code for the drawing of cube;

^_des – a code for the description about triangular prism;

^_draw – a code for the drawing of triangular prism;

des – a code for the description about any 3D shape;

draw – a code for the drawing of any 3D shape

Note that while # and ^ prefix indicate the categories of cube and triangular prisms, "des" and "draw" represent a more board categories about description and drawing. In other words, # and ^ are specific to shapes, and "des" and "draw" are more general to all 3D shapes. In school "wu", % prefix is used to indicate codes about cylinder and in school "siu", & prefix is used to indicate codes about pyramid.

The prefixing code is a very useful way to organize codes as they appear on the

screen It avoids the mistakes in coding as putting codes into a grouping that one can conveniently selected with on click as group. During the first-pass coding process, without prefixing codes, the researcher was prone to code a drawing with codes for descriptions or vice versa since the key words for the two types of codes are very similar. Using the above prefixes, the researcher could easily identify the miscoding when scrolling down through the coded pictures with the margin view at the left. It provides a clear overview of the current coding status of the scanned documents. The codes with "des" in margin pane are viewed horizontally at the left of the descriptions in the working place of ATLAS.ti. If the researcher found the codes with "draw" were viewed right at the left of the descriptions, the codes were misplaced.

Table 5.1 Code list for cubes and triangular prisms in the first-pass coding process

Code-Filter: All

HU: Apr 2 rose
File: [J:\study1\datacollection\RoseofLima\Apr 2 rose.hpr5]
Edited by: swpun
Date/Time: 05/07/07 10:00:25 AM

---

6 faces (cube)
Box and others (cube)
Cube description
Cube description at level 1
Cube description at level 2
Cube description at level 3
Cube description at level 4
Cube drawing
Cube drawing at level 1
Cube drawing at level 2
Cube drawing at level 3
Cube drawing at level 4
Mistaken 3 faces (cube)
Mistaken 4 faces (cube)
Mistaken 5 faces (cube)
Mistaken 6 edges (cube)
Mistaken parallelogram (cube)
Mistaken rectangle (cube)
Squares (cube)
^ 5 faces (triangular prism)
^ Chocolate bar
^ Mistaken 4 faces (triangular prism)
^ Mistaken parallelogram (triangular prism)
^ Mistaken trapezium (triangular prism)
^ Prism (triangular prism)
^ Rectangle (triangular prism)
^ Triangle (triangular prism)
^ Triangular prism as tetrahedron
^ Triangular prism description
^ Triangular prism description at level 1
^ Triangular prism description at level 2
^ Triangular prism description at level 3
^ Triangular prism description at level 4
^ Triangular prism drawing
^ Triangular prism drawing at level 1
^ Triangular prism drawing at level 2
^ Triangular prism drawing at level 3
^ Triangular prism drawing at level 4

(cont'd from table 5.1)

Describing with 2D terms
Few information in description
Incorrect description (general)
Like 2D drawing
Maintaining 2D properties in drawing
Mistaken hidden lines
Nontransparent
Not in perspective view
Perfect description
Perfect drawing
Perpendicular edges
SOLO level (description) %1
SOLO level (description) %2
SOLO level (description) %3
SOLO level (description) %4
SOLO level (drawing) %1
SOLO level (drawing) %2
SOLO level (drawing) %3
SOLO level (drawing) %4
Unable to describe/draw any features

Table 5.2 Modified code list for cubes and triangular prisms

Code-Filter: All

HU: May 15 rose
File: [J:\study1\datacollection\RoseofLima\May 15 rose.hpr5]
Edited by: swpun
Date/Time: 05/07/07 10:08:11 AM

---

12 edges (cube)
6 faces (cube)
8 vertices (cube)
Box and others (cube)
Cube description
Cube description at level 1
Cube description at level 2
Cube description at level 3
Cube description at level 4
Cube drawing
Cube drawing at level 1
Cube drawing at level 2
Cube drawing at level 3
Cube drawing at level 4

(cont'd from table 5.2)

Mistaken 3 faces (cube)
Mistaken 4 faces (cube)
Mistaken 5 faces (cube)
Mistaken 6 edges (cube)
Mistaken hidden lines WITHIN Cube drawing
Mistaken parallelogram (cube)
Mistaken rectangle (cube)
Squares (cube)
^ 5 faces (triangular prism)
^ 6 vertices (triangular prism)
^ 9 edges (triangular prism)
^ Chocolate bar
^ Mistaken 4 faces (triangular prism)
^ Mistaken parallelogram (triangular prism)
^ Mistaken trapezium (triangular prism)
^ Prism (triangular prism)
^ Rectangle (triangular prism)
^ Triangle (triangular prism)
^ Triangular prism as tetrahedron
^ Triangular prism description
^ Triangular prism description at level 1
^ Triangular prism description at level 2
^ Triangular prism description at level 3
^ Triangular prism description at level 4
^ Triangular prism drawing
^ Triangular prism drawing at level 1
^ Triangular prism drawing at level 2
^ Triangular prism drawing at level 3
^ Triangular prism drawing at level 4
Describing with 2D terms
Few information in description
Incorrect description (general)
Mistaken hidden lines
Nontransparent
Not in perspective view
Perfect description
Perfect drawing
Perpendicular edges
SOLO level (description) %1
SOLO level (description) %2
SOLO level (description) %3
SOLO level (description) %4
SOLO level (drawing) %1
SOLO level (drawing) %2
SOLO level (drawing) %3
SOLO level (drawing) %4
Some or all seen faces are drawn in a 2D format
Unable to describe/draw any features

Table 5.3 Final code list for cubes and triangular prisms

Code-Filter: All

HU: rose
File: [J:\study1\datacollection\RoseofLima\rose.hpr5]
Edited by: swpun
Date/Time: 03/08/07 09:32:11 AM

#_des 12 edges (cube)
#_des 6 faces (cube)
#_des 8 vertices (cube)
#_des Box and others (cube)
#_des Cube description
#_des Cube description at level 1
#_des Cube description at level 2
#_des Cube description at level 3
#_des Cube description at level 4
#_des Mistaken 3 faces (cube)
#_des Mistaken 4 faces (cube)
#_des Mistaken 5 faces (cube)
#_des Mistaken 6 edges (cube)
#_des Mistaken parallelogram (cube)
#_des Mistaken rectangle (cube)
#_des Prism (cube)
#_des Squares (cube)
#_draw Cube drawing
#_draw Cube drawing at level 1
#_draw Cube drawing at level 2
#_draw Cube drawing at level 3
#_draw Cube drawing at level 4
^_Triangular prism as tetrahedron
^_des 5 faces (triangular prism)
^_des 6 vertices (triangular prism)
^_des 9 edges (triangular prism)
^_des Chocolate bar
^_des Mistaken 4 faces (triangular prism)
^_des Mistaken parallelogram (triangular prism)
^_des Mistaken trapezium (triangular prism)
^_des Prism (triangular prism)
^_des Rectangle (triangular prism)
^_des Triangle (triangular prism)
^_des Triangular prism description
^_des Triangular prism description at level 1
^_des Triangular prism description at level 2
^_des Triangular prism description at level 3
^_des Triangular prism description at level 4
^_draw Triangular prism drawing
^_draw Triangular prism drawing at level 1
^_draw Triangular prism drawing at level 2
^_draw Triangular prism drawing at level 3
^_draw Triangular prism drawing at level 4

(cont'd from table 5.3)

des_Describing with 2D terms
des_Few information in description
des_Incorrect description (general)
des_Perfect description
des_SOLO level %1
des_SOLO level %2
des_SOLO level %3
des_SOLO level %4
draw_Hidden lines not in coordination
draw_Incomplete drawing of hidden lines
draw_Nontransparent
draw_Not in perspective view
draw_Perfect drawing
draw_Perpendicular edges
draw_SOLO level %1
draw_SOLO level %2
draw_SOLO level %3
draw_SOLO level %4
draw_Some or all seen faces are drawn in a 2D format
Unable to describe/draw any features

Appendix A is the final set of code list in this study.

The data set was initially coded using bottom-up approach and these grounded or rooted codes might be very specific to a particular 3D shape or a very narrow category and concept. In ATLAS.ti, there are code families which are analytic groupings of related codes or broad collections of codes about a theme. Code families can further be combined using Boolean operators such as AND, OR and NOT to build super families. This analysis used code families to collect and think about related codes. Thus, grouping of codes in families of super families can achieve higher level of abstraction and facilitate the formation of theory, that is, P-U-M-R levels of the SOLO model for 3D geometrical shapes.

Code families can be board collections and in this study some code families were theoretically focused towards to the SOLO model and spatial abilities. Note that in ATLAS.ti, code families are not mutually exclusive. One code that might have different prefixes can belong to many families since it is only creating a shortcut to codes. The actual code is still in its original location of the code list. For instance,

Table 5.3 shows a code family which groups 9 basic codes and the family became a board collection about students' difficulties in IFI-ability (See Section 2.1.2). Note that the family cuts across codes with different prefixes. Figure 5.7 shows the tool. in ATLAS.ti to create code families and Figure 5.8 illustrates how code families can be visualized.

Table 5.4 An Example of Code Family

Code Family: Difficulties in IFI-ability

HU: rose
File: [J:\study1\datacollection\RoseofLima\rose.hpr5]
Edited by: swpun
Date/Time: 08/08/07 09:26:01 AM

Created: 11/03/07 08:23:46 PM (swpun)
Comment: Pattern 3 in response pattern (Table 4.1)

Codes (9):
[#_des Mistaken 3 faces (cube)]
[#_des Mistaken 4 faces (cube)]
[#_des Mistaken 5 faces (cube)]
[#_des Mistaken 6 edges (cube)]
[Triangular prism as tetrahedron]
[_des Mistaken 4 faces (triangular prism)]
[des_Describing with 2D terms]
[des_Few information in description]
[des_Incorrect description (general)]

Quotation(s): 102

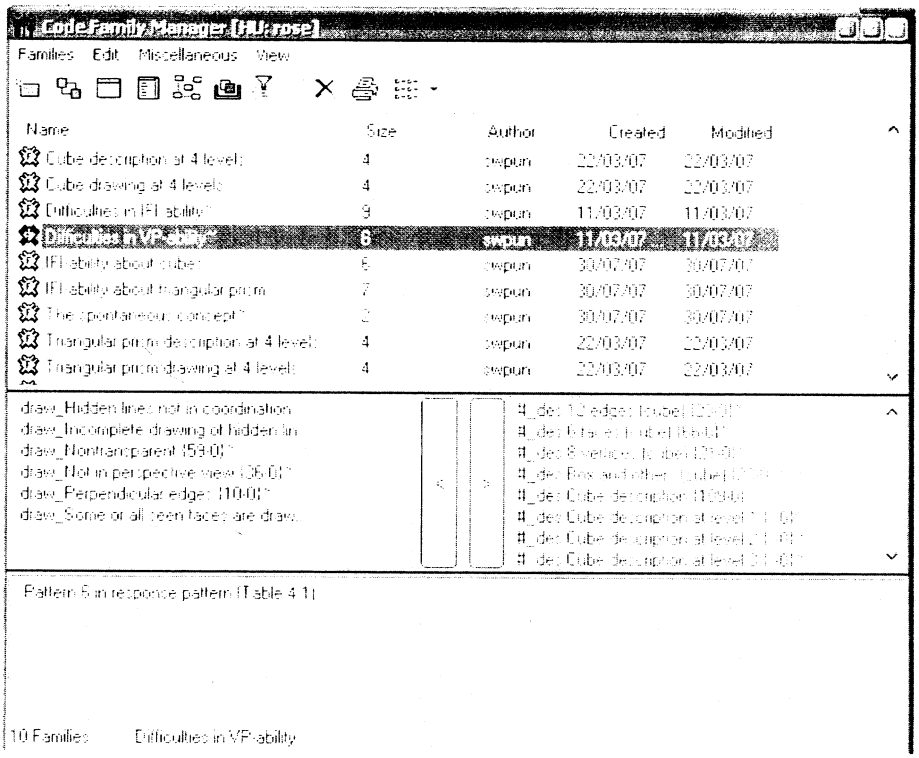


Figure 5.7 The code family manager

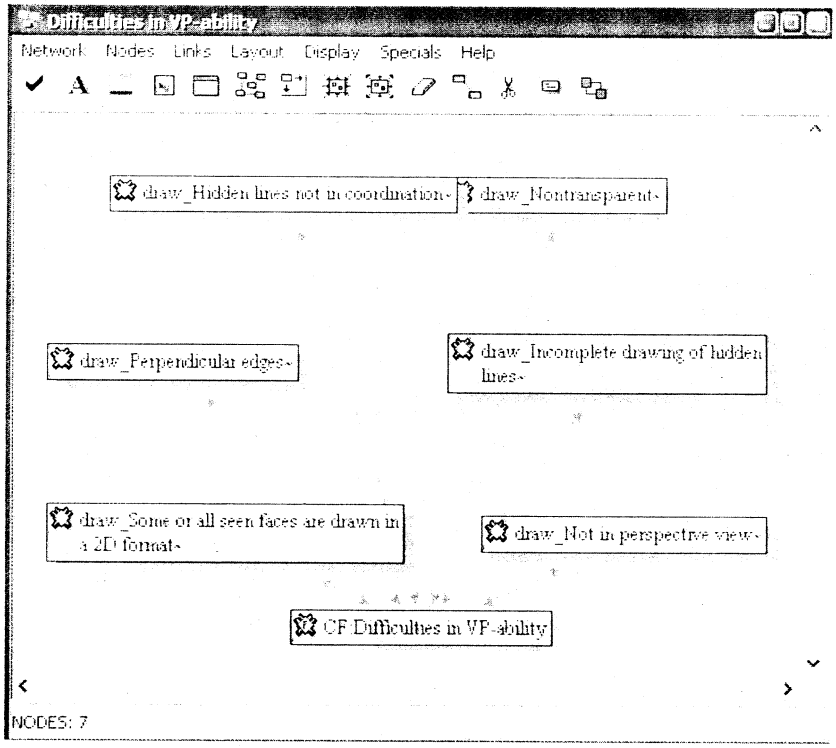


Figure 5.8 The network view of code family

5.2.3 Co-occurrence Query

The second research question of this study is to identify the P-U-M-R levels of the SOLO model. Each of the drawings and descriptions in the dataset was coded one of the four levels. This process results in four sets of students' drawings and four sets of students descriptions about 3D shapes. Then, what are the characteristics of each of these levels? The researcher wants to find the codes and the frequency of occurrences of these codes that are connected to the P-U-M-R levels for descriptions about and drawings of the 3D shapes. Co-occurrence query tool in ATLAS.ti allows the researcher to examine these potential connections, the codes which occur together.

Co-occurrence Explorer (Figure 4.5) is a way to view these connections. It returns of all other codes with quotations that are coded one of the P-U-M-R levels. To print a list of codes that are co-occurring with the four SOLO levels for the descriptions about cubes, the researcher sets the filter so that only the codes of cube descriptions at the four levels are involved and then prints the report (Table 5.5). Note that the researcher filters the dataset in order to focus the attention on a subset of codes within the dataset.

Table 5.5 Co-occurring Codes for the P-U-M-R levels about the descriptions of Cubes

Report: Co-occurring Codes

HU: rose
File: [H:\Study1 datacollection\RoseofLima\rose.hpr5]
Edited by: swpun
Date/Time: 15-08-07 02:56:55 PM

#_des Cube description at level 1 (Kozulin)~ [12]

#_des 6 faces (cube) {66-1}~
#_des Box and others (cube) {23-0}~
#_des Cube description {109-0}
#_des Mistaken 3 faces (cube) {1-1}~
#_des Mistaken 6 edges (cube) {2-0}~
#_des Prism (cube) {12-0}~
#_des Squares (cube) {72-0}~
des_Describing with 2D terms {27-0}~
des_Few information in description {39-0}~
des_Incorrect description (general) {28-0}~
des_SOLO level %1 {20-0}~
Unable to describe/draw any features {10-0}

#_des Cube description at level 2 {41-0}~ [15]

#_des 6 faces (cube) {66-1}~
#_des 8 vertices (cube) {21-0}~
#_des Box and others (cube) {23-0}~
#_des Cube description {109-0}
#_des Mistaken 4 faces (cube) {2-0}~
#_des Mistaken 5 faces (cube) {1-0}~
#_des Mistaken 6 edges (cube) {2-0}~
#_des Mistaken parallelogram (cube) {1-0}~
#_des Mistaken rectangle (cube) {2-0}~
#_des Prism (cube) {12-0}~
#_des Squares (cube) {72-0}~
des_Describing with 2D terms {27-0}~
des_Few information in description {39-0}~
des_Incorrect description (general) {28-0}~
des_SOLO level %2 {83-0}~

#_des Cube description at level 3 {37-0}~ [11]

#_des 12 edges (cube) {23-0}~
#_des 6 faces (cube) {66-1}~
#_des 8 vertices (cube) {21-0}~
#_des Box and others (cube) {23-0}~
#_des Cube description {109-0}
#_des Prism (cube) {12-0}~
#_des Squares (cube) {72-0}~

(Continued from Table 5.5)

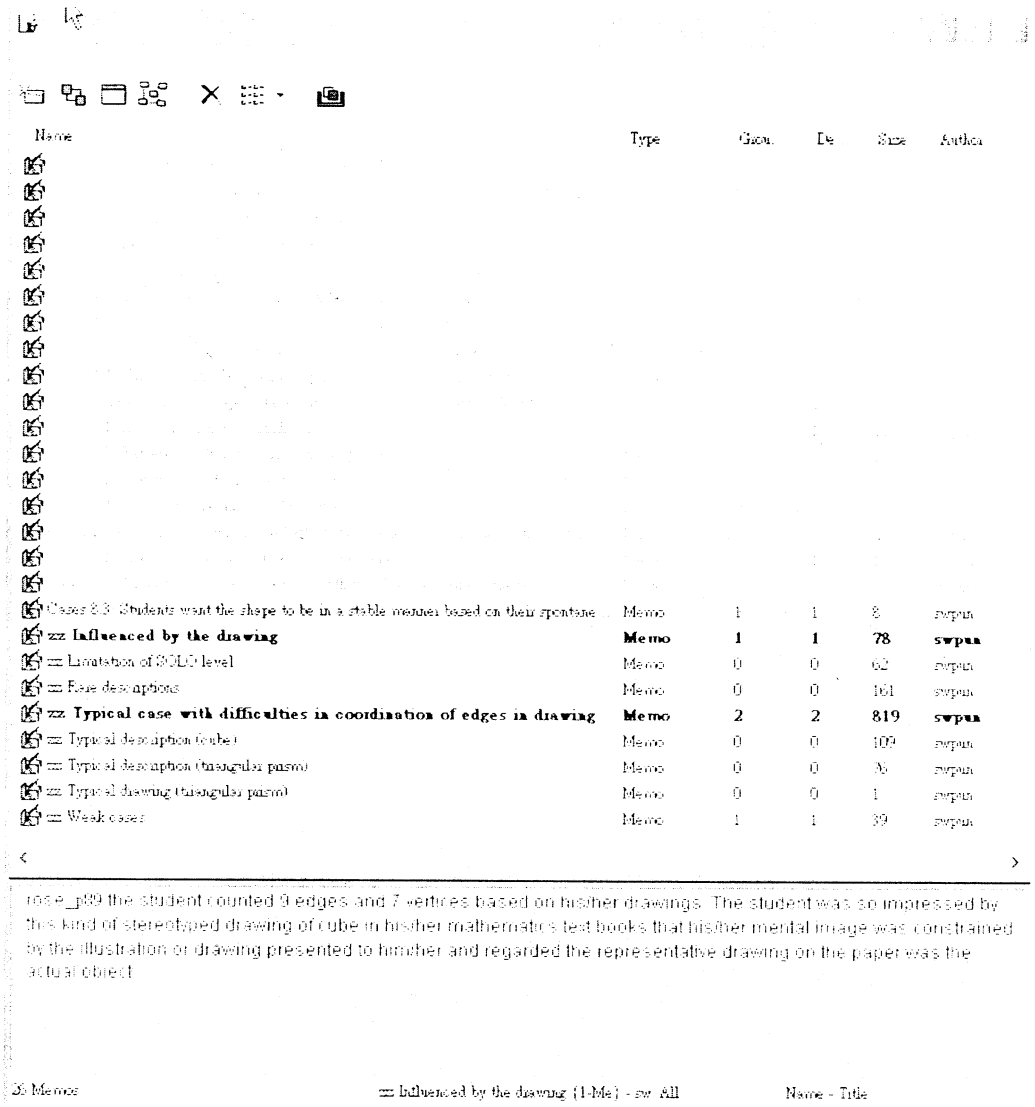
des_Describing with 2D terms {27-0}~
des_Few information in description {39-0}~
des_Incorrect description (general) {28-0}~
des_SOLO level %3 {80-0}~

#_des Cube description at level 4 {18-0}~ |8|
#_des 12 edges (cube) {23-0}~
#_des 6 faces (cube) {66-1}~
#_des 8 vertices (cube) {21-0}~
#_des Box and others (cube) {23-0}~
#_des Cube description {109-0}
#_des Prism (cube) {12-0}~
#_des Squares (cube) {72-0}~
des_SOLO level %4 {34-0}~

In Table 5.5, the numbers of co-occurrence codes for P-U-M-R levels (labelled as levels 1, 2, 3, 4 respectively in the software) are respectively 10, 14, 10, 8. The codes under each level are those co-occurring codes or connected the level. One can see that at the unistructural level (that is, level 1) there are mistakes or incorrect descriptions while at the relational level (that is, level 2) all properties of a cube are mentioned.

5.2.4 Writing Memos

During the analytic coding process, the researcher recorded the development of interpretations about some focused codes for making comparisons between data and data, data and other codes (keeping with Glaser and Strauss' constant comparative methods) and for articulating spontaneous conjectures about these comparisons. In ATLAS.ti, these interpretations and ideas generated are written down as memos. Figure 5.9 shows the memos generated during the coding of cubes and triangular prisms.


Name
Type
Size
Memo
Memo
Memo

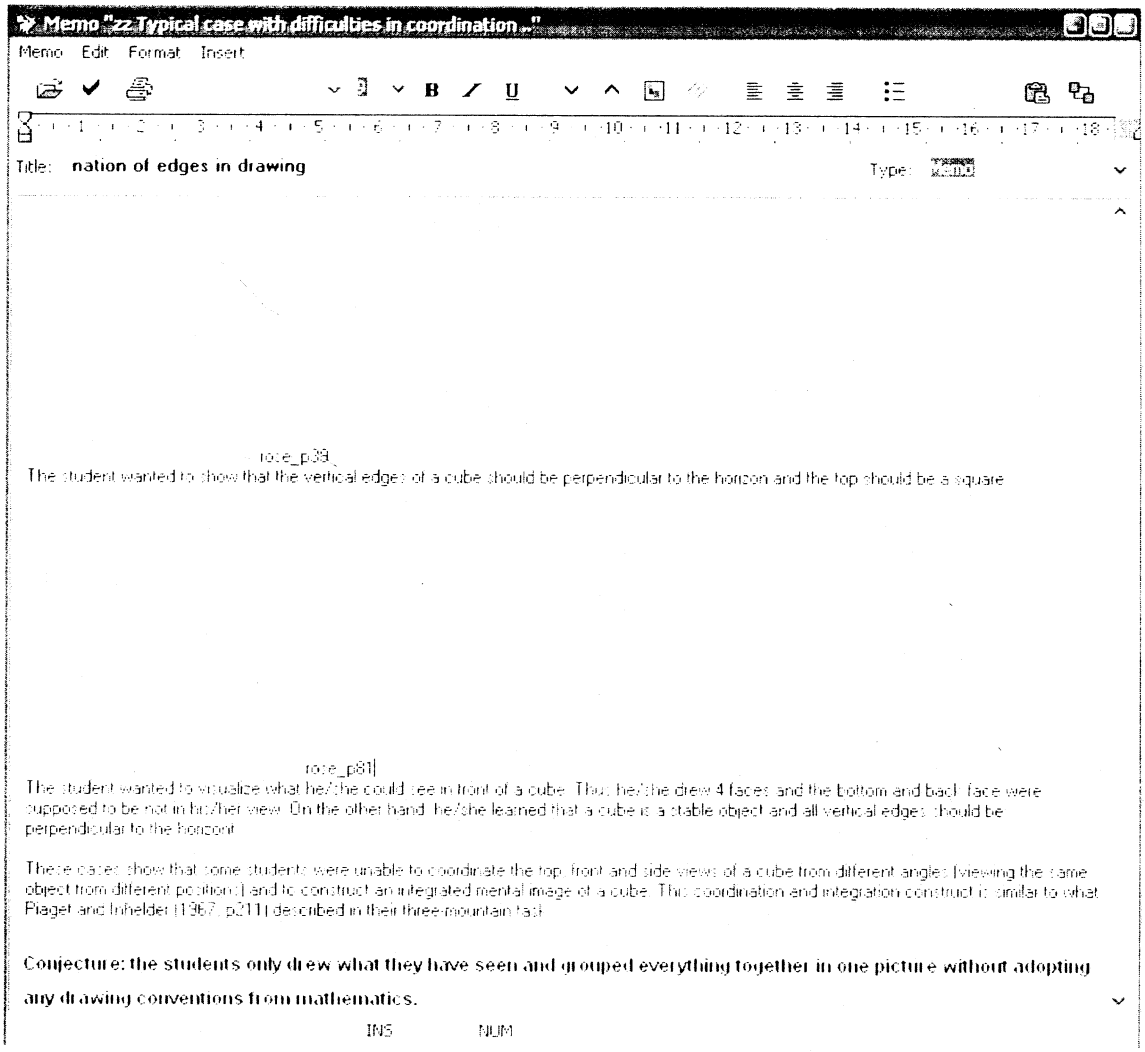


Figure 5.10 An example of memo

5.2.5 The Changes in Selecting and Naming Segments of Data

> "Qualitative coding, the process of defining what the data are about, is our first analytic step. Coding means naming segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data" (Charmaz, 2006, p. 43)

Naming segments of data (or quotations in ATLAS.ti) in concise terms for an accurate interpretation is a task that needs changes from time to time. At the very initial stage of this analysis process, the researcher did not want to overlook salient drawing and descriptive properties. He carried out a detailed descriptive open coding.

However, when codes were revisited, inaccurate coding occurred. It became difficult to move on to analyse at a more abstract level for building theory.

Using software to do data analysis has an advantage that any changes, either small leap or a big jump, can be dated so that the researcher can track developments in thinking. This section illustrates some of the changes in naming segments of data and the handling of these changes.

Merging codes In the initial coding, there were two different codes "Maintaining 2D properties in drawing" and "Like 2D drawing". Then, they were merged into "Almost like 2D drawing" and finally for more accurate description, it becomes "draw_Some or all seen faces are drawn in a 2D format". Figure 5.11 shows some of the pictures which had been assigned by this code. The final one reflects a more accurate description of these drawings.

[rose4B__0068.jpg]

[rose5A_0077.jpg]

[rose4B__0078.jpg]

[rose5A_0003.jpg]

Figure 5.11 Examples of merging codes

Splitting codes In the initial coding, the code, "draw_Hidden lines not in coordination" were used to code pictures like those in Figure 5.12. These selections were to split and assigned by two different codes. Drawings like those in the upper row were assigned the original code but drawing like those in the lower row were assigned a new code, "draw_Incomplete drawing of hidden lines".

[rose4B_0107.jpg] [rose5A_0048.jpg]



[rose4B_0033.jpg] [rose5A_0080.jpg]

Figure 5.12 Examples of spitting codes

Double coding Double coding happens for segments of data which embodied multiple interpretations. For example, Figure 5.13 was double coded "draw_Perpendicular edges" and "Stable solid shapes" A segment of data might have more than two interpretations. So, how far does double coding go? The researcher decided to limit each data segment with one code and all other interpretations, usually at a more abstract level, were commented as memos.



[rose4B_0056.jpg]

Figure 5.13 Example of segment of data that is embodied multiple interpretations

5.2.6 Linking Concepts

Linking in order to draw connections and define relationships between codes, quotations/segments of data is also a major task in this analytic coding process.

Linking includes linking memos to the scanned files, linking memos to codes, linking between quotations/segments of data and linking between codes. The linking may help when thinking and writing at an abstract level about the relationships and connections within the data. It also reminds the researcher the previous lines of thought and brings together many elements of the study in a schematic way.

Figure 5.14 shows the linking between "Cube description at level 1" and other codes of description associated with this level (prestructural level) and Figure 5.15 is visual view of this linking. It shows the associated attributes of the description of cube at Prestructural.

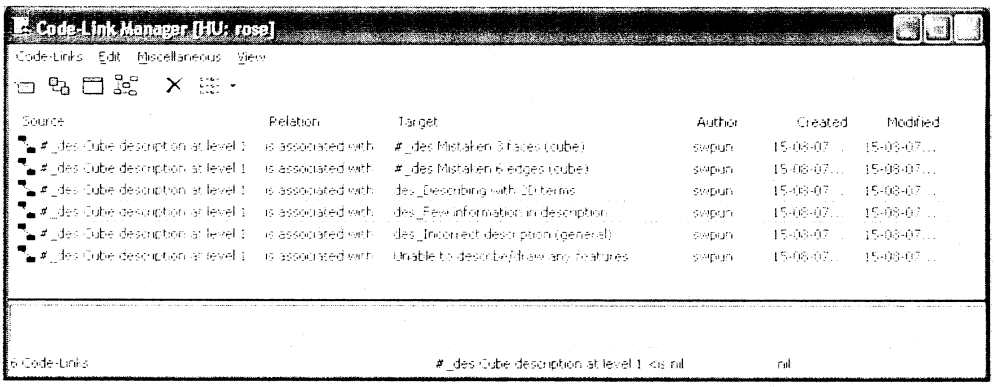


Figure 5.14 The linking between codes

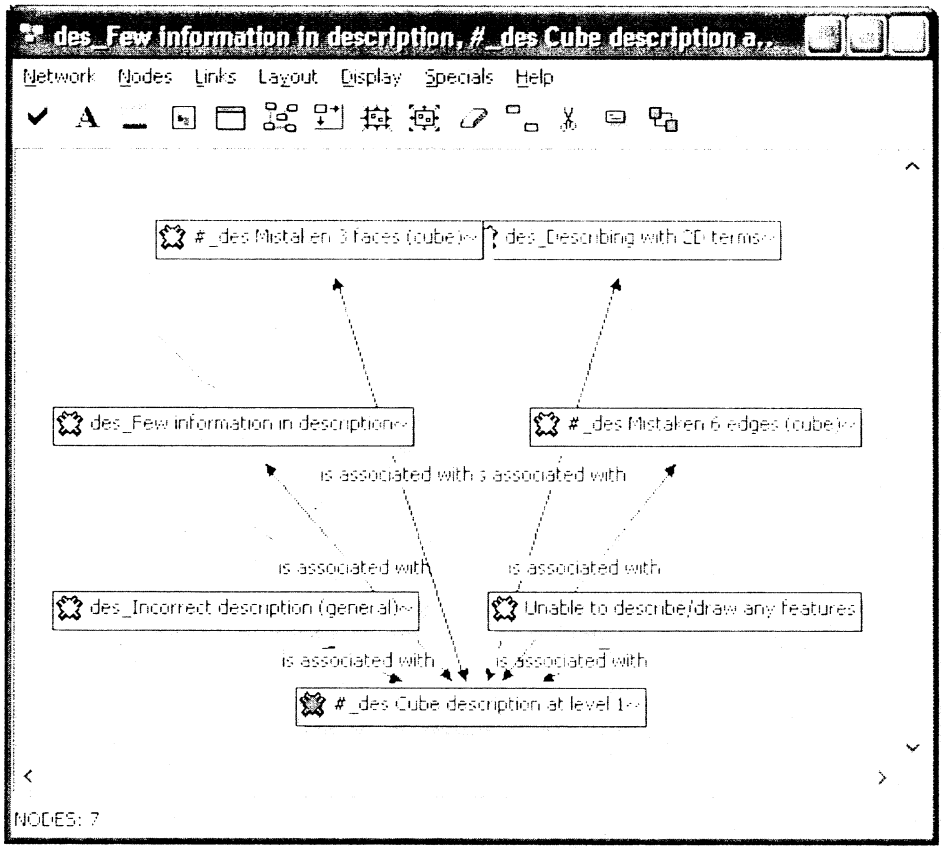


Figure 5.15 The visual view of the linking between codes

As results of the above major tasks that were done on the dataset of the 3D shapes, cube, triangular prisms, pyramids and cylinders, the sections below summarize the outcomes of this interpretative data analysis. The reports below are divided into scenes for cubes from three different schools and the other three 3D shapes. It intends to compare across the three schools on the students' drawings of and descriptions about cubes as well as display within-school analysis. As such, interpretations based on the scene of a 3D shapes could be explainable to other two batches of data as well as other 3D shapes for the purposes of Constant Comparison. The key function of this analytic coding is to test theory that the theory emerging from a 3D shape can explain the phenomenon of anther 3D shape.

The outcomes of this analysis report are achieved based on extracting data from the outputs generated by ATLAS.ti (See the Appendices). The software can enhance the

identification of patterns in the data by analysing the frequencies with which the patterns occur, and even by cross-tabulating different patterns. It can also infer connections between codes by examining how codes combine. Coded segments or quotations are retrieved by combining different codes using logical functions such as "and", "or", "not" in a search for features or patterns that could build up the theory.

5.3 The Data Sources

The data were collected from three schools, namely "Rose", "Siu" and "Wu". Table 5.6, 5.7 and 5.8 show the frequency counts of the descriptions about and drawings of the 3D shapes from the three schools. Notice that data for cube were collected from all the three schools. The data were extracted from the worksheets (class assignments) in which their teachers asked them to draw or sketch with pencils 3D shapes and then to describe these shapes in words (in Chinese). These drawings and descriptions were scanned and saved as pictures files (jpg computer files). These files are called primary documents in ATLAS.ti. The frequency counts are the number of the primary documents.

Table 5.6 Data from "Rose" School

Students	Year 4 (age 9-10)	Year 5 (age 10-11)	Year 6 (age 11-12)	Total
No of drawings of cubes	37	36	36	109
No of descriptions about cubes	37	36	36	109
No of drawings of triangular prisms	37	36	36	109
No of descriptions about triangular prisms	37	36	36	109

Table 5.7 Data from "Siu" School				
Students	Year 4 (age 9-10)	Year 5 (age 10-11)	Year 6 (age 11-12)	Total
No of drawings of cubes	31	24	30	85
No of descriptions about cubes	31	24	30	85
No of drawings of pyramid	31	24	30	85
No of descriptions about pyramid	31	24	30	85

Table 5.8 Data from "Wu" School				
Students	Year 4 (age 9-10)	Year 5 (age 10-11)	Year 6 (age 11-12)	Total
No of drawings of cubes	38	30	35	103
No of descriptions about cubes	38	30	35	103
No of drawings of cylinder	38	30	35	103
No of descriptions about cylinder	38	30	35	103

Coding and data analysis of each batch of data were done separately and then three resulting ATLAS.ti files were merged. The next two chapters report the patterns found for the descriptions about and drawings of the 3D shapes, cubes, triangular prisms and cylinders as well as the identification of the P-U-M-R levels of the SOLO model for each shape within the concrete symbolic mode (see Section 3.2).

CHAPTER 6 THE SCENE OF CUBES

The data presented here are generated by the output functions of ATLAS.ti with the query tool to find out the frequency counts for each of the response patterns. For each response pattern, selected typical case is provided in order to elucidate the meaning of the codes, the patterns found or the distinctions between patterns. In all the results of data analysis, the research questions will be addressed in turn. Vignettes are used for focused descriptions of cases taken to be typical and/or emblematic.

6.1 Description Patterns about Cubes

This study has developed a macro view of spatial abilities in 3D geometry (See Figure 3.4) which consists of IFI- and VP-abilities. IFI-ability involves the reading, understanding and interpreting of the visual representation and spatial vocabulary used in geometric work. Table 6.1 shows the patterns of students' understandings about cubes in terms of IFI-ability. It appears that there is a diversity of responses among the patterns found. #1, #2, #3, #4, #11 and #12 are the correct responses while #5, #6, #7, #8, #9, #10 and #15 are the incorrect responses patterns. 35 out of the 297 students were unable to describe any features of a cube while 20 out of the 297 (see Table 6.3) students were able to describe all the features of a cube. From this point, the descriptions and the understandings of the properties of a cube diverge enormously.

The following salient patterns are identified:

- A closer look at the total frequency shows clearly that a cube is identified by "6 faces" (#2) and/or "squares" (#12). In other words, most of the students in this sample tend to use "6 faces" and/or "squares" to describe cubes;
- Students who can describe in details recognize that there are 12 edges, 6 square faces and 8 vertices in a cube;
- A more perfect description is that they can also associate a cube with shapes we see in our daily living such as boxes, dice, ice cubes and chocolate cube;

- A few who describe incorrectly mention that there are 3 faces, 4 faces, 5 faces or 6 edges;
- A few who probably do not understand the drawing conventions regard square faces of the cube as parallelograms or rectangles;
- It is found that a significant number of students can only use 2D vocabularies or plane-figure names, to describe solid shapes. For instance, they use angles instead of vertices; and
- #16 shows that there are still some students who are lack of the IFI-ability to describe a cube.

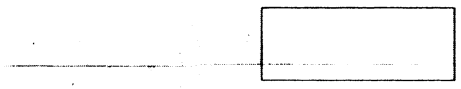
A classification of the IFI-ability and the difficulties in IFI-abilities about cubes can be found in Appendix J and K.

Table 6.1 Frequency of Description Patterns about Cubes Found in Three Samples (schools)	**"Rose"** (N =109)	**"Siu"** (N = 85)	**"Wu"** (N = 103)	**Total (N = 297)**
#1. Describing a cube with 12 edges	23	22	12	**57** (19.2%)
#2. Describing a cube with 6 faces	66	35	20	**121** (41.7%)
#3. Describing a cube with 8 vertices	21	26	11	**58** (19.5%)
#4. Cube is associated with the shapes we encounter in our living such as box, ice cube in the refrigerator, dice, piece of chocolate cube	23	6	4	**33** (11.1%)
#5. Describing a cube with 3 faces (incorrect property)	1	0	1	**2** (0.7%)
#6. Describing a cube with 4 faces (incorrect property)	2	2	0	**4** (1.4%)
#7. Describing a cube with 5 faces (incorrect property)	1	0	0	**1** (0.3%)
#8. Describing a cube with 6 edges (incorrect property)	2	1	0	**3** (1.0%)
#9. The square face of the cube is regarded as parallelogram in the description (incorrect property)	1	1	1	**3** (1.0%)
#10. The square face of the cube is regarded as rectangle in the description (incorrect property)	2	2	4	**8** (2.7%)
#11. Describing a cube as a prism	12	3	2	**17** (5.7%)
#12 Squares mentioned in the description	72	16	15	**103** (34.9%)
#13 In describing 3D shapes, only 2D terminologies are mentioned, e.g. right angle, acute angle, triangle, square, ...	12	7	34	**53** (17.9%)
#14. Describing the cube with few information that one cannot identify what it is	22	22	22	**66** (22.2%)
#15. Describing the cube with incorrect properties other than #5 to #10	8	12	3	**23** (7.7%)
#16. Unable to describe any features of a cube	3	14	18	**35** (11.8%)

Note: there may be more than one response patterns for each description about cube. The sum of the total frequencies is not equal to the number of cases in the sample.

Selected cases for the description patterns:

#1. Describing a cube with 12 edges



[wu6A_0138.jpg]

Translation: This solid has *twelve edges*, six faces and eight "angles". For each face, there are two pairs of parallel and equal opposite sides.

#2. Describing a cube with 6 faces



[rose6D_0020.jpg]

Translation: I draw a shape with *6 faces*. It can be made up by 12 edges and 8 vertices. There are two pairs of parallel lines in each face

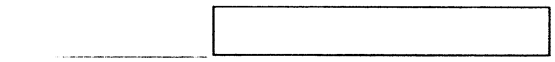
#3. Describing a cube with 8 vertices



[siu6A_0008.jpg]

Translation: This is a solid which looks like a dice. There are twelve edges, *eight vertices* and six faces

#4. Cube is associated with the shapes we encounter in our living such as box. ice cube in the refrigerator. dice. piece of chocolate cube



[rose5A_0038.jpg]

Translation: This is a shape which looks *like a square box*. The upper and lower bases are squares. We need eight pieces of clay and 12 bamboo sticks

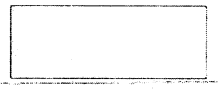
#5. Describing a cube with 3 faces (incorrect property)



[rose4B__0092.jpg
]

Translation: *three faces*. six edges. like a box and one ..

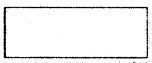
#6. Describing a cube with 4 faces (incorrect property)



[rose4B__0023.jpg]

Translation: This shape has *four faces*. All the faces are square

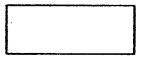
#7. Describing a cube with 5 faces (incorrect property)



[rose4B__0041.jpg]

Translation: This is a solid square with *five faces*.

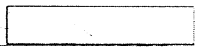
#8. Describing a cube with 6 edges (incorrect property)



[rose4B_0092.jpg]

Translation: There are three faces. six edges. like a box and one…

#9. The square face of the cube is regarded as parallelogram in the description (incorrect property)



[rose4B__0077.jpg]

Translation: At one side. there is a *parallelogram*. The upper and lower parts are square. The shape looks like a paper box but with a prism form

#10. The square face of the cube is regarded as rectangle in the description (incorrect property)



[rose4B__0014.jpg]

Translation: The picture has right angles and is a solid with six faces. Two faces are square and the other four faces are *rectangles*.

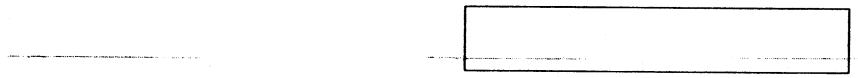
#11. Describing a cube as a prism



[siu6A_0056.jpg]

Translation: The picture has 8 vertices and 12 edges. It is a *prism*

#12. Squares are mentioned in the descriptions



[rose_0023.jpg]

Translation: The shape has 4 faces. *All faces are squares.*

#13 In describing 3D shapes, only 2D terminologies are mentioned, e.g. right angle, acute angle, triangle, square, ...

[rose5A_0053.jpg]

Translation: There are 4 angles in the base. The face also has 4 angles. Its length and with are the same.

#14. Describing the cube with few information that one cannot identify what it is

[rose6D_0047.jpg]

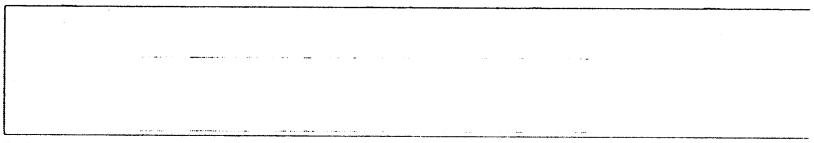
Translation: There are 6 faces. The faces are the same in area.

#15. Describing the cube with incorrect properties other than #5 to #10

[P57: rose4B_0086.jpg]

Translation: The figure is like a box. It is flat and looks like a box far away from you. It has right angles, no obtuse angles and no acute angles.

#16. Unable to describe any features of a cube



[siu4D_0083.jpg]

Translation: I draw a picture. Its opposite sides are parallel and equal.

6.2 Drawing Patterns of Cubes

VP-ability concerns the transformation of abstract properties of geometrical shapes into visual representations. It is an ability of the process that involves the manipulations of students' mental images about the solid shapes. When a student is asked to draw the 2D representation of a 3D shape, a mental image will be generated based on the name or other related information about the shape, he/she will draw according to this mental "observation" (see Section 2.1.2 and Figure 2.2). Table 6.2 and the following selected cases illustrate this mental process effectively. Only 9 out of 297 students were unable to draw the cube while 84 out of 297 students were able to draw the cube. This point shows that the performance of drawing cubes is better than descriptions. Except for patterns #e and #h, all patterns are due to the students' misunderstanding of the mathematical drawing conventions for 3D shapes. It appears that the VP-ability necessary to complete a proper drawing had not yet developed for the majority of students in this sample. Appendix L provides a list of difficulties in VP-abilities found in this study.

Table 6.2 Frequency of Drawing Patterns of Cubes Found in Three Samples (schools)	**"Rose" (N =109)**	**"Siu" (N =85)**	**"Wu" (N = 103)**	**Total (N = 297)**
#a. Hidden lines not in coordination	13	14	20	**47** (15.8%)
#b. Incomplete drawing of hidden	7	6	10	**23** (7.7%)
#c. Non-transparent drawing	43	8	28	**79** (26.6%)
#d. Drawing not in perspective	19	5	10	**34** (11.5%)
#e. Drawing the cube in a good 3D perspective taking all parts of the solid shape together in a	15	13	5	**33** (11.1%)
#f. Drawing with perpendicular	10	8	11	**29** (9.8%)
#g. Some or all seen faces are drawn in a 2D format	4	9	15	**28** (9.4%)
#h. Unable to draw any features	2	3	4	**9** (3.0%)

Note: there may be more than one response patterns for each drawing of cube. The sum of the total frequencies is not equal to the number of cases in the sample.

Selected cases for the drawing patterns:

#a. Hidden lines not in coordination

[wu6A__0093.jpg]

#b. Incomplete drawing of hidden lines

[rose6D_0050.jpg]

#c. Non-transparent drawing

[P13: rose4B_0020.jpg]

#d. Drawing not in perspective view.

[rose5A_0017.jpg]

#e. Drawing the cube in a good 3D perspective taking all parts of the solid shape together in a coordinating manner

[rose5A_0083.jpg]

[siu6A_0068.jpg]

#f. Drawing with perpendicular edges

[wu6A_0089.jpg]

[rose5A_0011.jpg]

#g. Some or all seen faces are drawn in a 2D format

[rose5A_0044.jpg]



[wu4A_00053.jpg]

#h. Unable to draw any features of the cube

[rose5A_0101.jpg]

6.3 Identification of P-U-M-R levels of the SOLO Model for Cubes

The researcher also rates the descriptions and drawings of cubes into the 4 levels of the SOLO model based on the general definitions of the prestructural, unistructural, multistructural and relational levels in Table 3.1.

6.3.1 The P-U-M-R levels of the SOLO Model for Cube Descriptions

Table 6.3 below shows the frequency of description patterns found co-occurring with each of the P-U-M-R levels (See Appendix B and Section 5.2.3). These response patterns show the characteristics of each level in the context of cubes of the present study. In the table, highest frequencies for each response patterns are shaded in order to indicate the characteristics of the responses for each level. The diversity of these patterns and the distinct differences in frequency counts of the patterns in each classification show clearly the existence of the SOLO levels.

Table 6.3 Frequency of Description Patterns of Cubes Rated as at P-U-M-R levels of the SOLO model	**Total (N = 297)**	**P-level (N = 95)**	**U-level (N = 113)**	**M-level (N = 69)**	**R-level (N = 20)**
#1. Describing a cube with 12 edges	**57**	0	14	36	7
#2. Describing a cube with 6 faces	**121**	2	46	57	16
#3. Describing a cube with 8 vertices	**58**	1	16	34	7
#4. Cube is associated with the shapes we encounter in our living such as box, ice cube in the refrigerator, dice, piece of chocolate cube	**33**	2	10	5	16
#5. Describing a cube with 3 faces (incorrect property)	**2**	2	0	0	0
#6. Describing a cube with 4 faces (incorrect property)	**4**	1	3	0	0
#7. Describing a cube with 5 faces (incorrect property)	**1**	0	1	0	0
#8. Describing a cube with 6 edges (incorrect property)	**3**	2	1	0	0
#9. The square face of the cube is regarded as parallelogram in the description (incorrect property)	**3**	1	2	0	0
#10. The square face of the cube is regarded as rectangle in the description (incorrect property)	**8**	1	6	0	0
#11. Describing a cube as a prism	**17**	1	5	8	3
#12 Squares mentioned in the description	**103**	3	41	44	15
#13 In describing 3D shapes, only 2D terminologies are mentioned, e.g. right angle, acute angle, triangle, square, ...	**53**	24	25	2	0
#14. Describing the cube with few information that one cannot identify what it is	**66**	30	24	4	0
#15. Describing the cube with incorrect properties other than #5 to #10	**23**	9	11	1	0
#16. Unable to describe any features of a cube	**35**	35	0	0	0

Note: There may be more than one response patterns for each descriptions of cube. The sum of the total frequencies is not equal to the number of cases in the sample.

The following responses are identified for each of the P-U-M-R levels:

Prestructural: Students in this level are unable to describe any features of a cube. They describe the cube with incorrect properties. Most significantly, a large number of cases describe the cube with information that one cannot identify what it is. Selected cases #14 and #16 in Section 6.1 are examples in this level.

Unistructural: In this level, students can describe the cube with only one correct property and sometimes make incorrect descriptions. Square is the most often mentioned property. It also appears that students tend to describe the cube using 2D mathematical terms such as right angle, acute angle, triangle and square. In other words, some of the responses were related to a 2D rather than a 3D description. Selected case #12 in Section 6.1 is an example in this level.

Multistructural: Students list more than one property of cube such as 12 edges, 6 faces and 8 vertices. Selected case #1 is an example

Relational: In addition to list more than one property of cube, students in this level can describe a cube in a global feature associating a cube with shapes we see in our living such as box, ice cube and dice.

Note that patterns #2 and #12 appear across three levels, showing that there might not be a clear-cut classification among the SOLO levels in terms of the patterns found in this study.

6.3.2 The P-U-M-R levels of the SOLO Model for Cube Drawings

Table 6.4 below shows the frequency of drawing patterns found co-occurring with each of P-U-M-R levels (See Appendix C and Section 5.2.3). The existence for the levels of SOLO model for cube drawings is apparent and the classification for each level is clear-cut in this sample.

Responses are identified for each of the P-U-M-R level:

Table 6.4 Frequency of Drawing Patterns of Cubes Rated as at P-U-M-R levels of the SOLO model	**Total (N = 297)**	**P-level (N = 17)**	**U-level (N = 63)**	**M-level (N = 133)**	**R-level (N = 84)**
#a. Hidden lines not in coordination	**47**	0	15	32	0
#b. Incomplete drawing of hidden lines	**23**	0	1	22	0
#c. Non-transparent drawing	**79**	0	21	58	0
#d. Drawing not in perspective view	**34**	0	14	20	0
#e. Drawing the cube in a good 3D perspective taking all parts of the solid shape together in a coordinating manner	**33**	0	0	0	33
#f. Drawing with perpendicular edges	**29**	0	18	11	0
#g. Some or all seen faces are drawn in a 2D format	**28**	9	19	0	0
#h. Unable to draw any features	**9**	9	0	0	0

Note: There may be more than one response patterns for each drawing of cube. The sum of the total frequencies is not equal to the number of cases in the sample.

Prestructural: Students in this level are unable to draw any features of a cube. Selected case #h in Section 6.2 is an example.

Unistructural: Overall students in this level found difficulty in visualising 3D shapes with an accurate awareness of their 2D representation. They knew the edges of a cube are perpendicular to each other and maintain the drawings in a 2D way. Some could only draw part of the faces of the cube in a 2D format. In other words, they could not draw the 3D aspects of a cube. Selected case #f in Section 6.2 is an example in this level.

Multistructural: Students in this level have the visualization ability in drawing the cube but they lack of the ability to coordinate the drawing of all the edges, the skeleton, of the cube or the ability to coordinate the drawing of all the perpendicular faces in a perspective view. Selected cases #a, #b, #c and #d are examples in this level.

Relational: Students are able to drawing the cube in a good 3D perspective taking all parts of the cube together in a coordinate manner. Selected case #e is an example in this level.

6.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model

Table 6.5 Descriptions about Cubes across Different Years of Students

Levels of the SOLO model	Year 4 (N = 106)	Year 5 (N = 90)	Year 6 (N = 101)	Total (N = 297)
Prestructural	32 (30.2%)	34 (37.8%)	20 (19.8%)	95 (32.0%)
Unistructural	40 (37.7%)	32 (35.6%)	39 (38.6%)	113 (38.0%)
Multistructural	15 (14.2%)	18 (20%)	33 (32.7%)	69 (23.2%)
Relational	5 (4.7%)	6 (6.7%)	9 (8.9%)	20 (6.7%)

SOLO model is concerned with the cognitive development of students on a theoretical basis from analysing and interpreting student responses. It is used to evaluate the learning quality of students. The P-U-M-R levels measure an increasing

sophistication in handling certain learning tasks (see Section 3.2).

A closer examination of the percentages in tables 6.5 and 6.6 shows that the four levels do measure the qualitative nature of students' learning outcomes of the properties and visualization ability of cube. For both descriptions and drawings outcomes, the percentages in Multistructural and Relational levels increases across Year 4, 5 and 6 while the percentages in Prestructural level and Unistructural levels decrease across Year 4, 5 and 6. Improved performance with ages reveals that the feature of each of P-U-M-R levels identified in Table 6.7 and Table 6.8 in this study shows the developmental progression in learning 3D geometrical shapes.

Table 6.6 Drawings of Cubes across Different Years of Students

Levels of the SOLO model	Year 4 (N = 106)	Year 5 (N = 90)	Year 6 (N = 101)	Total (N = 297)
Prestructural	9 (10%)	5 (5.6%)	3 (3.0%)	17 (5.7%)
Unistructural	38 (42.2%)	13 (14.4%)	12 (11.9%)	63 (21.2%)
Multistructural	49 (54.4%)	53 (58.9%)	31 (30.7%)	133 (44.8%)
Relational	10 (11.1%)	19 (21.1%)	55 (54.5%)	84 (28.3%)

6.4 Vignettes in Responses about the Descriptions about and Drawing of Cubes

6.4.1 The Influence of the Drawing on Students' Spatial Conceptions

[rose5A_0023.jpg]

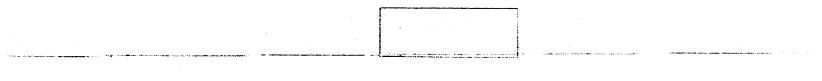


[rose5A_0023.jpg]

Translation: This is made up by nine wooden sticks. The faces are squares. The bottom is square. It has six faces. It is constructed by seven pieces of clay to form that solid shape.

Figure 6.1 The description influenced by the drawing

The drawing of this non-transparent cube and the description in Figure 6.1 were done by the same student. The student counted 9 edges and 7 vertices based on his/her drawings. The student was so impressed by this kind of stereotyped drawing of cube in his/her mathematics text books that his/her mental image was constrained by the illustration or drawing presented to him/her and regarded the representative drawing on the paper was the actual object.



[rose4B_0014.jpg]

Translation: There is a right angle in this picture. It is solid and has 6 faces. Two faces are squares. Other four faces are *rectangle*.

Figure 6.2 Description influenced by the drawing

Figure 6.2 is another example that the student actually did not understand that all the faces of a cube are squares. His/her description was influenced by the drawing.

6.4.2 Lack of Coordination of the Edges and Faces of Cube

[rose4B_0059.jpg]

Figure 6.3 Lack of coordination of the edges and faces

The student wanted to show that the vertical edges of a cube should be perpendicular to the horizon and the top should be a square. On the other hand, he/she learned that a cube is a stable object and all vertical edges should be perpendicular to the horizon. This case shows that some students were unable to coordinate the top, front and side views of a cube from different angles (viewing the same object from different positions) and to construct a mental image of a cube in a coordinating manner. This coordination and integration construct is similar to what Piaget and Inhelder (1967, p211) described in their three-mountain task. The research holds that the students only drew what they have seen and grouped everything together in one picture without adopting any drawing conventions from 3D geometry.

6.4.3 The Use of 2D Mathematical Terms in Description

[rose4B_0074.jpg]

Translation: Please guess what the shape is. It has four right angles, four lines of equal length and all lines are parallel.

Figure 6.4 The use of 2D mathematical terms

Figure 6.4 indicates that the student was unable to describe the cube with correct 3D mathematical terms. It seems that he/she cannot recognize the 3D terms for solid shapes such as edges, vertices and perpendicular faces.

6.4.4 Descriptions Reflecting How a Cube is Formed

[rose5A_0083.jpg]

[rose5A_0038.jpg]

Translation: The external shape of the body is like a square box. Its upper and lower parts are squares. We need eight pieces of clay and 12 bamboo sticks to make up the cube.

Figure 6.5 Descriptions reflecting how a cube is formed

The descriptions in Figure 6.5 reflect a class activity when the student learned the

properties of a cube. Teachers usually ask students to form the structure of a cube with 8 pieces of clay and 12 bamboo sticks to reinforce the properties of a cube.

6.5 Summary

By now, this chapter has provided the answers of the two research questions and an emerging theory about the levels of the SOLO models:

1. Research question (1): There are diversity and variety of response patterns found in upper primary students' description about cubes while there are less variety of response patterns found in drawings of cubes;
2. Research question (2): There exit P-U-M-R levels of the SOLO model in the case of the upper primary students' drawing representations of and descriptions about cubes. The classification of the P-U-M-R levels for cube drawings is more apparent than cube descriptions in this study;
3. An emerging theory of P-U-M-R levels of the SOLO model appears to be:

Table 6.7 Students' Response Patterns of 3D Geometrical Shapes

SOLO Levels	**VP-ability:** about drawing	**IFI-ability:** about describing
Prestructural	Unable to draw any features of the solid shape	Unable to describe any features of the solid shape
Unistructural	The drawing almost like a 2D figure and no ideas about the 3D drawing conventions	Describing the solid shape with 2D mathematical terms and having incorrect descriptions
Multi-structural	Lack of the ability to coordinate the drawing of all the edges and faces in a perspective view	Listing more than one property of the solid shape with 3D mathematical terms
Relational	Drawing the solid shape as a good 3D perspective taking all parts of the shape together in a coordinating manner	In addition to list more than one property of the solid shape, students can describe the shape in a global feature associating the solid with shapes in real world

Table 6.7 consists of generic statements the SOLO levels which are based on the conclusions in Section 6.3.1 and 6.3.2. Table 6.8 provides cases for illustrations of such statements.

Table 6.8 Selected Cases: Students' Response Patterns of 3D Geometrical Shapes

SOLO Levels	**VP-ability:** about drawing	**IFI-ability:** about describing
Prestructural		I draw a picture. Its opposite sides are parallel and equal.
Unistructural		The shape has 4 faces. All faces are squares.
Multi-structural		This solid has twelve edges, six faces and eight "angles". For each face, there are two pairs of parallel and equal opposite sides.
Relational		This is a shape which looks like a square box. The upper and lower bases are squares. We need eight pieces of clay and 12 bamboo sticks

4. Comparisons of frequencies across different years of students of the levels of P-U-M-R show that the nature of the cognitive development of the levels as

students of higher years performed better than those of lower years;

5. Some students regarded vertices (3D geometry) as the angles (in 2D geometry) in describing cubes;

6. The performance in drawing was better than descriptions;

7. The researcher could not find any cases that a student describes the squares are perpendicular to each other in the cube. Students might not be taught about how planes can be perpendicular to other planes in 3D geometry;

8. Some students unconsciously tended to transfer the geometrical properties of the shape represented to the graphical representation. Thus students made incorrect descriptions based on that 2D representation (Section 6.4.1);

9. Some students confused the perspective drawing with the properties of the cube and failed to coordinate the views of the perpendicular edges and faces (Section 6.4.2);

10. The use of 2D mathematics terms in students' descriptions about cube might indicate a lack of discrimination between 2D and 3D (Section 6.4.3); and

11. Hands-on activities to let students construct the cube using materials such as bamboo sticks and pieces of clay provided a very impressive way that students tended to describe how and what a cube was made up of (Section 6.4.4).

CHAPTER 7 THE SCENES OF TRIANGULAR PRISMS, PYRAMIDS AND CYLINDERS

Analysis work in the last chapter established the levels of P-U-M-R in SOLO model in the case of cube descriptions and drawings. This chapter repeats the same procedures and reports the results of data analysis about the other three solid shapes collected from the three schools. Response patterns in both descriptions and drawings are explored and rated based on the general definitions of the P-U-M-R levels in Table 3.1. The results are to compare with those of cube in order to ascertain the levels of P-U-M-R in SOLO model for 3D geometrical shapes.

7.1 The Scene of Triangular Prism

The data below are only drawn from one of the sample school, "rose", as only these data about triangular prism were collected from that school.

7.1.1 Description Patterns about Triangular Prisms

Table 7.1 and the selected cases below show a diversity of response patterns. Overall, students performed better than describing cubes (see Table 6.1). Frequencies of incorrect description responses, ^1, ^6, ^7, ^8 and ^14 are less than those of cubes. Only 3 out of 109 are unable to describe any features of a triangular prism.

The following salient patterns are identified:

- Most frequent responses (shaded) are ^11, ^2 and ^9, that is, students usually mentioned that there are triangles and it is a prism with 5 faces when describing triangular prisms:
- Students who can describe in details states that it is a prism, there are 6 vertices, 9 edges, two faces are triangles and 3 faces are rectangles;
- A more perfect description is that they can also associate a triangular prism with chocolate bar;
- Very few who do not know triangular prism regard the rectangles as

trapezium or parallelogram:

- Like the case in cube, a few students use plane-figure names to describe a triangular prism; and
- There are still a few students who lack of IFI-ability to describe a triangular prism.

Table 7.1 Frequency of Description Patterns about Triangular Prisms Found in the "rose" School	**N = 109**
^1. Describing a triangular prism as a tetrahedron (incorrect property)	**2 (1.8%)**
^2. Describing a triangular prism with 5 faces	**49 (44.9%)**
^3. Describing a triangular prism with 6 vertices	**25 (22.9%)**
^4. Describing a triangular prism with 9 edges	**27 (24.8%)**
^5. Triangular prism is associated with chocolate bar (Toblerone)	**23 (21.1%)**
^6. Describing a triangular prism with 4 faces (incorrect property)	**1 (0.9%)**
^7. The rectangles in the triangular prism are mistaken as parallelograms in description	**8 (7.3%)**
^8. The rectangles in the triangular prism are mistaken as trapeziums in description	**4 (3.7%)**
^9. Prisms are mentioned in the descriptions	**44 (40.4%)**
^10. Rectangles are mentioned in the descriptions	**39 (35.8%)**
^11. Triangles are mentioned in the description	**70 (64.2%)**
^12. Describing the triangular prism only with 2D mathematical terms	**14 (12.8%)**
^13. Describing the triangular prism with few information that one cannot identify	**17 (15.6%)**
^14. Describing a triangular prism with other incorrect properties (excluding the cases #1, #6, #7 and #8 above)	**7 (6.4%)**
^15. Unable to describe any features of the triangular prism	**3 (2.8%)**

Note: there may be more than one response patterns for each description about triangular prism. The sum of the total frequencies is not equal to the number of cases in the sample.

Selected cases for the description patterns:

^1. Describing a triangular prism as a tetrahedron (incorrect property)



[rose4B_0057.jpg]

Translation: *There are three triangles in the front. There is an isosceles triangle. Other two are scalene triangles.* It is like a triangular chocolate

^2. Describing the triangular prism with 5 faces



[rose_0003.jpg]

Translation: This body is a triangle. There are *5 faces*, 6 vertices and 8 edges. It is like a chocolate bar.

^3. Describing a triangular prism with 6 vertices



[rose6D_0108.jpg

Translation: It has 5 faces, *6 vertices*, 9 edges but only six pairs of parallel lines

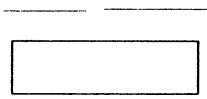
^4. Describing a triangular prism with 9 edges



[rose5A_0072.jpg]

Translation: I have drawn a figure with 5 faces. Its faces are triangles or rectangles. There are six vertices and *nine edges*.

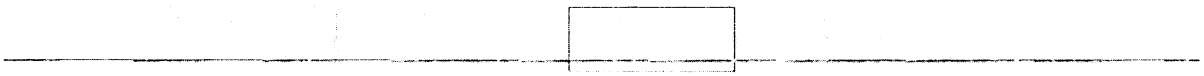
^5. Triangular prism is associated with chocolate bar (Toblerone)



[rose4B__0018.jpg]

Translation: The shape has two triangles. The base and face are transparent. It is a prism like a *triangular chocolate bar*.

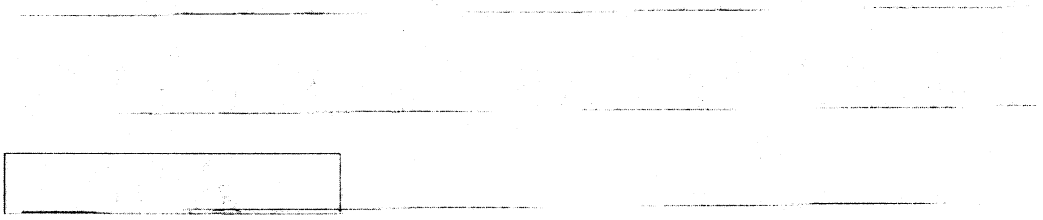
^6. Describing a triangular prism with 4 faces (incorrect property)



Primary document: P16: rose4B__0024.jpg - 16:6

Translation: This shape is a prism with *four faces*, two of which are triangles

^7. The rectangles in the triangular prism are mistaken as parallelograms in description



[rose4B__0015.jpg]

Translation: There is no right angle in this shape but only acute and obtuse angles. It is a solid with 5 faces two of which are triangles. The other three faces are *parallelogram*

^8. The rectangles in the triangular prism are mistaken as trapeziums in description



[rose4B__0006.jpg]

Translation: There are 5 faces. Two of them are triangles. Two of them are rectangles. One of them is a *trapezium*. It is transparent prism

^9. Prisms are mentioned in the descriptions



[P106: rose_0048.jpg]

Translation: The shape that I draw is a *prism*. The base and the face are triangles. Its two sides are rectangles

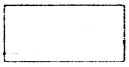
^10. Rectangles are mentioned in the descriptions



[rose6D_0033.jpg]

Translation: The shape I am now making uses five faces, two triangles and *three rectangles*. If you view from the front, there are two parallel lines.

^11. Triangles are mentioned in the description



[rose5A_0084.jpg]

Translation: It is a solid shape made by *triangles* and rectangles. It has 6 vertices, 9 edges and 5 faces.

^12. Describing the triangular prism only with 2D mathematical terms

[rose6D_0087.jpg]

Translation: *There are five faces and eight edges. Two edges are perpendicular. Five faces are the same. There are no right angles. Two faces are smaller while other faces are larger. The length of each edge is different*

^13. Describing the triangular prism with few information that one cannot identify

[rose4B__0009.jpg]

Translation: *This is a triangle and also a prism but no right angles*

^14. Describing a triangular prism with other incorrect properties (excluding the cases #1, #6, #7 and #8 above)

[rose4B__0066.jpg]

Translation: *There are 6 acute angles, 16 right angles*

^15. Unable to describe any features of the triangular prism

[rose5A_0093.jpg]

Translation: *It is a triangular body, transparent with length equal to human index finger*

7.1.2 Description Patterns about Triangular Prisms

The response patterns in Table 7.2 are strikingly similar to those of cube (Table 6.2) except for ^a. Only 5 (^a and ^h) out of 109 could not draw a triangular prism while 47 of 109 were able to draw. Overall, students performed better in drawing triangular prisms than cubes. 3 cases drew tetrahedron instead of triangular prism. This might due to the mix-up of ideas that both solid shapes have triangles.

No matter it is a drawing task or a description task and no matter whether the shape is cube or triangular prism, a significant number of students tends to use 2D mathematics terms or plane-figure names to describe and to draw part of the faces in a 2D format or the faces not in integrated manner (see selected case #h in Section 6.2 and ^g below).

Table 7.2 Frequency of Drawing Patterns of Triangular Prisms Found in "rose" School	**N = 109**
^a. Drawing a tetrahedron as a triangular prism	**3 (2.8%)**
^b. Hidden lines not in coordination	**5 (4.6%)**
^c. Incomplete drawing of hidden lines	**15 (13.8%)**
^d. Drawing a non-transparent triangular prism.	**16 (14.7%)**
^e. Drawing not in perspective view.	**17 (15.6%)**
^f. Drawing the triangular prism in a good 3D perspective taking all parts of the solid shape together in a coordinating manner	**16 (14.7%)**
^g. Some or all seen faces are drawn in a 2D format	**7 (6.4%)**
^h. Unable to draw any features of the triangular prisms	**2 (1.8%)**

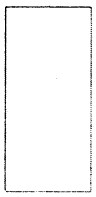
Note: there may be more than one response patterns for each drawing of triangular prisms. The sum of the total frequencies is not equal to the number of cases in the sample.

Selected cases for the drawing patterns:

^a. Drawing a tetrahedron as a triangular prism

[rose4B__0057.jpg]

^b. Hidden lines not in coordination



[rose5A_0048.jpg]

^c. Incomplete drawing of hidden lines



[rose5A_0024.jpg]

^d. Drawing a non-transparent triangular prism.

[rose4B__0003.jpg]

^e. Drawing not in perspective view.

[rose4B__0027.jpg]

^f. Drawing the triangular prism in a good 3D perspective taking all parts of the solid shape together in a coordinating manner

[rose5A_0042.jpg]

^g. Some or all seen faces are drawn in a 2D format

[rose4B__0078.jpg]

^h Unable to draw any features of the triangular prisms

[rose4B_0069.jpg]

7.1.3 Identification of the P-U-M-R levels of the SOLO Model for Triangular Prisms

Applying the same procedure as those used in cube, the researcher reports here the rating of the P-U-M-R levels for triangular prisms, making a comparison analysis and searching for similarity in response patterns against those of cubes in Section 6.3.

7.1.3.1 The P-U-M-R levels of the SOLO Model for Descriptions about Triangular Prism

Table 7.3 below shows the frequency of description patterns found co-occurring with each of the P-U-M-R levels (See Appendix D and Section 5.2.3). In Table 7.3, highest frequencies for each response patterns are shaded in to indicate the characteristics of the responses for each level. The four levels become evident and are identified:

Prestructural: Students in this level were unable to describe a triangular prism and a few might depict it as if it is a tetrahedron. Selected case ^15 in 7.1.1 in an example of this level:

Unistructural: Students in this level most often mentioned prisms as a major keyword in their description and tend to make incorrect descriptions. Some depicted the shape with little information that one cannot recognize what it is. Some described it using only plane-figure mathematical terms. Selected case ^12 and ^13 are examples:

Multistructural: Students described a triangular prism with 5 faces, 6 vertices, 9 edges, two triangles and three rectangles. Selected case ^10 is an example; and

Relational: In addition to multistructural level, students can associate triangular prism with shapes in our daily live such as chocolate bar. Selected case ^5 is an example.

Due to smaller sample size in this batch, the levels are not as apparent as those of cubes based on the frequency counts for the response patterns.

Table 7.3 Frequency of Description Patterns of Triangular Prisms Rated as at P-U-M-R levels of the SOLO model	**Total (N = 109)**	**P-level (N = 9)**	**U-level (N = 42)**	**M-level (N =41)**	**R-level (N = 17)**
^1. Describing a triangular prism as a tetrahedron (incorrect property)	**2**	2	0	0	0
^2. Describing a triangular prism with 5 faces	**49**	1	15	23	10
^3. Describing a triangular prism with 6 vertices	**25**	0	5	16	4
^4. Describing a triangular prism with 9 edges	**27**	0	6	15	6
^5. Triangular prism is associated with chocolate bar (Toblerone)	**23**	2	7	2	11
^6. Describing a triangular prism with 4 faces (incorrect property)	**1**	0	1	0	0
^7. The rectangles in the triangular prism are mistaken as parallelograms in	**8**	0	7	1	0
^8. The rectangles in the triangular prism are mistaken as trapeziums in	**4**	0	4	0	0
^9. Prisms are mentioned in the descriptions	**44**	0	22	14	11
^10. Rectangles are mentioned in the descriptions	**39**	0	4	26	9
^11. Triangles are mentioned in the description	**70**	0	22	34	13
^12. Describing the triangular prism only with 2D mathematical terms	**14**	2	10	2	0
^13. Describing the triangular prism with few information that one cannot identify	**17**	1	13	3	0
^14. Describing a triangular prism with other incorrect properties (excluding the cases #1, #6, #7 and #8 above)	**16**	4	10	2	0
^15. Unable to describe any features of the triangular prism	**3**	3	0	0	0

Note: there may be more than one response patterns for each description about triangular prism. The sum of the total frequencies is not equal to the number of cases in the sample.

Table 7.4 Frequency of Drawing Patterns of Triangular Prisms Rated as at P-U-M-R levels of the SOLO model	**Total (N = 109)**	**P-level (N = 17)**	**U-level (N = 63)**	**M-level (N = 133)**	**R-level (N = 84)**
^a. Drawing a tetrahedron as a triangular prism	**3**	3	0	0	0
^b. Hidden lines not in coordination	**6**	0	2	4	0
^c. Incomplete drawing of hidden lines	**15**	0	1	14	0
^d. Drawing a non-transparent triangular prism.	**16**	0	4	12	0
^e. Drawing not in perspective view.	**17**	0	5	12	0
^f. Drawing the triangular prism in a good 3D perspective taking all parts of the solid shape together in a	**16**	0	0	0	16
^g. Some or all seen faces are drawn in a 2D format	**7**	1	2	4	0
^h. Unable to draw any features of the triangular prisms	**2**	2	0	0	0

Note: There may be more than one response patterns for each drawing about triangular prism. The sum of the total frequencies is not equal to the number of cases in the sample.

7.1.3.2 The P-U-M-R Levels of the SOLO Model for Drawings of Triangular Prism

Table 7.4 above shows the frequency of drawing patterns found co-occuring with each of the P-U-M-R levels (See Appendix E and Section 5.2.3). The highest frequency for each drawing patterns of triangular prism in Table 7.4 is shaded to highlight the characteristic for each of the P-U-M-R levels. The characteristic for the Unistructural level is not clear as that for cube drawings (Table 6.4). It might be due to less number of cases in this sample. However, the other three levels are apparent.

Prestructural: Students in this level were unable to draw any features of a triangular prism. The worst is that they drew a tetrahedron as a triangular prism. Selected case ^h in Section 7.1.2 is an example.

Multistructural: Students in this level had the visualization ability in drawing the triangular prism but they lack of the ability to coordinate the drawing of all the edges and faces of the triangular prism. Selected cases ^b, ^c, ^d and ^e are examples in this level.

Relational: Students are able to draw the triangular prisms in a good 3D perspective taking all parts of the shape together in a coordinate manner.

7.1.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model

Table 7.5 and Table 7.6 show students' ability to describe and draw triangular prisms improved across grade levels. Except for the multistructural level at primary 4 in Table 7.6, this again validates that there exists the developmental growth nature of the present classification of P-U-M-R levels for students' description about and drawings of triangular prisms.

Table 7.5 Descriptions about Triangular Prisms across Different Grades of Students				
Levels of the SOLO model	Primary 4 (N=37)	Primary 5 (N=36)	Primary 6 (N=36)	Total (N = 109)
Prestructural	4 (10.8%)	4 (11.1%)	1 (2.8%)	9 (8.3%)
Unistructural	20 (54.1%)	11 (30.6%)	11 (30.6%)	42 (38.5%)
Multistructural	10 (27.0%)	16 (44.4%)	15 (41.7%)	41 (37.6%)
Relational	3 (8.1%)	5 (13.9%)	9 (25.0%)	17 (15.6%)

Table 7.6 Drawings of Triangular Prisms across Different Grades of Students				
Levels of the SOLO model	Primary 4 (N=37)	Primary 5 (N=36)	Primary 6 (N=36)	Total (N = 109)
Prestructural	5 (13.5%)	1 (2.8%)	1 (2.8%)	7 (6.4%)
Unistructural	6 (16.2%)	5 (13.9%)	1 (2.8%)	12 (11.0%)
Multistructural	21 (56.8%)	10 (27.8%)	12 (33.3%)	43 (39.5%)
Relational	5 (13.5%)	20 (55.6%)	22 (61.1%)	47 (43.1%)

7.1.4 Vignettes in Responses about the Descriptions about and Drawing of Triangular Prisms

7.1.4.1 Descriptions Based on the Meaning of the Name



[rose4B_0003.jpg]

Translation: This shape is long. At the left and the right, there are *triangles* and it is a *prism*

Figure 7.1 Triangles and prisms for triangular prism

Figure 7.1 is a typical example that a student describes the triangular prism. In this sample, 64.2% mentioned there were triangles and 40.4% mentioned there were prisms. This reveals that most students describe the shape based on the meanings of the words of the names of the shape. In Chinese, the name are composited by "triangle" plus "prism".

7.1.4.2 Association with Chocolate Bar in Descriptions



[rose4B__0018.jpg]

Translation: The shape has two triangles. The base and face are transparent. It is a prism like a *triangular chocolate bar*.

Figure 7.2 Associations with chocolate bar

Describing a shape, students like to associate with real objects in the world. In this sample, most students consistently mentioned the triangular chocolate bar (Toblerone) in the supermarkets. This might be the only object that has the shape of triangular prism in our daily live.

7.1.4.3 The Use of 2D Mathematical Terms in Description and Drawing in 2D Scenario



[rose4B__0078.jpg]

Translation: The upper is a triangle. The lower is a rectangle

Figure 7.3 Description and drawing in 2D scenario

Both the drawing and description were done by the same Primary 4 student. The drawing is combination of a triangle and a rectangle. The description uses only plane-figure terms. One possible explanation of this incorrect description and drawing is that learning 2D figures in textbooks during the early primary grades may cause such difficulties in learning 3D shapes.

7.2 The Scene of Pyramids

The data below are only drawn from one of the sample school, "siu", as only these data about pyramids were collected from that school.

7.2.1 Description Patterns about Pyramids

Table 7.7 shows wider variety of response patterns than those of cubes, triangular prisms and cylinders. The performance in describing pyramids is fairly close to describing cube when comparing the frequencies about the correct and incorrect response patterns in Table 7.7 and Table 6.1.

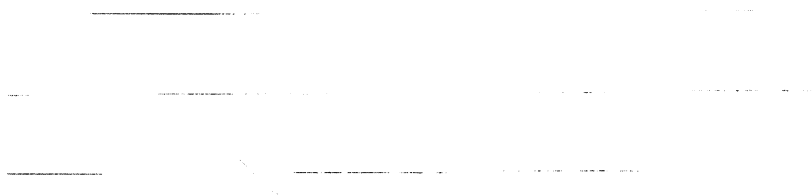
The following salient patterns are identified:

- Based on the more frequent patterns found (&1, &2, &3, &4 and &16) in this sample, students usually mentioned that there are 5 faces, 5 vertices, 8 edges, a square as base and 4 triangles around in depicting pyramids;
- A more perfect description also mentioned that pyramids look like those shapes in real world such as funnels and the roof of the clock tower;
- Some described that pyramids can be seen in Egypt;
- A significant number of students regarded tetrahedrons as pyramids;
- The response pattern of using plane-figure names to describe a pyramid is replicated;
- There are still a few students who cannot describe a pyramid.

Table 7.7 Frequency of Description Patterns about Pyramid Found in the "siu" School	**N = 85**
&1. Describing a pyramid with 4 triangles around	**16 (18.82%)**
&2. Describing a pyramid with 5 faces	**16 (18.82%)**
&3. Describing a pyramid with 5 vertices	**16 (18.82%)**
&4. Describing a pyramid with 8 edges	**18 (21.18%)**
&5. Describing pyramids are found in Egypt	**8 (9.41%)**
&6. Pyramids are associated with real life objects like funnels and others	**3 (3.53%)**
&7. Describing pyramids with 4 faces (incorrect property)	**1 (1.2%)**
&8. Describing pyramids with 4 vertices (incorrect property)	**2 (2.4%)**
&9. Describing pyramids with 7 edges (incorrect property)	**1 (1.2%)**
&10. Describing pyramids with 9 edges (incorrect property)	**1 (1.2%)**
&11. Describing a pyramid as a cone (incorrect property)	**1 (1.2%)**
&12. Describing a pyramid as a tetrahedron (incorrect property)	**6 (7.1%)**
&13. The square base of the pyramid is mistaken as parallelogram	**2 (2.4%)**
&14. The square base of the pyramid is mistaken as rectangle	**1 (1.2%)**
&15. Pyramids are associated with the roof of clock tower	**1 (1.2%)**
&16. Square base are mentioned	**15 (17.7%)**
&17. Describing the pyramid only with 2D mathematical terms	**3 (3.53%)**
&18. Describing the pyramid with few information that one cannot identify	**8 (9.4%)**
&19. Describing a pyramid with other incorrect properties (excluding the cases &7.&8. &9. &10. &11. &12. &13 and &14)	**6 (7.1%)**
&20. Unable to describe any features of the pyramid	**15 (17.6%)**

Selected cases for the description patterns:

&1. Describing a pyramid with 4 triangles around



[siu4D_0072.jpg]

Translation: This shape has 5 angles, 8 edges, 5 faces of which *4 are triangles* and one is square. Also, it looks like a cone.

&2. Describing a pyramid with 5 faces



[siu6A_0039.jpg]

Translation: This object is a solid. There are *five faces*, 1 vertex and 8 edges. It has a shape point at the top.

&3. Describing a pyramid with 5 vertices



[siu5B_0039.jpg]

Translation: It is transparent and has angles. There are *five angles*, eight edges, five faces. It looks like a pyramid.

&4. Describing a pyramid with 8 edges



[siu6A_0090.jpg]

Translation: This shape has 5 faces: 4 triangle, one base, *8 edges* and 3 vertices.

&5. Describing pyramids are found in Egypt



[siu6A_0024.jpg]

Translation: It has a shape point. It has five vertices. It has eight edges. *It can be seen in Egypt.*

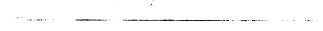
&6. Pyramids are associated with real life objects like funnels and others



[siu5B_0036.jpg]

Translation: I am drawing an object. It is transparent. It is also one kind of shapes. It has five faces and *looks like funnel*. Could you guess what it is?

&7. Describing pyramids with 4 faces (incorrect property)



[siu4D_0021.jpg]

Translation: It has twelve acute angles, *four faces* and a sharp point.

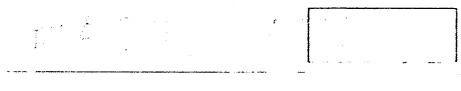
&8. Describing pyramids with 4 vertices (incorrect property)



[siu6A_0039.jpg]

Translation: This object is a solid. There are five faces, *4 vertices* and 8 edges. It has a shape point at the top.

&9. Describing pyramids with 7 edges (incorrect property)


[siu5B_0009.jpg]

Translation: It has 5 angles and 7 *edges.*

&10. Describing pyramids with 9 edges (incorrect property)


[siu5B_0042.jpg]

Translation: I am drawing a transparent object. It has a sharp end at the top. It has five faces. Its base is a square. The other four faces are congruent triangles. It has *nine edges.* It looks like a covered loud speaker.

&11. Describing a pyramid as a cone (incorrect property)


[siu5B_0021.jpg]

Translation: Can you guess what it is? It has a very sharp top. Its base is circular. It is very high. It looks like a cup of ice cream. *It is a cone.*

&12. Describing a pyramid as a tetrahedron (incorrect property)

[siu6A_0066.jpg]

Translation: *It is a cone with four vertices, six edges and four faces.*

&13. The square base of the pyramid is mistaken as parallelogram



[siu6A_0078.jpg]

Translation: This cone has 4 triangles of equal size, one *parallelogram*. Do you know what it is?

&14. The square base of the pyramid is mistaken as rectangle



[siu6A_0081.jpg]

Translation: I am drawing a solid with eight edges, four triangles and *a rectangle*. Guess what it is.

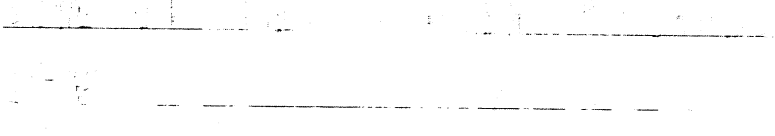
&15. Pyramids are associated with the roof of clock tower



[siu5B_0015.jpg]

Translation: I am drawing a shape with a square in the lower part. There are four triangles in upper part like the roof of a clock tower.

&16. Square base are mentioned



[siu4D_0009.jpg]

Translation: The head is very sharp. The bottom is a square. It is a cone like a pyramid.

&17. Describing the pyramid only with 2D mathematical terms



[siu4D_0021.jpg]

Translation: It has twelve acute angles. four faces and a sharp point.

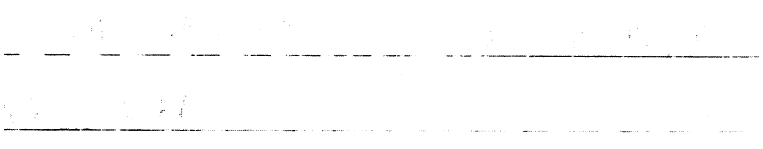
&18. Describing the pyramid with few information that one cannot identify



[siu4D_0051.jpg]

Translation: I draw a shape with a very sharp top. Guess what it is.

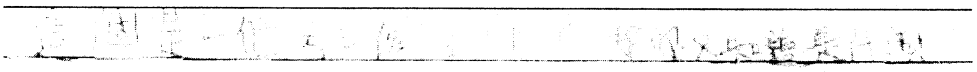
&19. Describing a pyramid with other incorrect properties (excluding the cases &7,&8, &9, &10, &11, &12, &13 and &14)



[siu5B_0063.jpg]

Translation: The shape has triangles. The edges at the left and right are equal in length. The edge at the bottom is shorter than those at the left and right.

&20. Unable to describe any features of the pyramid



[siu4D_0033.jpg]

Translation: This is a shape with three edges. Do you know what it is?

7.2.2 Drawing Patterns of Pyramids

Table 7.8 and the selected cases below show the variety of drawing patterns of pyramids. One surprising finding is that the mode of the patterns is &b, drawing a tetrahedron as a pyramid which will be discussed in Section 7.2.4.2. Also, the

response pattern "Incomplete drawing of hidden lines" did not appear for pyramid drawing while this pattern were found both in cubes and triangular prisms since there is no need to apply the partial occlusion technique (Golomb, 2004, p. 115) to draw all the hidden edges. The performance of drawing pyramids is close to drawing cubes when comparing Table 6.2 and 7.8.

Table 7.8 Frequency of Drawing Patterns of Pyramids Found in "siu" School	**N = 85**
&a. Drawing a cone as a pyramid	**4 (4.71%)**
&b. Drawing a tetrahedron as a pyramid	**16 (18.82%)**
&c. Drawing a pyramid without the square base	**8 (9.41%)**
&d. Hidden lines not in coordination	**4 (4.71%)**
&e. Drawing a non-transparent pyramid	**9 (10.6%)**
&f. Drawing not in perspective view.	**3 (3.5%)**
&g. Drawing the pyramid in a good 3D perspective taking all parts of the solid shape together in a coordinating manner	**15 (17.7%)**
&h. Some or all seen faces are drawn in a 2D format	**9 (10.6%)**
&i. Unable to draw any features of the pyramid	**4 (4.7%)**

Selected cases for the drawing patterns:

&a. Drawing a cone as a pyramid

_____[siu4D_0057.jpg]

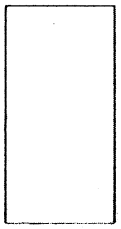
&b. Drawing a tetrahedron as a pyramid

[siu6A_0048.jpg]

&c. Drawing a pyramid without the square base

[siu4D_0063.jpg]

&d. Hidden lines not in coordination



[siu4D_0015.jpg]

&e. Drawing a non-transparent pyramid

[siu5B_0033.jpg]

&f. Drawing not in perspective view.

[siu4D_0033.jpg]

&g. Drawing the pyramid in a good 3D perspective taking all parts of the solid shape together in a coordinating manner

[siu5B_0039.jpg]

&h. Some or all seen faces are drawn in a 2D format

[siu5B_0060.jpg]

&i. Unable to draw any features of the pyramid

[siu4D_0093.jpg]

7.2.3 Identification of P-U-M-R levels of the SOLO Model for Pyramids

Applying the same procedure as those used in cube, the research reports here the rating of the P-U-M-R levels for pyramids making a comparison analysis and searching similarity in response patterns against those of cubes in Section 6.3.

7.2.3.1 The P-U-M-R levels of the SOLO Model for Pyramid Descriptions

Table 7.9 below shows the frequency of description patterns found co-occuring with each of the P-U-M-R levels (See Appendix F and Section 5.2.3). In Table 7.9, highest frequencies for each response patterns are shaded in order to indicate the characteristics of the responses for each level. Since there is no significant frequency under the R-level column, only the first three levels are identified:

Prestructural: Students are unable to describe any features of a pyramid. They describe the pyramids with incorrect property. Most significantly, a significant number of cases describe the shape as tetrahedron. Selected cases &12, &19 and &20 are examples in this level.

Unistructural: In this level, students can describe the pyramid with only one correct

property and sometimes make incorrect description. Square base and 4 triangles around are the most often mentioned property. Selected cases. &16 and &1 are examples in this level.

Multistructural: Students list more than one property of pyramid such as 5 faces. 5 vertices. 8 edges and a square base. Selected cases. &2. &3. &4 and &16 are examples.

Due to small sample size, no characteristics of relational level for pyramid can be concluded.

Table 7.9 Frequency of Description Patterns of Pyramids Rated as at P-U-M-R levels of the SOLO model	**Total (N = 85)**	**P-level (N = 41)**	**U-level (N = 23)**	**M-level (N = 19)**	**R-level (N = 2)**
&1. Describing a pyramid with 4 triangles around	**16**	1	7	6	2
&2. Describing a pyramid with 5 faces	**16**	1	2	12	1
&3. Describing a pyramid with 5 vertices	**16**	0	5	11	0
&4. Describing a pyramid with 8 edges	**18**	0	5	13	0
&5. Describing pyramids are found in Egypt	**8**	2	3	3	0
&6. Pyramids are associated with real life objects like funnels and others	**3**	1	1	1	0
&7. Describing pyramids with 4 faces (incorrect property)	**1**	0	1	0	0
&8. Describing pyramids with 4 vertices (incorrect property)	**2**	0	1	1	0
&9. Describing pyramids with 7 edges (incorrect property)	**1**	0	1	0	0
&10. Describing pyramids with 9 edges (incorrect property)	**1**	0	1	0	0
&11. Describing a pyramid as a cone (incorrect property)	**1**	1	0	0	0
&12. Describing a pyramid as a tetrahedron (incorrect property)	**6**	6	0	0	0
&13. The square base of the pyramid is mistaken as parallelogram	**2**	0	2	0	0
&14. The square base of the pyramid is mistaken as rectangle	**1**	0	1	0	0
&15. Pyramids are associated with the roof of clock tower	**1**	0	0	0	1
&16. Square base are mentioned	**15**	0	6	7	2
&17. Describing the pyramid only with 2D mathematical terms	**3**	2	1	0	0
&18. Describing the pyramid with few information that one cannot identify	**8**	6	2	0	0
&19. Describing a pyramid with other incorrect properties (excluding the cases &7,&8, &9, &10, &11, &12, &13 and &14)	**6**	6	0	0	0
&20. Unable to describe any features of the pyramid	**16**	16	0	0	0

Note: There may be more than one response patterns for each description about pyramid. The sum of the total frequencies is not equal to the number of cases in the sample.

Table 7.10 Frequency of Drawing Patterns of Pyramids Rated as at P-U-M-R levels of the SOLO model	**Total (N =85)**	**P-level (N = 26)**	**U-level (N = 15)**	**M-level (N = 8)**	**R-level (N = 36)**
&a. Drawing a cone as a pyramid	**4**	4	0	0	0
&b. Drawing a tetrahedron as a pyramid	**16**	16	0	0	0
&c. Drawing a pyramid without the square base	**8**	2	6	0	0
&d. Hidden lines not in coordination	**4**	0	2	2	0
&e. Drawing a non-transparent pyramid	**9**	0	4	5	0
&f. Drawing not in perspective view.	**3**	0	3	0	0
&g. Drawing the pyramid in a good 3D perspective taking all parts of the solid shape together in a coordinating manner	**15**	0	0	0	15
&h. Some or all seen faces are drawn in a 2D format	**9**	2	7	0	0
&i. Unable to draw any features of the pyramid	**4**	4	0	0	0

Note: There may be more than one response patterns for each drawing of pyramid. The sum of the total frequencies is not equal to the number of cases in the sample.

7.2.3.2 The P-U-M-R levels of the SOLO Model for Pyramid Drawings

Table 7.10 shows the frequencies of drawing patterns found co-occuring with each of the P-U-M-R levels (See Appendix G and Section 5.2.3). The existence of the four levels of SOLO model is obvious and the four levels are identified:

Prestructural: Students are unable to draw any features of the pyramid. They might make mistake by drawing a tetrahedron as a pyramid. Selected cases &b and &i in Section 7.2.2 are examples in this level.

Unistructural: Basically, students in this level cannot draw the shape in a 3D way. They draw the triangles of the pyramids without the square as base. &c and &h are examples in this level

Multistructural: The feature of this level is not so apparent. They are aware of the 3D drawing conventions but lack of the VP-ability to draw the hidden lines in a coordinating manner. &d is an example.

Relational: The pyramid is drawn in a good 3D perspective taking all parts of the solid shape together in a coordinating manner

7.2.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model

In Table 7.11, except for the row of Relational, frequencies of Prestructural and Unistructural levels increase as the grade levels increase. There are more primary 6 students in the Multistructural level than primary 4 and 5. It shows the developmental growth of the present classification of SOLO levels.

Table 7.11 Description about Pyramids across Different Grades of Students				
Levels of the SOLO model	Primary 4 (N=31)	Primary 5 (N=24)	Primary 6 (N=30)	Total (N = 85)
Prestructural	21 (67.7%)	14 (58.3%)	6 (20.0%)	41 (48.2%)
Unistructural	6 (19.4%)	6 (25.0%)	11 (36.7%)	23 (27.1%)
Multistructural	3 (9.7%)	3 (12.5%)	13 (43.3%)	19 (22.4%)
Relational	1 (3.2%)	1 (4.2%)	0 (0%)	2 (2.4%)

In table 7.12, there are fewer Primary 6 students in the Prestructural, Unistructual and multistructural levels while there are more Primay 4 and Primary 5 students in the Prestructural and Unistructural levels. This classification of the four SOLO levels in drawing pyramids shows the developmental growth patterns of the SOLO model.

Table 7.12 Drawings of Pyramids across Different Grades of Students				
Levels of the SOLO model	Primary 4 (N=31)	Primary 5 (N=24)	Primary 6 (N=30)	Total (N = 85)
Prestructural	10 (32.3%)	11 (45.8%)	5 (16.7%)	26 (30.6%)
Unistructural	13 (41.9%)	2 (8.3%)	0 (0%)	15 (17.6%)
Multistructural	3 (9.7%)	5 (20.8%)	0 (0%)	8 (9.4%)
Relational	5 (16.1%)	6 (25.0%)	25 (83.3%)	36 (42.4%)

7.2.4 Vignettes in Responses of the Descriptions about and Drawing of Pyramids

7.2.4.1 The Influence of the Drawing on Students' Spatial Conceptions



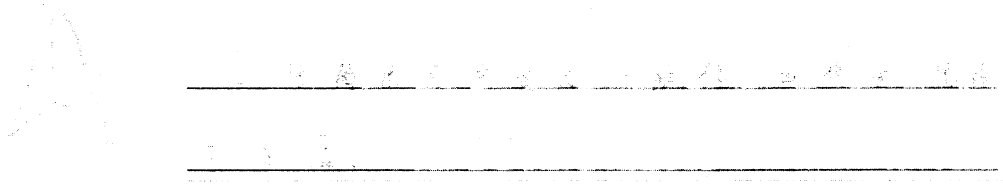
[siu6A_0015.jpg]

Translation: It is a pyramid. Its base is a parallelogram. Its sides are triangles.

Figure 7.4 The description influenced by the drawing

This response pattern was replicated as that of cube (See Figure 6.1). The student was unable to distinguish the drawing conventions and the visual conception. It is likely that the student only copied his/her visual image from textbook about pyramids.

7.2.4.2 Drawing Tetrahedrons as Pyramids



[siu6A_0036.jpg]

Translation: This shape has four vertices, six edges and four faces. Its base has three edges.

Figure 7.5 Drawing tetrahedrons as pyramids

This response pattern is consistent with Mariotti's (1993) finding (See Section 2.3.2). Pyramids and tetrahedrons are usually shown to students as typical examples of solid shapes in most textbooks. If the drawing is non-transparent like Figure 7.6, students cannot distinguish whether it is a pyramid or tetrahedron. Therefore, it leads to students' inconsistency among the mental images, real shapes and the names of the two shapes.

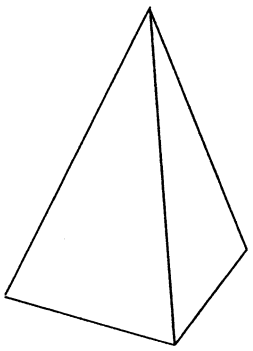


Figure 7.6 A pyramid or tetrahedron

7.3 The Scene of Cylinders

7.3.1 Description Patterns about Cylinders

Table 7.13 and the selected cases below show a variety of response patterns of students' descriptions about cylinder. Since there is a curved surface in this solid shape, the patterns are somewhat different from those of cube, triangular prism and pyramid which all have edges and vertices. The frequencies of items %15 and %16 show that cylinder is not easy to describe (See also the low frequencies of R-level in table 7.15). It seems that students could not find any proper words to describe the curved surface.

The following salient patterns are identified:

- From items %3 and %12 in Table 7.13, cylinders are often related to circles and prisms in students' descriptions;
- Better descriptions are those that was depicted with circles as bases and

associate shapes in real world such as cans of Coke: and

- Most incorrect descriptions involve descriptions with edges:

Table 7.13 Frequency of Description Patterns about Cylinders Found in the "wu" School	**N = 103**
%1. Describing a cylinder with 2 bases	**1 (1.0%)**
%2. Describing a cylinder with 3 faces	**1 (1.0%)**
%3. Circles are mentioned	**26 (25.2%)**
%4. Describing a cylinder with circles as bases	**17 (16.5%)**
%5. Describing a cylinder with curved surface	**1 (1.0%)**
%6. Cylinder associated with shapes in daily life	**16 (15.5%)**
%7. There are 2 edges (incorrect property)	**3 (2.9%)**
%8. There are 3 edges (incorrect property)	**1 (1.0%)**
%9. There are 4 edges (incorrect property)	**2 (1.9%)**
%10. Mistaken as a sphere (incorrect property)	**2 (1.9%)**
%11. Mistaken the middle part of the shape as rectangle (incorrect property)	**1 (1.0%)**
%12. Prisms are mentioned in the description	**19 (18.4%)**
%13. The shape formed by scrolling a rectangle	**1 (1.0%)**
%14. Describing the cylinder only with 2D mathematical terms	**3 (2.9%)**
%15. Describing the cylinder with few information that one cannot identify	**11 (10.7%)**
%16. Unable to describe any features	**25 (24.3%)**

Selected cases for the description patterns:

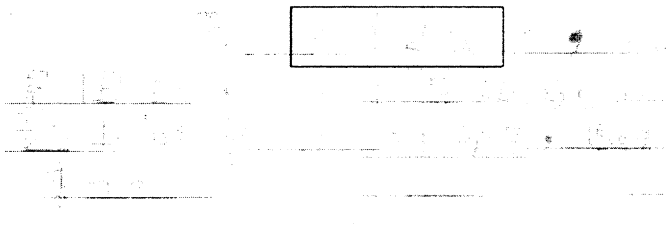
%1. Describing a cylinder with 2 bases



[wu4A_0028.jpg]

Translation: This picture has *a total of two faces in the upper and lower faces*. There are no faces at the left and right. Since it is bent. we need a flexible ruler or a string to measure.

%2. Describing a cylinder with 3 faces



[wu4A_0056.jpg]

Translation: There are *3 faces*. The lower part is a circle. The upper part is also a circle. The middle is a prism. It also has weight.

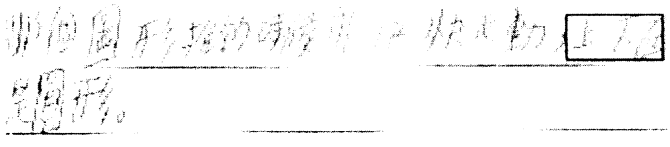
%3. Circles are mentioned



[wu5A_0008.jpg]

Translation: There are two *circles* at the two sides. In the middle, there is a long and circular object.

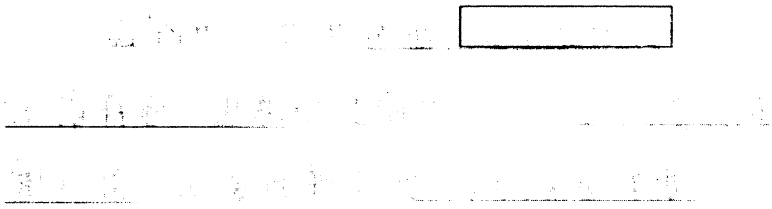
%4. Describing a cylinder with circles as bases



[wu4A_0132.jpg]

Translation: When we push this shape, it moves quickly. *The upper and lower faces are circles.*

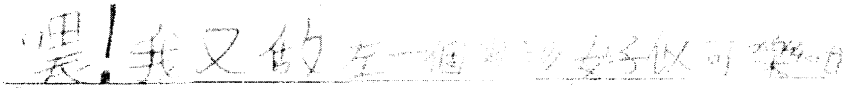
%5. Describing a cylinder with curved surface



[wu4A_0028.jpg]

Translation: This picture has a total of two faces in the upper and lower faces. There are no faces at the left and right. *Since it is bent, we need a flexible ruler or a string to measure.*

%6. Cylinder associated with shapes in daily life



[wu4A_0072]

Translation: Hi! I have constructed a shape like a can of Coke.

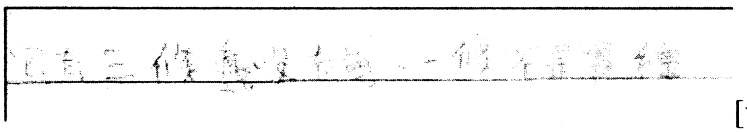
%7. There are 2 edges (incorrect property)



[wu6A_0032.jpg]

Translation: This shape is drawn by *two lines of equal length.*

%8. There are 3 edges (incorrect property)



[wu6A_0012.jpg]

Translation: It has *three edges*, no angles. One of the edges is not a solid line.

%9. There are 4 edges (incorrect property)



[wu6A_0108.jpg]

Translation: It is a curve constructed by four edges.

%10. Mistaken as a sphere (incorrect property)



[wi4A_0044.jpg]

Translation: The shape is a solid but it looks like a sphere.

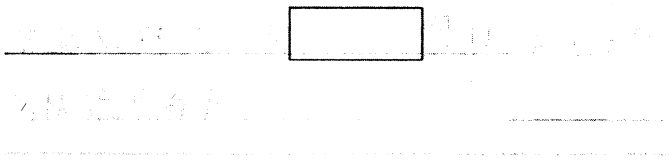
%11. Mistaken the middle part of the shape as rectangle (incorrect property)



[wu5A_0092.jpg]

Translation: The upper is a circle. The lower is a circle. *The middle is a rectangle.*

%12. Prisms are mentioned in the description



[wu6A_0080.jpg]

Translation: The shape is a prism. Some one can say there are no angles. The other one can say there are angles.

%13. The shape formed by scrolling a rectangle



[wu5A_0016.jpg]

Translation: It is formed by two circles in the upper and lower part. The middle is formed by scrolling a rectangle.

%14. Describing the cylinder only with 2D mathematical terms



[wu4A_0140.jpg]

Translation: It is a prism without angles. The opposite sides are not parallel.

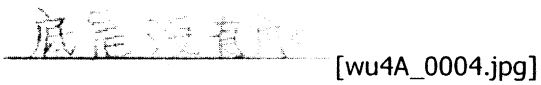
%15. Describing the cylinder with few information that one cannot identify



[wu5A_0036.jpg]

Translation: There are no right angles and it is circular.

%16. Unable to describe any features



[wu4A_0004.jpg]

Translation: The base has no angles.

7.3.2 Drawing Patterns of Cylinders

Table 7.14 and the selected cases below show the response patterns of students' drawing of cylinders. The performance in drawing cylinders is better than all the other three solid shapes (%b). The response patterns are also somewhat different from those of the other three shapes. A good drawing is those that show ellipses as bases for an ellipse is a perspective view of circle. Those incorrect drawings show edges in drawing the curved surface.

Table 7.14 Frequency of Drawing Patterns of Cylinders Found in "wu" School	**N = 103**
%a. Drawing a circle as base (not in perspective view)	**36 (35.0%)**
%b. Drawing an ellipse as base	**57 (55.3%)**
%c. Drawing a cylinder with 4 edges	**4 (3.9%)**
%d. Drawing a cylinder with 3 edges	**1 (1.0%)**
%e. Drawing a nontransparent cylinder	**6 (5.8%)**
%f. Drawing a cylinder with perpendicular edges	**4 (3.9%)**
%g. Unable to draw any features	**2 (1.9%)**

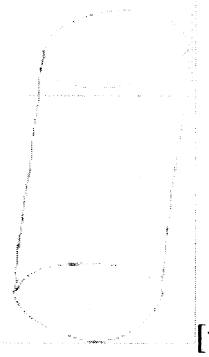
Selected cases for the drawing patterns:

%a. Drawing a circle as base (not in perspective view)



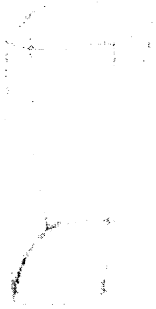
[wu4A_0067.jpg]

%b. Drawing an ellipse as base



[wu6A_0035.jpg]

%c. Drawing a cylinder with 4 edges



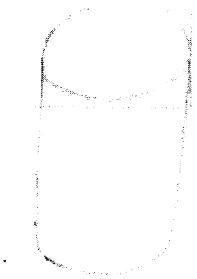
[wu6A_0107.jpg]

%d. Drawing a cylinder with 3 edges



[wu6A_0135.jpg]

%e. Drawing a nontransparent cylinder

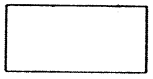


[wu4A_0039.jpg]

Table 7.15 Frequency of Description Patterns of Cylinders Rated as at P-U-M-R levels of the SOLO model	**Total (N = 103)**	**P-level (N = 42)**	**U-level (N = 43)**	**M-level (N = 17)**	**R-level (N = 1)**
%1. Describing a cylinder with 2 bases	**1**	0	1	0	0
%2. Describing a cylinder with 3 faces	**1**	0	0	1	0
%3. Circles are mentioned	**26**	0	18	8	0
%4. Describing a cylinder with circles as bases	**17**	0	8	8	1
%5. Describing a cylinder with curved surface	**1**	0	1	0	0
%6. Cylinder associated with shapes in daily life	**16**	0	11	5	0
%7. There are 2 edges (incorrect property)	**3**	2	1	0	0
%8. There are 3 edges (incorrect property)	**1**	1	0	0	0
%9. There are 4 edges (incorrect property)	**2**	2	0	0	0
%10. Mistaken as a sphere (incorrect property)	**2**	2	0	0	0
%11. Mistaken the middle part of the shape as rectangle (incorrect property)	**1**	0	1	0	0
%12. Prisms are mentioned in the description	**19**	0	8	11	0
%13. The shape formed by scrolling a rectangle	**1**	0	0	0	1
%14. Describing the cylinder only with 2D mathematical terms	**3**	0	3	0	0
%15. Describing the cylinder with few information that one cannot identify	**11**	11	0	0	0
%16. Unable to describe any features	**25**	25	0	0	0

Note: There may be more than one response patterns for each description of cylinder. The sum of the total frequencies is not equal to the number of cases in the sample.

%f. Drawing a cylinder with perpendicular edges



[wu4A_0139.jpg]

%g. Unable to draw any features



[wu4A_0015.jpg]

7.3.3 Identification of P-U-M-R levels of the SOLO Model for Cylinders

Applying the same procedure as those used in cube, the research reports here the rating of the P-U-M-R levels for cylinders making a comparison analysis and searching similarity in response patterns against those of cubes in Section 6.3.

7.3.3.1 The P-U-M-R levels of the SOLO Model for Cylinder Descriptions

Table 7.15 below shows the frequency of descriptions patterns found co-occuring with each of the P-U-M-R levels (See Appendix H and Section 5.2.3). In Table 7.15, highest frequencies for each response patterns are shaded in order to indicate the characteristics of the responses for each level. Since students' descriptions about cylinder were so unsatisfactory in this sample, except for Prestructural level, the other three levels are difficult to find a clear discrimination among the response patterns of highest frequencies.

In Prestructural level, students were unable to describe a cylinder. Other than that, a few descriptions were influenced by solid shapes with edges (See Selected cases %7, %8 and %9). This is a response pattern not found in other solid shapes in this study.

Table 7.16 Frequency of Drawing Patterns of Cylinders Rated as at P-U-M-R levels of the SOLO model	**Total (N = 103)**	**P-level (N = 2)**	**U-level (N = 13)**	**M-level (N = 33)**	**R-level (N = 55)**
%a. Drawing a circle as base (not in perspective view)	**36**	0	7	29	0
%b. Drawing an ellipse as base	**57**	0	0	2	55
%c. Drawing a cylinder with 4 edges	**4**	0	4	0	0
%d. Drawing a cylinder with 3 edges	**1**	0	1	0	0
%e. Drawing a nontransparent cylinder	**6**	0	2	4	0
%f. Drawing a cylinder with perpendicular edges	**4**	0	4	0	0
%g. Unable to draw any features	**2**	2	0	0	0

Note: There may be more than one response patterns for each drawing of cylinder. The sum of the total frequencies is not equal to the number of cases in the sample.

7.3.3.2 The P-U-M-R levels of the SOLO Model for Cylinder Drawings

Table 7.16 shows the frequencies of drawing patterns found co-occuring with each of the P-U-M-R levels (See Appendix I and Section 5.2.3). However, the four levels of SOLO model are more or less different from those shapes with edges when comparing against Table 6.7.

The four levels for cylinder drawings are identified:

Prestructural: Students in this level were unable to draw any features of cylinder.

Unistructural: Students in this level drew cylinders with edges. A few drew with perpendicular edges. Selected case %f. is an example.

Multistructural: Students drew cylinder not in a perspective view that circles were drawn as bases.

Relational: Students drew cylinder in a perspective view that ellipses were drawn as bases.

7.3.3.3 Developmental Patterns of P-U-M-R Levels of the SOLO Model

Table 7.17 shows that cylinder is the hardest shape described by students of all the three grades. About 80% of all the descriptions are in the Prestructural and Unistructural levels in the three grades. There is no sharp difference in percentages to discriminate a developmental growth across the grade levels in cylinder descriptions.

Table 7.17 Descriptions about Cylinders across Different Grades of Students

Levels of the SOLO model	Primary 4 (N=38)	Primary 5 (N=30)	Primary 6 (N=35)	Total (N=103)
Prestructural	13 (34.2%)	13 (43.3%)	16 (45.7%)	42 (40.8%)
Unistructural	20 (52.6%)	11 (36.7%)	12 (34.3%)	43 (41.7%)
Multistructural	5 (13.2%)	5 (16.7%)	7 (20.0%)	17 (16.5%)
Relational	0 (0%)	1 (3.3%)	0 (0%)	1 (1.0%)

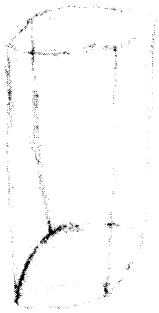
Table 7.17 shows cylinder is the easiest shape drawn by the students of all three grade levels. Over 80% of the drawings are in the Prestructural and Unistructural levels in all the three grades. There is no sharp difference in percentages to discriminate a developmental growth across the grade levels in cylinder drawings.

Table 7.18 Drawings of Cylinders across Different Grades of Students

Levels of the SOLO model	Primary 4 (N=38)	Primary 5 (N=30)	Primary 6 (N=35)	Total (N=103)
Prestructural	1 (2.6%)	0 (0%)	1 (2.8%)	2 (1.9%)
Unistructural	7 (18.4%)	1 (3.3%)	5 (14.3%)	13 (12.6%)
Multistructural	16 (42.1%)	8 (26.7%)	9 (25.7%)	33 (32.0%)
Relational	14 (36.9%)	21 (70%)	20 (57.1%)	55 (53.4%)

7.3.4 Vignettes in Responses of the Descriptions about and Drawing of Cylinders

7.3.4.1 Influenced by Solid Shapes with Edges and Faces



[wu6A_0107.jpg]



[wu6A_0106.jpg]

Translation: This is a shape with four equal edges. The opposite angles are equal and right angles.

Figure 7.7 Drawings and descriptions influenced by solid shapes with edges and faces

The drawing and the description were done by a primary 6 students. In both drawing and description, edges were drawn and mentioned. This outcome might be due to the student being unaware of the drawing conventions of curved surface of solid shape and maintaining using plane-figure terms to describe solid shapes.

7.3.4.2 Perpendicular Edges



[wu6A_0103.jpg] [wu5A_0115.jpg]

Figure 7.8 Perpendicular edges

This case is similar to that of cube (See 6.4.2). Though the students were in primary 6 and 5, they lack of the coordination in drawing the vertical plane with the horizontal plane. While they want to maintain the surface of the cylinder being perpendicular to the horizontal plane, they also want to maintain a perspective view in the upper part of the cylinder.

7.4 Summaries

Previous chapter has revealed there are a diversity of response patterns and the P-U-M-R levels of the SOLO model for cube descriptions and drawings. This chapter repeated the methods of data analysis for triangular prisms, pyramids and cylinders. Except for cylinders, the response patterns of descriptions and drawings for triangular prisms and pyramids are more or less the same. Students tend to depict the two shapes in terms of numbers of edges, vertices and faces (See Appendix J). Several drawing patterns (See Appendix L) such as "hidden lines not in

coordination", "Incomplete drawing of hidden lines", "Perpendicular edges" and "Some or all seen faces are drawn in 2D format" could be found in cubes, triangular prisms and pyramids.

Due to smaller sample sizes, there is no sharp difference to discriminate the P-U-M-R levels of the SOLO models. However, the emerging theory of the four levels (Table 6.7) can be applied to triangular prisms and pyramids. The figures (in Table 7.5, Table 7.6, Table 7.11 and Table 7.12) also show that the levels indicate a developmental growth nature of the classifications.

However, for the case of cylinders, the response patterns both in descriptions and drawings are different from those of cubes, triangular prisms and pyramids. Some students' descriptions and drawings were influenced by solid shapes with edges. The drawings are the easiest but the descriptions are the hardest that the features of each of the P-U-M-R levels of SOLO model cannot be identified. It seems that the four levels of the models cannot be distinguished for learning tasks that are either too easy or too difficult.

CHAPTER 8 CONCLUSIONS AND IMPLICATIONS

This study seeks to address the following research questions:

(1) What diversity and patterns can be identified in upper primary students' drawing representations of and descriptions about 3D geometrical shapes?

(2) Upon the identification of diversity and patterns in (1), are there prestructural-unistructural- multistructural- relational (P-U-M-R) levels of the SOLO model in the case of the upper primary students' drawing representations of and descriptions about 3D geometrical shapes?

Chapters 6 and 7 detailed the findings of the data analysis on the response patterns from the four 3D geometrical shapes (Figure 1.1). To address the above research questions, two generic conclusions are drawn from these findings, followed by a discussion of the findings to elaborate and support the two conclusions. This final chapter considers those findings in terms of the literature on spatial ability as reviewed in Chapter 2 and the theoretical framework proposed in Chapter 3. Implications, recommendations and further research are also discussed in this concluding chapter.

8.1 Conclusions

We are living in a 3D world and we also experience the gravitational force on the Earth that provides us with a stable, horizontal surface. Description about a solid shape conveys a student's internal representation or knowledge about the solid in the mind (Figure 2.3 and Section 2.4). Drawing of a solid shape addresses a student's problem of representing on a flat paper a solid extended in a 3D space. Both of these reflect a student's individual experience in a spatial world no matter whether these abilities are based on a student's spontaneous knowledge or scientific concepts (Section 3.3.1). The main issue in this aspect is their spatial abilities: the IFI-ability for descriptions and the VP-ability for 2D representational drawings (Section.2.4). Working within this IFI-VP dichotomy in spatial abilities, the researcher focuses on the response patterns from the students' descriptions about and drawings of the four

3D geometrical shapes. These patterns are first provisional and are then derived from existing theories (Chapter 2). Next, constant comparison of the data and the process of open coding in which the researcher looks at the data words by words in descriptions and lines by lines in drawings result in a variety of consistent response patterns. With the help of a qualitative data analysis software tool, overall, and across all the three grades of students and all shapes, this study arrives at the first conclusion addressing the first research question:

Conclusion (1):

The descriptions about and the drawings of mathematical 3D shapes appear to be more a matter of reproducing students' own experiences in the real world including those from mathematics lessons as well as their social practice or culture. The outcomes are subject to the students' own satisfaction rather than constructing a new representation just for the 3D shape. Therefore, the response patterns about the descriptions and the drawings of the 3D geometrical shapes are rich and diverse in this study.

IFI- and VP- abilities are only a classification of processes to be performed in learning geometry. However, mathematics teachers are only interested in what components of the spatial ability they are able to teach, what are the levels of students' understanding that they can assess students' learning outcome and what way they can overcome students' 3D visual obstacles. Thus, this study turns to investigate the cognitive developmental growth of spatial ability by considering the SOLO model (Pegg, et al., 1998). The SOLO Model offers the flexibility and versatility in categorising these responses. The Model is a series of levels that measure a growing complexity in understanding (See Section 3.2). Of main interest in this study are the P-U-M-R (Prestructural, Unistructural, Multistructional, Relational) levels. With the use of co-occurrence query of the software tool, except for cylinders, the characteristics for each of the P-U-M-R levels are identified (Table 6.7) and the theory of the developmental growth in understanding the three 3D

geometrical shapes (cube. triangular prism and pyramid) is established in conclusion (2).

However. the level descriptors for VP-ability are not easily accommodated into the SOLO Model. though not contradicting the developmental descriptors hypothesized in Table 3.1. The researcher argues that the students who maintain the 2D format in drawing a 3D shape use the 2D part of visual information. It can be considered as Unistructural as their abilities stay in less than one dimension in a 3D space. Coordinating the edges and faces of the solid shapes can also be considered as a relational level and therefore lack of coordination ability in drawing the edges in a perspective view can be classified in the Multistructural level.

Conclusion (2):

Table 6.7 Students' Response Patterns of 3D Geometrical Shapes

SOLO Levels	**VP-ability:** about drawing	**IFI-ability:** about describing
Prestructural	Unable to draw any features of the solid shape	Unable to describe any features of the solid shape
Unistructural	The drawing almost like a 2D figure and no ideas about the 3D drawing conventions	Describing the solid shape with 2D mathematical terms and having incorrect descriptions
Multi-structural	Lack of the ability to coordinate the drawing of all the edges and faces in a perspective view	Listing more than one property of the solid shape with 3D mathematical terms
Relational	Drawing the solid shape as a good 3D perspective taking all parts of the shape together in a coordinating manner	In addition to list more than one property of the solid shape, students can describe the shape in a global feature associating the solid with shapes in real world

These two conclusions, addressing to the two research questions, are based on the findings in chapters 6 and 7 as well as the evidences in the research literature. They will be elaborated in the following section.

8.2 Summary and Discussion of Findings

Ages of students in this study range from 9 to 12 years. Students in this sample are in the concrete symbolic mode as in the SOLO Model (See Figure 3.2) and are supposed to be able to use a symbol system such as written language and mathematical symbols. Overall, the present study shows that most students do have achieve the VP- and IFI- abilities in dealing with the four 3D geometrical shapes. Irrespective of the responses are drawings or descriptions, except for pyramid, over 65% of the responses are classified in the Unistructural, Multistructural or Relational levels. The study also shows that students' performance in drawing is better than descriptions, consistent with the researches of Cooper and Sweller (1989) (See Section 2.3.2.4). Additionally, with increasing age/grade, there is a tendency to produce more advanced descriptions and drawings. On the other hand, there are still errors in primary grade 6 students' (11 or 12 years of age) descriptions and drawings though these solid shapes had been taught and learned in the previous grades. It appears that the visualization ability necessary to draw the 3D geometrical shapes had not yet developed even for some year 6 students.

The subsections below present a summary of the findings of the research and the discussions arising from the findings and the research literature:

8.2.1 The Diversity in the Response Patterns

Definitions and conventions in mathematics should be rigorous and all mathematics teachers maintain the rigour of the properties and the drawing conventions of these 3D solids while teaching on this topic. The outcomes of students' descriptions and drawings should be consistent that there would not be so many variations. Yet, this study has illuminated the diverse range of students' responses both in descriptions and drawings as shown in the tables of Chapter 6 and Chapter 7.

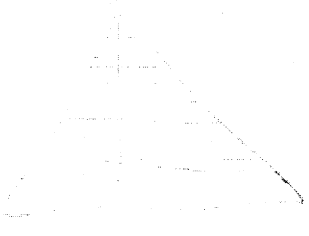
Literature (Bishop, 1989) has shown that VP-ability and the use of mental imagery, the internal representation, are very personal or idiosyncratic. Students tend to construct their own image which is in line with the constructivist paradigm (See Figure 2.2) and particularly, Piaget's two-factor cognitive theory of symbolic meaning (See Section 2.4). Furthermore, from Vygotsky' s view of human learning,

the outcomes of drawings and descriptions of 3D geometrical shapes reflect each individual's past experience, cultural context as well as interpretations of the goals of this learning activities (Crawford, 1996, p. 44). Due to the results of such personal construction activities, diversity in the response pattern is therefore expected in this study.

8.2.2 The Stereotyped Descriptions

Though descriptions are diverse, there are stereotyped descriptions for solids having faces and edges. The description through language is a matter of mathematical properties of the solid shapes. Students usually describe the shapes in terms of numbers of edges, vertices and faces such as triangles, squares and rectangles (See Table 6.3 for cube, Table 7.1 for triangular prism and Table 7.7 for pyramid). However, for cylinders, the students seem to lack the terminology to describe the curved surface. Very few students can supply enough information in the description about what a cylinder is (Table 7.17)

8.2.3 The Social Practice in the Descriptions and Drawings



[siu4D_001.jpg]

Figure 8.1 Steps in a pyramid

The descriptions and drawings are not only a matter of mathematical definition and convention but also a social practice. In some students' descriptions, they like to associate the shapes with objects we confront in our daily living such as cubes as boxes, triangular prisms as chocolate bars, pyramids found in Egypt and cylinders as cans of Coke (See Table 6.1: code #4, Table 7.1: code ^5, Table 7.7: code &4 and &6, Table:9 7.13 code %6). Some students depicted the solid shape in the ways of

the hands-on activities how these shapes are constructed such as rolling up a sheet of rectangle to form a cylinder (See Table 7.13: code %13) and using clay and sticks/straws to form a cube (See Section 6.4.4). An interesting case is that a student drew the pyramid with steps like those in Egypt (Figure 8.1)

Furthermore, due to the influence of the gravitational force, in all the drawings of pyramid and triangular prisms, there are no drawings that are upside down. Students have such a life experience that objects have to stay in a stable manner.

These findings here are coincident with Vygotsky's sociocultural theory (Kozulin, 2003; Vygotskiĭ & Cole, 1978) that learning is embedded within social events and occurs in terms of students' confrontation with the cultural environment, their own exploration, and their reactions to with people and objects.

8.2.4 The Chinese Names of the 3D Shapes

This study was done in Hong Kong primary schools and students used Chinese in describing the 3D shapes. The symbols (to give an analogy from English, they are the alphabets) of the Chinese writing system are characters. Each Chinese character is the smallest unit of wording and Chinese characters represent wording of the language (Halliday, 1989, p. 19). If the word "cube" was written in Chinese, there would be one character for the "regular", one character for "square" and one character for "body". Also, Chinese characters may depict objects or represent abstract concepts. This semantic feature of Chinese characters is called LOGOGRAM (Encyclopædia Britannica Inc, 2008; Halliday, 1989, p. 19). Therefore, these Chinese multi-character words display explicitly the classification taxonomy of things, or more accurately, related concepts often share some identical Chinese characters.

Thus, it explains that square are mentioned frequently in cube description (Table 6.1) because the Chinese name of cube is composed of three Chinese characters, regular + square + body, which imply that squares are part of a cube. Triangles and prisms were also mentioned frequently (Table 7.1) since the Chinese name of triangular prisms is composed of four characters, three + angle + prism + body (See 7.1.4.1). Also, when describing cylinders, students mentioned circle frequently since the

Chinese name of cylinder is composed of three characters, circle + prism + body.

This logographic nature of Chinese characters can enhance the learning of the meaning or properties of 3D shapes (Miura, 2001). Cultural factors affect the description and interpretation of 3D shapes (See Section 2.3.1.7). Again, Vygotsky's socialcultural theory accounts for this finding.

8.2.5 Describing Only with the 2D Mathematical Terms

In all the four 3D shapes in this study, it is found that a significant number of students can only use plane-figure names or 2D vocabularies to describe the solid shapes (See Table 6.1: #13, Table 7.1: ^12, Table 7.7: &17, Table 7.13: %15). For instance, they misused angles to describe vertices in all solid shapes and acute angles to describe vertices of the pyramid. They did not know planes and lines can be perpendicular to one anther in the space. No students can describe the perpendicular faces or perpendicular edges of the cube and the rectangles in triangular prism perpendicular to the triangles.

This finding indicates a lack of discrimination between the 2D and 3D spaces (Clements, 2003, p. 161). Clements commented that learning only 2D shapes in lower primary grades may cause such difficulty in learning the 3D shapes. Similar result was also found in the research literature (Everett & Mulligan, 2000, p. 247). This is also one of the important finding in this study that this phenomenon is the descriptor of the Unistructural level of SOLO Model in developmental growth of describing the solid shapes.

8.2.6 Drawing Solid Shape as 2D Drawing

Except for cylinder, it was found that some students could not draw the 3D aspects of the solid shapes (See Table 6.4: #g, Table 7.2: ^g and Table 7.8: &h). Some or all seen faces were drawn in a 2D format. They tended to represent the whole shape by drawing all the faces in an undistorted way (for instance, squares were not drawn as parallelograms) that clashes with the need to present the missing third dimension. This is an important descriptor found in this study for the Unistructural level of SOLO Model in the developmental growth of drawing solid shapes.

Note that both Section 8.2.5 and 8.2.6 ascertain that at the Unistructural Level students' reasoning the 3D geometrical shapes is much like that about plane figures.

8.2.7 The Spontaneous Concepts in Descriptions

Geometric concepts sometimes have to be introduced by the diagrams for illustrative purpose. However, students' knowledge of a concept would be constrained by the drawing presented. When a 3D geometrical concept is represented by a drawing, the representation is insufficient in terms of structure (See Section 2.3.15). A few cases in this study (For instance, see sections 6.4.1, 7.2.4.1 and 7.2.4.2) show that relying on their own drawings or the stereotyped drawings on the textbooks, students counted directly on these drawings about the number of faces, vertices or edges and thus made errors in the numbers. The errors made by students in descriptions of the 3D geometrical shapes are probably due to their spontaneous concepts (Section 3.3.1) about the shapes. It is because there are usually some losses of properties about the 2D representation drawings of the solid shapes (See Section 2.3.4) and they regarded the representative drawing on the paper was the actual object.

8.2.8 Consistent Errors in Drawings

Except for cylinders, analysis of the drawings of the other three 3D shapes in this study revealed that students produced consistent errors irrespectvie what the shape it is. These errors include (i) hidden lines not in coordination; (ii) Incomplete drawing of hidden lines; and (iii) perpendicular bias.

(i) Hidden lines not in coordination

The drawing of 3D shapes involves the process to manipulation and extrapolation of mental image of the shape and students should coordinate different viewpoints in order to drawing the edges and faces in a perspective manner. Some students seemed unable to recognize that the edges of the solid are parts of the edges of other views (See Section 2.3.2.1) such that more than actual hidden edges were drawn and the intersections of hidden lines were not in proper perspective view (See Table 6.2: #a, Table 7.2: ^b and Table 7.8: &d).

(ii) Incomplete drawing of hidden lines

Among all the errors in drawing, the most frequent one consisted of not knowing how to draw part of the edge which was behind, in front of, over or under one face which had been drawn already (See Table 6.2: #b and Table 7.2: ^ c). Incomplete drawing of hidden lines is due to students' inability to determine which edges and faces of the solid are nearer to them. Student faces the problem of overlapping faces and edges, and the need to eliminate hidden lines in their desire to portray the solid shapes in a specific orientation.

(iii) Perpendicular bias

Students found it difficult to draw a line obliquely on to a horizontal line and tended to draw a perpendicular edge of the cube and cylinder to the horizontal baseline (See Table 6.4: #f and Table 7.14: %f). It is a problem of perpendicular bias (Mitchelmore, 1985). Students tended to draw a stable (due to gravitational force) picture while they wanted a perspective view in the upper part of the picture.

Both (i), (ii) and (iii) are a lack of view-specific information that the phenomenon is one of the descriptors for the developmental growth at the Multistructual level of drawings in SOLO Model.

8.3 Implications for the Teaching and Curriculum Design

Previous section has highlighted the difficulties that many students may experience in visualising the 3D geometrical shapes. Students were unable to understand and use correctly the vocabulary to express what they have learned about the properties or definitions of the solid shapes. Perspective drawings do not appear to be a natural development of children (Golomb, 2004, p. 105). The drawing convention is not so intuitive for it needs to distort the shapes on our retina in order to creating a more realistic-looking 3D form. For instance, rectangles are represented by parallelograms for a perspective view. Such representation is counterintuitive and requires a modification of the students' representational concepts. Students have to learn various drawing conventions before they can produce an acceptable drawing of even such a basic solid as a cube (Mitchelmore, 1985, p. 305). In terms of Vygotsky

theory. the findings in Section 8.2 also forces mathematics teachers to consider the dialectical relationships between mathematics and existing cultural artefacts such as texts used, student's other activities including painting. live experiences about architecture and technology (Bussi. 1996. p. 20). While proper descriptions and drawings of 3D geometrical shapes are scientific concepts that it should be taught explicitly in schools, spontaneous concepts from student's live experiences and personal concerns about shapes cannot be separated in the teaching and learning process (Bussi, 1996, p. 14).

Now that this study has established the theory of the developmental growth in understanding the three 3D geometrical shapes (Table 6.7). It is this theory together with other results in the research literature that this study recommends a set of pedagogical knowledge that teachers should implement.

8.3.1 The 3D Geometric Vocabulary

For students who are in the Unistructural Level in descriptions (Table 6.7), teachers have to make sure students understanding the specific 3D geometrical concepts and vocabularies used in 3D geometry. For example, the distinctions between plane figures and 3D shapes that need discussions should include:

- angles and vertices;
- right-angles in squares and perpendicular edges in cubes;
- acute or obtuse angles between lines and angles between planes;
- perpendicular lines and perpendicular planes;
- parallel lines and parallel planes

8.3.2 Conventions in the 3D Geometry Drawings

This study reflects that there is not enough emphasis on dealing with students' misconceptions in teaching the 3D geometry drawings. For students who are in Unistructural Level in drawing (Table 6.7), there needs to be explicit discussions about their ideas in drawing the 3D shapes so that the students can confront their misconceptions. Students need to gain an understanding of mathematical drawing

conventions that are required to follow and they cannot draw what they know about the shapes. For example the sorts of questions that teachers should include:

- How do we represent the depth in the 3D drawing?
- What would a square, rectangle and circle look like in the 3D drawing?
- What are the differences between 2D representational drawings on paper from the physical 3D geometric shapes?

Students have to attempt to use some conventions of oblique drawing in their own work (e.g., drawing things farther away smaller, having parallel lines come closer together, using ellipses for circles, showing parallel edges with parallel lines).

8.3.3 The Static Nature of 2D Representational Drawings on Papers

Any drawing of the geometrical shape is not the shape itself. There are certainly some limitations of any 2D representational drawings of solid shapes on papers for a solid can be viewed from other positions, a distance away or close to the shape. So, every drawing of solid shapes on the textbooks represents only the particularity of the drawing from a specific view. Students should be aware of this particularity and the properties or the structure of a solid shape cannot be identified from such a particular drawing (See Section 2.3.1.2 and Figure 6.1).

8.3.4 Building Up the Coordination Views in VP-ability

Section 8.2.8 has shown that students had difficulties in joining hidden lines in a coordination manner. To make sure that students can build up the accurate mental images of the solids teachers can consider the following activities:

- Using physical model of the 3D geometrical shapes, students change the position and orientation of their viewpoint to watch the shapes in order to know the differences arising in the drawing. Then, they learn to "sees through" to the hidden faces and edges;
- Without physical shapes in front of the students, students mentally sketch front, top, and side views of the 3D shape (See Figure 2.9);
- Students sketch all the different parts together by imagining the shape from

geometric concepts and the properties of the shape;

- Students perform different spatial rotations of the mental images and construct different sketches of the shape.

8.3.5 The Partial Occlusion Technique

In dealing with the front-behind between edges and faces in the 3D drawing, the most common solution is the partial occlusion technique in which all the hidden-lines are in dotted lines. In this study, there were only a few students who could show their drawings using this technique. Whenever a student can successfully use this drawing skill, it shows that the student totally recognises the properties and the structure of the solid shapes.

8.3.6 Hands-on Activities

Triadafillidis (1995) suggested that the teaching of spatial ability should be approached in an 'active' way, incorporating perceptual stimuli referring to the concept with other senses apart from the vision, e.g. by touching, manipulating, constructing and drawing. Triadafillidis also indicated that when a shape was explored haptically, the student had to be aware that exploration should be focused not in manipulating the solid but in viewing the shape. This study has revealed that some students described the shape in terms of their hands-on activities in classes (See Section 6.4.4 and Table 7.13: %13). Teachers should be aware that when students playing with the sticks, clays, papers to form a 3D geometrical shape, students are given a very impressive knowledge about the shape.

8.3.7 Relating 3D Objects in the Real World

When describing 3D shapes, students like to associate the shape with objects in the real world. This finding was replicated in all the four 3D shapes in this study (See Table 6.1: #4, Table 7.3: ^5, Table 7.7: &5 &6, Table 7.13: %6). Vygotskians stress the role of the spontaneous concept for it provides the "live knowledge" for the development of scientific concept in school learning (Moll, 1990, p. 10). Furthermore, this study also reveals that when students find it is difficult to describe

a solid shape, they are likely to describe it in terms of the real world objects. Accordingly, relating the 3D geometrical shapes to the objects of the same shape in the real world is an effective teaching strategy to develop the 3D geometric concepts.

8.3.8 SOLO Levels for the 3D Geometrical Shapes

This study has extended the knowledge of SOLO levels to the 3D geometrical shapes. The findings support the P-U-M-R levels of the SOLO model. A major finding that can be drawn from this study is the set of descriptors of students' developmental representation patterns for the four levels both in the descriptions and drawings (Table 6.7). This set of descriptors is a concern for the formative nature of the assessment. Teachers have to identify student progress or understanding of the 3D geometrical shapes in terms of their SOLO levels and adapt learning activities suggested in the above sections. Teachers, equipped with this knowledge of developmental growth, can now focus the instruction in 3D geometry to be directed more accurately at the students' needs and readiness.

Though upper primary students are in the Concrete Symbolic Mode of the SOLO model, they did not perform well with the 3D geometrical shapes. The curriculum designer should not avoid the inclusion of 3D geometry in the primary mathematics curriculum. Verbal descriptions and perspective drawings of the 3D geometrical shapes are valuable for primary students, and should be taught and discussed explicitly. For introducing concepts, real-life 3D objects related to the 3D geometrical shapes are preferable. The inclusion of 3D geometry is also a response to the widespread concern over secondary school students' lack of understanding of key geometric concepts and the development of spatial abilities of young children (Everett & Mulligan, 2000; Kwon, et al., 2002; Owens, et al., 1999).

8.4 Limitations of the Study

This research has attempted to discover the diversity and patterns of students' drawings and descriptions of the four specified 3D geometrical shapes. The coding of responses is subject to the researcher's personal judgment. However, whatever interpretations of the data the researcher have made, selected cases and detailed

outcomes of the data analysis are also presented in the Appendices so that readers can scrutinize the results of the data analysis and bring their own interpretations to the data. In this way, the researcher claims that the data are shown in a manner sufficiently transparent to allow readers' own judgements.

Overall, the data analysis on the response patterns about the cube was successful. There were three schools and a total of more than 300 samples for cube. The coding process was replicated for three schools and reached a point of data saturation (Charmaz, 2006, p. 96) that there was no more emerging code. Thus the theory of P-U-M-R levels for the cube is well-established. However, there were not enough sampling of responses from triangular prism and pyramid to discriminate each of the U-U-M-R levels, though the response patterns of descriptions and drawings for these two shapes were more or less the same.

Conclusions drawn from the results of this study may be generalised only to the students in Hong Kong who use Chinese as their medium of learning mathematics. Questions remain regarding whether these results are particular to these grades and hybrid cultural experiences of east and west as the majority of people in Hong Kong have adopted western ways in living. It is likely that this study may have different results if conducted for other grade levels or students with English as their medium of learning.

Due to the research ethics, one major shortcoming of this study is that the researcher has no opportunities to interview those students in the study to find out the students' intentions and decisions in making such descriptions and drawings. On the other hand, this shortcoming strengthens the objectivity of the data collected as the researcher could not intervene the learning and teaching activities about the 3D geometrical shapes in the three sample schools.

8.5 Implications for Further Research

The results of this study suggest more questions that are beyond the scope of this research. These questions could form the basis of further research and development.

One question of importance is the hypothesis that P-U-M-R levels of the SOLO

Model can be extended to the 3D geometrical shapes. For the case of cylinder, since there is a curved surface, the response patterns are different from those solid shapes with straight edges and plane surfaces. Students' responses also reveal that their descriptions and drawings are influenced by solid shapes with straight edges and plane surface. While this particular question is not addressed in this study, further investigations are required to work on the group of solid shapes with curved surfaces such as spheres and cones. Cylinder is in fact quite easy to draw. The features of each of the four P-U-M-R levels cannot be sharply identified. It requires clarifying the issue whether or not the four levels of the SOLO Model are valid for learning tasks that are too easy or simple to complete.

This research, based on students' response patterns, has assisted in establishing various practical activities (See Section 8.3) to improve students' spatial ability of the 3D geometrical shapes. Further research needs to use the present framework (Figure 3.4) as a basis for designing a teaching program aimed at improving students' spatial skills. Classroom studies are needed to ascertain the effectiveness of these practical activities.

This study produces very little evidence about the use of mental images (Figure 2.1) in drawing these 3D geometrical shapes. As this internal representation is very personal and idiosyncratic, much further psychological research is needed to investigate the accuracy of the mental image and whether students' difficulties in drawing 3D shapes are due to their inability to draw what they actually image. These issues appear to be vital to our knowledge of how students acquire 3D geometric competencies as well as the cognitive development of students' spatial ability in space.

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Appendix A: Code List

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 22/10/07 08:54:47 AM

Coding scheme:

#_des - a code for the description about cube;

#_draw - a code for the drawing of cube;

_des - a code for the description about cylinder;

_draw - a code for the drawing of cylinder;

&_des - a code for the description about triangular prism;

&_draw - a code for the drawing of triangular prism;

^_des - a code for the description about triangular prism;

^_draw - a code for the drawing of triangular prism;

des - a code for the description about any 3D shape;

draw - a code for the drawing of any 3D shape

no prefix - generic code applied to descriptions and drawing

#_des 12 edges (cube)
#_des 6 faces (cube)
#_des 8 vertices (cube)
#_des Box and others (cube)
#_des Cube description
#_des Cube description at level 1
#_des Cube description at level 2
#_des Cube description at level 3
#_des Cube description at level 4
#_des Mistaken 3 faces (cube)
#_des Mistaken 4 faces (cube)
#_des Mistaken 5 faces (cube)
#_des Mistaken 6 edges (cube)
#_des Mistaken parallelogram (cube)
#_des Mistaken rectangle (cube)
#_des Prism (cube)
#_des Squares (cube)
#_draw Cube drawing
#_draw Cube drawing at level 1
#_draw Cube drawing at level 2
#_draw Cube drawing at level 3

#_draw Cube drawing at level 4
%_des 2 bases (cylinder)
%_des 3 faces (cylinder)
%_des Circle (cylinder)
%_des Circles as bases (cylinder)
%_des Curved surface (cylinder)
%_des Cylinder associated with shapes in daily life (cylinder)
%_des Cylinder description
%_des Cylinder description at level 1
%_des Cylinder description at level 2
%_des Cylinder description at level 3
%_des Cylinder description at level 4
%_des Mistaken as 2 edges (cylinder)
%_des Mistaken as 4 edges (cylinder)
%_des Mistaken as a sphere (cylinder)
%_des Mistaken the middle of the shape as rectangle (cylinder)
%_des Prism (Cylinder)
%_des The shape formed by scrolling a rectangle (cylinder)
%_draw Circle as base (cylinder)
%_draw Cylinder drawing
%_draw Cylinder drawing at level 1
%_draw Cylinder drawing at level 2
%_draw Cylinder drawing at level 3
%_draw Cylinder drawing at level 4
%_draw Ellipse as base (cylinder)
%_draw Four edges (cylinder)
%_draw Three edges (cylinder)
&_des 4 triangles around (pyramid)
&_des 5 faces (pyramid)
&_des 5 vertices (pyramid)
&_des 8 edges (pyramid)
&_des Eygpt (pyramid)
&_des Funnel and others (pyramid)
&_des Mistaken 4 faces (pyramid)
&_des Mistaken 4 vertices (pyramid)
&_des Mistaken 7 edges (pyramid)
&_des Mistaken 9 edges (pyramid)
&_des Mistaken as cone (pyramid)
&_des Mistaken as tetrahedron (pyramid)
&_des Mistaken square base as parallelogram (pyramid)
&_des Mistaken square base as rectangle (pyramid)
&_des Pyramid description
&_des Pyramid description at level 1
&_des Pyramid description at level 2
&_des Pyramid description at level 3
&_des Pyramid description at level 4
&_des Roof of clock tower (pyramid)
&_des Square base (pyramid)
&_draw Mistaken as cone (pyramid)
&_draw Mistaken as tetrahedron (pyramid)
&_draw No structure of square base (pyramid)
&_draw Pyramid drawing
&_draw Pyramid drawing at level 1
&_draw Pyramid drawing at level 2
&_draw Pyramid drawing at level 3
&_draw Pyramid drawing at level 4
^ Triangular prism as tetrahedron

^_des 5 faces (triangular prism)
^_des 6 vertices (triangular prism)
^_des 9 edges (triangular prism)
^_des Chocolate bar (triangular prism)
^_des Mistaken 4 faces (triangular prism)
^_des Mistaken parallelogram (triangular prism)
^_des Mistaken trapezium (triangular prism)
^_des Prism (triangular prism)
^_des Rectangle (triangular prism)
^_des Triangle (triangular prism)
^_des Triangular prism description
^_des Triangular prism description at level 1
^_des Triangular prism description at level 2
^_des Triangular prism description at level 3
^_des Triangular prism description at level 4
^_draw Triangular prism drawing
^_draw Triangular prism drawing at level 1
^_draw Triangular prism drawing at level 2
^_draw Triangular prism drawing at level 3
^_draw Triangular prism drawing at level 4
des_Describing with 2D terms
des_Few information in description
des_Incorrect description (general)
des_Perfect description
des_SOLO level %1
des_SOLO level %2
des_SOLO level %3
des_SOLO level %4
draw_Hidden lines not in coordination
draw_Incomplete drawing of hidden lines
draw_Nontransparent
draw_Not in perspective view
draw_Perfect drawing
draw_Perpendicular edges
draw_SOLO level %1
draw_SOLO level %2
draw_SOLO level %3
draw_SOLO level %4
draw_Some or all seen faces are drawn in a 2D format
Unable to describe/draw any features

Appendix B: Cooccurring Codes for Cube Descriptions

HU: merger
File: [D:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 22/10/07 12:23:11

#_des Cube description at level 1 {95-6}~ [16]

#_des 6 faces (cube) {121-4}~ [4]
549:3 siu6A_0041.jpg (2005:2124):
549:4 siu6A_0041.jpg (2027:2076):
671:3 rose5A_0023.jpg (1864:1960):
671:4 rose5A_0023.jpg (1717:2103):

#_des 8 vertices (cube) {58-2}~ [2]
549:3 siu6A_0041.jpg (2005:2124):
549:5 siu6A_0041.jpg (2031:2099):

#_des Box and others (cube) {33-2}~ [4]
639:2 rose4B__0086.jpg (1751:2114):
639:3 rose4B__0086.jpg (1777:1853):
643:3 rose4B__0092.jpg (1760:1978):
643:5 rose4B__0092.jpg (1872:1966):

#_des Cube description {297-0} [95]
2:1 wu4A_0002.jpg (454:574):
10:1 wu4A_0010.jpg (424:737):
14:1 wu4A_0014.jpg (367:629):
22:1 wu4A_0022.jpg (460:563):
30:1 wu4A_0030.jpg (451:764):
42:1 wu4A_0042.jpg (414:702):
46:1 wu4A_0046.jpg (423:606):
58:1 wu4A_0058.jpg (417:592):
70:1 wu4A_0070.jpg (412:700):
78:1 wu4A_0078.jpg (426:597):
82:1 wu4A_0082.jpg (429:569):
90:1 wu4A_0090.jpg (434:595):
94:1 wu4A_0094.jpg (403:712):
98:1 wu4A_0098.jpg (467:593):
102:1 wu4A_0102.jpg (423:606):
106:1 wu4A_0106.jpg (423:595):
110:1 wu4A_0110.jpg (482:949):
126:1 wu4A_0126.jpg (345:702):
134:1 wu4A_0134.jpg (426:600):
138:1 wu4A_0138.jpg (436:591):
150:1 wu4A_0150.jpg (480:574):
154:1 wu5A__0002.jpg (395:600):
166:1 wu5A__0014.jpg (401:716):
170:1 wu5A__0018.jpg (414:634):
186:1 wu5A__0034.jpg (441:703):
190:1 wu5A__0038.jpg (431:578):
194:1 wu5A__0042.jpg (443:563):
202:1 wu5A__0050.jpg (447:562):
206:1 wu5A__0054.jpg (323:540):
210:1 wu5A__0058.jpg (453:596):
218:1 wu5A__0066.jpg (410:567):
226:1 wu5A__0074.jpg (386:566):
230:1 wu5A__0078.jpg (429:583):
238:1 wu5A__0086.jpg (460:569):
242:1 wu5A__0090.jpg (467:605):
246:1 wu5A__0094.jpg (425:626):
250:1 wu5A__0098.jpg (444:573):
262:1 wu5A__0110.jpg (334:706):
266:1 wu5A__0114.jpg (433:922):
274:1 wu6A__0002.jpg (428:686):
278:1 wu6A__0006.jpg (386:563):
306:1 wu6A__0034.jpg (406:580):
314:1 wu6A__0042.jpg (458:581):

318:1 wu6A__0046.jpg (443:706):
326:1 wu6A__0054.jpg (417:603):
330:1 wu6A__0058.jpg (436:729):
334:1 wu6A__0062.jpg (437:574):
350:1 wu6A__0078.jpg (431:698):
354:1 wu6A__0082.jpg (423:595):
362:1 wu6A__0090.jpg (397:580):
366:1 wu6A__0094.jpg (434:715):
370:1 wu6A__0098.jpg (440:606):
374:1 wu6A__0102.jpg (433:563):
378:1 wu6A__0106.jpg (443:578):
382:1 wu6A__0110.jpg (438:608):
386:1 wu6A__0114.jpg (476:706):
406:1 wu6A__0134.jpg (412:697):
413:2 siu4D_0002.jpg (1965:2277):
423:2 siu4D_0017.jpg (1957:2285):
427:2 siu4D_0023.jpg (1996:2267):
429:2 siu4D_0026.jpg (1995:2250):
431:2 siu4D_0029.jpg (2001:2265):
435:3 siu4D_0035.jpg (1965:2279):
447:2 siu4D_0053.jpg (2011:2154):
449:3 siu4D_0056.jpg (1930:2416):
453:4 siu4D_0062.jpg (1949:2153):
457:2 siu4D_0068.jpg (1981:2245):
461:2 siu4D_0074.jpg (1979:2131):
465:2 siu4D_0080.jpg (1978:2138):
467:3 siu4D_0083.jpg (2000:2259):
469:2 siu4D_0086.jpg (1995:2277):
473:2 siu4D_0092.jpg (1973:2278):
475:3 siu5B_0002.jpg (2021:2419):
481:2 siu5B_0011.jpg (2005:2229):
485:3 siu5B_0017.jpg (2002:2439):
487:2 siu5B_0020.jpg (2022:2280):
489:3 siu5B_0023.jpg (2025:2305):
501:3 siu5B_0041.jpg (2031:2274):
505:2 siu5B_0047.jpg (1994:2286):
507:3 siu5B_0050.jpg (2004:2273):
513:2 siu5B_0059.jpg (2014:2141):
515:2 siu5B_0062.jpg (1979:2183):
549:3 siu6A_0041.jpg (2005:2124):
567:2 siu6A_0068.jpg (2001:2142):
595:1 rose4B__0020.jpg (1781:1968):
601:2 rose4B__0029.jpg (1728:1860):
639:2 rose4B__0086.jpg (1751:2114):
643:3 rose4B__0092.jpg (1760:1978):
645:2 rose4B__0095.jpg (1757:1878):
671:4 rose5A_0023.jpg (1717:2103):
675:2 rose5A_0029.jpg (1704:1855):
685:2 rose5A_0044.jpg (1742:1985):
691:3 rose5A_0053.jpg (1724:2004):
701:2 rose5A_0068.jpg (1711:1978):
707:2 rose5A_0077.jpg (1724:1884):

#_des Mistaken 3 faces (cube) {2-2}~ [4]
326:1 wu6A__0054.jpg (417:603):
326:2 wu6A__0054.jpg (467:566):
643:3 rose4B__0092.jpg (1760:1978):
643:4 rose4B__0092.jpg (1763:1858):

#_des Mistaken 4 faces (cube) {4-0}~ [2]
501:3 siu5B_0041.jpg (2031:2274):
501:5 siu5B_0041.jpg (2061:2109):

#_des Mistaken 6 edges (cube) {3-1}~ [4]
501:3 siu5B_0041.jpg (2031:2274):
501:4 siu5B_0041.jpg (2174:2271):
643:3 rose4B__0092.jpg (1760:1978):
643:6 rose4B__0092.jpg (1746:1855):

#_des Mistaken parallelogram (cube) {3-0}~ [2]
507:3 siu5B_0050.jpg (2004:2273):
507:4 siu5B_0050.jpg (2032:2106):

#_des Mistaken rectangle (cube) {8-0}~ [4]
230:1 wu5A__0078.jpg (429:583):

230:2 wu5A__0078.jpg (452:540):
507:3 siu5B_0050.jpg (2004:2273):
507:5 siu5B_0050.jpg (2027:2120):
#_des Prism (cube) {17-1}~ [2]
685:2 rose5A_0044.jpg (1742:1985):
685:3 rose5A_0044.jpg (1867:1967):
#_des Squares (cube) {103-3}~ [5]
595:1 rose4B__0020.jpg (1781:1968):
595:2 rose4B__0020.jpg (1778:1851):
601:2 rose4B__0029.jpg (1728:1860):
671:2 rose5A_0023.jpg (1738:1834):
671:4 rose5A_0023.jpg (1717:2103):
des_Describing with 2D terms {71-4}~ [27]
70:1 wu4A_0070.jpg (412:700):
102:1 wu4A_0102.jpg (423:606):
126:1 wu4A_0126.jpg (345:702):
126:2 wu4A_0126.jpg (531:664):
134:1 wu4A_0134.jpg (426:600):
138:1 wu4A_0138.jpg (436:591):
150:1 wu4A_0150.jpg (480:574):
186:1 wu5A__0034.jpg (441:703):
190:1 wu5A__0038.jpg (431:578):
194:1 wu5A__0042.jpg (443:563):
206:1 wu5A__0054.jpg (323:540):
230:1 wu5A__0078.jpg (429:583):
238:1 wu5A__0086.jpg (460:569):
242:1 wu5A__0090.jpg (467:605):
278:1 wu6A__0006.jpg (386:563):
306:1 wu6A__0034.jpg (406:580):
330:1 wu6A__0058.jpg (436:729):
350:1 wu6A__0078.jpg (431:698):
366:1 wu6A__0094.jpg (434:715):
370:1 wu6A__0098.jpg (440:606):
378:1 wu6A__0106.jpg (443:578):
429:2 siu4D_0026.jpg (1995:2250):
595:1 rose4B__0020.jpg (1781:1968):
595:2 rose4B__0020.jpg (1778:1851):
601:2 rose4B__0029.jpg (1728:1860):
601:3 rose4B__0029.jpg (1738:1854):
691:3 rose5A_0053.jpg (1724:2004):
des_Few information in description {94-4}~ [30]
2:1 wu4A_0002.jpg (454:574):
10:1 wu4A_0010.jpg (424:737):
42:1 wu4A_0042.jpg (414:702):
46:1 wu4A_0046.jpg (423:606):
58:1 wu4A_0058.jpg (417:592):
70:1 wu4A_0070.jpg (412:700):
78:1 wu4A_0078.jpg (426:597):
202:1 wu5A__0050.jpg (447:562):
210:1 wu5A__0058.jpg (453:596):
218:1 wu5A__0066.jpg (410:567):
226:1 wu5A__0074.jpg (386:566):
250:1 wu5A__0098.jpg (444:573):
262:1 wu5A__0110.jpg (334:706):
306:1 wu6A__0034.jpg (406:580):
314:1 wu6A__0042.jpg (458:581):
318:1 wu6A__0046.jpg (443:706):
330:1 wu6A__0058.jpg (436:729):
334:1 wu6A__0062.jpg (437:574):
362:1 wu6A__0090.jpg (397:580):
406:1 wu6A__0134.jpg (412:697):
427:2 siu4D_0023.jpg (1996:2267):
429:2 siu4D_0026.jpg (1995:2250):
447:2 siu4D_0053.jpg (2011:2154):
449:3 siu4D_0056.jpg (1930:2416):
473:2 siu4D_0092.jpg (1973:2278):
485:3 siu5B_0017.jpg (2002:2439):
567:2 siu6A_0068.jpg (2001:2142):
595:1 rose4B__0020.jpg (1781:1968):
601:2 rose4B__0029.jpg (1728:1860):

645:2 rose4B__0095.jpg (1757:1878):
des_Incorrect description (general) {43-3}~ [11]
106:1 wu4A_0106.jpg (423:595):
106:2 wu4A_0106.jpg (480:560):
423:2 siu4D_0017.jpg (1957:2285):
431:2 siu4D_0029.jpg (2001:2265):
507:3 siu5B_0050.jpg (2004:2273):
507:6 siu5B_0050.jpg (2155:2259):
515:2 siu5B_0062.jpg (1979:2183):
639:2 rose4B__0086.jpg (1751:2114):
671:4 rose5A_0023.jpg (1717:2103):
671:5 rose5A_0023.jpg (1759:1840):
701:2 rose5A_0068.jpg (1711:1978):
des_SOLO level %1 {187-0}~ [95]
2:1 wu4A_0002.jpg (454:574):
10:1 wu4A_0010.jpg (424:737):
14:1 wu4A_0014.jpg (367:629):
22:1 wu4A_0022.jpg (460:563):
30:1 wu4A_0030.jpg (451:764):
42:1 wu4A_0042.jpg (414:702):
46:1 wu4A_0046.jpg (423:606):
58:1 wu4A_0058.jpg (417:592):
70:1 wu4A_0070.jpg (412:700):
78:1 wu4A_0078.jpg (426:597):
82:1 wu4A_0082.jpg (429:569):
90:1 wu4A_0090.jpg (434:595):
94:1 wu4A_0094.jpg (403:712):
98:1 wu4A_0098.jpg (467:593):
102:1 wu4A_0102.jpg (423:606):
106:1 wu4A_0106.jpg (423:595):
110:1 wu4A_0110.jpg (482:949):
126:1 wu4A_0126.jpg (345:702):
134:1 wu4A_0134.jpg (426:600):
138:1 wu4A_0138.jpg (436:591):
150:1 wu4A_0150.jpg (480:574):
154:1 wu5A__0002.jpg (395:600):
166:1 wu5A__0014.jpg (401:716):
170:1 wu5A__0018.jpg (414:634):
186:1 wu5A__0034.jpg (441:703):
190:1 wu5A__0038.jpg (431:578):
194:1 wu5A__0042.jpg (443:563):
202:1 wu5A__0050.jpg (447:562):
206:1 wu5A__0054.jpg (323:540):
210:1 wu5A__0058.jpg (453:596):
218:1 wu5A__0066.jpg (410:567):
226:1 wu5A__0074.jpg (386:566):
230:1 wu5A__0078.jpg (429:583):
238:1 wu5A__0086.jpg (460:569):
242:1 wu5A__0090.jpg (467:605):
246:1 wu5A__0094.jpg (425:626):
250:1 wu5A__0098.jpg (444:573):
262:1 wu5A__0110.jpg (334:706):
266:1 wu5A__0114.jpg (433:922):
274:1 wu6A__0002.jpg (428:686):
278:1 wu6A__0006.jpg (386:563):
306:1 wu6A__0034.jpg (406:580):
314:1 wu6A__0042.jpg (458:581):
318:1 wu6A__0046.jpg (443:706):
326:1 wu6A__0054.jpg (417:603):
330:1 wu6A__0058.jpg (436:729):
334:1 wu6A__0062.jpg (437:574):
350:1 wu6A__0078.jpg (431:698):
354:1 wu6A__0082.jpg (423:595):
362:1 wu6A__0090.jpg (397:580):
366:1 wu6A__0094.jpg (434:715):
370:1 wu6A__0098.jpg (440:606):
374:1 wu6A__0102.jpg (433:563):
378:1 wu6A__0106.jpg (443:578):
382:1 wu6A__0110.jpg (438:608):
386:1 wu6A__0114.jpg (476:706):
406:1 wu6A__0134.jpg (412:697):

413:2 siu4D_0002.jpg (1965:2277):
423:2 siu4D_0017.jpg (1957:2285):
427:2 siu4D_0023.jpg (1996:2267):
429:2 siu4D_0026.jpg (1995:2250):
431:2 siu4D_0029.jpg (2001:2265):
435:3 siu4D_0035.jpg (1965:2279):
447:2 siu4D_0053.jpg (2011:2154):
449:3 siu4D_0056.jpg (1930:2416):
453:4 siu4D_0062.jpg (1949:2153):
457:2 siu4D_0068.jpg (1981:2245):
461:2 siu4D_0074.jpg (1979:2131):
465:2 siu4D_0080.jpg (1978:2138):
467:3 siu4D_0083.jpg (2000:2259):
469:2 siu4D_0086.jpg (1995:2277):
473:2 siu4D_0092.jpg (1973:2278):
475:3 siu5B_0002.jpg (2021:2419):
481:2 siu5B_0011.jpg (2005:2229):
485:3 siu5B_0017.jpg (2002:2439):
487:2 siu5B_0020.jpg (2022:2280):
489:3 siu5B_0023.jpg (2025:2305):
501:3 siu5B_0041.jpg (2031:2274):
505:2 siu5B_0047.jpg (1994:2286):
507:3 siu5B_0050.jpg (2004:2273):
513:2 siu5B_0059.jpg (2014:2141):
515:2 siu5B_0062.jpg (1979:2183):
549:3 siu6A_0041.jpg (2005:2124):
567:2 siu6A_0068.jpg (2001:2142):
595:1 rose4B__0020.jpg (1781:1968):
601:2 rose4B__0029.jpg (1728:1860):
639:2 rose4B__0086.jpg (1751:2114):
643:3 rose4B__0092.jpg (1760:1978):
645:2 rose4B__0095.jpg (1757:1878):
671:4 rose5A_0023.jpg (1717:2103):
675:2 rose5A_0029.jpg (1704:1855):
685:2 rose5A_0044.jpg (1742:1985):
691:3 rose5A_0053.jpg (1724:2004):
701:2 rose5A_0068.jpg (1711:1978):
707:2 rose5A_0077.jpg (1724:1884):
Unable to describe/draw any features {96-4} [35]
14:1 wu4A_0014.jpg (367:629):
22:1 wu4A_0022.jpg (460:563):
30:1 wu4A_0030.jpg (451:764):
82:1 wu4A_0082.jpg (429:569):
90:1 wu4A_0090.jpg (434:595):
94:1 wu4A_0094.jpg (403:712):
98:1 wu4A_0098.jpg (467:593):
110:1 wu4A_0110.jpg (482:949):
154:1 wu5A__0002.jpg (395:600):
166:1 wu5A__0014.jpg (401:716):
170:1 wu5A__0018.jpg (414:634):
246:1 wu5A__0094.jpg (425:626):
266:1 wu5A__0114.jpg (433:922):
274:1 wu6A__0002.jpg (428:686):
354:1 wu6A__0082.jpg (423:595):
374:1 wu6A__0102.jpg (433:563):
382:1 wu6A__0110.jpg (438:608):
386:1 wu6A__0114.jpg (476:706):
413:2 siu4D_0002.jpg (1965:2277):
435:3 siu4D_0035.jpg (1965:2279):
453:4 siu4D_0062.jpg (1949:2153):
457:2 siu4D_0068.jpg (1981:2245):
461:2 siu4D_0074.jpg (1979:2131):
465:2 siu4D_0080.jpg (1978:2138):
467:3 siu4D_0083.jpg (2000:2259):
469:2 siu4D_0086.jpg (1995:2277):
475:3 siu5B_0002.jpg (2021:2419):
481:2 siu5B_0011.jpg (2005:2229):
487:2 siu5B_0020.jpg (2022:2280):
489:3 siu5B_0023.jpg (2025:2305):
505:2 siu5B_0047.jpg (1994:2286):
513:2 siu5B_0059.jpg (2014:2141):

675:2 rose5A_0029.jpg (1704:1855):
685:2 rose5A_0044.jpg (1742:1985):
707:2 rose5A_0077.jpg (1724:1884):

#_des Cube description at level 2 {113-7}~ [16]

#_des 12 edges (cube) {57-2}~ [28]

198:1 wu5A__0046.jpg (468:578):
198:3 wu5A__0046.jpg (488:538):
270:1 wu5A__0118.jpg (426:696):
270:3 wu5A__0118.jpg (593:663):
282:1 wu6A__0010.jpg (467:582):
282:2 wu6A__0010.jpg (489:564):
298:1 wu6A__0026.jpg (431:816):
298:2 wu6A__0026.jpg (463:551):
302:1 wu6A__0030.jpg (472:723):
302:2 wu6A__0030.jpg (486:554):
310:1 wu6A__0038.jpg (432:609):
310:3 wu6A__0038.jpg (483:552):
342:1 wu6A__0070.jpg (423:641):
342:2 wu6A__0070.jpg (478:556):
346:1 wu6A__0074.jpg (436:611):
346:3 wu6A__0074.jpg (480:549):
479:3 siu5B_0008.jpg (1996:2291):
479:6 siu5B_0008.jpg (2138:2259):
525:2 siu6A_0005.jpg (1993:2285):
525:4 siu6A_0005.jpg (2137:2257):
533:3 siu6A_0017.jpg (1997:2131):
533:5 siu6A_0017.jpg (2023:2105):
557:2 siu6A_0053.jpg (1985:2107):
557:4 siu6A_0053.jpg (2007:2097):
575:2 siu6A_0080.jpg (1985:2449):
575:3 siu6A_0080.jpg (2137:2273):
577:2 siu6A_0083.jpg (2031:2149):
577:4 siu6A_0083.jpg (2031:2112):

#_des 6 faces (cube) {121-4}~ [92]

6:1 wu4A_0006.jpg (420:703):
6:2 wu4A_0006.jpg (472:566):
34:1 wu4A_0034.jpg (392:692):
34:2 wu4A_0034.jpg (417:503):
54:1 wu4A_0054.jpg (421:907):
54:2 wu4A_0054.jpg (444:558):
62:1 wu4A_0062.jpg (430:567):
62:2 wu4A_0062.jpg (460:540):
74:1 wu4A_0074.jpg (391:733):
74:2 wu4A_0074.jpg (452:543):
114:1 wu4A_0114.jpg (403:606):
114:2 wu4A_0114.jpg (437:552):
162:1 wu5A__0010.jpg (420:574):
162:2 wu5A__0010.jpg (443:537):
174:1 wu5A__0022.jpg (432:697):
174:2 wu5A__0022.jpg (477:546):
198:1 wu5A__0046.jpg (468:578):
198:2 wu5A__0046.jpg (483:543):
222:1 wu5A__0070.jpg (375:701):
222:2 wu5A__0070.jpg (448:561):
254:1 wu5A__0102.jpg (397:589):
254:2 wu5A__0102.jpg (420:537):
282:1 wu6A__0010.jpg (467:582):
282:3 wu6A__0010.jpg (498:549):
298:1 wu6A__0026.jpg (431:816):
298:4 wu6A__0026.jpg (596:691):
302:1 wu6A__0030.jpg (472:723):
302:3 wu6A__0030.jpg (489:546):
425:2 siu4D_0020.jpg (1990:2131):
425:3 siu4D_0020.jpg (2013:2097):
437:1 siu4D_0038.jpg (2033:2148):
437:3 siu4D_0038.jpg (2033:2116):
455:3 siu4D_0065.jpg (1971:2249):
455:4 siu4D_0065.jpg (1978:2112):

477:2 siu5B_0005.jpg (1986:2462):
477:3 siu5B_0005.jpg (2125:2277):
479:3 siu5B_0008.jpg (1996:2291):
479:4 siu5B_0008.jpg (2005:2132):
491:2 siu5B_0026.jpg (2016:2196):
491:3 siu5B_0026.jpg (2036:2130):
495:2 siu5B_0032.jpg (1976:2425):
495:3 siu5B_0032.jpg (2251:2402):
497:2 siu5B_0035.jpg (1997:2293):
497:3 siu5B_0035.jpg (2041:2109):
511:2 siu5B_0056.jpg (2013:2300):
511:4 siu5B_0056.jpg (2166:2282):
519:3 siu5B_0068.jpg (1986:2216):
519:4 siu5B_0068.jpg (2038:2116):
529:2 siu6A_0011.jpg (2005:2095):
529:3 siu6A_0011.jpg (1990:2141):
563:2 siu6A_0062.jpg (1989:2133):
563:3 siu6A_0062.jpg (2001:2105):
573:2 siu6A_0077.jpg (2039:2127):
573:4 siu6A_0077.jpg (2056:2110):
579:2 siu6A_0086.jpg (1972:2125):
579:4 siu6A_0086.jpg (1995:2101):
591:2 rose4B__0014.jpg (1734:2021):
591:5 rose4B__0014.jpg (1764:1838):
663:3 rose5A_0011.jpg (1744:2126):
663:5 rose5A_0011.jpg (1891:1978):
679:2 rose5A_0035.jpg (1757:1984):
679:3 rose5A_0035.jpg (1767:1844):
683:2 rose5A_0041.jpg (1738:1872):
683:3 rose5A_0041.jpg (1764:1835):
721:2 rose5A_0098.jpg (1752:1881):
721:3 rose5A_0098.jpg (1775:1849):
729:2 rose6D_0002.jpg (1755:1966):
729:3 rose6D_0002.jpg (1778:1840):
743:2 rose6D_0023.jpg (1766:1978):
743:3 rose6D_0023.jpg (1766:1844):
757:2 rose6D_0044.jpg (1735:1872):
757:3 rose6D_0044.jpg (1769:1838):
759:3 rose6D_0047.jpg (1739:1880):
759:4 rose6D_0047.jpg (1764:1834):
769:2 rose6D_0062.jpg (1767:1964):
769:3 rose6D_0062.jpg (1771:1821):
775:2 rose6D_0071.jpg (1747:2124):
775:3 rose6D_0071.jpg (1764:1854):
777:2 rose6D_0074.jpg (1741:2091):
777:3 rose6D_0074.jpg (1874:1971):
779:2 rose6D_0077.jpg (1758:2006):
779:3 rose6D_0077.jpg (1760:1832):
783:2 rose6D_0083.jpg (1754:2111):
783:3 rose6D_0083.jpg (1771:1841):
785:2 rose6D_0086.jpg (1763:1998):
785:3 rose6D_0086.jpg (1763:1852):
787:3 rose6D_0089.jpg (1721:1984):
787:4 rose6D_0089.jpg (1874:1961):
793:2 rose6D_0098.jpg (1741:2081):
793:3 rose6D_0098.jpg (1767:1831):
797:2 rose6D_0104.jpg (1755:2002):
797:3 rose6D_0104.jpg (1782:1844):

#_des 8 vertices (cube) {58-2}~ [31]

254:1 wu5A__0102.jpg (397:589):
254:3 wu5A__0102.jpg (412:549):
270:1 wu5A__0118.jpg (426:696):
270:2 wu5A__0118.jpg (461:548):
282:1 wu6A__0010.jpg (467:582):
282:4 wu6A__0010.jpg (500:544):
310:1 wu6A__0038.jpg (432:609):
310:2 wu6A__0038.jpg (472:574):
342:1 wu6A__0070.jpg (423:641):
342:3 wu6A__0070.jpg (481:551):
346:1 wu6A__0074.jpg (436:611):
346:2 wu6A__0074.jpg (466:549):

463:2 siu4D_0077.jpg (1990:2282):
463:3 siu4D_0077.jpg (2016:2091):
479:3 siu5B_0008.jpg (1996:2291):
479:5 siu5B_0008.jpg (2004:2106):
503:3 siu5B_0044.jpg (1997:2411):
511:2 siu5B_0056.jpg (2013:2300):
511:3 siu5B_0056.jpg (2013:2143):
525:2 siu6A_0005.jpg (1993:2285):
525:3 siu6A_0005.jpg (2009:2101):
533:3 siu6A_0017.jpg (1997:2131):
533:4 siu6A_0017.jpg (2012:2094):
557:2 siu6A_0053.jpg (1985:2107):
557:3 siu6A_0053.jpg (2015:2097):
563:2 siu6A_0062.jpg (1989:2133):
563:4 siu6A_0062.jpg (1989:2097):
577:2 siu6A_0083.jpg (2031:2149):
577:3 siu6A_0083.jpg (2053:2131):
775:2 rose6D_0071.jpg (1747:2124):
775:6 rose6D_0071.jpg (2025:2078):

#_des Box and others (cube) {33-2}~ [19]

50:1 wu4A_0050.jpg (437:720):
50:2 wu4A_0050.jpg (592:663):
86:1 wu4A_0086.jpg (421:626):
417:2 siu4D_0008.jpg (1986:2290):
417:3 siu4D_0008.jpg (2138:2271):
483:2 siu5B_0014.jpg (1968:2155):
483:3 siu5B_0014.jpg (2002:2107):
517:3 siu5B_0065.jpg (2031:2281):
517:4 siu5B_0065.jpg (2173:2258):
555:2 siu6A_0050.jpg (2001:2138):
555:3 siu6A_0050.jpg (1979:2083):
619:2 rose4B__0056.jpg (1904:1978):
619:6 rose4B__0056.jpg (1763:2012):
633:3 rose4B__0077.jpg (1760:1986):
633:5 rose4B__0077.jpg (1892:1975):
651:2 rose4B__0104.jpg (1743:1857):
651:4 rose4B__0104.jpg (1772:1843):
787:3 rose6D_0089.jpg (1721:1984):
787:5 rose6D_0089.jpg (1741:1838):

#_des Cube description {297-0} [113]

6:1 wu4A_0006.jpg (420:703):
18:1 wu4A_0018.jpg (455:594):
34:1 wu4A_0034.jpg (392:692):
38:1 wu4A_0038.jpg (401:721):
50:1 wu4A_0050.jpg (437:720):
54:1 wu4A_0054.jpg (421:907):
62:1 wu4A_0062.jpg (430:567):
66:1 wu4A_0066.jpg (468:691):
74:1 wu4A_0074.jpg (391:733):
86:1 wu4A_0086.jpg (421:626):
114:1 wu4A_0114.jpg (403:606):
118:1 wu4A_0118.jpg (454:675):
122:1 wu4A_0122.jpg (438:809):
130:1 wu4A_0130.jpg (372:668):
142:1 wu4A_0142.jpg (440:692):
146:1 wu4A_0146.jpg (440:717):
158:1 wu5A__0006.jpg (441:711):
162:1 wu5A__0010.jpg (420:574):
174:1 wu5A__0022.jpg (432:697):
178:1 wu5A__0026.jpg (426:692):
198:1 wu5A__0046.jpg (468:578):
222:1 wu5A__0070.jpg (375:701):
254:1 wu5A__0102.jpg (397:589):
258:1 wu5A__0106.jpg (397:680):
270:1 wu5A__0118.jpg (426:696):
282:1 wu6A__0010.jpg (467:582):
286:1 wu6A__0014.jpg (443:598):
290:1 wu6A__0018.jpg (444:607):
294:1 wu6A__0022.jpg (446:831):
298:1 wu6A__0026.jpg (431:816):
302:1 wu6A__0030.jpg (472:723):

310:1 wu6A__0038.jpg (432:609):
322:1 wu6A__0050.jpg (429:691):
342:1 wu6A__0070.jpg (423:641):
346:1 wu6A__0074.jpg (436:611):
358:1 wu6A__0086.jpg (453:598):
394:1 wu6A__0122.jpg (446:603):
398:1 wu6A__0126.jpg (417:686):
402:1 wu6A__0130.jpg (420:677):
415:3 siu4D_0005.jpg (1953:2285):
417:2 siu4D_0008.jpg (1986:2290):
419:2 siu4D_0011.jpg (2009:2290):
425:2 siu4D_0020.jpg (1990:2131):
433:2 siu4D_0032.jpg (2021:2275):
437:1 siu4D_0038.jpg (2033:2148):
439:3 siu4D_0041.jpg (1989:2281):
441:2 siu4D_0044.jpg (2016:2133):
443:2 siu4D_0047.jpg (2005:2449):
445:2 siu4D_0050.jpg (1981:2249):
455:3 siu4D_0065.jpg (1971:2249):
463:2 siu4D_0077.jpg (1990:2282):
477:2 siu5B_0005.jpg (1986:2462):
479:3 siu5B_0008.jpg (1996:2291):
483:2 siu5B_0014.jpg (1968:2155):
491:2 siu5B_0026.jpg (2016:2196):
495:2 siu5B_0032.jpg (1976:2425):
497:2 siu5B_0035.jpg (1997:2293):
503:3 siu5B_0044.jpg (1997:2411):
511:2 siu5B_0056.jpg (2013:2300):
517:3 siu5B_0065.jpg (2031:2281):
519:3 siu5B_0068.jpg (1986:2216):
521:2 siu5B_0071.jpg (1989:2253):
525:2 siu6A_0005.jpg (1993:2285):
529:3 siu6A_0011.jpg (1990:2141):
533:3 siu6A_0017.jpg (1997:2131):
555:2 siu6A_0050.jpg (2001:2138):
557:2 siu6A_0053.jpg (1985:2107):
563:2 siu6A_0062.jpg (1989:2133):
573:2 siu6A_0077.jpg (2039:2127):
575:2 siu6A_0080.jpg (1985:2449):
577:2 siu6A_0083.jpg (2031:2149):
579:2 siu6A_0086.jpg (1972:2125):
583:2 rose4B__0002.jpg (1745:1973):
591:2 rose4B__0014.jpg (1734:2021):
597:2 rose4B__0023.jpg (1741:1875):
605:3 rose4B__0035.jpg (1763:2114):
609:2 rose4B__0041.jpg (1766:1875):
619:6 rose4B__0056.jpg (1763:2012):
625:2 rose4B__0065.jpg (1734:1858):
627:1 rose4B__0068.jpg (1764:1981):
629:2 rose4B__0071.jpg (1748:1868):
631:2 rose4B__0074.jpg (1755:2089):
633:3 rose4B__0077.jpg (1760:1986):
641:2 rose4B__0089.jpg (1773:2023):
651:2 rose4B__0104.jpg (1743:1857):
653:2 rose4B__0107.jpg (1772:1998):
661:2 rose5A_0008.jpg (1744:1979):
663:3 rose5A_0011.jpg (1744:2126):
665:2 rose5A_0014.jpg (1705:1988):
677:2 rose5A_0032.jpg (1749:1969):
679:2 rose5A_0035.jpg (1757:1984):
683:2 rose5A_0041.jpg (1738:1872):
687:3 rose5A_0047.jpg (1727:1991):
695:3 rose5A_0059.jpg (1749:1880):
713:2 rose5A_0086.jpg (1745:1880):
717:2 rose5A_0092.jpg (1732:1979):
719:3 rose5A_0095.jpg (1748:1868):
721:2 rose5A_0098.jpg (1752:1881):
729:2 rose6D_0002.jpg (1755:1966):
743:2 rose6D_0023.jpg (1766:1978):
757:2 rose6D_0044.jpg (1735:1872):
759:3 rose6D_0047.jpg (1739:1880):

769:2 rose6D_0062.jpg (1767:1964):
771:1 rose6D_0065.jpg (1744:1961):
775:2 rose6D_0071.jpg (1747:2124):
777:2 rose6D_0074.jpg (1741:2091):
779:2 rose6D_0077.jpg (1758:2006):
781:3 rose6D_0080.jpg (1752:1997):
783:2 rose6D_0083.jpg (1754:2111):
785:2 rose6D_0086.jpg (1763:1998):
787:3 rose6D_0089.jpg (1721:1984):
793:2 rose6D_0098.jpg (1741:2081):
797:2 rose6D_0104.jpg (1755:2002):
#_des Mistaken 4 faces (cube) {4-0}~ [6]
443:2 siu4D_0047.jpg (2005:2449):
443:4 siu4D_0047.jpg (2177:2277):
583:2 rose4B__0002.jpg (1745:1973):
583:3 rose4B__0002.jpg (1755:1850):
597:2 rose4B__0023.jpg (1741:1875):
597:3 rose4B__0023.jpg (1756:1834):
#_des Mistaken 5 faces (cube) {1-0}~ [2]
609:2 rose4B__0041.jpg (1766:1875):
609:3 rose4B__0041.jpg (1783:1843):
#_des Mistaken 6 edges (cube) {3-1}~ [2]
619:3 rose4B__0056.jpg (1775:1855):
619:6 rose4B__0056.jpg (1763:2012):
#_des Mistaken parallelogram (cube) {3-0}~ [4]
294:1 wu6A__0022.jpg (446:831):
294:3 wu6A__0022.jpg (608:673):
633:3 rose4B__0077.jpg (1760:1986):
633:6 rose4B__0077.jpg (1767:1844):
#_des Mistaken rectangle (cube) {8-0}~ [12]
118:1 wu4A_0118.jpg (454:675):
118:2 wu4A_0118.jpg (480:546):
130:1 wu4A_0130.jpg (372:668):
130:2 wu4A_0130.jpg (372:505):
294:1 wu6A__0022.jpg (446:831):
294:2 wu6A__0022.jpg (481:553):
573:2 siu6A_0077.jpg (2039:2127):
573:3 siu6A_0077.jpg (2056:2116):
591:2 rose4B__0014.jpg (1734:2021):
591:4 rose4B__0014.jpg (1887:1964):
775:2 rose6D_0071.jpg (1747:2124):
775:4 rose6D_0071.jpg (2008:2078):
#_des Prism (cube) {17-1}~ [10]
18:1 wu4A_0018.jpg (455:594):
18:2 wu4A_0018.jpg (482:556):
583:2 rose4B__0002.jpg (1745:1973):
583:5 rose4B__0002.jpg (1870:1947):
641:2 rose4B__0089.jpg (1773:2023):
641:4 rose4B__0089.jpg (1778:1845):
713:2 rose5A_0086.jpg (1745:1880):
713:4 rose5A_0086.jpg (1783:1846):
719:3 rose5A_0095.jpg (1748:1868):
719:5 rose5A_0095.jpg (1772:1835):
#_des Squares (cube) {103-3}~ [82]
34:1 wu4A_0034.jpg (392:692):
34:3 wu4A_0034.jpg (434:512):
38:1 wu4A_0038.jpg (401:721):
38:2 wu4A_0038.jpg (455:548):
62:1 wu4A_0062.jpg (430:567):
62:3 wu4A_0062.jpg (464:537):
118:1 wu4A_0118.jpg (454:675):
118:3 wu4A_0118.jpg (483:552):
142:1 wu4A_0142.jpg (440:692):
142:2 wu4A_0142.jpg (466:546):
146:1 wu4A_0146.jpg (440:717):
146:2 wu4A_0146.jpg (483:560):
258:1 wu5A__0106.jpg (397:680):
258:2 wu5A__0106.jpg (570:657):
298:1 wu6A__0026.jpg (431:816):
298:3 wu6A__0026.jpg (601:686):

322:1 wu6A__0050.jpg (429:691):
322:2 wu6A__0050.jpg (448:550):
358:1 wu6A__0086.jpg (453:598):
358:2 wu6A__0086.jpg (488:561):
394:1 wu6A__0122.jpg (446:603):
394:2 wu6A__0122.jpg (481:541):
398:1 wu6A__0126.jpg (417:686):
398:2 wu6A__0126.jpg (580:663):
402:1 wu6A__0130.jpg (420:677):
402:2 wu6A__0130.jpg (452:546):
437:1 siu4D_0038.jpg (2033:2148):
437:2 siu4D_0038.jpg (2059:2122):
443:2 siu4D_0047.jpg (2005:2449):
443:3 siu4D_0047.jpg (2033:2121):
519:3 siu5B_0068.jpg (1986:2216):
519:5 siu5B_0068.jpg (2046:2112):
521:2 siu5B_0071.jpg (1989:2253):
521:3 siu5B_0071.jpg (2001:2113):
579:2 siu6A_0086.jpg (1972:2125):
579:3 siu6A_0086.jpg (2009:2083):
583:2 rose4B__0002.jpg (1745:1973):
583:4 rose4B__0002.jpg (1754:1850):
591:2 rose4B__0014.jpg (1734:2021):
591:3 rose4B__0014.jpg (1904:1967):
597:2 rose4B__0023.jpg (1741:1875):
597:4 rose4B__0023.jpg (1767:1845):
609:2 rose4B__0041.jpg (1766:1875):
609:4 rose4B__0041.jpg (1781:1851):
619:1 rose4B__0056.jpg (1775:1861):
619:6 rose4B__0056.jpg (1763:2012):
629:2 rose4B__0071.jpg (1748:1868):
629:3 rose4B__0071.jpg (1772:1840):
633:3 rose4B__0077.jpg (1760:1986):
633:4 rose4B__0077.jpg (1775:1840):
641:2 rose4B__0089.jpg (1773:2023):
641:3 rose4B__0089.jpg (1788:1853):
651:2 rose4B__0104.jpg (1743:1857):
651:3 rose4B__0104.jpg (1772:1843):
661:2 rose5A_0008.jpg (1744:1979):
661:3 rose5A_0008.jpg (1752:1836):
663:3 rose5A_0011.jpg (1744:2126):
663:4 rose5A_0011.jpg (1761:1844):
665:2 rose5A_0014.jpg (1705:1988):
665:3 rose5A_0014.jpg (1782:1850):
677:2 rose5A_0032.jpg (1749:1969):
677:3 rose5A_0032.jpg (1749:1858):
679:2 rose5A_0035.jpg (1757:1984):
679:4 rose5A_0035.jpg (1767:1841):
683:2 rose5A_0041.jpg (1738:1872):
683:4 rose5A_0041.jpg (1767:1849):
687:3 rose5A_0047.jpg (1727:1991):
687:4 rose5A_0047.jpg (1772:1847):
695:3 rose5A_0059.jpg (1749:1880):
695:4 rose5A_0059.jpg (1772:1846):
713:2 rose5A_0086.jpg (1745:1880):
713:3 rose5A_0086.jpg (1780:1852):
717:2 rose5A_0092.jpg (1732:1979):
717:3 rose5A_0092.jpg (1748:1848):
719:3 rose5A_0095.jpg (1748:1868):
719:4 rose5A_0095.jpg (1771:1848):
721:2 rose5A_0098.jpg (1752:1881):
721:4 rose5A_0098.jpg (1772:1838):
757:2 rose6D_0044.jpg (1735:1872):
757:4 rose6D_0044.jpg (1772:1843):
781:3 rose6D_0080.jpg (1752:1997):
781:4 rose6D_0080.jpg (1902:1965):

des_Describing with 2D terms {71-4}~ [27]

50:1 wu4A_0050.jpg (437:720):
54:1 wu4A_0054.jpg (421:907):
54:3 wu4A_0054.jpg (698:827):
66:1 wu4A_0066.jpg (468:691):

122:1 wu4A_0122.jpg (438:809):
130:1 wu4A_0130.jpg (372:668):
158:1 wu5A__0006.jpg (441:711):
174:1 wu5A__0022.jpg (432:697):
174:3 wu5A__0022.jpg (589:666):
178:1 wu5A__0026.jpg (426:692):
222:1 wu5A__0070.jpg (375:701):
282:1 wu6A__0010.jpg (467:582):
286:1 wu6A__0014.jpg (443:598):
298:1 wu6A__0026.jpg (431:816):
310:1 wu6A__0038.jpg (432:609):
398:1 wu6A__0126.jpg (417:686):
425:2 siu4D_0020.jpg (1990:2131):
439:3 siu4D_0041.jpg (1989:2281):
605:3 rose4B__0035.jpg (1763:2114):
625:2 rose4B__0065.jpg (1734:1858):
627:1 rose4B__0068.jpg (1764:1981):
631:2 rose4B__0074.jpg (1755:2089):
651:2 rose4B__0104.jpg (1743:1857):
777:2 rose6D_0074.jpg (1741:2091):
785:2 rose6D_0086.jpg (1763:1998):
793:2 rose6D_0098.jpg (1741:2081):
797:2 rose6D_0104.jpg (1755:2002):
des_Few information in description {94-4}~ [24]
286:1 wu6A__0014.jpg (443:598):
290:1 wu6A__0018.jpg (444:607):
415:3 siu4D_0005.jpg (1953:2285):
419:2 siu4D_0011.jpg (2009:2290):
433:2 siu4D_0032.jpg (2021:2275):
439:3 siu4D_0041.jpg (1989:2281):
441:2 siu4D_0044.jpg (2016:2133):
445:2 siu4D_0050.jpg (1981:2249):
521:2 siu5B_0071.jpg (1989:2253):
641:2 rose4B__0089.jpg (1773:2023):
653:2 rose4B__0107.jpg (1772:1998):
661:2 rose5A_0008.jpg (1744:1979):
665:2 rose5A_0014.jpg (1705:1988):
683:2 rose5A_0041.jpg (1738:1872):
687:3 rose5A_0047.jpg (1727:1991):
695:3 rose5A_0059.jpg (1749:1880):
729:2 rose6D_0002.jpg (1755:1966):
743:2 rose6D_0023.jpg (1766:1978):
759:3 rose6D_0047.jpg (1739:1880):
769:2 rose6D_0062.jpg (1767:1964):
771:1 rose6D_0065.jpg (1744:1961):
779:2 rose6D_0077.jpg (1758:2006):
783:2 rose6D_0083.jpg (1754:2111):
793:2 rose6D_0098.jpg (1741:2081):
des_Incorrect description (general) {43-3}~ [21]
74:1 wu4A_0074.jpg (391:733):
74:3 wu4A_0074.jpg (573:672):
198:1 wu5A__0046.jpg (468:578):
198:4 wu5A__0046.jpg (491:523):
425:2 siu4D_0020.jpg (1990:2131):
425:4 siu4D_0020.jpg (2024:2091):
629:2 rose4B__0071.jpg (1748:1868):
629:4 rose4B__0071.jpg (1769:1834):
663:3 rose5A_0011.jpg (1744:2126):
729:2 rose6D_0002.jpg (1755:1966):
729:4 rose6D_0002.jpg (1767:1824):
757:2 rose6D_0044.jpg (1735:1872):
757:5 rose6D_0044.jpg (1775:1849):
775:2 rose6D_0071.jpg (1747:2124):
775:5 rose6D_0071.jpg (2015:2075):
781:3 rose6D_0080.jpg (1752:1997):
781:5 rose6D_0080.jpg (1765:1837):
785:2 rose6D_0086.jpg (1763:1998):
785:4 rose6D_0086.jpg (1860:1960):
787:3 rose6D_0089.jpg (1721:1984):
787:6 rose6D_0089.jpg (1868:1974):
des_SOLO level %2 {221-0}~ [113]

6:1 wu4A_0006.jpg (420:703):
18:1 wu4A_0018.jpg (455:594):
34:1 wu4A_0034.jpg (392:692):
38:1 wu4A_0038.jpg (401:721):
50:1 wu4A_0050.jpg (437:720):
54:1 wu4A_0054.jpg (421:907):
62:1 wu4A_0062.jpg (430:567):
66:1 wu4A_0066.jpg (468:691):
74:1 wu4A_0074.jpg (391:733):
86:1 wu4A_0086.jpg (421:626):
114:1 wu4A_0114.jpg (403:606):
118:1 wu4A_0118.jpg (454:675):
122:1 wu4A_0122.jpg (438:809):
130:1 wu4A_0130.jpg (372:668):
142:1 wu4A_0142.jpg (440:692):
146:1 wu4A_0146.jpg (440:717):
158:1 wu5A__0006.jpg (441:711):
162:1 wu5A__0010.jpg (420:574):
174:1 wu5A__0022.jpg (432:697):
178:1 wu5A__0026.jpg (426:692):
198:1 wu5A__0046.jpg (468:578):
222:1 wu5A__0070.jpg (375:701):
254:1 wu5A__0102.jpg (397:589):
258:1 wu5A__0106.jpg (397:680):
270:1 wu5A__0118.jpg (426:696):
282:1 wu6A__0010.jpg (467:582):
286:1 wu6A__0014.jpg (443:598):
290:1 wu6A__0018.jpg (444:607):
294:1 wu6A__0022.jpg (446:831):
298:1 wu6A__0026.jpg (431:816):
302:1 wu6A__0030.jpg (472:723):
310:1 wu6A__0038.jpg (432:609):
322:1 wu6A__0050.jpg (429:691):
342:1 wu6A__0070.jpg (423:641):
346:1 wu6A__0074.jpg (436:611):
358:1 wu6A__0086.jpg (453:598):
394:1 wu6A__0122.jpg (446:603):
398:1 wu6A__0126.jpg (417:686):
402:1 wu6A__0130.jpg (420:677):
415:3 siu4D_0005.jpg (1953:2285):
417:2 siu4D_0008.jpg (1986:2290):
419:2 siu4D_0011.jpg (2009:2290):
425:2 siu4D_0020.jpg (1990:2131):
433:2 siu4D_0032.jpg (2021:2275):
437:1 siu4D_0038.jpg (2033:2148):
439:3 siu4D_0041.jpg (1989:2281):
441:2 siu4D_0044.jpg (2016:2133):
443:2 siu4D_0047.jpg (2005:2449):
445:2 siu4D_0050.jpg (1981:2249):
455:3 siu4D_0065.jpg (1971:2249):
463:2 siu4D_0077.jpg (1990:2282):
477:2 siu5B_0005.jpg (1986:2462):
479:3 siu5B_0008.jpg (1996:2291):
483:2 siu5B_0014.jpg (1968:2155):
491:2 siu5B_0026.jpg (2016:2196):
495:2 siu5B_0032.jpg (1976:2425):
497:2 siu5B_0035.jpg (1997:2293):
503:3 siu5B_0044.jpg (1997:2411):
511:2 siu5B_0056.jpg (2013:2300):
517:3 siu5B_0065.jpg (2031:2281):
519:3 siu5B_0068.jpg (1986:2216):
521:2 siu5B_0071.jpg (1989:2253):
525:2 siu6A_0005.jpg (1993:2285):
529:3 siu6A_0011.jpg (1990:2141):
533:3 siu6A_0017.jpg (1997:2131):
555:2 siu6A_0050.jpg (2001:2138):
557:2 siu6A_0053.jpg (1985:2107):
563:2 siu6A_0062.jpg (1989:2133):
573:2 siu6A_0077.jpg (2039:2127):
575:2 siu6A_0080.jpg (1985:2449):
577:2 siu6A_0083.jpg (2031:2149):

579:2 siu6A_0086.jpg (1972:2125):
583:2 rose4B__0002.jpg (1745:1973):
591:2 rose4B__0014.jpg (1734:2021):
597:2 rose4B__0023.jpg (1741:1875):
605:3 rose4B__0035.jpg (1763:2114):
609:2 rose4B__0041.jpg (1766:1875):
619:6 rose4B__0056.jpg (1763:2012):
625:2 rose4B__0065.jpg (1734:1858):
627:1 rose4B__0068.jpg (1764:1981):
629:2 rose4B__0071.jpg (1748:1868):
631:2 rose4B__0074.jpg (1755:2089):
633:3 rose4B__0077.jpg (1760:1986):
641:2 rose4B__0089.jpg (1773:2023):
651:2 rose4B__0104.jpg (1743:1857):
653:2 rose4B__0107.jpg (1772:1998):
661:2 rose5A_0008.jpg (1744:1979):
663:3 rose5A_0011.jpg (1744:2126):
665:2 rose5A_0014.jpg (1705:1988):
677:2 rose5A_0032.jpg (1749:1969):
679:2 rose5A_0035.jpg (1757:1984):
683:2 rose5A_0041.jpg (1738:1872):
687:3 rose5A_0047.jpg (1727:1991):
695:3 rose5A_0059.jpg (1749:1880):
713:2 rose5A_0086.jpg (1745:1880):
717:2 rose5A_0092.jpg (1732:1979):
719:3 rose5A_0095.jpg (1748:1868):
721:2 rose5A_0098.jpg (1752:1881):
729:2 rose6D_0002.jpg (1755:1966):
743:2 rose6D_0023.jpg (1766:1978):
757:2 rose6D_0044.jpg (1735:1872):
759:3 rose6D_0047.jpg (1739:1880):
769:2 rose6D_0062.jpg (1767:1964):
771:1 rose6D_0065.jpg (1744:1961):
775:2 rose6D_0071.jpg (1747:2124):
777:2 rose6D_0074.jpg (1741:2091):
779:2 rose6D_0077.jpg (1758:2006):
781:3 rose6D_0080.jpg (1752:1997):
783:2 rose6D_0083.jpg (1754:2111):
785:2 rose6D_0086.jpg (1763:1998):
787:3 rose6D_0089.jpg (1721:1984):
793:2 rose6D_0098.jpg (1741:2081):
797:2 rose6D_0104.jpg (1755:2002):

#_des Cube description at level 3 {69-4}~ [11]

#_des 12 edges (cube) {57-2}~ [72]

214:1 wu5A__0062.jpg (449:677):
214:2 wu5A__0062.jpg (474:532):
338:1 wu6A__0066.jpg (443:823):
338:2 wu6A__0066.jpg (592:689):
390:1 wu6A__0118.jpg (443:716):
390:4 wu6A__0118.jpg (486:548):
410:1 wu6A__0138.jpg (438:731):
410:2 wu6A__0138.jpg (481:558):
459:2 siu4d_0071.jpg (1637:2007):
459:5 siu4d_0071.jpg (1647:1723):
499:2 siu5B_0038.jpg (2005:2290):
499:4 siu5B_0038.jpg (2047:2107):
523:2 siu6A_0002.jpg (2008:2149):
523:4 siu6A_0002.jpg (2023:2101):
527:2 siu6A_0008.jpg (2023:2249):
527:4 siu6A_0008.jpg (2020:2116):
537:2 siu6A_0023.jpg (1971:2145):
537:4 siu6A_0023.jpg (2031:2112):
539:2 siu6A_0026.jpg (1968:2283):
539:5 siu6A_0026.jpg (2138:2249):
543:2 siu6A_0032.jpg (1992:2278):
543:3 siu6A_0032.jpg (2022:2118):
545:2 siu6A_0035.jpg (2014:2278):
545:5 siu6A_0035.jpg (2037:2107):

547:2 siu6A_0038.jpg (1985:2282):
547:4 siu6A_0038.jpg (1998:2091):
551:2 siu6A_0044.jpg (1997:2281):
551:4 siu6A_0044.jpg (2013:2129):
559:2 siu6A_0056.jpg (1986:2160):
559:4 siu6A_0056.jpg (2019:2108):
561:2 siu6A_0059.jpg (2001:2251):
561:5 siu6A_0059.jpg (2024:2104):
565:2 siu6A_0065.jpg (1981:2273):
565:4 siu6A_0065.jpg (1990:2106):
569:2 siu6A_0071.jpg (1987:2284):
569:4 siu6A_0071.jpg (2041:2107):
571:2 siu6A_0074.jpg (2027:2153):
571:4 siu6A_0074.jpg (2050:2121):
581:2 siu6A_0089.jpg (1997:2265):
581:4 siu6A_0089.jpg (2005:2093):
657:3 rose5A_0002.jpg (1774:1988):
657:8 rose5A_0002.jpg (1771:1835):
659:4 rose5A_0005.jpg (1744:1995):
659:6 rose5A_0005.jpg (1775:1822):
667:2 rose5A_0017.jpg (1705:1998):
667:6 rose5A_0017.jpg (1852:1968):
669:2 rose5A_0020.jpg (1744:2011):
669:5 rose5A_0020.jpg (1775:1848):
703:2 rose5A_0071.jpg (1709:1995):
703:6 rose5A_0071.jpg (1890:1960):
711:2 rose5A_0083.jpg (1713:2002):
711:6 rose5A_0083.jpg (1887:1964):
723:2 rose5A_0101.jpg (1709:2067):
723:3 rose5A_0101.jpg (1755:1844):
725:3 rose5A_0104.jpg (1740:1877):
725:5 rose5A_0104.jpg (1775:1827):
727:2 rose5A_0107.jpg (1727:2097):
727:5 rose5A_0107.jpg (1998:2081):
733:2 rose6D_0008.jpg (1735:2001):
733:4 rose6D_0008.jpg (1886:1964):
735:2 rose6D_0011.jpg (1751:2128):
735:4 rose6D_0011.jpg (1758:1845):
741:2 rose6D_0020.jpg (1744:1982):
741:4 rose6D_0020.jpg (1758:1842):
761:3 rose6D_0050.jpg (1737:2098):
761:6 rose6D_0050.jpg (1875:1975):
763:2 rose6D_0053.jpg (1760:1980):
763:5 rose6D_0053.jpg (1789:1835):
765:2 rose6D_0056.jpg (1754:1991):
765:5 rose6D_0056.jpg (1789:1827):
799:2 rose6D_0107.jpg (1737:2004):
799:4 rose6D_0107.jpg (1771:1838):
#_des 6 faces (cube) {121-4}~ [114]
26:1 wu4A_0026.jpg (445:841):
26:2 wu4A_0026.jpg (474:559):
182:1 wu5A__0030.jpg (443:733):
182:2 wu5A__0030.jpg (598:678):
338:1 wu6A__0066.jpg (443:823):
338:4 wu6A__0066.jpg (586:657):
390:1 wu6A__0118.jpg (443:716):
390:2 wu6A__0118.jpg (486:558):
410:1 wu6A__0138.jpg (438:731):
410:3 wu6A__0138.jpg (491:558):
421:3 siu4D_0014.jpg (2001:2286):
421:5 siu4D_0014.jpg (2016:2097):
459:2 siu4d_0071.jpg (1637:2007):
459:3 siu4d_0071.jpg (1763:1840):
471:2 siu4D_0089.jpg (1963:2171):
471:3 siu4D_0089.jpg (2000:2125):
493:3 siu5B_0029.jpg (1942:2272):
493:4 siu5B_0029.jpg (2023:2120):
499:2 siu5B_0038.jpg (2005:2290):
499:3 siu5B_0038.jpg (2044:2119):
509:2 siu5B_0053.jpg (2009:2285):
509:4 siu5B_0053.jpg (2017:2117):

523:2 siu6A_0002.jpg (2008:2149):
523:3 siu6A_0002.jpg (2027:2112):
527:2 siu6A_0008.jpg (2023:2249):
527:6 siu6A_0008.jpg (2172:2264):
539:2 siu6A_0026.jpg (1968:2283):
539:3 siu6A_0026.jpg (2005:2116):
541:2 siu6A_0029.jpg (1977:2145):
541:3 siu6A_0029.jpg (1993:2113):
543:2 siu6A_0032.jpg (1992:2278):
543:4 siu6A_0032.jpg (2158:2262):
545:2 siu6A_0035.jpg (2014:2278):
545:4 siu6A_0035.jpg (2041:2114):
547:2 siu6A_0038.jpg (1985:2282):
547:5 siu6A_0038.jpg (2151:2242):
551:2 siu6A_0044.jpg (1997:2281):
551:3 siu6A_0044.jpg (2025:2129):
553:2 siu6A_0047.jpg (1964:2268):
553:3 siu6A_0047.jpg (2016:2112):
561:2 siu6A_0059.jpg (2001:2251):
561:4 siu6A_0059.jpg (2017:2111):
565:2 siu6A_0065.jpg (1981:2273):
565:5 siu6A_0065.jpg (2175:2259):
571:2 siu6A_0074.jpg (2027:2153):
571:3 siu6A_0074.jpg (2047:2124):
581:2 siu6A_0089.jpg (1997:2265):
581:3 siu6A_0089.jpg (2021:2117):
585:2 rose4B__0005.jpg (1765:1850):
585:4 rose4B__0005.jpg (1749:1971):
587:3 rose4B__0008.jpg (1771:1848):
587:4 rose4B__0008.jpg (1754:1995):
589:1 rose4B__0011.jpg (1777:1879):
589:2 rose4B__0011.jpg (1799:1836):
599:1 rose4B__0026.jpg (1780:1989):
599:4 rose4B__0026.jpg (1795:1866):
607:2 rose4B__0038.jpg (1779:2107):
607:3 rose4B__0038.jpg (1769:1829):
613:2 rose4B__0047.jpg (1735:1969):
613:4 rose4B__0047.jpg (1744:1835):
617:2 rose4B__0053.jpg (1723:1972):
617:4 rose4B__0053.jpg (1895:1961):
621:3 rose4B__0059.jpg (1736:1995):
621:6 rose4B__0059.jpg (1743:1832):
635:2 rose4B__0080.jpg (1717:1894):
635:4 rose4B__0080.jpg (1763:1836):
637:2 rose4B__0083.jpg (1739:1879):
637:4 rose4B__0083.jpg (1751:1849):
655:2 rose4B__0110.jpg (1755:1879):
655:4 rose4B__0110.jpg (1767:1848):
657:3 rose5A_0002.jpg (1774:1988):
657:5 rose5A_0002.jpg (1884:1964):
659:3 rose5A_0005.jpg (1747:1844):
659:4 rose5A_0005.jpg (1744:1995):
667:2 rose5A_0017.jpg (1705:1998):
667:4 rose5A_0017.jpg (1740:1840):
669:2 rose5A_0020.jpg (1744:2011):
669:4 rose5A_0020.jpg (1764:1844):
673:2 rose5A_0026.jpg (1727:1841):
673:5 rose5A_0026.jpg (1713:2118):
703:2 rose5A_0071.jpg (1709:1995):
703:4 rose5A_0071.jpg (1759:1844):
711:2 rose5A_0083.jpg (1713:2002):
711:4 rose5A_0083.jpg (1871:1987):
715:2 rose5A_0089.jpg (1741:1881):
715:4 rose5A_0089.jpg (1769:1855):
727:2 rose5A_0107.jpg (1727:2097):
727:3 rose5A_0107.jpg (1993:2112):
733:2 rose6D_0008.jpg (1735:2001):
733:3 rose6D_0008.jpg (1766:1838):
735:2 rose6D_0011.jpg (1751:2128):
735:3 rose6D_0011.jpg (1754:1861):
737:2 rose6D_0014.jpg (1762:2010):

737:4 rose6D_0014.jpg (1892:1977):
741:2 rose6D_0020.jpg (1744:1982):
741:3 rose6D_0020.jpg (1774:1854):
749:2 rose6D_0032.jpg (1726:1998):
749:4 rose6D_0032.jpg (1756:1848):
751:2 rose6D_0035.jpg (1749:1982):
751:4 rose6D_0035.jpg (1762:1844):
753:2 rose6D_0038.jpg (1754:1966):
753:3 rose6D_0038.jpg (1762:1838):
761:3 rose6D_0050.jpg (1737:2098):
761:4 rose6D_0050.jpg (1761:1844):
763:2 rose6D_0053.jpg (1760:1980):
763:4 rose6D_0053.jpg (1785:1840):
765:2 rose6D_0056.jpg (1754:1991):
765:3 rose6D_0056.jpg (1789:1852):
767:2 rose6D_0059.jpg (1755:1964):
767:3 rose6D_0059.jpg (1779:1844):
789:3 rose6D_0092.jpg (1737:1881):
789:4 rose6D_0092.jpg (1764:1838):
799:2 rose6D_0107.jpg (1737:2004):
799:3 rose6D_0107.jpg (1778:1848):
#_des 8 vertices (cube) {58-2}~ [68]
182:1 wu5A__0030.jpg (443:733):
182:3 wu5A__0030.jpg (588:673):
338:1 wu6A__0066.jpg (443:823):
338:3 wu6A__0066.jpg (580:669):
390:1 wu6A__0118.jpg (443:716):
390:5 wu6A__0118.jpg (498:548):
410:1 wu6A__0138.jpg (438:731):
410:4 wu6A__0138.jpg (473:561):
499:2 siu5B_0038.jpg (2005:2290):
499:5 siu5B_0038.jpg (2050:2116):
523:2 siu6A_0002.jpg (2008:2149):
523:5 siu6A_0002.jpg (2027:2097):
527:2 siu6A_0008.jpg (2023:2249):
527:5 siu6A_0008.jpg (2031:2116):
535:2 siu6A_0020.jpg (1981:2405):
535:4 siu6A_0020.jpg (2129:2269):
537:2 siu6A_0023.jpg (1971:2145):
537:3 siu6A_0023.jpg (2005:2123):
539:2 siu6A_0026.jpg (1968:2283):
539:4 siu6A_0026.jpg (2123:2264):
541:2 siu6A_0029.jpg (1977:2145):
541:4 siu6A_0029.jpg (2009:2117):
545:2 siu6A_0035.jpg (2014:2278):
545:3 siu6A_0035.jpg (2034:2104):
547:2 siu6A_0038.jpg (1985:2282):
547:3 siu6A_0038.jpg (2005:2098):
551:2 siu6A_0044.jpg (1997:2281):
551:5 siu6A_0044.jpg (2017:2121):
559:2 siu6A_0056.jpg (1986:2160):
559:3 siu6A_0056.jpg (2023:2112):
561:2 siu6A_0059.jpg (2001:2251):
561:3 siu6A_0059.jpg (2021:2097):
565:2 siu6A_0065.jpg (1981:2273):
565:3 siu6A_0065.jpg (1995:2120):
569:2 siu6A_0071.jpg (1987:2284):
569:3 siu6A_0071.jpg (2019:2113):
571:2 siu6A_0074.jpg (2027:2153):
571:5 siu6A_0074.jpg (2039:2107):
581:2 siu6A_0089.jpg (1997:2265):
581:5 siu6A_0089.jpg (2149:2237):
657:3 rose5A_0002.jpg (1774:1988):
657:6 rose5A_0002.jpg (1871:1948):
659:4 rose5A_0005.jpg (1744:1995):
659:5 rose5A_0005.jpg (1765:1825):
667:2 rose5A_0017.jpg (1705:1998):
667:5 rose5A_0017.jpg (1856:1971):
703:2 rose5A_0071.jpg (1709:1995):
703:5 rose5A_0071.jpg (1894:1971):
711:2 rose5A_0083.jpg (1713:2002):

711:5 rose5A_0083.jpg (1871:1952):
723:2 rose5A_0101.jpg (1709:2067):
723:4 rose5A_0101.jpg (1775:1829):
725:3 rose5A_0104.jpg (1740:1877):
725:6 rose5A_0104.jpg (1784:1832):
727:2 rose5A_0107.jpg (1727:2097):
727:6 rose5A_0107.jpg (2018:2068):
735:2 rose6D_0011.jpg (1751:2128):
735:5 rose6D_0011.jpg (1758:1835):
737:2 rose6D_0014.jpg (1762:2010):
737:5 rose6D_0014.jpg (1875:1968):
741:2 rose6D_0020.jpg (1744:1982):
741:5 rose6D_0020.jpg (1768:1835):
763:2 rose6D_0053.jpg (1760:1980):
763:6 rose6D_0053.jpg (1795:1838):
765:2 rose6D_0056.jpg (1754:1991):
765:6 rose6D_0056.jpg (1792:1844):
799:2 rose6D_0107.jpg (1737:2004):
799:5 rose6D_0107.jpg (1774:1851):
#_des Box and others (cube) {33-2}~ [10]
214:1 wu5A__0062.jpg (449:677):
214:4 wu5A__0062.jpg (477:546):
451:2 siu4D_0059.jpg (1985:2409):
451:3 siu4D_0059.jpg (2133:2273):
527:2 siu6A_0008.jpg (2023:2249):
527:3 siu6A_0008.jpg (2016:2112):
621:3 rose4B__0059.jpg (1736:1995):
621:4 rose4B__0059.jpg (1741:1841):
673:4 rose5A_0026.jpg (1868:1971):
673:5 rose5A_0026.jpg (1713:2118):
#_des Cube description {297-0} [69]
26:1 wu4A_0026.jpg (445:841):
182:1 wu5A__0030.jpg (443:733):
214:1 wu5A__0062.jpg (449:677):
338:1 wu6A__0066.jpg (443:823):
390:1 wu6A__0118.jpg (443:716):
410:1 wu6A__0138.jpg (438:731):
421:3 siu4D_0014.jpg (2001:2286):
451:2 siu4D_0059.jpg (1985:2409):
459:2 siu4d_0071.jpg (1637:2007):
471:2 siu4D_0089.jpg (1963:2171):
493:3 siu5B_0029.jpg (1942:2272):
499:2 siu5B_0038.jpg (2005:2290):
509:2 siu5B_0053.jpg (2009:2285):
523:2 siu6A_0002.jpg (2008:2149):
527:2 siu6A_0008.jpg (2023:2249):
535:2 siu6A_0020.jpg (1981:2405):
537:2 siu6A_0023.jpg (1971:2145):
539:2 siu6A_0026.jpg (1968:2283):
541:2 siu6A_0029.jpg (1977:2145):
543:2 siu6A_0032.jpg (1992:2278):
545:2 siu6A_0035.jpg (2014:2278):
547:2 siu6A_0038.jpg (1985:2282):
551:2 siu6A_0044.jpg (1997:2281):
553:2 siu6A_0047.jpg (1964:2268):
559:2 siu6A_0056.jpg (1986:2160):
561:2 siu6A_0059.jpg (2001:2251):
565:2 siu6A_0065.jpg (1981:2273):
569:2 siu6A_0071.jpg (1987:2284):
571:2 siu6A_0074.jpg (2027:2153):
581:2 siu6A_0089.jpg (1997:2265):
585:4 rose4B__0005.jpg (1749:1971):
587:4 rose4B__0008.jpg (1754:1995):
589:1 rose4B__0011.jpg (1777:1879):
599:1 rose4B__0026.jpg (1780:1989):
607:2 rose4B__0038.jpg (1779:2107):
613:2 rose4B__0047.jpg (1735:1969):
617:2 rose4B__0053.jpg (1723:1972):
621:3 rose4B__0059.jpg (1736:1995):
623:3 rose4B__0062.jpg (1752:1881):
635:2 rose4B__0080.jpg (1717:1894):

637:2 rose4B__0083.jpg (1739:1879):
647:2 rose4B__0098.jpg (1772:2017):
655:2 rose4B__0110.jpg (1755:1879):
657:3 rose5A_0002.jpg (1774:1988):
659:4 rose5A_0005.jpg (1744:1995):
667:2 rose5A_0017.jpg (1705:1998):
669:2 rose5A_0020.jpg (1744:2011):
673:5 rose5A_0026.jpg (1713:2118):
689:2 rose5A_0050.jpg (1714:1971):
703:2 rose5A_0071.jpg (1709:1995):
705:2 rose5A_0074.jpg (1758:1866):
711:2 rose5A_0083.jpg (1713:2002):
715:2 rose5A_0089.jpg (1741:1881):
723:2 rose5A_0101.jpg (1709:2067):
725:3 rose5A_0104.jpg (1740:1877):
727:2 rose5A_0107.jpg (1727:2097):
733:2 rose6D_0008.jpg (1735:2001):
735:2 rose6D_0011.jpg (1751:2128):
737:2 rose6D_0014.jpg (1762:2010):
741:2 rose6D_0020.jpg (1744:1982):
749:2 rose6D_0032.jpg (1726:1998):
751:2 rose6D_0035.jpg (1749:1982):
753:2 rose6D_0038.jpg (1754:1966):
761:3 rose6D_0050.jpg (1737:2098):
763:2 rose6D_0053.jpg (1760:1980):
765:2 rose6D_0056.jpg (1754:1991):
767:2 rose6D_0059.jpg (1755:1964):
789:3 rose6D_0092.jpg (1737:1881):
799:2 rose6D_0107.jpg (1737:2004):
#_des Prism (cube) {17-1}~ [15]
214:1 wu5A__0062.jpg (449:677):
214:3 wu5A__0062.jpg (469:537):
559:2 siu6A_0056.jpg (1986:2160):
565:2 siu6A_0065.jpg (1981:2273):
565:7 siu6A_0065.jpg (2000:2115):
587:4 rose4B__0008.jpg (1754:1995):
587:6 rose4B__0008.jpg (1771:1852):
647:2 rose4B__0098.jpg (1772:2017):
647:4 rose4B__0098.jpg (1775:1835):
655:2 rose4B__0110.jpg (1755:1879):
655:5 rose4B__0110.jpg (1775:1840):
689:2 rose5A_0050.jpg (1714:1971):
689:4 rose5A_0050.jpg (1748:1838):
705:2 rose5A_0074.jpg (1758:1866):
705:4 rose5A_0074.jpg (1775:1838):
#_des Squares (cube) {103-3}~ [87]
26:1 wu4A_0026.jpg (445:841):
26:3 wu4A_0026.jpg (730:786):
390:1 wu6A__0118.jpg (443:716):
390:3 wu6A__0118.jpg (491:561):
421:3 siu4D_0014.jpg (2001:2286):
421:4 siu4D_0014.jpg (2001:2097):
451:2 siu4D_0059.jpg (1985:2409):
451:4 siu4D_0059.jpg (2129:2265):
459:2 siu4d_0071.jpg (1637:2007):
459:4 siu4d_0071.jpg (1760:1847):
493:3 siu5B_0029.jpg (1942:2272):
493:5 siu5B_0029.jpg (2038:2105):
509:2 siu5B_0053.jpg (2009:2285):
509:3 siu5B_0053.jpg (2017:2129):
535:2 siu6A_0020.jpg (1981:2405):
535:3 siu6A_0020.jpg (2009:2101):
547:2 siu6A_0038.jpg (1985:2282):
547:6 siu6A_0038.jpg (2155:2252):
551:2 siu6A_0044.jpg (1997:2281):
551:6 siu6A_0044.jpg (2145:2257):
553:2 siu6A_0047.jpg (1964:2268):
553:4 siu6A_0047.jpg (2149:2283):
569:2 siu6A_0071.jpg (1987:2284):
569:5 siu6A_0071.jpg (2027:2110):
585:3 rose4B__0005.jpg (1860:1971):

585:4 rose4B__0005.jpg (1749:1971):
587:2 rose4B__0008.jpg (1781:1851):
587:4 rose4B__0008.jpg (1754:1995):
589:1 rose4B__0011.jpg (1777:1879):
589:3 rose4B__0011.jpg (1803:1839):
599:1 rose4B__0026.jpg (1780:1989):
599:2 rose4B__0026.jpg (1903:1972):
607:2 rose4B__0038.jpg (1779:2107):
613:2 rose4B__0047.jpg (1735:1969):
613:3 rose4B__0047.jpg (1748:1848):
617:2 rose4B__0053.jpg (1723:1972):
617:3 rose4B__0053.jpg (1883:1968):
621:3 rose4B__0059.jpg (1736:1995):
621:5 rose4B__0059.jpg (1852:1983):
623:3 rose4B__0062.jpg (1752:1881):
623:4 rose4B__0062.jpg (1769:1852):
635:2 rose4B__0080.jpg (1717:1894):
635:3 rose4B__0080.jpg (1752:1848):
637:2 rose4B__0083.jpg (1739:1879):
637:3 rose4B__0083.jpg (1747:1849):
647:2 rose4B__0098.jpg (1772:2017):
647:3 rose4B__0098.jpg (1920:1977):
655:2 rose4B__0110.jpg (1755:1879):
655:3 rose4B__0110.jpg (1775:1852):
659:2 rose5A_0005.jpg (1751:1831):
659:4 rose5A_0005.jpg (1744:1995):
667:2 rose5A_0017.jpg (1705:1998):
667:3 rose5A_0017.jpg (1732:1840):
669:2 rose5A_0020.jpg (1744:2011):
669:3 rose5A_0020.jpg (1778:1848):
673:3 rose5A_0026.jpg (1734:1848):
673:5 rose5A_0026.jpg (1713:2118):
689:2 rose5A_0050.jpg (1714:1971):
689:3 rose5A_0050.jpg (1751:1841):
703:2 rose5A_0071.jpg (1709:1995):
703:3 rose5A_0071.jpg (1752:1856):
705:2 rose5A_0074.jpg (1758:1866):
705:3 rose5A_0074.jpg (1775:1841):
711:2 rose5A_0083.jpg (1713:2002):
711:3 rose5A_0083.jpg (1752:1844):
715:2 rose5A_0089.jpg (1741:1881):
715:3 rose5A_0089.jpg (1769:1855):
725:3 rose5A_0104.jpg (1740:1877):
725:4 rose5A_0104.jpg (1775:1847):
727:2 rose5A_0107.jpg (1727:2097):
727:4 rose5A_0107.jpg (1753:1845):
737:2 rose6D_0014.jpg (1762:2010):
737:3 rose6D_0014.jpg (1774:1852):
749:2 rose6D_0032.jpg (1726:1998):
749:3 rose6D_0032.jpg (1780:1844):
751:2 rose6D_0035.jpg (1749:1982):
751:3 rose6D_0035.jpg (1771:1842):
753:2 rose6D_0038.jpg (1754:1966):
753:4 rose6D_0038.jpg (1764:1848):
761:3 rose6D_0050.jpg (1737:2098):
761:5 rose6D_0050.jpg (1874:1974):
763:2 rose6D_0053.jpg (1760:1980):
763:3 rose6D_0053.jpg (1788:1848):
765:2 rose6D_0056.jpg (1754:1991):
765:4 rose6D_0056.jpg (1892:1975):
789:3 rose6D_0092.jpg (1737:1881):
789:5 rose6D_0092.jpg (1747:1828):

des_Describing with 2D terms {71-4}~ [4]

421:3 siu4D_0014.jpg (2001:2286):
421:6 siu4D_0014.jpg (2172:2246):
599:1 rose4B__0026.jpg (1780:1989):
599:5 rose4B__0026.jpg (1795:1844):

des_Few information in description {94-4}~ [4]

725:3 rose5A_0104.jpg (1740:1877):
733:2 rose6D_0008.jpg (1735:2001):
735:2 rose6D_0011.jpg (1751:2128):

767:2 rose6D_0059.jpg (1755:1964):
des_Incorrect description (general) {43-3}~ [2]
753:2 rose6D_0038.jpg (1754:1966):
753:5 rose6D_0038.jpg (1761:1845):
des_SOLO level %3 {146-0}~ [69]
26:1 wu4A_0026.jpg (445:841):
182:1 wu5A__0030.jpg (443:733):
214:1 wu5A__0062.jpg (449:677):
338:1 wu6A__0066.jpg (443:823):
390:1 wu6A__0118.jpg (443:716):
410:1 wu6A__0138.jpg (438:731):
421:3 siu4D_0014.jpg (2001:2286):
451:2 siu4D_0059.jpg (1985:2409):
459:2 siu4d_0071.jpg (1637:2007):
471:2 siu4D_0089.jpg (1963:2171):
493:3 siu5B_0029.jpg (1942:2272):
499:2 siu5B_0038.jpg (2005:2290):
509:2 siu5B_0053.jpg (2009:2285):
523:2 siu6A_0002.jpg (2008:2149):
527:2 siu6A_0008.jpg (2023:2249):
535:2 siu6A_0020.jpg (1981:2405):
537:2 siu6A_0023.jpg (1971:2145):
539:2 siu6A_0026.jpg (1968:2283):
541:2 siu6A_0029.jpg (1977:2145):
543:2 siu6A_0032.jpg (1992:2278):
545:2 siu6A_0035.jpg (2014:2278):
547:2 siu6A_0038.jpg (1985:2282):
551:2 siu6A_0044.jpg (1997:2281):
553:2 siu6A_0047.jpg (1964:2268):
559:2 siu6A_0056.jpg (1986:2160):
561:2 siu6A_0059.jpg (2001:2251):
565:2 siu6A_0065.jpg (1981:2273):
569:2 siu6A_0071.jpg (1987:2284):
571:2 siu6A_0074.jpg (2027:2153):
581:2 siu6A_0089.jpg (1997:2265):
585:4 rose4B__0005.jpg (1749:1971):
587:4 rose4B__0008.jpg (1754:1995):
589:1 rose4B__0011.jpg (1777:1879):
599:1 rose4B__0026.jpg (1780:1989):
607:2 rose4B__0038.jpg (1779:2107):
613:2 rose4B__0047.jpg (1735:1969):
617:2 rose4B__0053.jpg (1723:1972):
621:3 rose4B__0059.jpg (1736:1995):
623:3 rose4B__0062.jpg (1752:1881):
635:2 rose4B__0080.jpg (1717:1894):
637:2 rose4B__0083.jpg (1739:1879):
647:2 rose4B__0098.jpg (1772:2017):
655:2 rose4B__0110.jpg (1755:1879):
657:3 rose5A_0002.jpg (1774:1988):
659:4 rose5A_0005.jpg (1744:1995):
667:2 rose5A_0017.jpg (1705:1998):
669:2 rose5A_0020.jpg (1744:2011):
673:5 rose5A_0026.jpg (1713:2118):
689:2 rose5A_0050.jpg (1714:1971):
703:2 rose5A_0071.jpg (1709:1995):
705:2 rose5A_0074.jpg (1758:1866):
711:2 rose5A_0083.jpg (1713:2002):
715:2 rose5A_0089.jpg (1741:1881):
723:2 rose5A_0101.jpg (1709:2067):
725:3 rose5A_0104.jpg (1740:1877):
727:2 rose5A_0107.jpg (1727:2097):
733:2 rose6D_0008.jpg (1735:2001):
735:2 rose6D_0011.jpg (1751:2128):
737:2 rose6D_0014.jpg (1762:2010):
741:2 rose6D_0020.jpg (1744:1982):
749:2 rose6D_0032.jpg (1726:1998):
751:2 rose6D_0035.jpg (1749:1982):
753:2 rose6D_0038.jpg (1754:1966):
761:3 rose6D_0050.jpg (1737:2098):
763:2 rose6D_0053.jpg (1760:1980):
765:2 rose6D_0056.jpg (1754:1991):

767:2 rose6D_0059.jpg (1755:1964):
789:3 rose6D_0092.jpg (1737:1881):
799:2 rose6D_0107.jpg (1737:2004):

#_des Cube description at level 4 {20-5}~ [8]

#_des 12 edges (cube) {57-2}~ [14]

615:2 rose4B__0050.jpg (1775:1995):
615:4 rose4B__0050.jpg (1879:1971):
681:2 rose5A_0038.jpg (1744:2108):
681:6 rose5A_0038.jpg (2018:2091):
731:2 rose6D_0005.jpg (1758:1900):
731:5 rose6D_0005.jpg (1785:1848):
739:3 rose6D_0017.jpg (1666:2129):
739:7 rose6D_0017.jpg (1749:1834):
755:2 rose6D_0041.jpg (1729:2089):
755:4 rose6D_0041.jpg (1751:1835):
773:2 rose6D_0068.jpg (1737:2141):
773:6 rose6D_0068.jpg (1885:1958):
795:2 rose6D_0101.jpg (1737:2121):
795:5 rose6D_0101.jpg (1987:2083):

#_des 6 faces (cube) {121-4}~ [32]

234:1 wu5A__0082.jpg (424:697):
234:3 wu5A__0082.jpg (460:544):
531:2 siu6A_0014.jpg (1978:2145):
531:3 siu6A_0014.jpg (2015:2121):
593:1 rose4B__0017.jpg (1772:1993):
593:2 rose4B__0017.jpg (1792:1847):
603:2 rose4B__0032.jpg (1759:1983):
603:5 rose4B__0032.jpg (1772:1838):
615:2 rose4B__0050.jpg (1775:1995):
615:5 rose4B__0050.jpg (1781:1832):
649:2 rose4B__0101.jpg (1734:2111):
649:3 rose4B__0101.jpg (1721:1851):
693:3 rose5A_0056.jpg (1732:1863):
693:5 rose5A_0056.jpg (1713:2056):
699:2 rose5A_0065.jpg (1747:2094):
699:4 rose5A_0065.jpg (1747:1838):
709:3 rose5A_0080.jpg (1735:1992):
709:4 rose5A_0080.jpg (1749:1841):
731:2 rose6D_0005.jpg (1758:1900):
731:3 rose6D_0005.jpg (1783:1846):
739:3 rose6D_0017.jpg (1666:2129):
739:4 rose6D_0017.jpg (1749:1855):
745:2 rose6D_0026.jpg (1749:1909):
745:4 rose6D_0026.jpg (1769:1851):
747:2 rose6D_0029.jpg (1738:1862):
747:4 rose6D_0029.jpg (1764:1852):
773:2 rose6D_0068.jpg (1737:2141):
773:4 rose6D_0068.jpg (1749:1835):
791:2 rose6D_0095.jpg (1752:1995):
791:5 rose6D_0095.jpg (1769:1832):
795:2 rose6D_0101.jpg (1737:2121):
795:4 rose6D_0101.jpg (1734:1854):

#_des 8 vertices (cube) {58-2}~ [14]

234:1 wu5A__0082.jpg (424:697):
234:4 wu5A__0082.jpg (444:554):
681:2 rose5A_0038.jpg (1744:2108):
681:5 rose5A_0038.jpg (1888:1958):
739:3 rose6D_0017.jpg (1666:2129):
739:8 rose6D_0017.jpg (1890:1979):
747:2 rose6D_0029.jpg (1738:1862):
747:5 rose6D_0029.jpg (1764:1838):
755:2 rose6D_0041.jpg (1729:2089):
755:5 rose6D_0041.jpg (1778:1828):
773:2 rose6D_0068.jpg (1737:2141):
773:7 rose6D_0068.jpg (1881:1958):
795:2 rose6D_0101.jpg (1737:2121):
795:6 rose6D_0101.jpg (2010:2087):

#_des Box and others (cube) {33-2}~ [32]

234:1 wu5A__0082.jpg (424:697):
234:2 wu5A__0082.jpg (454:530):
593:1 rose4B__0017.jpg (1772:1993):
593:4 rose4B__0017.jpg (1907:1960):
611:2 rose4B__0044.jpg (1751:1974):
611:3 rose4B__0044.jpg (1878:1964):
649:2 rose4B__0101.jpg (1734:2111):
649:5 rose4B__0101.jpg (1848:1971):
681:2 rose5A_0038.jpg (1744:2108):
681:4 rose5A_0038.jpg (1754:1838):
693:4 rose5A_0056.jpg (1852:2006):
693:5 rose5A_0056.jpg (1713:2056):
699:2 rose5A_0065.jpg (1747:2094):
699:5 rose5A_0065.jpg (1868:1958):
709:3 rose5A_0080.jpg (1735:1992):
709:6 rose5A_0080.jpg (1866:1972):
731:2 rose6D_0005.jpg (1758:1900):
731:4 rose6D_0005.jpg (1772:1835):
739:3 rose6D_0017.jpg (1666:2129):
739:6 rose6D_0017.jpg (1989:2092):
745:2 rose6D_0026.jpg (1749:1909):
745:5 rose6D_0026.jpg (1742:1864):
747:2 rose6D_0029.jpg (1738:1862):
747:3 rose6D_0029.jpg (1736:1824):
755:2 rose6D_0041.jpg (1729:2089):
755:3 rose6D_0041.jpg (1886:1975):
773:2 rose6D_0068.jpg (1737:2141):
773:5 rose6D_0068.jpg (1981:2075):
791:2 rose6D_0095.jpg (1752:1995):
791:3 rose6D_0095.jpg (1772:1840):
795:2 rose6D_0101.jpg (1737:2121):
795:3 rose6D_0101.jpg (1858:1971):

#_des Cube description {297-0} [20]

234:1 wu5A__0082.jpg (424:697):
531:2 siu6A_0014.jpg (1978:2145):
593:1 rose4B__0017.jpg (1772:1993):
603:2 rose4B__0032.jpg (1759:1983):
611:2 rose4B__0044.jpg (1751:1974):
615:2 rose4B__0050.jpg (1775:1995):
649:2 rose4B__0101.jpg (1734:2111):
681:2 rose5A_0038.jpg (1744:2108):
693:5 rose5A_0056.jpg (1713:2056):
697:2 rose5A_0062.jpg (1745:2005):
699:2 rose5A_0065.jpg (1747:2094):
709:3 rose5A_0080.jpg (1735:1992):
731:2 rose6D_0005.jpg (1758:1900):
739:3 rose6D_0017.jpg (1666:2129):
745:2 rose6D_0026.jpg (1749:1909):
747:2 rose6D_0029.jpg (1738:1862):
755:2 rose6D_0041.jpg (1729:2089):
773:2 rose6D_0068.jpg (1737:2141):
791:2 rose6D_0095.jpg (1752:1995):
795:2 rose6D_0101.jpg (1737:2121):

#_des Prism (cube) {17-1}~ [6]

531:2 siu6A_0014.jpg (1978:2145):
531:5 siu6A_0014.jpg (1990:2080):
603:2 rose4B__0032.jpg (1759:1983):
603:4 rose4B__0032.jpg (1760:1841):
697:2 rose5A_0062.jpg (1745:2005):
697:4 rose5A_0062.jpg (1902:1971):

#_des Squares (cube) {103-3}~ [29]

531:2 siu6A_0014.jpg (1978:2145):
593:1 rose4B__0017.jpg (1772:1993):
593:3 rose4B__0017.jpg (1797:1857):
603:2 rose4B__0032.jpg (1759:1983):
603:3 rose4B__0032.jpg (1887:1975):
611:2 rose4B__0044.jpg (1751:1974):
611:4 rose4B__0044.jpg (1767:1856):
615:2 rose4B__0050.jpg (1775:1995):
615:3 rose4B__0050.jpg (1779:1844):
649:2 rose4B__0101.jpg (1734:2111):

649:4 rose4B__0101.jpg (1751:1838):
681:2 rose5A_0038.jpg (1744:2108):
681:3 rose5A_0038.jpg (1754:1844):
693:2 rose5A_0056.jpg (1728:1856):
693:5 rose5A_0056.jpg (1713:2056):
697:2 rose5A_0062.jpg (1745:2005):
697:3 rose5A_0062.jpg (1760:1867):
699:2 rose5A_0065.jpg (1747:2094):
699:3 rose5A_0065.jpg (1754:1838):
709:3 rose5A_0080.jpg (1735:1992):
709:5 rose5A_0080.jpg (1884:1975):
739:3 rose6D_0017.jpg (1666:2129):
739:5 rose6D_0017.jpg (1875:1966):
745:2 rose6D_0026.jpg (1749:1909):
745:3 rose6D_0026.jpg (1773:1846):
773:2 rose6D_0068.jpg (1737:2141):
773:3 rose6D_0068.jpg (1769:1858):
791:2 rose6D_0095.jpg (1752:1995):
791:4 rose6D_0095.jpg (1766:1846):

des_SOLO level %4 {40-0}~ [20]

234:1 wu5A__0082.jpg (424:697):
531:2 siu6A_0014.jpg (1978:2145):
593:1 rose4B__0017.jpg (1772:1993):
603:2 rose4B__0032.jpg (1759:1983):
611:2 rose4B__0044.jpg (1751:1974):
615:2 rose4B__0050.jpg (1775:1995):
649:2 rose4B__0101.jpg (1734:2111):
681:2 rose5A_0038.jpg (1744:2108):
693:5 rose5A_0056.jpg (1713:2056):
697:2 rose5A_0062.jpg (1745:2005):
699:2 rose5A_0065.jpg (1747:2094):
709:3 rose5A_0080.jpg (1735:1992):
731:2 rose6D_0005.jpg (1758:1900):
739:3 rose6D_0017.jpg (1666:2129):
745:2 rose6D_0026.jpg (1749:1909):
747:2 rose6D_0029.jpg (1738:1862):
755:2 rose6D_0041.jpg (1729:2089):
773:2 rose6D_0068.jpg (1737:2141):
791:2 rose6D_0095.jpg (1752:1995):
795:2 rose6D_0101.jpg (1737:2121):

Appendix C: Cooccurring Codes for Cube Drawings

HU: merger
File: [D:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 22/10/07 12:19:19

#_draw Cube drawing at level 1 {17-2}~ [4]
- #_draw Cube drawing {297-4}~ [17]
  - 13:1 wu4A_0013.jpg (899:1794):
  - 29:1 wu4A_0029.jpg (1378:1549):
  - 109:1 wu4A_0109.jpg (839:1564):
  - 273:1 wu6A__0001.jpg (903:1522):
  - 401:1 wu6A__0129.jpg (877:1651):
  - 423:1 siu4D_0017.jpg (884:1216):
  - 427:1 siu4D_0023.jpg (915:1550):
  - 431:1 siu4D_0029.jpg (727:1264):
  - 437:4 siu4D_0038.jpg (952:1090):
  - 473:1 siu4D_0092.jpg (704:1569):
  - 481:1 siu5B_0011.jpg (1000:1601):
  - 513:1 siu5B_0059.jpg (950:1187):
  - 525:1 siu6A_0005.jpg (907:1203):
  - 627:2 rose4B__0068.jpg (797:1257):
  - 685:1 rose5A_0044.jpg (892:1070):
  - 707:1 rose5A_0077.jpg (767:1254):
  - 723:1 rose5A_0101.jpg (826:1183):
- draw_SOLO level %1 {52-1}~ [17]
  - 13:1 wu4A_0013.jpg (899:1794):
  - 29:1 wu4A_0029.jpg (1378:1549):
  - 109:1 wu4A_0109.jpg (839:1564):
  - 273:1 wu6A__0001.jpg (903:1522):
  - 401:1 wu6A__0129.jpg (877:1651):
  - 423:1 siu4D_0017.jpg (884:1216):
  - 427:1 siu4D_0023.jpg (915:1550):
  - 431:1 siu4D_0029.jpg (727:1264):
  - 437:4 siu4D_0038.jpg (952:1090):
  - 473:1 siu4D_0092.jpg (704:1569):
  - 481:1 siu5B_0011.jpg (1000:1601):
  - 513:1 siu5B_0059.jpg (950:1187):
  - 525:1 siu6A_0005.jpg (907:1203):
  - 627:2 rose4B__0068.jpg (797:1257):
  - 685:1 rose5A_0044.jpg (892:1070):
  - 707:1 rose5A_0077.jpg (767:1254):
  - 723:1 rose5A_0101.jpg (826:1183):
- draw_Some or all seen faces are drawn in a 2D format {44-2}~ [9]
  - 29:1 wu4A_0029.jpg (1378:1549):
  - 427:1 siu4D_0023.jpg (915:1550):
  - 437:4 siu4D_0038.jpg (952:1090):
  - 481:1 siu5B_0011.jpg (1000:1601):
  - 525:1 siu6A_0005.jpg (907:1203):
  - 627:2 rose4B__0068.jpg (797:1257):
  - 685:1 rose5A_0044.jpg (892:1070):
  - 707:1 rose5A_0077.jpg (767:1254):
  - 723:1 rose5A_0101.jpg (826:1183):
- Unable to describe/draw any features {96-4} [9]
  - 13:1 wu4A_0013.jpg (899:1794):
  - 109:1 wu4A_0109.jpg (839:1564):
  - 273:1 wu6A__0001.jpg (903:1522):
  - 401:1 wu6A__0129.jpg (877:1651):
  - 431:1 siu4D_0029.jpg (727:1264):
  - 473:1 siu4D_0092.jpg (704:1569):
  - 513:1 siu5B_0059.jpg (950:1187):
  - 707:1 rose5A_0077.jpg (767:1254):
  - 723:1 rose5A_0101.jpg (826:1183):

#_draw Cube drawing at level 2 {63-1}~ [8]

#_draw Cube drawing {297-4}~ [63]

1:1 wu4A_0001.jpg (1146:1400):
5:1 wu4A_0005.jpg (868:1381):
33:1 wu4A_0033.jpg (854:1434):
41:1 wu4A_0041.jpg (941:1476):
45:1 wu4A_0045.jpg (926:1355):
53:1 wu4A_0053.jpg (1108:1397):
65:1 wu4A_0065.jpg (869:1465):
77:1 wu4A_0077.jpg (1025:1423):
81:1 wu4A_0081.jpg (1032:1666):
93:1 wu4A_0093.jpg (808:1112):
97:1 wu4A_0097.jpg (1020:1503):
105:1 wu4A_0105.jpg (1282:1422):
113:1 wu4A_0113.jpg (814:1136):
125:1 wu4A_0125.jpg (915:1404):
129:1 wu4A_0129.jpg (843:1048):
133:1 wu4A_0133.jpg (896:1287):
137:1 wu4A_0137.jpg (909:1092):
149:1 wu4A_0149.jpg (1030:1389):
165:1 wu5A__0013.jpg (931:1324):
169:1 wu5A__0017.jpg (918:1461):
217:1 wu5A__0065.jpg (969:1320):
225:1 wu5A__0073.jpg (1120:1643):
229:1 wu5A__0077.jpg (778:1507):
253:1 wu5A__0101.jpg (943:1509):
261:1 wu5A__0109.jpg (824:1473):
265:1 wu5A__0113.jpg (733:1776):
293:1 wu6A__0021.jpg (891:1774):
325:1 wu6A__0053.jpg (770:1359):
345:1 wu6A__0073.jpg (873:1549):
349:1 wu6A__0077.jpg (929:1381):
353:1 wu6A__0081.jpg (877:1298):
369:1 wu6A__0097.jpg (987:1291):
373:1 wu6A__0101.jpg (808:1719):
385:1 wu6A__0113.jpg (911:1524):
393:1 wu6A__0121.jpg (864:1307):
413:1 siu4D_0002.jpg (886:1188):
417:1 siu4D_0008.jpg (867:1278):
419:1 siu4D_0011.jpg (844:1392):
425:1 siu4D_0020.jpg (1153:1397):
433:1 siu4D_0032.jpg (884:1284):
435:1 siu4D_0035.jpg (1113:1364):
447:1 siu4D_0053.jpg (782:1074):
449:1 siu4D_0056.jpg (1305:1671):
453:1 siu4D_0062.jpg (736:1463):
455:1 siu4D_0065.jpg (760:1396):
461:1 siu4D_0074.jpg (930:1345):
467:1 siu4D_0083.jpg (1116:1453):
479:1 siu5B_0008.jpg (641:1696):
489:1 siu5B_0023.jpg (708:1294):
533:1 siu6A_0017.jpg (874:1197):
563:1 siu6A_0062.jpg (704:1441):
573:1 siu6A_0077.jpg (874:1286):
583:1 rose4B__0002.jpg (743:1284):
591:1 rose4B__0014.jpg (774:1088):
593:5 rose4B__0017.jpg (812:1008):
605:1 rose4B__0035.jpg (826:1458):
619:4 rose4B__0056.jpg (867:1377):
621:1 rose4B__0059.jpg (725:1223):
629:1 rose4B__0071.jpg (718:1157):
643:1 rose4B__0092.jpg (894:1206):
663:1 rose5A_0011.jpg (752:1277):
691:1 rose5A_0053.jpg (687:1215):
701:1 rose5A_0068.jpg (817:1154):

draw_Hidden lines not in coordination {57-2}~ [27]

33:1 wu4A_0033.jpg (854:1434):
81:1 wu4A_0081.jpg (1032:1666):
113:1 wu4A_0113.jpg (814:1136):

113:2 wu4A_0113.jpg (899:1096):
165:1 wu5A__0013.jpg (931:1324):
165:2 wu5A__0013.jpg (1031:1287):
217:1 wu5A__0065.jpg (969:1320):
217:2 wu5A__0065.jpg (1069:1199):
225:1 wu5A__0073.jpg (1120:1643):
225:2 wu5A__0073.jpg (1173:1473):
253:1 wu5A__0101.jpg (943:1509):
253:2 wu5A__0101.jpg (1063:1426):
435:1 siu4D_0035.jpg (1113:1364):
435:2 siu4D_0035.jpg (1161:1307):
449:1 siu4D_0056.jpg (1305:1671):
449:2 siu4D_0056.jpg (1379:1625):
453:1 siu4D_0062.jpg (736:1463):
453:2 siu4D_0062.jpg (778:1273):
479:1 siu5B_0008.jpg (641:1696):
479:2 siu5B_0008.jpg (923:1605):
533:1 siu6A_0017.jpg (874:1197):
533:2 siu6A_0017.jpg (886:1052):
563:1 siu6A_0062.jpg (704:1441):
593:5 rose4B__0017.jpg (812:1008):
593:6 rose4B__0017.jpg (850:952):
701:1 rose5A_0068.jpg (817:1154):
701:3 rose5A_0068.jpg (863:1045):

draw_Incomplete drawing of hidden lines {38-2}~ [2]
489:1 siu5B_0023.jpg (708:1294):
489:2 siu5B_0023.jpg (844:1179):

draw_Nontransparent {110-2}~ [21]
5:1 wu4A_0005.jpg (868:1381):
93:1 wu4A_0093.jpg (808:1112):
129:1 wu4A_0129.jpg (843:1048):
133:1 wu4A_0133.jpg (896:1287):
137:1 wu4A_0137.jpg (909:1092):
229:1 wu5A__0077.jpg (778:1507):
293:1 wu6A__0021.jpg (891:1774):
349:1 wu6A__0077.jpg (929:1381):
369:1 wu6A__0097.jpg (987:1291):
385:1 wu6A__0113.jpg (911:1524):
393:1 wu6A__0121.jpg (864:1307):
433:1 siu4D_0032.jpg (884:1284):
447:1 siu4D_0053.jpg (782:1074):
467:1 siu4D_0083.jpg (1116:1453):
583:1 rose4B__0002.jpg (743:1284):
591:1 rose4B__0014.jpg (774:1088):
605:1 rose4B__0035.jpg (826:1458):
619:4 rose4B__0056.jpg (867:1377):
621:1 rose4B__0059.jpg (725:1223):
629:1 rose4B__0071.jpg (718:1157):
643:1 rose4B__0092.jpg (894:1206):

draw_Not in perspective view {54-3}~ [15]
33:1 wu4A_0033.jpg (854:1434):
77:1 wu4A_0077.jpg (1025:1423):
93:1 wu4A_0093.jpg (808:1112):
129:1 wu4A_0129.jpg (843:1048):
229:1 wu5A__0077.jpg (778:1507):
393:1 wu6A__0121.jpg (864:1307):
455:1 siu4D_0065.jpg (760:1396):
467:1 siu4D_0083.jpg (1116:1453):
583:1 rose4B__0002.jpg (743:1284):
605:1 rose4B__0035.jpg (826:1458):
605:2 rose4B__0035.jpg (1238:1451):
619:4 rose4B__0056.jpg (867:1377):
621:1 rose4B__0059.jpg (725:1223):
663:1 rose5A_0011.jpg (752:1277):
701:1 rose5A_0068.jpg (817:1154):

draw_Perpendicular edges {33-1}~ [36]
5:1 wu4A_0005.jpg (868:1381):
5:2 wu4A_0005.jpg (1269:1362):
41:1 wu4A_0041.jpg (941:1476):
41:2 wu4A_0041.jpg (1351:1457):

45:1 wu4A_0045.jpg (926:1355):
45:2 wu4A_0045.jpg (1222:1317):
97:1 wu4A_0097.jpg (1020:1503):
97:2 wu4A_0097.jpg (1352:1461):
133:1 wu4A_0133.jpg (896:1287):
133:2 wu4A_0133.jpg (1123:1218):
217:1 wu5A__0065.jpg (969:1320):
217:3 wu5A__0065.jpg (1236:1286):
293:1 wu6A__0021.jpg (891:1774):
293:2 wu6A__0021.jpg (1638:1761):
349:1 wu6A__0077.jpg (929:1381):
349:2 wu6A__0077.jpg (1272:1352):
369:1 wu6A__0097.jpg (987:1291):
369:2 wu6A__0097.jpg (1197:1274):
453:1 siu4D_0062.jpg (736:1463):
453:3 siu4D_0062.jpg (1291:1430):
455:1 siu4D_0065.jpg (760:1396):
455:2 siu4D_0065.jpg (1268:1364):
583:1 rose4B__0002.jpg (743:1284):
583:6 rose4B__0002.jpg (1130:1243):
605:1 rose4B__0035.jpg (826:1458):
605:2 rose4B__0035.jpg (1238:1451):
619:4 rose4B__0056.jpg (867:1377):
619:5 rose4B__0056.jpg (1261:1357):
621:1 rose4B__0059.jpg (725:1223):
621:2 rose4B__0059.jpg (1084:1188):
643:1 rose4B__0092.jpg (894:1206):
643:2 rose4B__0092.jpg (1120:1183):
663:1 rose5A_0011.jpg (752:1277):
663:2 rose5A_0011.jpg (1142:1296):
691:1 rose5A_0053.jpg (687:1215):
691:2 rose5A_0053.jpg (1053:1177):
draw_SOLO level %2 {103-1}~ [63]
1:1 wu4A_0001.jpg (1146:1400):
5:1 wu4A_0005.jpg (868:1381):
33:1 wu4A_0033.jpg (854:1434):
41:1 wu4A_0041.jpg (941:1476):
45:1 wu4A_0045.jpg (926:1355):
53:1 wu4A_0053.jpg (1108:1397):
65:1 wu4A_0065.jpg (869:1465):
77:1 wu4A_0077.jpg (1025:1423):
81:1 wu4A_0081.jpg (1032:1666):
93:1 wu4A_0093.jpg (808:1112):
97:1 wu4A_0097.jpg (1020:1503):
105:1 wu4A_0105.jpg (1282:1422):
113:1 wu4A_0113.jpg (814:1136):
125:1 wu4A_0125.jpg (915:1404):
129:1 wu4A_0129.jpg (843:1048):
133:1 wu4A_0133.jpg (896:1287):
137:1 wu4A_0137.jpg (909:1092):
149:1 wu4A_0149.jpg (1030:1389):
165:1 wu5A__0013.jpg (931:1324):
169:1 wu5A__0017.jpg (918:1461):
217:1 wu5A__0065.jpg (969:1320):
225:1 wu5A__0073.jpg (1120:1643):
229:1 wu5A__0077.jpg (778:1507):
253:1 wu5A__0101.jpg (943:1509):
261:1 wu5A__0109.jpg (824:1473):
265:1 wu5A__0113.jpg (733:1776):
293:1 wu6A__0021.jpg (891:1774):
325:1 wu6A__0053.jpg (770:1359):
345:1 wu6A__0073.jpg (873:1549):
349:1 wu6A__0077.jpg (929:1381):
353:1 wu6A__0081.jpg (877:1298):
369:1 wu6A__0097.jpg (987:1291):
373:1 wu6A__0101.jpg (808:1719):
385:1 wu6A__0113.jpg (911:1524):
393:1 wu6A__0121.jpg (864:1307):
413:1 siu4D_0002.jpg (886:1188):
417:1 siu4D_0008.jpg (867:1278):
419:1 siu4D_0011.jpg (844:1392):

425:1 siu4D_0020.jpg (1153:1397):
433:1 siu4D_0032.jpg (884:1284):
435:1 siu4D_0035.jpg (1113:1364):
447:1 siu4D_0053.jpg (782:1074):
449:1 siu4D_0056.jpg (1305:1671):
453:1 siu4D_0062.jpg (736:1463):
455:1 siu4D_0065.jpg (760:1396):
461:1 siu4D_0074.jpg (930:1345):
467:1 siu4D_0083.jpg (1116:1453):
479:1 siu5B_0008.jpg (641:1696):
489:1 siu5B_0023.jpg (708:1294):
533:1 siu6A_0017.jpg (874:1197):
563:1 siu6A_0062.jpg (704:1441):
573:1 siu6A_0077.jpg (874:1286):
583:1 rose4B__0002.jpg (743:1284):
591:1 rose4B__0014.jpg (774:1088):
593:5 rose4B__0017.jpg (812:1008):
605:1 rose4B__0035.jpg (826:1458):
619:4 rose4B__0056.jpg (867:1377):
621:1 rose4B__0059.jpg (725:1223):
629:1 rose4B__0071.jpg (718:1157):
643:1 rose4B__0092.jpg (894:1206):
663:1 rose5A_0011.jpg (752:1277):
691:1 rose5A_0053.jpg (687:1215):
701:1 rose5A_0068.jpg (817:1154):

draw_Some or all seen faces are drawn in a 2D format {44-2}~ [19]

1:1 wu4A_0001.jpg (1146:1400):
53:1 wu4A_0053.jpg (1108:1397):
65:1 wu4A_0065.jpg (869:1465):
77:1 wu4A_0077.jpg (1025:1423):
105:1 wu4A_0105.jpg (1282:1422):
125:1 wu4A_0125.jpg (915:1404):
149:1 wu4A_0149.jpg (1030:1389):
169:1 wu5A__0017.jpg (918:1461):
261:1 wu5A__0109.jpg (824:1473):
265:1 wu5A__0113.jpg (733:1776):
325:1 wu6A__0053.jpg (770:1359):
345:1 wu6A__0073.jpg (873:1549):
353:1 wu6A__0081.jpg (877:1298):
373:1 wu6A__0101.jpg (808:1719):
413:1 siu4D_0002.jpg (886:1188):
417:1 siu4D_0008.jpg (867:1278):
419:1 siu4D_0011.jpg (844:1392):
425:1 siu4D_0020.jpg (1153:1397):
461:1 siu4D_0074.jpg (930:1345):

#_draw Cube drawing at level 3 {133-4}~ [7]

#_draw Cube drawing {297-4}~ [133]

9:1 wu4A_0009.jpg (818:1686):
17:1 wu4A_0017.jpg (1011:1324):
21:1 wu4A_0021.jpg (1630:1791):
25:1 wu4A_0025.jpg (975:1280):
37:1 wu4A_0037.jpg (992:1570):
49:1 wu4A_0049.jpg (1040:1283):
57:1 wu4A_0057.jpg (1013:1617):
61:1 wu4A_0061.jpg (801:1127):
69:1 wu4A_0069.jpg (854:1765):
73:1 wu4A_0073.jpg (1085:1450):
85:1 wu4A_0085.jpg (994:1583):
89:1 wu4A_0089.jpg (884:1719):
101:1 wu4A_0101.jpg (1469:1731):
117:1 wu4A_0117.jpg (911:1241):
121:1 wu4A_0121.jpg (747:1317):
141:1 wu4A_0141.jpg (965:1424):
145:1 wu4A_0145.jpg (832:1323):
153:1 wu5A__0001.jpg (888:1457):
157:1 wu5A__0005.jpg (1032:1564):
177:1 wu5A__0025.jpg (1104:1541):
181:1 wu5A__0029.jpg (831:1507):

185:1 wu5A__0033.jpg (1229:1458):
189:1 wu5A__0037.jpg (1243:1412):
193:1 wu5A__0041.jpg (767:1344):
197:1 wu5A__0045.jpg (923:1409):
201:1 wu5A__0049.jpg (850:1245):
205:1 wu5A__0053.jpg (977:1524):
209:1 wu5A__0057.jpg (884:1307):
221:1 wu5A__0069.jpg (874:1444):
237:1 wu5A__0085.jpg (1001:1361):
241:1 wu5A__0089.jpg (907:1359):
245:1 wu5A__0093.jpg (1048:1438):
249:1 wu5A__0097.jpg (918:1241):
257:1 wu5A__0105.jpg (1020:1455):
285:1 wu6A__0013.jpg (911:1211):
289:1 wu6A__0017.jpg (1106:1329):
309:1 wu6A__0037.jpg (918:1753):
317:1 wu6A__0045.jpg (782:1791):
337:1 wu6A__0065.jpg (884:1301):
361:1 wu6A__0089.jpg (953:1647):
365:1 wu6A__0093.jpg (1049:1444):
381:1 wu6A__0109.jpg (823:1223):
389:1 wu6A__0117.jpg (794:1444):
397:1 wu6A__0125.jpg (1161:1558):
405:1 wu6A__0133.jpg (730:1534):
415:1 siu4D_0005.jpg (782:1588):
421:1 siu4D_0014.jpg (960:1382):
429:1 siu4D_0026.jpg (657:1162):
439:1 siu4D_0041.jpg (800:1164):
441:1 siu4D_0044.jpg (883:1118):
443:1 siu4D_0047.jpg (1074:1523):
451:1 siu4D_0059.jpg (956:1220):
457:1 siu4D_0068.jpg (1074:1652):
465:1 siu4D_0080.jpg (1004:1371):
469:1 siu4D_0086.jpg (616:1602):
475:1 siu5B_0002.jpg (875:1230):
483:1 siu5B_0014.jpg (691:1284):
485:1 siu5B_0017.jpg (908:1751):
487:1 siu5B_0020.jpg (762:1602):
491:1 siu5B_0026.jpg (783:1361):
493:1 siu5B_0029.jpg (870:1611):
495:1 siu5B_0032.jpg (789:1155):
501:1 siu5B_0041.jpg (879:1328):
503:1 siu5B_0044.jpg (662:1430):
507:1 siu5B_0050.jpg (699:1694):
509:1 siu5B_0053.jpg (750:1657):
515:1 siu5B_0062.jpg (866:1416):
517:1 siu5B_0065.jpg (796:1611):
519:1 siu5B_0068.jpg (639:1245):
549:1 siu6A_0041.jpg (971:1286):
553:1 siu6A_0047.jpg (963:1434):
557:1 siu6A_0053.jpg (760:1191):
565:1 siu6A_0065.jpg (764:1453):
589:4 rose4B__0011.jpg (789:1100):
595:3 rose4B__0020.jpg (820:1274):
597:1 rose4B__0023.jpg (845:1112):
599:3 rose4B__0026.jpg (723:1219):
601:1 rose4B__0029.jpg (664:1289):
603:1 rose4B__0032.jpg (829:1373):
607:1 rose4B__0038.jpg (849:1335):
609:1 rose4B__0041.jpg (853:1362):
613:1 rose4B__0047.jpg (911:1385):
615:1 rose4B__0050.jpg (890:1427):
623:1 rose4B__0062.jpg (752:1119):
625:1 rose4B__0065.jpg (1049:1431):
631:1 rose4B__0074.jpg (664:1300):
633:1 rose4B__0077.jpg (768:1161):
637:1 rose4B__0083.jpg (784:1307):
639:1 rose4B__0086.jpg (970:1288):
641:1 rose4B__0089.jpg (572:1182):
645:1 rose4B__0095.jpg (737:1154):
647:1 rose4B__0098.jpg (698:1219):

649:1 rose4B__0101.jpg (937:1347):
651:1 rose4B__0104.jpg (880:1129):
653:1 rose4B__0107.jpg (1007:1274):
657:1 rose5A_0002.jpg (745:1146):
661:1 rose5A_0008.jpg (799:1165):
665:1 rose5A_0014.jpg (790:1047):
667:1 rose5A_0017.jpg (1146:1493):
671:1 rose5A_0023.jpg (799:1262):
673:1 rose5A_0026.jpg (791:1119):
675:1 rose5A_0029.jpg (741:1107):
677:1 rose5A_0032.jpg (800:1141):
679:1 rose5A_0035.jpg (656:1073):
681:1 rose5A_0038.jpg (710:1157):
683:1 rose5A_0041.jpg (694:1188):
687:1 rose5A_0047.jpg (808:1126):
689:1 rose5A_0050.jpg (760:1080):
695:1 rose5A_0059.jpg (717:1126):
697:1 rose5A_0062.jpg (714:1184):
699:1 rose5A_0065.jpg (845:1196):
705:1 rose5A_0074.jpg (698:961):
709:1 rose5A_0080.jpg (901:1181):
717:1 rose5A_0092.jpg (795:1258):
719:1 rose5A_0095.jpg (691:1146):
725:1 rose5A_0104.jpg (754:1117):
727:1 rose5A_0107.jpg (683:1065):
737:1 rose6D_0014.jpg (744:1097):
739:1 rose6D_0017.jpg (721:1273):
743:1 rose6D_0023.jpg (815:1186):
749:1 rose6D_0032.jpg (710:1220):
753:1 rose6D_0038.jpg (762:1460):
757:1 rose6D_0044.jpg (768:1073):
759:1 rose6D_0047.jpg (771:1009):
761:1 rose6D_0050.jpg (594:1142):
771:2 rose6D_0065.jpg (747:1137):
775:1 rose6D_0071.jpg (791:1350):
777:1 rose6D_0074.jpg (826:1242):
779:1 rose6D_0077.jpg (806:1240):
781:1 rose6D_0080.jpg (696:1146):
785:1 rose6D_0086.jpg (698:1038):
787:1 rose6D_0089.jpg (837:1364):
789:1 rose6D_0092.jpg (760:1215):
draw_Hidden lines not in coordination {57-2}~ [61]
25:1 wu4A_0025.jpg (975:1280):
25:2 wu4A_0025.jpg (1092:1189):
153:1 wu5A__0001.jpg (888:1457):
153:2 wu5A__0001.jpg (960:1101):
157:1 wu5A__0005.jpg (1032:1564):
157:2 wu5A__0005.jpg (1211:1461):
193:1 wu5A__0041.jpg (767:1344):
193:2 wu5A__0041.jpg (877:1215):
205:1 wu5A__0053.jpg (977:1524):
205:2 wu5A__0053.jpg (1184:1424):
209:1 wu5A__0057.jpg (884:1307):
209:2 wu5A__0057.jpg (922:1282):
221:1 wu5A__0069.jpg (874:1444):
221:2 wu5A__0069.jpg (1034:1334):
237:1 wu5A__0085.jpg (1001:1361):
237:2 wu5A__0085.jpg (1057:1254):
241:1 wu5A__0089.jpg (907:1359):
241:2 wu5A__0089.jpg (1032:1241):
245:1 wu5A__0093.jpg (1048:1438):
245:2 wu5A__0093.jpg (1120:1332):
285:1 wu6A__0013.jpg (911:1211):
285:2 wu6A__0013.jpg (944:1101):
361:1 wu6A__0089.jpg (953:1647):
361:3 wu6A__0089.jpg (1082:1370):
365:1 wu6A__0093.jpg (1049:1444):
365:2 wu6A__0093.jpg (1184:1390):
415:1 siu4D_0005.jpg (782:1588):
415:2 siu4D_0005.jpg (1065:1444):
421:1 siu4D_0014.jpg (960:1382):

421:2 siu4D_0014.jpg (1008:1264):
457:1 siu4D_0068.jpg (1074:1652):
469:1 siu4D_0086.jpg (616:1602):
485:1 siu5B_0017.jpg (908:1751):
485:2 siu5B_0017.jpg (1047:1596):
487:1 siu5B_0020.jpg (762:1602):
493:1 siu5B_0029.jpg (870:1611):
493:2 siu5B_0029.jpg (1014:1370):
501:1 siu5B_0041.jpg (879:1328):
501:2 siu5B_0041.jpg (1032:1268):
589:4 rose4B__0011.jpg (789:1100):
589:5 rose4B__0011.jpg (880:1005):
653:1 rose4B__0107.jpg (1007:1274):
653:3 rose4B__0107.jpg (1157:1246):
657:1 rose5A_0002.jpg (745:1146):
657:2 rose5A_0002.jpg (899:1069):
695:1 rose5A_0059.jpg (717:1126):
695:2 rose5A_0059.jpg (906:1095):
725:1 rose5A_0104.jpg (754:1117):
725:2 rose5A_0104.jpg (864:981):
737:1 rose6D_0014.jpg (744:1097):
737:6 rose6D_0014.jpg (810:956):
739:1 rose6D_0017.jpg (721:1273):
739:2 rose6D_0017.jpg (806:1184):
771:2 rose6D_0065.jpg (747:1137):
771:3 rose6D_0065.jpg (824:1047):
785:1 rose6D_0086.jpg (698:1038):
785:5 rose6D_0086.jpg (764:965):
787:1 rose6D_0089.jpg (837:1364):
787:2 rose6D_0089.jpg (984:1137):
789:1 rose6D_0092.jpg (760:1215):
789:2 rose6D_0092.jpg (829:1026):
draw_Incomplete drawing of hidden lines {38-2}~ [42]
49:1 wu4A_0049.jpg (1040:1283):
49:2 wu4A_0049.jpg (1046:1203):
57:1 wu4A_0057.jpg (1013:1617):
57:2 wu4A_0057.jpg (1067:1583):
89:1 wu4A_0089.jpg (884:1719):
89:2 wu4A_0089.jpg (1325:1465):
141:1 wu4A_0141.jpg (965:1424):
141:2 wu4A_0141.jpg (1184:1343):
145:1 wu4A_0145.jpg (832:1323):
145:2 wu4A_0145.jpg (883:1275):
181:1 wu5A__0029.jpg (831:1507):
181:2 wu5A__0029.jpg (858:1093):
189:1 wu5A__0037.jpg (1243:1412):
189:2 wu5A__0037.jpg (1309:1352):
285:1 wu6A__0013.jpg (911:1211):
285:2 wu6A__0013.jpg (944:1101):
317:1 wu6A__0045.jpg (782:1791):
317:2 wu6A__0045.jpg (831:1249):
389:1 wu6A__0117.jpg (794:1444):
389:2 wu6A__0117.jpg (847:1201):
441:1 siu4D_0044.jpg (883:1118):
451:1 siu4D_0059.jpg (956:1220):
451:5 siu4D_0059.jpg (970:1163):
475:1 siu5B_0002.jpg (875:1230):
553:1 siu6A_0047.jpg (963:1434):
553:5 siu6A_0047.jpg (1166:1273):
565:1 siu6A_0065.jpg (764:1453):
565:6 siu6A_0065.jpg (801:1092):
623:1 rose4B__0062.jpg (752:1119):
623:2 rose4B__0062.jpg (775:984):
709:1 rose5A_0080.jpg (901:1181):
709:2 rose5A_0080.jpg (921:1044):
719:1 rose5A_0095.jpg (691:1146):
719:2 rose5A_0095.jpg (725:988):
727:1 rose5A_0107.jpg (683:1065):
727:7 rose5A_0107.jpg (814:944):
759:1 rose6D_0047.jpg (771:1009):
759:2 rose6D_0047.jpg (866:954):

761:1 rose6D_0050.jpg (594:1142):
761:2 rose6D_0050.jpg (779:1026):
781:1 rose6D_0080.jpg (696:1146):
781:2 rose6D_0080.jpg (771:956):
draw_Nontransparent {110-2}~ [58]
17:1 wu4A_0017.jpg (1011:1324):
21:1 wu4A_0021.jpg (1630:1791):
37:1 wu4A_0037.jpg (992:1570):
61:1 wu4A_0061.jpg (801:1127):
69:1 wu4A_0069.jpg (854:1765):
73:1 wu4A_0073.jpg (1085:1450):
85:1 wu4A_0085.jpg (994:1583):
101:1 wu4A_0101.jpg (1469:1731):
117:1 wu4A_0117.jpg (911:1241):
121:1 wu4A_0121.jpg (747:1317):
185:1 wu5A__0033.jpg (1229:1458):
201:1 wu5A__0049.jpg (850:1245):
249:1 wu5A__0097.jpg (918:1241):
289:1 wu6A__0017.jpg (1106:1329):
309:1 wu6A__0037.jpg (918:1753):
337:1 wu6A__0065.jpg (884:1301):
381:1 wu6A__0109.jpg (823:1223):
429:1 siu4D_0026.jpg (657:1162):
443:1 siu4D_0047.jpg (1074:1523):
465:1 siu4D_0080.jpg (1004:1371):
483:1 siu5B_0014.jpg (691:1284):
495:1 siu5B_0032.jpg (789:1155):
595:3 rose4B__0020.jpg (820:1274):
597:1 rose4B__0023.jpg (845:1112):
599:3 rose4B__0026.jpg (723:1219):
601:1 rose4B__0029.jpg (664:1289):
603:1 rose4B__0032.jpg (829:1373):
607:1 rose4B__0038.jpg (849:1335):
609:1 rose4B__0041.jpg (853:1362):
613:1 rose4B__0047.jpg (911:1385):
615:1 rose4B__0050.jpg (890:1427):
625:1 rose4B__0065.jpg (1049:1431):
631:1 rose4B__0074.jpg (664:1300):
633:1 rose4B__0077.jpg (768:1161):
637:1 rose4B__0083.jpg (784:1307):
639:1 rose4B__0086.jpg (970:1288):
641:1 rose4B__0089.jpg (572:1182):
645:1 rose4B__0095.jpg (737:1154):
647:1 rose4B__0098.jpg (698:1219):
649:1 rose4B__0101.jpg (937:1347):
651:1 rose4B__0104.jpg (880:1129):
665:1 rose5A_0014.jpg (790:1047):
671:1 rose5A_0023.jpg (799:1262):
673:1 rose5A_0026.jpg (791:1119):
675:1 rose5A_0029.jpg (741:1107):
679:1 rose5A_0035.jpg (656:1073):
681:1 rose5A_0038.jpg (710:1157):
683:1 rose5A_0041.jpg (694:1188):
687:1 rose5A_0047.jpg (808:1126):
689:1 rose5A_0050.jpg (760:1080):
697:1 rose5A_0062.jpg (714:1184):
705:1 rose5A_0074.jpg (698:961):
743:1 rose6D_0023.jpg (815:1186):
749:1 rose6D_0032.jpg (710:1220):
757:1 rose6D_0044.jpg (768:1073):
775:1 rose6D_0071.jpg (791:1350):
777:1 rose6D_0074.jpg (826:1242):
779:1 rose6D_0077.jpg (806:1240):
draw_Not in perspective view {54-3}~ [20]
101:1 wu4A_0101.jpg (1469:1731):
177:1 wu5A__0025.jpg (1104:1541):
257:1 wu5A__0105.jpg (1020:1455):
397:1 wu6A__0125.jpg (1161:1558):
451:1 siu4D_0059.jpg (956:1220):
515:1 siu5B_0062.jpg (866:1416):
557:1 siu6A_0053.jpg (760:1191):

599:3 rose4B__0026.jpg (723:1219):
603:1 rose4B__0032.jpg (829:1373):
615:1 rose4B__0050.jpg (890:1427):
653:1 rose4B__0107.jpg (1007:1274):
661:1 rose5A_0008.jpg (799:1165):
667:1 rose5A_0017.jpg (1146:1493):
675:1 rose5A_0029.jpg (741:1107):
677:1 rose5A_0032.jpg (800:1141):
679:1 rose5A_0035.jpg (656:1073):
681:1 rose5A_0038.jpg (710:1157):
699:1 rose5A_0065.jpg (845:1196):
757:1 rose6D_0044.jpg (768:1073):
785:1 rose6D_0086.jpg (698:1038):
draw_Perpendicular edges {33-1}~ [22]
197:1 wu5A__0045.jpg (923:1409):
197:2 wu5A__0045.jpg (1243:1369):
361:1 wu6A__0089.jpg (953:1647):
361:2 wu6A__0089.jpg (1465:1590):
439:1 siu4D_0041.jpg (800:1164):
439:2 siu4D_0041.jpg (1032:1132):
503:1 siu5B_0044.jpg (662:1430):
503:2 siu5B_0044.jpg (1245:1384):
507:1 siu5B_0050.jpg (699:1694):
507:2 siu5B_0050.jpg (1546:1680):
517:1 siu5B_0065.jpg (796:1611):
517:2 siu5B_0065.jpg (1393:1602):
519:1 siu5B_0068.jpg (639:1245):
519:2 siu5B_0068.jpg (1051:1231):
549:1 siu6A_0041.jpg (971:1286):
549:2 siu6A_0041.jpg (1193:1264):
633:1 rose4B__0077.jpg (768:1161):
633:2 rose4B__0077.jpg (1038:1130):
657:1 rose5A_0002.jpg (745:1146):
657:7 rose5A_0002.jpg (1053:1119):
687:1 rose5A_0047.jpg (808:1126):
687:2 rose5A_0047.jpg (1037:1112):
draw_SOLO level %3 {217-2}~ [133]
9:1 wu4A_0009.jpg (818:1686):
17:1 wu4A_0017.jpg (1011:1324):
21:1 wu4A_0021.jpg (1630:1791):
25:1 wu4A_0025.jpg (975:1280):
37:1 wu4A_0037.jpg (992:1570):
49:1 wu4A_0049.jpg (1040:1283):
57:1 wu4A_0057.jpg (1013:1617):
61:1 wu4A_0061.jpg (801:1127):
69:1 wu4A_0069.jpg (854:1765):
73:1 wu4A_0073.jpg (1085:1450):
85:1 wu4A_0085.jpg (994:1583):
89:1 wu4A_0089.jpg (884:1719):
101:1 wu4A_0101.jpg (1469:1731):
117:1 wu4A_0117.jpg (911:1241):
121:1 wu4A_0121.jpg (747:1317):
141:1 wu4A_0141.jpg (965:1424):
145:1 wu4A_0145.jpg (832:1323):
153:1 wu5A__0001.jpg (888:1457):
157:1 wu5A__0005.jpg (1032:1564):
177:1 wu5A__0025.jpg (1104:1541):
181:1 wu5A__0029.jpg (831:1507):
185:1 wu5A__0033.jpg (1229:1458):
189:1 wu5A__0037.jpg (1243:1412):
193:1 wu5A__0041.jpg (767:1344):
197:1 wu5A__0045.jpg (923:1409):
201:1 wu5A__0049.jpg (850:1245):
205:1 wu5A__0053.jpg (977:1524):
209:1 wu5A__0057.jpg (884:1307):
221:1 wu5A__0069.jpg (874:1444):
237:1 wu5A__0085.jpg (1001:1361):
241:1 wu5A__0089.jpg (907:1359):
245:1 wu5A__0093.jpg (1048:1438):
249:1 wu5A__0097.jpg (918:1241):
257:1 wu5A__0105.jpg (1020:1455):

285:1 wu6A__0013.jpg (911:1211):
289:1 wu6A__0017.jpg (1106:1329):
309:1 wu6A__0037.jpg (918:1753):
317:1 wu6A__0045.jpg (782:1791):
337:1 wu6A__0065.jpg (884:1301):
361:1 wu6A__0089.jpg (953:1647):
365:1 wu6A__0093.jpg (1049:1444):
381:1 wu6A__0109.jpg (823:1223):
389:1 wu6A__0117.jpg (794:1444):
397:1 wu6A__0125.jpg (1161:1558):
405:1 wu6A__0133.jpg (730:1534):
415:1 siu4D_0005.jpg (782:1588):
421:1 siu4D_0014.jpg (960:1382):
429:1 siu4D_0026.jpg (657:1162):
439:1 siu4D_0041.jpg (800:1164):
441:1 siu4D_0044.jpg (883:1118):
443:1 siu4D_0047.jpg (1074:1523):
451:1 siu4D_0059.jpg (956:1220):
457:1 siu4D_0068.jpg (1074:1652):
465:1 siu4D_0080.jpg (1004:1371):
469:1 siu4D_0086.jpg (616:1602):
475:1 siu5B_0002.jpg (875:1230):
483:1 siu5B_0014.jpg (691:1284):
485:1 siu5B_0017.jpg (908:1751):
487:1 siu5B_0020.jpg (762:1602):
491:1 siu5B_0026.jpg (783:1361):
493:1 siu5B_0029.jpg (870:1611):
495:1 siu5B_0032.jpg (789:1155):
501:1 siu5B_0041.jpg (879:1328):
503:1 siu5B_0044.jpg (662:1430):
507:1 siu5B_0050.jpg (699:1694):
509:1 siu5B_0053.jpg (750:1657):
515:1 siu5B_0062.jpg (866:1416):
517:1 siu5B_0065.jpg (796:1611):
519:1 siu5B_0068.jpg (639:1245):
549:1 siu6A_0041.jpg (971:1286):
553:1 siu6A_0047.jpg (963:1434):
557:1 siu6A_0053.jpg (760:1191):
565:1 siu6A_0065.jpg (764:1453):
589:4 rose4B__0011.jpg (789:1100):
595:3 rose4B__0020.jpg (820:1274):
597:1 rose4B__0023.jpg (845:1112):
599:3 rose4B__0026.jpg (723:1219):
601:1 rose4B__0029.jpg (664:1289):
603:1 rose4B__0032.jpg (829:1373):
607:1 rose4B__0038.jpg (849:1335):
609:1 rose4B__0041.jpg (853:1362):
613:1 rose4B__0047.jpg (911:1385):
615:1 rose4B__0050.jpg (890:1427):
623:1 rose4B__0062.jpg (752:1119):
625:1 rose4B__0065.jpg (1049:1431):
631:1 rose4B__0074.jpg (664:1300):
633:1 rose4B__0077.jpg (768:1161):
637:1 rose4B__0083.jpg (784:1307):
639:1 rose4B__0086.jpg (970:1288):
641:1 rose4B__0089.jpg (572:1182):
645:1 rose4B__0095.jpg (737:1154):
647:1 rose4B__0098.jpg (698:1219):
649:1 rose4B__0101.jpg (937:1347):
651:1 rose4B__0104.jpg (880:1129):
653:1 rose4B__0107.jpg (1007:1274):
657:1 rose5A_0002.jpg (745:1146):
661:1 rose5A_0008.jpg (799:1165):
665:1 rose5A_0014.jpg (790:1047):
667:1 rose5A_0017.jpg (1146:1493):
671:1 rose5A_0023.jpg (799:1262):
673:1 rose5A_0026.jpg (791:1119):
675:1 rose5A_0029.jpg (741:1107):
677:1 rose5A_0032.jpg (800:1141):
679:1 rose5A_0035.jpg (656:1073):
681:1 rose5A_0038.jpg (710:1157):

683:1 rose5A_0041.jpg (694:1188):
687:1 rose5A_0047.jpg (808:1126):
689:1 rose5A_0050.jpg (760:1080):
695:1 rose5A_0059.jpg (717:1126):
697:1 rose5A_0062.jpg (714:1184):
699:1 rose5A_0065.jpg (845:1196):
705:1 rose5A_0074.jpg (698:961):
709:1 rose5A_0080.jpg (901:1181):
717:1 rose5A_0092.jpg (795:1258):
719:1 rose5A_0095.jpg (691:1146):
725:1 rose5A_0104.jpg (754:1117):
727:1 rose5A_0107.jpg (683:1065):
737:1 rose6D_0014.jpg (744:1097):
739:1 rose6D_0017.jpg (721:1273):
743:1 rose6D_0023.jpg (815:1186):
749:1 rose6D_0032.jpg (710:1220):
753:1 rose6D_0038.jpg (762:1460):
757:1 rose6D_0044.jpg (768:1073):
759:1 rose6D_0047.jpg (771:1009):
761:1 rose6D_0050.jpg (594:1142):
771:2 rose6D_0065.jpg (747:1137):
775:1 rose6D_0071.jpg (791:1350):
777:1 rose6D_0074.jpg (826:1242):
779:1 rose6D_0077.jpg (806:1240):
781:1 rose6D_0080.jpg (696:1146):
785:1 rose6D_0086.jpg (698:1038):
787:1 rose6D_0089.jpg (837:1364):
789:1 rose6D_0092.jpg (760:1215):

#_draw Cube drawing at level 4 {84-1}~ [3]

#_draw Cube drawing {297-4}~ [84]

161:1 wu5A__0009.jpg (958:1729):
173:1 wu5A__0021.jpg (733:1328):
213:1 wu5A__0061.jpg (877:1120):
233:1 wu5A__0081.jpg (964:1666):
269:1 wu5A__0117.jpg (1093:1476):
277:1 wu6A__0005.jpg (896:1401):
281:1 wu6A__0009.jpg (926:1332):
297:1 wu6A__0025.jpg (981:1324):
301:1 wu6A__0029.jpg (782:1568):
305:1 wu6A__0033.jpg (1112:1450):
313:1 wu6A__0041.jpg (945:1427):
321:1 wu6A__0049.jpg (808:1271):
329:1 wu6A__0057.jpg (786:1708):
333:1 wu6A__0061.jpg (1123:1392):
341:1 wu6A__0069.jpg (884:1366):
357:1 wu6A__0085.jpg (1025:1613):
377:1 wu6A__0105.jpg (721:1203):
409:1 wu6A__0137.jpg (862:1522):
445:1 siu4D_0050.jpg (620:1629):
459:1 siu4d_0071.jpg (783:1170):
463:1 siu4D_0077.jpg (977:1449):
471:1 siu4D_0089.jpg (1065:1412):
477:1 siu5B_0005.jpg (792:1666):
497:1 siu5B_0035.jpg (833:1426):
499:1 siu5B_0038.jpg (949:1365):
505:1 siu5B_0047.jpg (829:1319):
511:1 siu5B_0056.jpg (694:1458):
521:1 siu5B_0071.jpg (727:1490):
523:1 siu6A_0002.jpg (722:1361):
527:1 siu6A_0008.jpg (952:1175):
529:1 siu6A_0011.jpg (1174:1378):
531:1 siu6A_0014.jpg (852:1315):
535:1 siu6A_0020.jpg (832:1200):
537:1 siu6A_0023.jpg (849:1349):
539:1 siu6A_0026.jpg (797:1212):
541:1 siu6A_0029.jpg (796:1472):
543:1 siu6A_0032.jpg (727:1151):
545:1 siu6A_0035.jpg (778:1379):

547:1 siu6A_0038.jpg (780:1433):
551:1 siu6A_0044.jpg (861:1264):
555:1 siu6A_0050.jpg (856:1375):
559:1 siu6A_0056.jpg (786:1475):
561:1 siu6A_0059.jpg (914:1244):
567:1 siu6A_0068.jpg (829:1541):
569:1 siu6A_0071.jpg (793:1301):
571:1 siu6A_0074.jpg (904:1322):
575:1 siu6A_0080.jpg (625:1236):
577:1 siu6A_0083.jpg (787:1444):
579:1 siu6A_0086.jpg (954:1338):
581:1 siu6A_0089.jpg (829:1287):
585:1 rose4B__0005.jpg (710:1361):
587:1 rose4B__0008.jpg (797:1230):
611:1 rose4B__0044.jpg (691:1238):
617:1 rose4B__0053.jpg (664:1350):
635:1 rose4B__0080.jpg (787:1227):
655:1 rose4B__0110.jpg (729:1451):
659:1 rose5A_0005.jpg (930:1285):
669:1 rose5A_0020.jpg (679:1316):
693:1 rose5A_0056.jpg (648:1269):
703:1 rose5A_0071.jpg (625:1034):
711:1 rose5A_0083.jpg (737:1416):
713:1 rose5A_0086.jpg (786:981):
715:1 rose5A_0089.jpg (826:1212):
721:1 rose5A_0098.jpg (795:1316):
729:1 rose6D_0002.jpg (802:1103):
731:1 rose6D_0005.jpg (756:1354):
733:1 rose6D_0008.jpg (709:1080):
735:1 rose6D_0011.jpg (606:922):
741:1 rose6D_0020.jpg (680:1102):
745:1 rose6D_0026.jpg (928:1269):
747:1 rose6D_0029.jpg (805:1287):
751:1 rose6D_0035.jpg (684:1392):
755:1 rose6D_0041.jpg (742:1206):
763:1 rose6D_0053.jpg (903:1152):
765:1 rose6D_0056.jpg (876:1285):
767:1 rose6D_0059.jpg (764:1184):
769:1 rose6D_0062.jpg (1069:1350):
773:1 rose6D_0068.jpg (774:1024):
783:1 rose6D_0083.jpg (891:1130):
791:1 rose6D_0095.jpg (724:1244):
793:1 rose6D_0098.jpg (887:1231):
795:1 rose6D_0101.jpg (810:1150):
797:1 rose6D_0104.jpg (687:1076):
799:1 rose6D_0107.jpg (807:1161):
draw_Perfect drawing {66-2} [33]
277:1 wu6A__0005.jpg (896:1401):
313:1 wu6A__0041.jpg (945:1427):
341:1 wu6A__0069.jpg (884:1366):
357:1 wu6A__0085.jpg (1025:1613):
377:1 wu6A__0105.jpg (721:1203):
459:1 siu4d_0071.jpg (783:1170):
471:1 siu4D_0089.jpg (1065:1412):
499:1 siu5B_0038.jpg (949:1365):
505:1 siu5B_0047.jpg (829:1319):
511:1 siu5B_0056.jpg (694:1458):
537:1 siu6A_0023.jpg (849:1349):
541:1 siu6A_0029.jpg (796:1472):
543:1 siu6A_0032.jpg (727:1151):
545:1 siu6A_0035.jpg (778:1379):
555:1 siu6A_0050.jpg (856:1375):
567:1 siu6A_0068.jpg (829:1541):
577:1 siu6A_0083.jpg (787:1444):
581:1 siu6A_0089.jpg (829:1287):
611:1 rose4B__0044.jpg (691:1238):
617:1 rose4B__0053.jpg (664:1350):
635:1 rose4B__0080.jpg (787:1227):
659:1 rose5A_0005.jpg (930:1285):
669:1 rose5A_0020.jpg (679:1316):
693:1 rose5A_0056.jpg (648:1269):

721:1 rose5A_0098.jpg (795:1316):
729:1 rose6D_0002.jpg (802:1103):
741:1 rose6D_0020.jpg (680:1102):
745:1 rose6D_0026.jpg (928:1269):
747:1 rose6D_0029.jpg (805:1287):
751:1 rose6D_0035.jpg (684:1392):
769:1 rose6D_0062.jpg (1069:1350):
791:1 rose6D_0095.jpg (724:1244):
799:1 rose6D_0107.jpg (807:1161):
draw_SOLO level %4 {222-2}~ [84]
161:1 wu5A__0009.jpg (958:1729):
173:1 wu5A__0021.jpg (733:1328):
213:1 wu5A__0061.jpg (877:1120):
233:1 wu5A__0081.jpg (964:1666):
269:1 wu5A__0117.jpg (1093:1476):
277:1 wu6A__0005.jpg (896:1401):
281:1 wu6A__0009.jpg (926:1332):
297:1 wu6A__0025.jpg (981:1324):
301:1 wu6A__0029.jpg (782:1568):
305:1 wu6A__0033.jpg (1112:1450):
313:1 wu6A__0041.jpg (945:1427):
321:1 wu6A__0049.jpg (808:1271):
329:1 wu6A__0057.jpg (786:1708):
333:1 wu6A__0061.jpg (1123:1392):
341:1 wu6A__0069.jpg (884:1366):
357:1 wu6A__0085.jpg (1025:1613):
377:1 wu6A__0105.jpg (721:1203):
409:1 wu6A__0137.jpg (862:1522):
445:1 siu4D_0050.jpg (620:1629):
459:1 siu4d_0071.jpg (783:1170):
463:1 siu4D_0077.jpg (977:1449):
471:1 siu4D_0089.jpg (1065:1412):
477:1 siu5B_0005.jpg (792:1666):
497:1 siu5B_0035.jpg (833:1426):
499:1 siu5B_0038.jpg (949:1365):
505:1 siu5B_0047.jpg (829:1319):
511:1 siu5B_0056.jpg (694:1458):
521:1 siu5B_0071.jpg (727:1490):
523:1 siu6A_0002.jpg (722:1361):
527:1 siu6A_0008.jpg (952:1175):
529:1 siu6A_0011.jpg (1174:1378):
531:1 siu6A_0014.jpg (852:1315):
535:1 siu6A_0020.jpg (832:1200):
537:1 siu6A_0023.jpg (849:1349):
539:1 siu6A_0026.jpg (797:1212):
541:1 siu6A_0029.jpg (796:1472):
543:1 siu6A_0032.jpg (727:1151):
545:1 siu6A_0035.jpg (778:1379):
547:1 siu6A_0038.jpg (780:1433):
551:1 siu6A_0044.jpg (861:1264):
555:1 siu6A_0050.jpg (856:1375):
559:1 siu6A_0056.jpg (786:1475):
561:1 siu6A_0059.jpg (914:1244):
567:1 siu6A_0068.jpg (829:1541):
569:1 siu6A_0071.jpg (793:1301):
571:1 siu6A_0074.jpg (904:1322):
575:1 siu6A_0080.jpg (625:1236):
577:1 siu6A_0083.jpg (787:1444):
579:1 siu6A_0086.jpg (954:1338):
581:1 siu6A_0089.jpg (829:1287):
585:1 rose4B__0005.jpg (710:1361):
587:1 rose4B__0008.jpg (797:1230):
611:1 rose4B__0044.jpg (691:1238):
617:1 rose4B__0053.jpg (664:1350):
635:1 rose4B__0080.jpg (787:1227):
655:1 rose4B__0110.jpg (729:1451):
659:1 rose5A_0005.jpg (930:1285):
669:1 rose5A_0020.jpg (679:1316):
693:1 rose5A_0056.jpg (648:1269):
703:1 rose5A_0071.jpg (625:1034):
711:1 rose5A_0083.jpg (737:1416):

713:1 rose5A_0086.jpg (786:981):
715:1 rose5A_0089.jpg (826:1212):
721:1 rose5A_0098.jpg (795:1316):
729:1 rose6D_0002.jpg (802:1103):
731:1 rose6D_0005.jpg (756:1354):
733:1 rose6D_0008.jpg (709:1080):
735:1 rose6D_0011.jpg (606:922):
741:1 rose6D_0020.jpg (680:1102):
745:1 rose6D_0026.jpg (928:1269):
747:1 rose6D_0029.jpg (805:1287):
751:1 rose6D_0035.jpg (684:1392):
755:1 rose6D_0041.jpg (742:1206):
763:1 rose6D_0053.jpg (903:1152):
765:1 rose6D_0056.jpg (876:1285):
767:1 rose6D_0059.jpg (764:1184):
769:1 rose6D_0062.jpg (1069:1350):
773:1 rose6D_0068.jpg (774:1024):
783:1 rose6D_0083.jpg (891:1130):
791:1 rose6D_0095.jpg (724:1244):
793:1 rose6D_0098.jpg (887:1231):
795:1 rose6D_0101.jpg (810:1150):
797:1 rose6D_0104.jpg (687:1076):
799:1 rose6D_0107.jpg (807:1161):

Appendix D: Cooccurring Codes for Triangular Prism Descriptions

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HU: rose
File: [J:\study1\datacollection\RoseofLima\rose.hpr5]
Edited by: swpun
Date/Time: 03/11/07 09:06:19 AM

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^_des Triangular prism description at level 1 {9-3}~ [9]

^ Triangular prism as tetrahedron {5-2}~ [2]
38:2 rose4B__0057.jpg (1765:2088):
62:1 rose4B__0093.jpg (1754:1978):
^_des 5 faces (triangular prism) {49-3}~ [2]
202:2 rose6D_0084.jpg (1730:1985):
202:3 rose6D_0084.jpg (1747:1835):
^_des Chocolate bar (triangular prism) {23-2} [4]
38:2 rose4B__0057.jpg (1765:2088):
38:3 rose4B__0057.jpg (1906:1969):
62:1 rose4B__0093.jpg (1754:1978):
62:3 rose4B__0093.jpg (1881:1958):
^_des Triangular prism description {109-0}~ [9]
38:2 rose4B__0057.jpg (1765:2088):
44:2 rose4B__0066.jpg (1728:1864):
62:1 rose4B__0093.jpg (1754:1978):
72:2 rose4B__0108.jpg (1737:1894):
94:2 rose5A_0030.jpg (1752:1863):
98:2 rose5A_0036.jpg (1727:1994):
110:2 rose5A_0054.jpg (1751:1864):
136:2 rose5A_0093.jpg (1731:1864):
202:2 rose6D_0084.jpg (1730:1985):
des_Describing with 2D terms {27-4}~ [2]
44:2 rose4B__0066.jpg (1728:1864):
110:2 rose5A_0054.jpg (1751:1864):
des_Few information in description {39-4}~ [1]
44:2 rose4B__0066.jpg (1728:1864):
des_Incorrect description (general) {28-3}~ [4]
44:2 rose4B__0066.jpg (1728:1864):
72:2 rose4B__0108.jpg (1737:1894):
136:2 rose5A_0093.jpg (1731:1864):
202:2 rose6D_0084.jpg (1730:1985):
des_SOLO level %1 {20-0}~ [9]
38:2 rose4B__0057.jpg (1765:2088):
44:2 rose4B__0066.jpg (1728:1864):
62:1 rose4B__0093.jpg (1754:1978):
72:2 rose4B__0108.jpg (1737:1894):
94:2 rose5A_0030.jpg (1752:1863):
98:2 rose5A_0036.jpg (1727:1994):
110:2 rose5A_0054.jpg (1751:1864):
136:2 rose5A_0093.jpg (1731:1864):
202:2 rose6D_0084.jpg (1730:1985):
Unable to describe/draw any features {10-4} [3]
94:2 rose5A_0030.jpg (1752:1863):
98:2 rose5A_0036.jpg (1727:1994):
136:2 rose5A_0093.jpg (1731:1864):

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^_des Triangular prism description at level 2 {42-11}~ [15]

^_des 5 faces (triangular prism) {49-3}~ [30]
4:1 rose4B__0006.jpg (1746:1850):
4:2 rose4B__0006.jpg (1742:2083):
10:2 rose4B__0015.jpg (1754:2117):
10:3 rose4B__0015.jpg (1873:1966):
18:2 rose4B__0027.jpg (1767:1968):
18:6 rose4B__0027.jpg (1786:1838):
22:3 rose4B__0033.jpg (1748:2095):

22:7 rose4B__0033.jpg (1760:1822):
46:2 rose4B__0069.jpg (1758:1858):
46:4 rose4B__0069.jpg (1795:1837):
76:2 rose5A_0003.jpg (1744:1983):
76:3 rose5A_0003.jpg (1760:1838):
112:3 rose5A_0057.jpg (1844:1956):
112:5 rose5A_0057.jpg (1698:2002):
118:3 rose5A_0066.jpg (1725:2126):
118:5 rose5A_0066.jpg (1867:1975):
148:2 rose6D_0003.jpg (1755:2110):
148:3 rose6D_0003.jpg (1762:1834):
152:2 rose6D_0009.jpg (1720:2100):
152:3 rose6D_0009.jpg (1757:1840):
158:3 rose6D_0018.jpg (1701:2161):
158:6 rose6D_0018.jpg (1863:1968):
160:2 rose6D_0021.jpg (1759:2087):
160:3 rose6D_0021.jpg (1769:1847):
162:2 rose6D_0024.jpg (1732:2130):
162:3 rose6D_0024.jpg (1750:1842):
196:2 rose6D_0075.jpg (1751:1961):
196:3 rose6D_0075.jpg (1754:1828):
204:2 rose6D_0087.jpg (1698:2168):
204:3 rose6D_0087.jpg (1732:1840):
^_des 6 vertices (triangular prism) {25-3}~ [10]
76:2 rose5A_0003.jpg (1744:1983):
76:6 rose5A_0003.jpg (1875:1952):
86:2 rose5A_0018.jpg (1684:1991):
86:3 rose5A_0018.jpg (1860:1952):
158:3 rose6D_0018.jpg (1701:2161):
158:8 rose6D_0018.jpg (1997:2094):
160:2 rose6D_0021.jpg (1759:2087):
160:6 rose6D_0021.jpg (1778:1832):
214:2 rose6D_0102.jpg (1711:2101):
214:5 rose6D_0102.jpg (2001:2071):
^_des 9 edges (triangular prism) {27-3}~ [12]
86:2 rose5A_0018.jpg (1684:1991):
86:4 rose5A_0018.jpg (1856:1964):
152:2 rose6D_0009.jpg (1720:2100):
152:4 rose6D_0009.jpg (1992:2067):
158:3 rose6D_0018.jpg (1701:2161):
158:7 rose6D_0018.jpg (1986:2086):
160:2 rose6D_0021.jpg (1759:2087):
160:7 rose6D_0021.jpg (1791:1820):
196:2 rose6D_0075.jpg (1751:1961):
196:4 rose6D_0075.jpg (1758:1828):
214:2 rose6D_0102.jpg (1711:2101):
214:4 rose6D_0102.jpg (1995:2068):
^_des Chocolate bar (triangular prism) {23-2} [14]
30:2 rose4B__0045.jpg (1717:1983):
30:5 rose4B__0045.jpg (1883:1969):
52:1 rose4B__0078.jpg (1760:2078):
52:3 rose4B__0078.jpg (1895:1969):
58:2 rose4B__0087.jpg (1726:2089):
58:3 rose4B__0087.jpg (1763:1834):
76:2 rose5A_0003.jpg (1744:1983):
76:5 rose5A_0003.jpg (1860:1982):
92:6 rose5A_0027.jpg (1705:2083):
92:7 rose5A_0027.jpg (1875:1971):
158:3 rose6D_0018.jpg (1701:2161):
158:9 rose6D_0018.jpg (1875:1948):
200:2 rose6D_0081.jpg (1744:1978):
200:3 rose6D_0081.jpg (1761:1851):
^_des Mistaken 4 faces (triangular prism) {1-1}~ [2]
16:3 rose4B__0024.jpg (1757:1881):
16:6 rose4B__0024.jpg (1772:1838):
^_des Mistaken parallelogram (triangular prism) {8-2}~ [14]
10:2 rose4B__0015.jpg (1754:2117):
10:4 rose4B__0015.jpg (2010:2087):
30:2 rose4B__0045.jpg (1717:1983):
30:3 rose4B__0045.jpg (1743:1846):
116:2 rose5A_0063.jpg (1756:1986):

116:4 rose5A_0063.jpg (1864:1975):
120:2 rose5A_0069.jpg (1727:1967):
120:4 rose5A_0069.jpg (1867:1990):
124:2 rose5A_0075.jpg (1745:1895):
124:3 rose5A_0075.jpg (1763:1835):
126:2 rose5A_0078.jpg (1751:1981):
126:3 rose5A_0078.jpg (1757:1841):
214:2 rose6D_0102.jpg (1711:2101):
214:3 rose6D_0102.jpg (1861:1964):
^_des Mistaken trapezium (triangular prism) {4-1}~ [8]
4:2 rose4B__0006.jpg (1742:2083):
4:6 rose4B__0006.jpg (1870:1974):
18:2 rose4B__0027.jpg (1767:1968):
18:3 rose4B__0027.jpg (1898:1958):
22:3 rose4B__0033.jpg (1748:2095):
22:4 rose4B__0033.jpg (1860:1983):
158:3 rose6D_0018.jpg (1701:2161):
158:4 rose6D_0018.jpg (1863:1975):
^_des Prism (triangular prism) {44-3}~ [44]
4:2 rose4B__0006.jpg (1742:2083):
4:5 rose4B__0006.jpg (1866:1951):
6:2 rose4B__0009.jpg (1729:1915):
6:4 rose4B__0009.jpg (1760:1838):
16:3 rose4B__0024.jpg (1757:1881):
16:4 rose4B__0024.jpg (1767:1834):
18:2 rose4B__0027.jpg (1767:1968):
18:4 rose4B__0027.jpg (1775:1843):
20:2 rose4B__0030.jpg (1728:1863):
20:3 rose4B__0030.jpg (1728:1836):
22:3 rose4B__0033.jpg (1748:2095):
22:6 rose4B__0033.jpg (1769:1835):
24:2 rose4B__0036.jpg (1734:2088):
24:3 rose4B__0036.jpg (1854:1971):
30:2 rose4B__0045.jpg (1717:1983):
30:4 rose4B__0045.jpg (1738:1829):
40:2 rose4B__0060.jpg (1736:1975):
40:3 rose4B__0060.jpg (1863:1968):
42:2 rose4B__0063.jpg (1749:1858):
42:4 rose4B__0063.jpg (1764:1835):
46:2 rose4B__0069.jpg (1758:1858):
46:3 rose4B__0069.jpg (1775:1845):
50:2 rose4B__0075.jpg (1746:2175):
50:3 rose4B__0075.jpg (1866:1963):
56:1 rose4B__0084.jpg (1732:1857):
56:2 rose4B__0084.jpg (1760:1829):
60:2 rose4B__0090.jpg (1755:1973):
60:4 rose4B__0090.jpg (1872:1965):
70:2 rose4B__0105.jpg (1747:1971):
70:4 rose4B__0105.jpg (1757:1847):
92:3 rose5A_0027.jpg (1732:1852):
92:6 rose5A_0027.jpg (1705:2083):
104:3 rose5A_0045.jpg (1740:1979):
104:4 rose5A_0045.jpg (1863:1971):
116:2 rose5A_0063.jpg (1756:1986):
116:3 rose5A_0063.jpg (1867:1956):
118:3 rose5A_0066.jpg (1725:2126):
118:4 rose5A_0066.jpg (1744:1844):
124:2 rose5A_0075.jpg (1745:1895):
124:5 rose5A_0075.jpg (1773:1848):
126:2 rose5A_0078.jpg (1751:1981):
126:5 rose5A_0078.jpg (1874:1968):
132:2 rose5A_0087.jpg (1746:1866):
132:4 rose5A_0087.jpg (1763:1858):
^_des Rectangle (triangular prism) {39-2}~ [8]
4:2 rose4B__0006.jpg (1742:2083):
4:7 rose4B__0006.jpg (1871:1956):
30:2 rose4B__0045.jpg (1717:1983):
30:7 rose4B__0045.jpg (1856:1933):
70:2 rose4B__0105.jpg (1747:1971):
70:5 rose4B__0105.jpg (1771:1851):
200:2 rose6D_0081.jpg (1744:1978):

200:5 rose6D_0081.jpg (1901:1971):
^_des Triangle (triangular prism) {70-3}~ [44]
4:2 rose4B__0006.jpg (1742:2083):
4:8 rose4B__0006.jpg (1761:1843):
6:2 rose4B__0009.jpg (1729:1915):
6:3 rose4B__0009.jpg (1760:1834):
10:2 rose4B__0015.jpg (1754:2117):
10:5 rose4B__0015.jpg (1871:1979):
14:2 rose4B__0021.jpg (1764:1961):
14:3 rose4B__0021.jpg (1775:1843):
16:3 rose4B__0024.jpg (1757:1881):
16:5 rose4B__0024.jpg (1757:1831):
18:2 rose4B__0027.jpg (1767:1968):
18:8 rose4B__0027.jpg (1787:1831):
22:3 rose4B__0033.jpg (1748:2095):
22:5 rose4B__0033.jpg (1879:1971):
30:2 rose4B__0045.jpg (1717:1983):
30:6 rose4B__0045.jpg (1767:1848):
40:2 rose4B__0060.jpg (1736:1975):
40:4 rose4B__0060.jpg (1736:1829):
42:2 rose4B__0063.jpg (1749:1858):
42:3 rose4B__0063.jpg (1764:1835):
56:1 rose4B__0084.jpg (1732:1857):
56:3 rose4B__0084.jpg (1757:1835):
60:2 rose4B__0090.jpg (1755:1973):
60:3 rose4B__0090.jpg (1775:1844):
64:1 rose4B__0096.jpg (1735:1881):
64:2 rose4B__0096.jpg (1763:1841):
70:2 rose4B__0105.jpg (1747:1971):
70:6 rose4B__0105.jpg (1784:1843):
92:4 rose5A_0027.jpg (1860:1975):
92:6 rose5A_0027.jpg (1705:2083):
112:4 rose5A_0057.jpg (1709:1836):
112:5 rose5A_0057.jpg (1698:2002):
120:2 rose5A_0069.jpg (1727:1967):
120:3 rose5A_0069.jpg (1741:1849):
124:2 rose5A_0075.jpg (1745:1895):
124:4 rose5A_0075.jpg (1773:1833):
126:2 rose5A_0078.jpg (1751:1981):
126:4 rose5A_0078.jpg (1774:1851):
132:2 rose5A_0087.jpg (1746:1866):
132:3 rose5A_0087.jpg (1755:1843):
158:3 rose6D_0018.jpg (1701:2161):
158:5 rose6D_0018.jpg (1744:1833):
200:2 rose6D_0081.jpg (1744:1978):
200:4 rose6D_0081.jpg (1754:1844):
^_des Triangular prism description {109-0}~ [42]
4:2 rose4B__0006.jpg (1742:2083):
6:2 rose4B__0009.jpg (1729:1915):
10:2 rose4B__0015.jpg (1754:2117):
14:2 rose4B__0021.jpg (1764:1961):
16:3 rose4B__0024.jpg (1757:1881):
18:2 rose4B__0027.jpg (1767:1968):
20:2 rose4B__0030.jpg (1728:1863):
22:3 rose4B__0033.jpg (1748:2095):
24:2 rose4B__0036.jpg (1734:2088):
30:2 rose4B__0045.jpg (1717:1983):
40:2 rose4B__0060.jpg (1736:1975):
42:2 rose4B__0063.jpg (1749:1858):
46:2 rose4B__0069.jpg (1758:1858):
50:2 rose4B__0075.jpg (1746:2175):
52:1 rose4B__0078.jpg (1760:2078):
56:1 rose4B__0084.jpg (1732:1857):
58:2 rose4B__0087.jpg (1726:2089):
60:2 rose4B__0090.jpg (1755:1973):
64:1 rose4B__0096.jpg (1735:1881):
70:2 rose4B__0105.jpg (1747:1971):
76:2 rose5A_0003.jpg (1744:1983):
86:2 rose5A_0018.jpg (1684:1991):
92:6 rose5A_0027.jpg (1705:2083):
104:3 rose5A_0045.jpg (1740:1979):

112:5 rose5A_0057.jpg (1698:2002):
116:2 rose5A_0063.jpg (1756:1986):
118:3 rose5A_0066.jpg (1725:2126):
120:2 rose5A_0069.jpg (1727:1967):
124:2 rose5A_0075.jpg (1745:1895):
126:2 rose5A_0078.jpg (1751:1981):
132:2 rose5A_0087.jpg (1746:1866):
148:2 rose6D_0003.jpg (1755:2110):
152:2 rose6D_0009.jpg (1720:2100):
158:3 rose6D_0018.jpg (1701:2161):
160:2 rose6D_0021.jpg (1759:2087):
162:2 rose6D_0024.jpg (1732:2130):
196:2 rose6D_0075.jpg (1751:1961):
200:2 rose6D_0081.jpg (1744:1978):
204:2 rose6D_0087.jpg (1698:2168):
212:2 rose6D_0099.jpg (1736:2080):
214:2 rose6D_0102.jpg (1711:2101):
216:2 rose6D_0105.jpg (1755:2006):
des_Describing with 2D terms {27-4}~ [12]
10:2 rose4B__0015.jpg (1754:2117):
18:2 rose4B__0027.jpg (1767:1968):
18:7 rose4B__0027.jpg (1792:1858):
24:2 rose4B__0036.jpg (1734:2088):
50:2 rose4B__0075.jpg (1746:2175):
52:1 rose4B__0078.jpg (1760:2078):
52:2 rose4B__0078.jpg (1786:1855):
58:2 rose4B__0087.jpg (1726:2089):
60:2 rose4B__0090.jpg (1755:1973):
204:2 rose6D_0087.jpg (1698:2168):
212:2 rose6D_0099.jpg (1736:2080):
216:2 rose6D_0105.jpg (1755:2006):
des_Few information in description {39-4}~ [13]
6:2 rose4B__0009.jpg (1729:1915):
14:2 rose4B__0021.jpg (1764:1961):
20:2 rose4B__0030.jpg (1728:1863):
40:2 rose4B__0060.jpg (1736:1975):
42:2 rose4B__0063.jpg (1749:1858):
56:1 rose4B__0084.jpg (1732:1857):
58:2 rose4B__0087.jpg (1726:2089):
118:3 rose5A_0066.jpg (1725:2126):
148:2 rose6D_0003.jpg (1755:2110):
152:2 rose6D_0009.jpg (1720:2100):
162:2 rose6D_0024.jpg (1732:2130):
196:2 rose6D_0075.jpg (1751:1961):
212:2 rose6D_0099.jpg (1736:2080):
des_Incorrect description (general) {28-3}~ [17]
20:2 rose4B__0030.jpg (1728:1863):
20:4 rose4B__0030.jpg (1744:1852):
64:1 rose4B__0096.jpg (1735:1881):
64:3 rose4B__0096.jpg (1749:1846):
70:2 rose4B__0105.jpg (1747:1971):
76:2 rose5A_0003.jpg (1744:1983):
76:7 rose5A_0003.jpg (1886:1953):
86:2 rose5A_0018.jpg (1684:1991):
86:5 rose5A_0018.jpg (1728:1833):
92:5 rose5A_0027.jpg (1740:1829):
92:6 rose5A_0027.jpg (1705:2083):
160:2 rose6D_0021.jpg (1759:2087):
160:4 rose6D_0021.jpg (1868:1959):
162:2 rose6D_0024.jpg (1732:2130):
162:4 rose6D_0024.jpg (2005:2090):
200:2 rose6D_0081.jpg (1744:1978):
204:2 rose6D_0087.jpg (1698:2168):
des_SOLO level %2 {83-0}~ [42]
4:2 rose4B__0006.jpg (1742:2083):
6:2 rose4B__0009.jpg (1729:1915):
10:2 rose4B__0015.jpg (1754:2117):
14:2 rose4B__0021.jpg (1764:1961):
16:3 rose4B__0024.jpg (1757:1881):
18:2 rose4B__0027.jpg (1767:1968):
20:2 rose4B__0030.jpg (1728:1863):

22:3 rose4B__0033.jpg (1748:2095):
24:2 rose4B__0036.jpg (1734:2088):
30:2 rose4B__0045.jpg (1717:1983):
40:2 rose4B__0060.jpg (1736:1975):
42:2 rose4B__0063.jpg (1749:1858):
46:2 rose4B__0069.jpg (1758:1858):
50:2 rose4B__0075.jpg (1746:2175):
52:1 rose4B__0078.jpg (1760:2078):
56:1 rose4B__0084.jpg (1732:1857):
58:2 rose4B__0087.jpg (1726:2089):
60:2 rose4B__0090.jpg (1755:1973):
64:1 rose4B__0096.jpg (1735:1881):
70:2 rose4B__0105.jpg (1747:1971):
76:2 rose5A_0003.jpg (1744:1983):
86:2 rose5A_0018.jpg (1684:1991):
92:6 rose5A_0027.jpg (1705:2083):
104:3 rose5A_0045.jpg (1740:1979):
112:5 rose5A_0057.jpg (1698:2002):
116:2 rose5A_0063.jpg (1756:1986):
118:3 rose5A_0066.jpg (1725:2126):
120:2 rose5A_0069.jpg (1727:1967):
124:2 rose5A_0075.jpg (1745:1895):
126:2 rose5A_0078.jpg (1751:1981):
132:2 rose5A_0087.jpg (1746:1866):
148:2 rose6D_0003.jpg (1755:2110):
152:2 rose6D_0009.jpg (1720:2100):
158:3 rose6D_0018.jpg (1701:2161):
160:2 rose6D_0021.jpg (1759:2087):
162:2 rose6D_0024.jpg (1732:2130):
196:2 rose6D_0075.jpg (1751:1961):
200:2 rose6D_0081.jpg (1744:1978):
204:2 rose6D_0087.jpg (1698:2168):
212:2 rose6D_0099.jpg (1736:2080):
214:2 rose6D_0102.jpg (1711:2101):
216:2 rose6D_0105.jpg (1755:2006):

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^_des Triangular prism description at level 3 {41-9}~ [13]

^_des 5 faces (triangular prism) {49-3}~ [46]

26:1 rose4B__0039.jpg (1745:2082):
26:5 rose4B__0039.jpg (1772:1838):
28:2 rose4B__0042.jpg (1757:1857):
28:5 rose4B__0042.jpg (1792:1841):
36:2 rose4B__0054.jpg (1757:1968):
36:5 rose4B__0054.jpg (1764:1835):
54:2 rose4B__0081.jpg (1717:1991):
54:3 rose4B__0081.jpg (1767:1840):
74:2 rose4B__0111.jpg (1741:2084):
74:5 rose4B__0111.jpg (1755:1825):
78:2 rose5A_0006.jpg (1737:1988):
78:3 rose5A_0006.jpg (1764:1838):
122:2 rose5A_0072.jpg (1732:1983):
122:3 rose5A_0072.jpg (1744:1833):
130:2 rose5A_0084.jpg (1725:1991):
130:5 rose5A_0084.jpg (1860:1960):
134:2 rose5A_0090.jpg (1737:1978):
134:3 rose5A_0090.jpg (1755:1838):
146:6 rose5A_0108.jpg (1878:1968):
146:7 rose5A_0108.jpg (1705:2103):
154:2 rose6D_0012.jpg (1747:2144):
154:7 rose6D_0012.jpg (1784:1830):
164:2 rose6D_0027.jpg (1725:1989):
164:5 rose6D_0027.jpg (1892:1969):
168:2 rose6D_0033.jpg (1734:2094):
168:4 rose6D_0033.jpg (1748:1848):
172:3 rose6D_0039.jpg (1756:1968):
172:4 rose6D_0039.jpg (1770:1838):
174:2 rose6D_0042.jpg (1760:2106):
174:3 rose6D_0042.jpg (1882:1960):
178:3 rose6D_0048.jpg (1741:1871):

178:5 rose6D_0048.jpg (1747:1858):
184:2 rose6D_0057.jpg (1734:2131):
184:4 rose6D_0057.jpg (1891:1968):
186:2 rose6D_0060.jpg (1751:1971):
186:5 rose6D_0060.jpg (1764:1841):
190:3 rose6D_0066.jpg (1744:1981):
190:6 rose6D_0066.jpg (1884:1964):
194:2 rose6D_0072.jpg (1758:1966):
194:3 rose6D_0072.jpg (1760:1826):
198:2 rose6D_0078.jpg (1754:1991):
198:3 rose6D_0078.jpg (1761:1851):
210:3 rose6D_0096.jpg (1755:1969):
210:5 rose6D_0096.jpg (1772:1829):
218:2 rose6D_0108.jpg (1764:1854):
218:4 rose6D_0108.jpg (1779:1834):
^_des 6 vertices (triangular prism) {25-3}~ [32]
78:2 rose5A_0006.jpg (1737:1988):
78:6 rose5A_0006.jpg (1758:1822):
82:3 rose5A_0012.jpg (1737:2104):
82:7 rose5A_0012.jpg (2011:2081):
100:3 rose5A_0039.jpg (1754:2088):
100:7 rose5A_0039.jpg (1888:1958):
122:2 rose5A_0072.jpg (1732:1983):
122:6 rose5A_0072.jpg (1888:1958):
130:2 rose5A_0084.jpg (1725:1991):
130:6 rose5A_0084.jpg (1867:1952):
142:2 rose5A_0102.jpg (1690:1894):
142:4 rose5A_0102.jpg (1752:1844):
144:6 rose5A_0105.jpg (1674:1991):
144:9 rose5A_0105.jpg (1764:1828):
146:7 rose5A_0108.jpg (1705:2103):
146:9 rose5A_0108.jpg (1871:1952):
154:2 rose6D_0012.jpg (1747:2144):
154:5 rose6D_0012.jpg (1755:1840):
156:2 rose6D_0015.jpg (1749:2092):
156:4 rose6D_0015.jpg (1761:1835):
172:3 rose6D_0039.jpg (1756:1968):
172:8 rose6D_0039.jpg (1888:1952):
182:8 rose6D_0054.jpg (1915:1955):
182:9 rose6D_0054.jpg (1715:1998):
184:2 rose6D_0057.jpg (1734:2131):
184:8 rose6D_0057.jpg (1890:1955):
186:2 rose6D_0060.jpg (1751:1971):
186:6 rose6D_0060.jpg (1881:1948):
194:2 rose6D_0072.jpg (1758:1966):
194:5 rose6D_0072.jpg (1861:1948):
218:2 rose6D_0108.jpg (1764:1854):
218:3 rose6D_0108.jpg (1771:1834):
^_des 9 edges (triangular prism) {27-3}~ [30]
34:2 rose4B__0051.jpg (1767:2076):
34:5 rose4B__0051.jpg (1875:1960):
82:3 rose5A_0012.jpg (1737:2104):
82:6 rose5A_0012.jpg (2005:2078):
100:3 rose5A_0039.jpg (1754:2088):
100:8 rose5A_0039.jpg (1881:1958):
122:2 rose5A_0072.jpg (1732:1983):
122:7 rose5A_0072.jpg (1888:1958):
130:2 rose5A_0084.jpg (1725:1991):
130:7 rose5A_0084.jpg (1875:1948):
142:2 rose5A_0102.jpg (1690:1894):
142:3 rose5A_0102.jpg (1759:1829):
144:6 rose5A_0105.jpg (1674:1991):
144:8 rose5A_0105.jpg (1771:1828):
146:7 rose5A_0108.jpg (1705:2103):
146:8 rose5A_0108.jpg (1898:1956):
154:2 rose6D_0012.jpg (1747:2144):
154:4 rose6D_0012.jpg (1755:1844):
172:3 rose6D_0039.jpg (1756:1968):
172:7 rose6D_0039.jpg (1888:1962):
182:7 rose6D_0054.jpg (1895:1955):
182:9 rose6D_0054.jpg (1715:1998):

184:2 rose6D_0057.jpg (1734:2131):
184:7 rose6D_0057.jpg (1768:1835):
194:2 rose6D_0072.jpg (1758:1966):
194:6 rose6D_0072.jpg (1774:1820):
198:2 rose6D_0078.jpg (1754:1991):
198:4 rose6D_0078.jpg (1774:1820):
218:2 rose6D_0108.jpg (1764:1854):
218:5 rose6D_0108.jpg (1775:1829):
^_des Chocolate bar (triangular prism) {23-2} [4]
100:3 rose5A_0039.jpg (1754:2088):
100:6 rose5A_0039.jpg (1779:1852):
156:2 rose6D_0015.jpg (1749:2092):
156:3 rose6D_0015.jpg (1992:2095):
^_des Mistaken parallelogram (triangular prism) {8-2}~ [2]
164:2 rose6D_0027.jpg (1725:1989):
164:6 rose6D_0027.jpg (1769:1838):
^_des Prism (triangular prism) {44-3}~ [28]
2:2 rose4B__0003.jpg (1748:1968):
2:4 rose4B__0003.jpg (1856:1955):
8:2 rose4B__0012.jpg (1756:1927):
8:3 rose4B__0012.jpg (1847:1902):
28:2 rose4B__0042.jpg (1757:1857):
28:3 rose4B__0042.jpg (1777:1837):
66:2 rose4B__0099.jpg (1760:1991):
66:3 rose4B__0099.jpg (1767:1838):
74:2 rose4B__0111.jpg (1741:2084):
74:6 rose4B__0111.jpg (1758:1825):
106:4 rose5A_0048.jpg (1763:1840):
106:7 rose5A_0048.jpg (1725:1991):
128:5 rose5A_0081.jpg (1840:1948):
128:6 rose5A_0081.jpg (1717:1995):
138:3 rose5A_0096.jpg (1734:1891):
138:4 rose5A_0096.jpg (1751:1861):
140:2 rose5A_0099.jpg (1770:1975):
140:3 rose5A_0099.jpg (1770:1842):
144:5 rose5A_0105.jpg (1886:1955):
144:6 rose5A_0105.jpg (1674:1991):
164:2 rose6D_0027.jpg (1725:1989):
164:3 rose6D_0027.jpg (1760:1838):
178:3 rose6D_0048.jpg (1741:1871):
178:6 rose6D_0048.jpg (1774:1820):
182:4 rose6D_0054.jpg (1785:1845):
182:9 rose6D_0054.jpg (1715:1998):
190:3 rose6D_0066.jpg (1744:1981):
190:7 rose6D_0066.jpg (1761:1820):
^_des Rectangle (triangular prism) {39-2}~ [52]
26:1 rose4B__0039.jpg (1745:2082):
26:4 rose4B__0039.jpg (1875:1960):
32:2 rose4B__0048.jpg (1723:2098):
32:4 rose4B__0048.jpg (1743:1823):
34:2 rose4B__0051.jpg (1767:2076):
34:6 rose4B__0051.jpg (1782:1836):
36:2 rose4B__0054.jpg (1757:1968):
36:4 rose4B__0054.jpg (1879:1960):
66:2 rose4B__0099.jpg (1760:1991):
66:5 rose4B__0099.jpg (1902:1964):
74:2 rose4B__0111.jpg (1741:2084):
74:7 rose4B__0111.jpg (1774:1833):
78:2 rose5A_0006.jpg (1737:1988):
78:5 rose5A_0006.jpg (1744:1841):
80:2 rose5A_0009.jpg (1725:1991):
80:4 rose5A_0009.jpg (1860:1960):
82:3 rose5A_0012.jpg (1737:2104):
82:4 rose5A_0012.jpg (1888:1974):
96:2 rose5A_0033.jpg (1740:2126):
96:4 rose5A_0033.jpg (1871:1964):
106:6 rose5A_0048.jpg (1892:1980):
106:7 rose5A_0048.jpg (1725:1991):
114:2 rose5A_0060.jpg (1745:1968):
114:4 rose5A_0060.jpg (1882:1962):
122:2 rose5A_0072.jpg (1732:1983):

122:5 rose5A_0072.jpg (1852:1979):
128:4 rose5A_0081.jpg (1728:1852):
128:6 rose5A_0081.jpg (1717:1995):
130:2 rose5A_0084.jpg (1725:1991):
130:4 rose5A_0084.jpg (1740:1848):
134:2 rose5A_0090.jpg (1737:1978):
134:5 rose5A_0090.jpg (1872:1955):
140:2 rose5A_0099.jpg (1770:1975):
140:5 rose5A_0099.jpg (1782:1832):
144:6 rose5A_0105.jpg (1674:1991):
144:7 rose5A_0105.jpg (1701:1744):
146:5 rose5A_0108.jpg (1731:1841):
146:7 rose5A_0108.jpg (1705:2103):
168:2 rose6D_0033.jpg (1734:2094):
168:5 rose6D_0033.jpg (1882:1970):
172:3 rose6D_0039.jpg (1756:1968):
172:6 rose6D_0039.jpg (1890:1966):
174:2 rose6D_0042.jpg (1760:2106):
174:5 rose6D_0042.jpg (1995:2086):
182:6 rose6D_0054.jpg (1767:1840):
182:9 rose6D_0054.jpg (1715:1998):
184:2 rose6D_0057.jpg (1734:2131):
184:5 rose6D_0057.jpg (1884:1948):
186:2 rose6D_0060.jpg (1751:1971):
186:4 rose6D_0060.jpg (1767:1841):
210:3 rose6D_0096.jpg (1755:1969):
210:6 rose6D_0096.jpg (1900:1966):
^_des Triangle (triangular prism) {70-3}~ [69]
2:2 rose4B__0003.jpg (1748:1968):
2:3 rose4B__0003.jpg (1871:1958):
8:2 rose4B__0012.jpg (1756:1927):
8:4 rose4B__0012.jpg (1780:1827):
26:1 rose4B__0039.jpg (1745:2082):
26:3 rose4B__0039.jpg (1755:1852):
28:2 rose4B__0042.jpg (1757:1857):
28:4 rose4B__0042.jpg (1775:1838):
32:2 rose4B__0048.jpg (1723:2098):
32:3 rose4B__0048.jpg (1737:1828):
34:2 rose4B__0051.jpg (1767:2076):
34:3 rose4B__0051.jpg (1767:1848):
36:2 rose4B__0054.jpg (1757:1968):
36:3 rose4B__0054.jpg (1881:1961):
66:2 rose4B__0099.jpg (1760:1991):
66:4 rose4B__0099.jpg (1907:1960):
74:2 rose4B__0111.jpg (1741:2084):
74:3 rose4B__0111.jpg (1751:1834):
78:2 rose5A_0006.jpg (1737:1988):
78:4 rose5A_0006.jpg (1764:1834):
80:2 rose5A_0009.jpg (1725:1991):
80:3 rose5A_0009.jpg (1725:1848):
82:3 rose5A_0012.jpg (1737:2104):
82:5 rose5A_0012.jpg (1757:1841):
96:2 rose5A_0033.jpg (1740:2126):
96:3 rose5A_0033.jpg (1741:1834):
100:3 rose5A_0039.jpg (1754:2088):
100:5 rose5A_0039.jpg (1880:1958):
106:5 rose5A_0048.jpg (1752:1840):
106:7 rose5A_0048.jpg (1725:1991):
114:2 rose5A_0060.jpg (1745:1968):
114:3 rose5A_0060.jpg (1758:1872):
122:2 rose5A_0072.jpg (1732:1983):
122:4 rose5A_0072.jpg (1748:1848):
128:3 rose5A_0081.jpg (1732:1844):
128:6 rose5A_0081.jpg (1717:1995):
130:2 rose5A_0084.jpg (1725:1991):
130:3 rose5A_0084.jpg (1740:1848):
134:2 rose5A_0090.jpg (1737:1978):
134:4 rose5A_0090.jpg (1746:1832):
138:3 rose5A_0096.jpg (1734:1891):
138:5 rose5A_0096.jpg (1758:1851):
140:2 rose5A_0099.jpg (1770:1975):

140:4 rose5A_0099.jpg (1770:1832):
144:3 rose5A_0105.jpg (1746:1852):
144:6 rose5A_0105.jpg (1674:1991):
146:4 rose5A_0108.jpg (1724:1834):
146:7 rose5A_0108.jpg (1705:2103):
164:2 rose6D_0027.jpg (1725:1989):
164:4 rose6D_0027.jpg (1765:1845):
168:2 rose6D_0033.jpg (1734:2094):
168:3 rose6D_0033.jpg (1762:1838):
172:3 rose6D_0039.jpg (1756:1968):
172:9 rose6D_0039.jpg (1777:1840):
174:2 rose6D_0042.jpg (1760:2106):
174:4 rose6D_0042.jpg (2006:2084):
178:3 rose6D_0048.jpg (1741:1871):
178:7 rose6D_0048.jpg (1771:1820):
182:5 rose6D_0054.jpg (1785:1837):
182:9 rose6D_0054.jpg (1715:1998):
184:2 rose6D_0057.jpg (1734:2131):
184:3 rose6D_0057.jpg (1747:1841):
184:6 rose6D_0057.jpg (2014:2078):
186:2 rose6D_0060.jpg (1751:1971):
186:3 rose6D_0060.jpg (1754:1838):
190:3 rose6D_0066.jpg (1744:1981):
190:5 rose6D_0066.jpg (1751:1838):
210:3 rose6D_0096.jpg (1755:1969):
210:4 rose6D_0096.jpg (1775:1823):
^_des Triangular prism description {109-0}~ [41]
2:2 rose4B__0003.jpg (1748:1968):
8:2 rose4B__0012.jpg (1756:1927):
26:1 rose4B__0039.jpg (1745:2082):
28:2 rose4B__0042.jpg (1757:1857):
32:2 rose4B__0048.jpg (1723:2098):
34:2 rose4B__0051.jpg (1767:2076):
36:2 rose4B__0054.jpg (1757:1968):
54:2 rose4B__0081.jpg (1717:1991):
66:2 rose4B__0099.jpg (1760:1991):
74:2 rose4B__0111.jpg (1741:2084):
78:2 rose5A_0006.jpg (1737:1988):
80:2 rose5A_0009.jpg (1725:1991):
82:3 rose5A_0012.jpg (1737:2104):
96:2 rose5A_0033.jpg (1740:2126):
100:3 rose5A_0039.jpg (1754:2088):
106:7 rose5A_0048.jpg (1725:1991):
114:2 rose5A_0060.jpg (1745:1968):
122:2 rose5A_0072.jpg (1732:1983):
128:6 rose5A_0081.jpg (1717:1995):
130:2 rose5A_0084.jpg (1725:1991):
134:2 rose5A_0090.jpg (1737:1978):
138:3 rose5A_0096.jpg (1734:1891):
140:2 rose5A_0099.jpg (1770:1975):
142:2 rose5A_0102.jpg (1690:1894):
144:6 rose5A_0105.jpg (1674:1991):
146:7 rose5A_0108.jpg (1705:2103):
154:2 rose6D_0012.jpg (1747:2144):
156:2 rose6D_0015.jpg (1749:2092):
164:2 rose6D_0027.jpg (1725:1989):
168:2 rose6D_0033.jpg (1734:2094):
172:3 rose6D_0039.jpg (1756:1968):
174:2 rose6D_0042.jpg (1760:2106):
178:3 rose6D_0048.jpg (1741:1871):
182:9 rose6D_0054.jpg (1715:1998):
184:2 rose6D_0057.jpg (1734:2131):
186:2 rose6D_0060.jpg (1751:1971):
190:3 rose6D_0066.jpg (1744:1981):
194:2 rose6D_0072.jpg (1758:1966):
198:2 rose6D_0078.jpg (1754:1991):
210:3 rose6D_0096.jpg (1755:1969):
218:2 rose6D_0108.jpg (1764:1854):
des_Describing with 2D terms {27-4}~ [2]
78:2 rose5A_0006.jpg (1737:1988):
82:3 rose5A_0012.jpg (1737:2104):

des_Few information in description {39-4}~ [3]
142:2 rose5A_0102.jpg (1690:1894):
156:2 rose6D_0015.jpg (1749:2092):
194:2 rose6D_0072.jpg (1758:1966):
des_Incorrect description (general) {28-3}~ [4]
78:2 rose5A_0006.jpg (1737:1988):
78:7 rose5A_0006.jpg (1765:1822):
154:2 rose6D_0012.jpg (1747:2144):
154:6 rose6D_0012.jpg (1887:1971):
des_SOLO level %3 {80-0}~ [41]
2:2 rose4B__0003.jpg (1748:1968):
8:2 rose4B__0012.jpg (1756:1927):
26:1 rose4B__0039.jpg (1745:2082):
28:2 rose4B__0042.jpg (1757:1857):
32:2 rose4B__0048.jpg (1723:2098):
34:2 rose4B__0051.jpg (1767:2076):
36:2 rose4B__0054.jpg (1757:1968):
54:2 rose4B__0081.jpg (1717:1991):
66:2 rose4B__0099.jpg (1760:1991):
74:2 rose4B__0111.jpg (1741:2084):
78:2 rose5A_0006.jpg (1737:1988):
80:2 rose5A_0009.jpg (1725:1991):
82:3 rose5A_0012.jpg (1737:2104):
96:2 rose5A_0033.jpg (1740:2126):
100:3 rose5A_0039.jpg (1754:2088):
106:7 rose5A_0048.jpg (1725:1991):
114:2 rose5A_0060.jpg (1745:1968):
122:2 rose5A_0072.jpg (1732:1983):
128:6 rose5A_0081.jpg (1717:1995):
130:2 rose5A_0084.jpg (1725:1991):
134:2 rose5A_0090.jpg (1737:1978):
138:3 rose5A_0096.jpg (1734:1891):
140:2 rose5A_0099.jpg (1770:1975):
142:2 rose5A_0102.jpg (1690:1894):
144:6 rose5A_0105.jpg (1674:1991):
146:7 rose5A_0108.jpg (1705:2103):
154:2 rose6D_0012.jpg (1747:2144):
156:2 rose6D_0015.jpg (1749:2092):
164:2 rose6D_0027.jpg (1725:1989):
168:2 rose6D_0033.jpg (1734:2094):
172:3 rose6D_0039.jpg (1756:1968):
174:2 rose6D_0042.jpg (1760:2106):
178:3 rose6D_0048.jpg (1741:1871):
182:9 rose6D_0054.jpg (1715:1998):
184:2 rose6D_0057.jpg (1734:2131):
186:2 rose6D_0060.jpg (1751:1971):
190:3 rose6D_0066.jpg (1744:1981):
194:2 rose6D_0072.jpg (1758:1966):
198:2 rose6D_0078.jpg (1754:1991):
210:3 rose6D_0096.jpg (1755:1969):
218:2 rose6D_0108.jpg (1764:1854):

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^_des Triangular prism description at level 4 {17-7}~ [9]
^_des 5 faces (triangular prism) {49-3}~ [20]
68:2 rose4B__0102.jpg (1730:2091):
68:3 rose4B__0102.jpg (1750:1835):
90:3 rose5A_0024.jpg (1725:2110):
90:6 rose5A_0024.jpg (1856:1968):
102:2 rose5A_0042.jpg (1707:1967):
102:5 rose5A_0042.jpg (1752:1843):
150:2 rose6D_0006.jpg (1758:1907):
150:4 rose6D_0006.jpg (1770:1844):
166:2 rose6D_0030.jpg (1751:1866):
166:4 rose6D_0030.jpg (1766:1838):
176:2 rose6D_0045.jpg (1748:1878):
176:5 rose6D_0045.jpg (1761:1831):
180:2 rose6D_0051.jpg (1740:2002):
180:3 rose6D_0051.jpg (1740:1840):
188:2 rose6D_0063.jpg (1734:1978):
188:6 rose6D_0063.jpg (1774:1834):

206:2 rose6D_0090.jpg (1747:1988):
206:7 rose6D_0090.jpg (1761:1850):
208:3 rose6D_0093.jpg (1757:1838):
208:7 rose6D_0093.jpg (1739:2001):
^_des 6 vertices (triangular prism) {25-3}~ [8]
90:3 rose5A_0024.jpg (1725:2110):
90:8 rose5A_0024.jpg (1875:1960):
166:2 rose6D_0030.jpg (1751:1866):
166:6 rose6D_0030.jpg (1771:1833):
170:2 rose6D_0036.jpg (1731:1978):
170:6 rose6D_0036.jpg (1886:1949):
206:2 rose6D_0090.jpg (1747:1988):
206:5 rose6D_0090.jpg (1771:1829):
^_des 9 edges (triangular prism) {27-3}~ [12]
90:3 rose5A_0024.jpg (1725:2110):
90:7 rose5A_0024.jpg (1752:1833):
150:2 rose6D_0006.jpg (1758:1907):
150:5 rose6D_0006.jpg (1768:1828):
166:2 rose6D_0030.jpg (1751:1866):
166:5 rose6D_0030.jpg (1760:1830):
170:2 rose6D_0036.jpg (1731:1978):
170:7 rose6D_0036.jpg (1890:1960):
180:2 rose6D_0051.jpg (1740:2002):
180:6 rose6D_0051.jpg (1768:1828):
206:2 rose6D_0090.jpg (1747:1988):
206:8 rose6D_0090.jpg (1862:1944):
^_des Chocolate bar (triangular prism) {23-2} [22]
12:1 rose4B__0018.jpg (1764:1982):
12:2 rose4B__0018.jpg (1894:1962):
48:2 rose4B__0072.jpg (1760:1910):
48:4 rose4B__0072.jpg (1762:1830):
68:2 rose4B__0102.jpg (1730:2091):
68:4 rose4B__0102.jpg (1873:1958):
84:3 rose5A_0015.jpg (1874:1998):
84:6 rose5A_0015.jpg (1731:2072):
150:2 rose6D_0006.jpg (1758:1907):
150:3 rose6D_0006.jpg (1772:1832):
166:2 rose6D_0030.jpg (1751:1866):
166:3 rose6D_0030.jpg (1753:1831):
170:2 rose6D_0036.jpg (1731:1978):
170:5 rose6D_0036.jpg (1874:1958):
176:2 rose6D_0045.jpg (1748:1878):
176:3 rose6D_0045.jpg (1771:1841):
188:2 rose6D_0063.jpg (1734:1978):
188:5 rose6D_0063.jpg (1891:1964):
192:3 rose6D_0069.jpg (1758:1969):
192:6 rose6D_0069.jpg (1883:1949):
206:2 rose6D_0090.jpg (1747:1988):
206:4 rose6D_0090.jpg (1864:1951):
^_des Prism (triangular prism) {44-3}~ [16]
12:1 rose4B__0018.jpg (1764:1982):
12:3 rose4B__0018.jpg (1777:1832):
68:2 rose4B__0102.jpg (1730:2091):
68:5 rose4B__0102.jpg (1991:2088):
88:3 rose5A_0021.jpg (1737:2151):
88:5 rose5A_0021.jpg (1747:1848):
102:2 rose5A_0042.jpg (1707:1967):
102:3 rose5A_0042.jpg (1746:1832):
108:2 rose5A_0051.jpg (1738:1971):
108:3 rose5A_0051.jpg (1748:1851):
180:2 rose6D_0051.jpg (1740:2002):
180:4 rose6D_0051.jpg (1759:1844):
188:2 rose6D_0063.jpg (1734:1978):
188:7 rose6D_0063.jpg (1768:1845):
208:4 rose6D_0093.jpg (1744:1848):
208:7 rose6D_0093.jpg (1739:2001):
^_des Rectangle (triangular prism) {39-2}~ [18]
84:4 rose5A_0015.jpg (1744:1844):
84:6 rose5A_0015.jpg (1731:2072):
88:3 rose5A_0021.jpg (1737:2151):
88:6 rose5A_0021.jpg (1998:2098):

90:3 rose5A_0024.jpg (1725:2110):
90:5 rose5A_0024.jpg (1871:1971):
102:2 rose5A_0042.jpg (1707:1967):
102:6 rose5A_0042.jpg (1866:1963):
108:2 rose5A_0051.jpg (1738:1971):
108:5 rose5A_0051.jpg (1861:1961):
170:2 rose6D_0036.jpg (1731:1978):
170:3 rose6D_0036.jpg (1745:1845):
188:2 rose6D_0063.jpg (1734:1978):
188:4 rose6D_0063.jpg (1881:1981):
192:3 rose6D_0069.jpg (1758:1969):
192:5 rose6D_0069.jpg (1892:1955):
208:6 rose6D_0093.jpg (1884:1968):
208:7 rose6D_0093.jpg (1739:2001):
^_des Triangle (triangular prism) {70-3}~ [26]
12:1 rose4B__0018.jpg (1764:1982):
12:4 rose4B__0018.jpg (1777:1832):
48:2 rose4B__0072.jpg (1760:1910):
48:3 rose4B__0072.jpg (1776:1834):
84:5 rose5A_0015.jpg (1754:1824):
84:6 rose5A_0015.jpg (1731:2072):
88:3 rose5A_0021.jpg (1737:2151):
88:4 rose5A_0021.jpg (1744:1858):
90:3 rose5A_0024.jpg (1725:2110):
90:4 rose5A_0024.jpg (1732:1852):
102:2 rose5A_0042.jpg (1707:1967):
102:4 rose5A_0042.jpg (1746:1843):
108:2 rose5A_0051.jpg (1738:1971):
108:4 rose5A_0051.jpg (1741:1835):
170:2 rose6D_0036.jpg (1731:1978):
170:4 rose6D_0036.jpg (1751:1840):
176:2 rose6D_0045.jpg (1748:1878):
176:4 rose6D_0045.jpg (1768:1844):
180:2 rose6D_0051.jpg (1740:2002):
180:5 rose6D_0051.jpg (1867:1983):
188:2 rose6D_0063.jpg (1734:1978):
188:3 rose6D_0063.jpg (1774:1851):
192:3 rose6D_0069.jpg (1758:1969):
192:7 rose6D_0069.jpg (1764:1807):
208:5 rose6D_0093.jpg (1761:1844):
208:7 rose6D_0093.jpg (1739:2001):
^_des Triangular prism description {109-0}~ [17]
12:1 rose4B__0018.jpg (1764:1982):
48:2 rose4B__0072.jpg (1760:1910):
68:2 rose4B__0102.jpg (1730:2091):
84:6 rose5A_0015.jpg (1731:2072):
88:3 rose5A_0021.jpg (1737:2151):
90:3 rose5A_0024.jpg (1725:2110):
102:2 rose5A_0042.jpg (1707:1967):
108:2 rose5A_0051.jpg (1738:1971):
150:2 rose6D_0006.jpg (1758:1907):
166:2 rose6D_0030.jpg (1751:1866):
170:2 rose6D_0036.jpg (1731:1978):
176:2 rose6D_0045.jpg (1748:1878):
180:2 rose6D_0051.jpg (1740:2002):
188:2 rose6D_0063.jpg (1734:1978):
192:3 rose6D_0069.jpg (1758:1969):
206:2 rose6D_0090.jpg (1747:1988):
208:7 rose6D_0093.jpg (1739:2001):
des_SOLO level %4 {35-0}~ [17]
12:1 rose4B__0018.jpg (1764:1982):
48:2 rose4B__0072.jpg (1760:1910):
68:2 rose4B__0102.jpg (1730:2091):
84:6 rose5A_0015.jpg (1731:2072):
88:3 rose5A_0021.jpg (1737:2151):
90:3 rose5A_0024.jpg (1725:2110):
102:2 rose5A_0042.jpg (1707:1967):
108:2 rose5A_0051.jpg (1738:1971):
150:2 rose6D_0006.jpg (1758:1907):
166:2 rose6D_0030.jpg (1751:1866):
170:2 rose6D_0036.jpg (1731:1978):

176:2 rose6D_0045.jpg (1748:1878):
180:2 rose6D_0051.jpg (1740:2002):
188:2 rose6D_0063.jpg (1734:1978):
192:3 rose6D_0069.jpg (1758:1969):
206:2 rose6D_0090.jpg (1747:1988):
208:7 rose6D_0093.jpg (1739:2001):

Appendix E: Cooccurring Codes for Triangular Prism Drawings

HU: rose
File: [J:\study1\datacollection\RoseofLima\rose.hpr5]
Edited by: swpun
Date/Time: 03/11/07 09:15:58 AM

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^_draw Triangular prism drawing at level 1 {7-2}~ [5]
- ^ Triangular prism as tetrahedron {5-2}~ [3]
  - 38:1 rose4B__0057.jpg (1098:1344):
  - 62:4 rose4B__0093.jpg (834:1277):
  - 98:1 rose5A_0036.jpg (752:1188):
- ^_draw Triangular prism drawing {109-0}~ [7]
  - 38:1 rose4B__0057.jpg (1098:1344):
  - 46:1 rose4B__0069.jpg (863:1243):
  - <52:4 rose4B__0078.jpg (617:1240):
  - 62:4 rose4B__0093.jpg (834:1277):
  - 72:1 rose4B__0108.jpg (760:1208):
  - 98:1 rose5A_0036.jpg (752:1188):
  - 152:1 rose6D_0009.jpg (654:960):
- draw_SOLO level %1 {11-0}~ [7]
  - 38:1 rose4B__0057.jpg (1098:1344):
  - 46:1 rose4B__0069.jpg (863:1243):
  - <52:4 rose4B__0078.jpg (617:1240):
  - 62:4 rose4B__0093.jpg (834:1277):
  - 72:1 rose4B__0108.jpg (760:1208):
  - 98:1 rose5A_0036.jpg (752:1188):
  - 152:1 rose6D_0009.jpg (654:960):
- draw_Some or all seen faces are drawn in a 2D format {11-2}~ [1]
  - <52:4 rose4B__0078.jpg (617:1240):
- Unable to describe/draw any features {10-4} [2]
  - 46:1 rose4B__0069.jpg (863:1243):
  - 72:1 rose4B__0108.jpg (760:1208):

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^_draw Triangular prism drawing at level 2 {12-3}~ [8]
- ^_des Chocolate bar (triangular prism) {23-2} [1]
  - 94:1 rose5A_0030.jpg (912:1263):
- ^_draw Triangular prism drawing {109-0}~ [12]
  - 2:1 rose4B__0003.jpg (914:1173):
  - 6:1 rose4B__0009.jpg (957:1129):
  - 10:1 rose4B__0015.jpg (894:1026):
  - 26:2 rose4B__0039.jpg (1023:1352):
  - 40:1 rose4B__0060.jpg (860:1181):
  - 64:5 rose4B__0096.jpg (743:1472):
  - 76:1 rose5A_0003.jpg (941:1204):
  - 94:1 rose5A_0030.jpg (912:1263):
  - 106:1 rose5A_0048.jpg (706:1020):
  - 136:1 rose5A_0093.jpg (747:1021):
  - 138:1 rose5A_0096.jpg (617:930):
  - 192:1 rose6D_0069.jpg (854:1037):
- draw_Hidden lines not in coordination {19-2}~ [4]
  - 106:1 rose5A_0048.jpg (706:1020):
  - 106:2 rose5A_0048.jpg (757:946):
  - 192:1 rose6D_0069.jpg (854:1037):
  - 192:2 rose6D_0069.jpg (932:1017):
- draw_Incomplete drawing of hidden lines {22-2}~ [2]
  - 138:1 rose5A_0096.jpg (617:930):
  - 138:2 rose5A_0096.jpg (640:806):
- draw_Nontransparent {59-2}~ [4]
  - 2:1 rose4B__0003.jpg (914:1173):
  - 10:1 rose4B__0015.jpg (894:1026):
  - 26:2 rose4B__0039.jpg (1023:1352):
  - 64:5 rose4B__0096.jpg (743:1472):
- draw_Not in perspective view {36-3}~ [5]
  - 6:1 rose4B__0009.jpg (957:1129):

26:2 rose4B__0039.jpg (1023:1352):
40:1 rose4B__0060.jpg (860:1181):
76:1 rose5A_0003.jpg (941:1204):
106:1 rose5A_0048.jpg (706:1020):
draw_SOLO level %2 {23-0}~ [12]
2:1 rose4B__0003.jpg (914:1173):
6:1 rose4B__0009.jpg (957:1129):
10:1 rose4B__0015.jpg (894:1026):
26:2 rose4B__0039.jpg (1023:1352):
40:1 rose4B__0060.jpg (860:1181):
64:5 rose4B__0096.jpg (743:1472):
76:1 rose5A_0003.jpg (941:1204):
94:1 rose5A_0030.jpg (912:1263):
106:1 rose5A_0048.jpg (706:1020):
136:1 rose5A_0093.jpg (747:1021):
138:1 rose5A_0096.jpg (617:930):
192:1 rose6D_0069.jpg (854:1037):
draw_Some or all seen faces are drawn in a 2D format {11-2}~ [2]
6:1 rose4B__0009.jpg (957:1129):
136:1 rose5A_0093.jpg (747:1021):

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^_draw Triangular prism drawing at level 3 {43-3}~ [7]
^_draw Triangular prism drawing {109-0}~ [43]
4:3 rose4B__0006.jpg (828:1432):
8:1 rose4B__0012.jpg (723:1149):
14:1 rose4B__0021.jpg (1004:1238):
16:1 rose4B__0024.jpg (810:1251):
18:1 rose4B__0027.jpg (918:1273):
20:1 rose4B__0030.jpg (799:1134):
22:1 rose4B__0033.jpg (814:1373):
28:1 rose4B__0042.jpg (767:1424):
32:1 rose4B__0048.jpg (853:1242):
34:1 rose4B__0051.jpg (914:1296):
42:1 rose4B__0063.jpg (988:1223):
44:1 rose4B__0066.jpg (824:1347):
48:1 rose4B__0072.jpg (914:1161):
50:1 rose4B__0075.jpg (841:1130):
>56:4 rose4B__0084.jpg (809:1277):
58:1 rose4B__0087.jpg (989:1285):
60:1 rose4B__0090.jpg (650:1270):
66:1 rose4B__0099.jpg (734:1127):
68:1 rose4B__0102.jpg (1039:1224):
70:1 rose4B__0105.jpg (1047:1250):
74:1 rose4B__0111.jpg (1130:1397):
82:1 rose5A_0012.jpg (660:1235):
86:1 rose5A_0018.jpg (710:1371):
88:1 rose5A_0021.jpg (737:1504):
90:1 rose5A_0024.jpg (760:1262):
100:1 rose5A_0039.jpg (702:1431):
104:1 rose5A_0045.jpg (856:1196):
108:1 rose5A_0051.jpg (729:1146):
116:1 rose5A_0063.jpg (748:984):
118:1 rose5A_0066.jpg (818:1254):
146:1 rose5A_0108.jpg (600:1124):
156:1 rose6D_0015.jpg (714:972):
158:1 rose6D_0018.jpg (683:1265):
168:1 rose6D_0033.jpg (797:1117):
172:1 rose6D_0039.jpg (764:1130):
178:1 rose6D_0048.jpg (784:1157):
180:1 rose6D_0051.jpg (880:1296):
182:1 rose6D_0054.jpg (894:1156):
190:1 rose6D_0066.jpg (826:1273):
194:1 rose6D_0072.jpg (660:1060):
202:1 rose6D_0084.jpg (824:1122):
208:1 rose6D_0093.jpg (633:1184):
210:1 rose6D_0096.jpg (720:1337):
draw_Hidden lines not in coordination {19-2}~ [6]
>56:4 rose4B__0084.jpg (809:1277):
70:1 rose4B__0105.jpg (1047:1250):

182:1 rose6D_0054.jpg (894:1156):
182:2 rose6D_0054.jpg (1054:1121):
190:1 rose6D_0066.jpg (826:1273):
190:2 rose6D_0066.jpg (903:1273):
draw_Incomplete drawing of hidden lines {22-2}~ [28]
16:1 rose4B__0024.jpg (810:1251):
16:2 rose4B__0024.jpg (857:981):
22:1 rose4B__0033.jpg (814:1373):
22:2 rose4B__0033.jpg (845:1007):
66:1 rose4B__0099.jpg (734:1127):
66:6 rose4B__0099.jpg (784:917):
82:1 rose5A_0012.jpg (660:1235):
82:2 rose5A_0012.jpg (687:911):
88:1 rose5A_0021.jpg (737:1504):
88:2 rose5A_0021.jpg (794:1037):
90:1 rose5A_0024.jpg (760:1262):
90:2 rose5A_0024.jpg (829:1022):
100:1 rose5A_0039.jpg (702:1431):
100:2 rose5A_0039.jpg (702:1073):
104:1 rose5A_0045.jpg (856:1196):
104:2 rose5A_0045.jpg (938:1042):
118:1 rose5A_0066.jpg (818:1254):
118:2 rose5A_0066.jpg (880:1161):
146:1 rose5A_0108.jpg (600:1124):
146:2 rose5A_0108.jpg (714:931):
158:1 rose6D_0018.jpg (683:1265):
158:2 rose6D_0018.jpg (667:887):
172:1 rose6D_0039.jpg (764:1130):
172:2 rose6D_0039.jpg (794:904):
178:1 rose6D_0048.jpg (784:1157):
178:2 rose6D_0048.jpg (887:1044):
210:1 rose6D_0096.jpg (720:1337):
210:2 rose6D_0096.jpg (777:991):
draw_Nontransparent {59-2}~ [12]
28:1 rose4B__0042.jpg (767:1424):
32:1 rose4B__0048.jpg (853:1242):
34:1 rose4B__0051.jpg (914:1296):
42:1 rose4B__0063.jpg (988:1223):
44:1 rose4B__0066.jpg (824:1347):
58:1 rose4B__0087.jpg (989:1285):
68:1 rose4B__0102.jpg (1039:1224):
74:1 rose4B__0111.jpg (1130:1397):
168:1 rose6D_0033.jpg (797:1117):
194:1 rose6D_0072.jpg (660:1060):
202:1 rose6D_0084.jpg (824:1122):
208:1 rose6D_0093.jpg (633:1184):
draw_Not in perspective view {36-3}~ [12]
8:1 rose4B__0012.jpg (723:1149):
14:1 rose4B__0021.jpg (1004:1238):
18:1 rose4B__0027.jpg (918:1273):
20:1 rose4B__0030.jpg (799:1134):
32:1 rose4B__0048.jpg (853:1242):
42:1 rose4B__0063.jpg (988:1223):
48:1 rose4B__0072.jpg (914:1161):
50:1 rose4B__0075.jpg (841:1130):
60:1 rose4B__0090.jpg (650:1270):
108:1 rose5A_0051.jpg (729:1146):
116:1 rose5A_0063.jpg (748:984):
158:1 rose6D_0018.jpg (683:1265):
draw_SOLO level %3 {103-0}~ [43]
4:3 rose4B__0006.jpg (828:1432):
8:1 rose4B__0012.jpg (723:1149):
14:1 rose4B__0021.jpg (1004:1238):
16:1 rose4B__0024.jpg (810:1251):
18:1 rose4B__0027.jpg (918:1273):
20:1 rose4B__0030.jpg (799:1134):
22:1 rose4B__0033.jpg (814:1373):
28:1 rose4B__0042.jpg (767:1424):
32:1 rose4B__0048.jpg (853:1242):
34:1 rose4B__0051.jpg (914:1296):
42:1 rose4B__0063.jpg (988:1223):

44:1 rose4B__0066.jpg (824:1347):
48:1 rose4B__0072.jpg (914:1161):
50:1 rose4B__0075.jpg (841:1130):
>56:4 rose4B__0084.jpg (809:1277):
58:1 rose4B__0087.jpg (989:1285):
60:1 rose4B__0090.jpg (650:1270):
66:1 rose4B__0099.jpg (734:1127):
68:1 rose4B__0102.jpg (1039:1224):
70:1 rose4B__0105.jpg (1047:1250):
74:1 rose4B__0111.jpg (1130:1397):
82:1 rose5A_0012.jpg (660:1235):
86:1 rose5A_0018.jpg (710:1371):
88:1 rose5A_0021.jpg (737:1504):
90:1 rose5A_0024.jpg (760:1262):
100:1 rose5A_0039.jpg (702:1431):
104:1 rose5A_0045.jpg (856:1196):
108:1 rose5A_0051.jpg (729:1146):
116:1 rose5A_0063.jpg (748:984):
118:1 rose5A_0066.jpg (818:1254):
146:1 rose5A_0108.jpg (600:1124):
156:1 rose6D_0015.jpg (714:972):
158:1 rose6D_0018.jpg (683:1265):
168:1 rose6D_0033.jpg (797:1117):
172:1 rose6D_0039.jpg (764:1130):
178:1 rose6D_0048.jpg (784:1157):
180:1 rose6D_0051.jpg (880:1296):
182:1 rose6D_0054.jpg (894:1156):
190:1 rose6D_0066.jpg (826:1273):
194:1 rose6D_0072.jpg (660:1060):
202:1 rose6D_0084.jpg (824:1122):
208:1 rose6D_0093.jpg (633:1184):
210:1 rose6D_0096.jpg (720:1337):

draw_Some or all seen faces are drawn in a 2D format {11-2}~ [4]

8:1 rose4B__0012.jpg (723:1149):
14:1 rose4B__0021.jpg (1004:1238):
18:1 rose4B__0027.jpg (918:1273):
20:1 rose4B__0030.jpg (799:1134):

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^_draw Triangular prism drawing at level 4 {47-1}~ [3]

^_draw Triangular prism drawing {109-0}~ [47]

12:5 rose4B__0018.jpg (716:1032):
24:1 rose4B__0036.jpg (747:1514):
30:1 rose4B__0045.jpg (718:1246):
36:1 rose4B__0054.jpg (664:1424):
54:1 rose4B__0081.jpg (814:1412):
78:1 rose5A_0006.jpg (876:1424):
80:1 rose5A_0009.jpg (664:1184):
84:1 rose5A_0015.jpg (679:1181):
92:1 rose5A_0027.jpg (733:1296):
96:1 rose5A_0033.jpg (640:1366):
102:1 rose5A_0042.jpg (683:1292):
110:1 rose5A_0054.jpg (700:1193):
112:1 rose5A_0057.jpg (548:1277):
114:1 rose5A_0060.jpg (667:1277):
120:1 rose5A_0069.jpg (685:1138):
122:1 rose5A_0072.jpg (691:1092):
124:1 rose5A_0075.jpg (720:1067):
126:1 rose5A_0078.jpg (853:1339):
128:1 rose5A_0081.jpg (829:1142):
130:1 rose5A_0084.jpg (752:1150):
132:1 rose5A_0087.jpg (1000:1366):
134:1 rose5A_0090.jpg (714:1123):
140:1 rose5A_0099.jpg (727:1324):
142:1 rose5A_0102.jpg (725:1204):
144:1 rose5A_0105.jpg (718:1208):
148:1 rose6D_0003.jpg (917:1184):
150:1 rose6D_0006.jpg (746:1406):
154:1 rose6D_0012.jpg (903:1370):
160:1 rose6D_0021.jpg (770:1037):

162:1 rose6D_0024.jpg (941:1245):
164:1 rose6D_0027.jpg (710:1248):
166:1 rose6D_0030.jpg (831:1339):
170:1 rose6D_0036.jpg (925:1476):
174:1 rose6D_0042.jpg (702:1442):
176:1 rose6D_0045.jpg (718:1238):
184:1 rose6D_0057.jpg (783:1335):
186:1 rose6D_0060.jpg (829:1277):
188:1 rose6D_0063.jpg (857:1087):
196:1 rose6D_0075.jpg (806:1358):
198:1 rose6D_0078.jpg (911:1451):
200:1 rose6D_0081.jpg (709:1389):
204:1 rose6D_0087.jpg (702:1173):
206:1 rose6D_0090.jpg (840:1357):
212:1 rose6D_0099.jpg (679:1219):
214:1 rose6D_0102.jpg (810:1343):
216:1 rose6D_0105.jpg (710:1331):
218:1 rose6D_0108.jpg (951:1334):
draw_Perfect drawing {31-2} [16]
30:1 rose4B__0045.jpg (718:1246):
36:1 rose4B__0054.jpg (664:1424):
78:1 rose5A_0006.jpg (876:1424):
80:1 rose5A_0009.jpg (664:1184):
84:1 rose5A_0015.jpg (679:1181):
96:1 rose5A_0033.jpg (640:1366):
102:1 rose5A_0042.jpg (683:1292):
130:1 rose5A_0084.jpg (752:1150):
132:1 rose5A_0087.jpg (1000:1366):
140:1 rose5A_0099.jpg (727:1324):
148:1 rose6D_0003.jpg (917:1184):
164:1 rose6D_0027.jpg (710:1248):
170:1 rose6D_0036.jpg (925:1476):
174:1 rose6D_0042.jpg (702:1442):
216:1 rose6D_0105.jpg (710:1331):
218:1 rose6D_0108.jpg (951:1334):
draw_SOLO level %4 {81-0}~ [47]
12:5 rose4B__0018.jpg (716:1032):
24:1 rose4B__0036.jpg (747:1514):
30:1 rose4B__0045.jpg (718:1246):
36:1 rose4B__0054.jpg (664:1424):
54:1 rose4B__0081.jpg (814:1412):
78:1 rose5A_0006.jpg (876:1424):
80:1 rose5A_0009.jpg (664:1184):
84:1 rose5A_0015.jpg (679:1181):
92:1 rose5A_0027.jpg (733:1296):
96:1 rose5A_0033.jpg (640:1366):
102:1 rose5A_0042.jpg (683:1292):
110:1 rose5A_0054.jpg (700:1193):
112:1 rose5A_0057.jpg (548:1277):
114:1 rose5A_0060.jpg (667:1277):
120:1 rose5A_0069.jpg (685:1138):
122:1 rose5A_0072.jpg (691:1092):
124:1 rose5A_0075.jpg (720:1067):
126:1 rose5A_0078.jpg (853:1339):
128:1 rose5A_0081.jpg (829:1142):
130:1 rose5A_0084.jpg (752:1150):
132:1 rose5A_0087.jpg (1000:1366):
134:1 rose5A_0090.jpg (714:1123):
140:1 rose5A_0099.jpg (727:1324):
142:1 rose5A_0102.jpg (725:1204):
144:1 rose5A_0105.jpg (718:1208):
148:1 rose6D_0003.jpg (917:1184):
150:1 rose6D_0006.jpg (746:1406):
154:1 rose6D_0012.jpg (903:1370):
160:1 rose6D_0021.jpg (770:1037):
162:1 rose6D_0024.jpg (941:1245):
164:1 rose6D_0027.jpg (710:1248):
166:1 rose6D_0030.jpg (831:1339):
170:1 rose6D_0036.jpg (925:1476):
174:1 rose6D_0042.jpg (702:1442):
176:1 rose6D_0045.jpg (718:1238):

184:1 rose6D_0057.jpg (783:1335):
186:1 rose6D_0060.jpg (829:1277):
188:1 rose6D_0063.jpg (857:1087):
196:1 rose6D_0075.jpg (806:1358):
198:1 rose6D_0078.jpg (911:1451):
200:1 rose6D_0081.jpg (709:1389):
204:1 rose6D_0087.jpg (702:1173):
206:1 rose6D_0090.jpg (840:1357):
212:1 rose6D_0099.jpg (679:1219):
214:1 rose6D_0102.jpg (810:1343):
216:1 rose6D_0105.jpg (710:1331):
218:1 rose6D_0108.jpg (951:1334):

Appendix F: Cooccurring Codes for Pyramid Descriptions

HU: siu
File: [J:\study1\datacollection\SiuHonSum\siu.hpr5]
Edited by: swpun
Date/Time: 11/11/07 06:31:59 PM

&_des Pyramid description at level 1 {41-0} [12]

- &_des 4 triangles around (pyramid) {16-0}~ [2]
  - 12:1 siu4D_0018.jpg (1983:2290):
  - 12:3 siu4D_0018.jpg (2175:2269):
- &_des 5 faces (pyramid) {16-0}~ [2]
  - 80:2 siu5B_0027.jpg (2044:2185):
  - 80:3 siu5B_0027.jpg (2081:2145):
- &_des Egypt (pyramid) {8-0}~ [4]
  - 112:2 siu6A_0003.jpg (2016:2168):
  - 112:3 siu6A_0003.jpg (2027:2123):
  - 142:2 siu6A_0048.jpg (2005:2183):
  - 142:3 siu6A_0048.jpg (2031:2131):
- &_des Funnel and others (pyramid) {3-0}~ [2]
  - 106:2 siu5B_0066.jpg (2037:2444):
  - 106:3 siu5B_0066.jpg (2344:2428):
- &_des Mistaken as cone (pyramid) {1-0}~ [1]
  - 76:1 siu5B_0021.jpg (2043:2327):
- &_des Mistaken as tetrahedron (pyramid) {6-0} [6]
  - 32:2 siu4D_0048.jpg (2045:2341):
  - 66:2 siu5B_0006.jpg (1986:2324):
  - 112:2 siu6A_0003.jpg (2016:2168):
  - 134:2 siu6A_0036.jpg (2045:2296):
  - 154:2 siu6A_0066.jpg (1993:2169):
  - 158:2 siu6A_0072.jpg (2001:2345):
- &_des Pyramid description {85-0} [41]
  - 2:2 siu4D_0003.jpg (1987:2304):
  - 12:1 siu4D_0018.jpg (1983:2290):
  - 16:2 siu4D_0024.jpg (1989:2315):
  - 18:2 siu4D_0027.jpg (2009:2162):
  - 20:2 siu4D_0030.jpg (2021:2285):
  - 22:2 siu4D_0033.jpg (2061:2177):
  - 24:1 siu4D_0036.jpg (2019:2286):
  - 30:2 siu4D_0045.jpg (1995:2162):
  - 32:2 siu4D_0048.jpg (2045:2341):
  - 34:2 siu4D_0051.jpg (2004:2226):
  - 36:2 siu4D_0054.jpg (2026:2167):
  - 38:2 siu4D_0057.jpg (2009:2333):
  - 40:2 siu4D_0060.jpg (1986:2314):
  - 42:2 siu4D_0063.jpg (2019:2167):
  - 44:2 siu4D_0066.jpg (2001:2315):
  - 50:2 siu4D_0075.jpg (2004:2189):
  - 52:2 siu4D_0078.jpg (2021:2329):
  - 54:2 siu4D_0081.jpg (2005:2160):
  - 56:2 siu4D_0084.jpg.(2032:2305):
  - 58:2 siu4D_0087.jpg (2013:2476):
  - 62:2 siu4D_0093.jpg (1990:2208):
  - 64:2 siu5B_0003.jpg (2057:2473):
  - 66:2 siu5B_0006.jpg (1986:2324):
  - 70:2 siu5B_0012.jpg (2004:2324):
  - 74:2 siu5B_0018.jpg (2026:2588):
  - 76:1 siu5B_0021.jpg (2043:2327):
  - 78:2 siu5B_0024.jpg (2039:2348):
  - 80:2 siu5B_0027.jpg (2044:2185):
  - 92:2 siu5B_0045.jpg (2024:2311):
  - 96:2 siu5B_0051.jpg (2013:2458):
  - 100:2 siu5B_0057.jpg (2027:2314):
  - 102:2 siu5B_0060.jpg (2027:2176):
  - 104:2 siu5B_0063.jpg (1990:2347):

106:2 siu5B_0066.jpg (2037:2444):
110:2 siu5B_0072.jpg (2021:2193):
112:2 siu6A_0003.jpg (2016:2168):
114:2 siu6A_0006.jpg (2001:2313):
134:2 siu6A_0036.jpg (2045:2296):
142:2 siu6A_0048.jpg (2005:2183):
154:2 siu6A_0066.jpg (1993:2169):
158:2 siu6A_0072.jpg (2001:2345):
des_Describing with 2D terms {7-0} [3]
12:1 siu4D_0018.jpg (1983:2290):
18:2 siu4D_0027.jpg (2009:2162):
18:3 siu4D_0027.jpg (2031:2114):
des_Few information in description {22-0}~ [6]
16:2 siu4D_0024.jpg (1989:2315):
34:2 siu4D_0051.jpg (2004:2226):
44:2 siu4D_0066.jpg (2001:2315):
54:2 siu4D_0081.jpg (2005:2160):
74:2 siu5B_0018.jpg (2026:2588):
114:2 siu6A_0006.jpg (2001:2313):
des_Incorrect description (general) {11-0}~ [6]
38:2 siu4D_0057.jpg (2009:2333):
42:2 siu4D_0063.jpg (2019:2167):
62:2 siu4D_0093.jpg (1990:2208):
92:2 siu5B_0045.jpg (2024:2311):
100:2 siu5B_0057.jpg (2027:2314):
104:2 siu5B_0063.jpg (1990:2347):
des_SOLO level %1 {68-0}~ [41]
2:2 siu4D_0003.jpg (1987:2304):
12:1 siu4D_0018.jpg (1983:2290):
16:2 siu4D_0024.jpg (1989:2315):
18:2 siu4D_0027.jpg (2009:2162):
20:2 siu4D_0030.jpg (2021:2285):
22:2 siu4D_0033.jpg (2061:2177):
24:1 siu4D_0036.jpg (2019:2286):
30:2 siu4D_0045.jpg (1995:2162):
32:2 siu4D_0048.jpg (2045:2341):
34:2 siu4D_0051.jpg (2004:2226):
36:2 siu4D_0054.jpg (2026:2167):
38:2 siu4D_0057.jpg (2009:2333):
40:2 siu4D_0060.jpg (1986:2314):
42:2 siu4D_0063.jpg (2019:2167):
44:2 siu4D_0066.jpg (2001:2315):
50:2 siu4D_0075.jpg (2004:2189):
52:2 siu4D_0078.jpg (2021:2329):
54:2 siu4D_0081.jpg (2005:2160):
56:2 siu4D_0084.jpg (2032:2305):
58:2 siu4D_0087.jpg (2013:2476):
62:2 siu4D_0093.jpg (1990:2208):
64:2 siu5B_0003.jpg (2057:2473):
66:2 siu5B_0006.jpg (1986:2324):
70:2 siu5B_0012.jpg (2004:2324):
74:2 siu5B_0018.jpg (2026:2588):
76:1 siu5B_0021.jpg (2043:2327):
78:2 siu5B_0024.jpg (2039:2348):
80:2 siu5B_0027.jpg (2044:2185):
92:2 siu5B_0045.jpg (2024:2311):
96:2 siu5B_0051.jpg (2013:2458):
100:2 siu5B_0057.jpg (2027:2314):
102:2 siu5B_0060.jpg (2027:2176):
104:2 siu5B_0063.jpg (1990:2347):
106:2 siu5B_0066.jpg (2037:2444):
110:2 siu5B_0072.jpg (2021:2193):
112:2 siu6A_0003.jpg (2016:2168):
114:2 siu6A_0006.jpg (2001:2313):
134:2 siu6A_0036.jpg (2045:2296):
142:2 siu6A_0048.jpg (2005:2183):
154:2 siu6A_0066.jpg (1993:2169):
158:2 siu6A_0072.jpg (2001:2345):
Unable to describe/draw any features {37-0} [18]
2:2 siu4D_0003.jpg (1987:2304):
22:2 siu4D_0033.jpg (2061:2177):

24:1 siu4D_0036.jpg (2019:2286):
30:2 siu4D_0045.jpg (1995:2162):
36:2 siu4D_0054.jpg (2026:2167):
40:2 siu4D_0060.jpg (1986:2314):
50:2 siu4D_0075.jpg (2004:2189):
52:2 siu4D_0078.jpg (2021:2329):
56:2 siu4D_0084.jpg (2032:2305):
58:2 siu4D_0087.jpg (2013:2476):
64:2 siu5B_0003.jpg (2057:2473):
64:3 siu5B_0003.jpg (2349:2437):
70:2 siu5B_0012.jpg (2004:2324):
78:2 siu5B_0024.jpg (2039:2348):
78:3 siu5B_0024.jpg (2037:2312):
96:2 siu5B_0051.jpg (2013:2458):
102:2 siu5B_0060.jpg (2027:2176):
110:2 siu5B_0072.jpg (2021:2193):

&_des Pyramid description at level 2 {23-0} [17]

&_des 4 triangles around (pyramid) {16-0}~ [14]
10:3 siu4D_0015.jpg (2016:2301):
10:4 siu4D_0015.jpg (2046:2148):
28:2 siu4D_0042.jpg (2021:2197):
28:3 siu4D_0042.jpg (2029:2149):
90:2 siu5B_0042.jpg (2053:2457):
90:5 siu5B_0042.jpg (2216:2294):
108:3 siu5B_0069.jpg (2035:2192):
108:5 siu5B_0069.jpg (2068:2148):
120:2 siu6A_0015.jpg (1974:2158):
120:3 siu6A_0015.jpg (2011:2124):
162:2 siu6A_0078.jpg (2056:2316):
162:3 siu6A_0078.jpg (2079:2148):
164:2 siu6A_0081.jpg (2012:2435):
164:4 siu6A_0081.jpg (2175:2290):

&_des 5 faces (pyramid) {16-0}~ [4]
90:2 siu5B_0042.jpg (2053:2457):
90:3 siu5B_0042.jpg (2068:2127):
166:2 siu6A_0084.jpg (2023:2167):
166:3 siu6A_0084.jpg (2038:2119):

&_des 5 vertices (pyramid) {16-0} [10]
68:3 siu5B_0009.jpg (2000:2157):
68:4 siu5B_0009.jpg (2004:2115):
118:2 siu6A_0012.jpg (2020:2276):
118:3 siu6A_0012.jpg (2035:2129):
148:2 siu6A_0057.jpg (1997:2183):
148:3 siu6A_0057.jpg (2034:2142):
160:2 siu6A_0075.jpg (2075:2162):
160:3 siu6A_0075.jpg (2102:2147):
166:2 siu6A_0084.jpg (2023:2167):
166:4 siu6A_0084.jpg (2027:2134):

&_des 8 edges (pyramid) {18-0} [10]
84:2 siu5B_0033.jpg (2006:2314):
84:3 siu5B_0033.jpg (2145:2285):
146:2 siu6A_0054.jpg (2019:2168):
146:3 siu6A_0054.jpg (2039:2119):
148:2 siu6A_0057.jpg (1997:2183):
148:4 siu6A_0057.jpg (2046:2142):
160:2 siu6A_0075.jpg (2075:2162):
160:4 siu6A_0075.jpg (2077:2150):
164:2 siu6A_0081.jpg (2012:2435):
164:3 siu6A_0081.jpg (2020:2149):

&_des Egypt (pyramid) {8-0}~ [6]
128:2 siu6A_0027.jpg (2030:2136):
128:3 siu6A_0027.jpg (2030:2116):
152:2 siu6A_0063.jpg (2016:2179):
152:3 siu6A_0063.jpg (2034:2153):
156:2 siu6A_0069.jpg (2046:2201):
156:3 siu6A_0069.jpg (2064:2131):

&_des Funnel and others (pyramid) {3-0}~ [2]
90:2 siu5B_0042.jpg (2053:2457):

90:7 siu5B_0042.jpg (2353:2435):
&_des Mistaken 4 faces (pyramid) {1-0} [2]
14:3 siu4D_0021.jpg (1990:2182):
14:4 siu4D_0021.jpg (2031:2123):
&_des Mistaken 4 vertices (pyramid) {2-0} [2]
146:2 siu6A_0054.jpg (2019:2168):
146:4 siu6A_0054.jpg (2033:2116):
&_des Mistaken 7 edges (pyramid) {1-0} [2]
68:3 siu5B_0009.jpg (2000:2157):
68:5 siu5B_0009.jpg (2004:2115):
&_des Mistaken 9 edges (pyramid) {1-0} [2]
90:2 siu5B_0042.jpg (2053:2457):
90:6 siu5B_0042.jpg (2201:2294):
&_des Mistaken square base as parallelogram (pyramid) {2-0} [4]
120:2 siu6A_0015.jpg (1974:2158):
120:4 siu6A_0015.jpg (2001:2131):
162:2 siu6A_0078.jpg (2056:2316):
162:4 siu6A_0078.jpg (2062:2145):
&_des Mistaken square base as rectangle (pyramid) {1-0} [2]
164:2 siu6A_0081.jpg (2012:2435):
164:5 siu6A_0081.jpg (2183:2290):
&_des Pyramid description {85-0} [23]
6:2 siu4D_0009.jpg (2025:2313):
8:2 siu4D_0012.jpg (2027:2294):
10:3 siu4D_0015.jpg (2016:2301):
14:3 siu4D_0021.jpg (1990:2182):
28:2 siu4D_0042.jpg (2021:2197):
46:2 siu4D_0069.jpg (1995:2180):
68:3 siu5B_0009.jpg (2000:2157):
84:2 siu5B_0033.jpg (2006:2314):
90:2 siu5B_0042.jpg (2053:2457):
94:2 siu5B_0048.jpg (2024:2311):
98:2 siu5B_0054.jpg (2027:2314):
108:3 siu5B_0069.jpg (2035:2192):
118:2 siu6A_0012.jpg (2020:2276):
120:2 siu6A_0015.jpg (1974:2158):
128:2 siu6A_0027.jpg (2030:2136):
146:2 siu6A_0054.jpg (2019:2168):
148:2 siu6A_0057.jpg (1997:2183):
152:2 siu6A_0063.jpg (2016:2179):
156:2 siu6A_0069.jpg (2046:2201):
160:2 siu6A_0075.jpg (2075:2162):
162:2 siu6A_0078.jpg (2056:2316):
164:2 siu6A_0081.jpg (2012:2435):
166:2 siu6A_0084.jpg (2023:2167):
&_des Square base (pyramid) {15-0} [12]
6:2 siu4D_0009.jpg (2025:2313):
6:3 siu4D_0009.jpg (2057:2161):
8:2 siu4D_0012.jpg (2027:2294):
8:3 siu4D_0012.jpg (2172:2283):
90:2 siu5B_0042.jpg (2053:2457):
90:4 siu5B_0042.jpg (2235:2301):
94:2 siu5B_0048.jpg (2024:2311):
94:3 siu5B_0048.jpg (2034:2155):
98:2 siu5B_0054.jpg (2027:2314):
98:3 siu5B_0054.jpg (2175:2296):
108:3 siu5B_0069.jpg (2035:2192):
108:4 siu5B_0069.jpg (2055:2145):
des_Describing with 2D terms {7-0} [1]
14:3 siu4D_0021.jpg (1990:2182):
des_Few information in description {22-0}~ [2]
46:2 siu4D_0069.jpg (1995:2180):
68:3 siu5B_0009.jpg (2000:2157):
des_SOLO level %2 {56-0}~ [23]
6:2 siu4D_0009.jpg (2025:2313):
8:2 siu4D_0012.jpg (2027:2294):
10:3 siu4D_0015.jpg (2016:2301):
14:3 siu4D_0021.jpg (1990:2182):
28:2 siu4D_0042.jpg (2021:2197):
46:2 siu4D_0069.jpg (1995:2180):
68:3 siu5B_0009.jpg (2000:2157):

84:2 siu5B_0033.jpg (2006:2314):
90:2 siu5B_0042.jpg (2053:2457):
94:2 siu5B_0048.jpg (2024:2311):
98:2 siu5B_0054.jpg (2027:2314):
108:3 siu5B_0069.jpg (2035:2192):
118:2 siu6A_0012.jpg (2020:2276):
120:2 siu6A_0015.jpg (1974:2158):
128:2 siu6A_0027.jpg (2030:2136):
146:2 siu6A_0054.jpg (2019:2168):
148:2 siu6A_0057.jpg (1997:2183):
152:2 siu6A_0063.jpg (2016:2179):
156:2 siu6A_0069.jpg (2046:2201):
160:2 siu6A_0075.jpg (2075:2162):
162:2 siu6A_0078.jpg (2056:2316):
164:2 siu6A_0081.jpg (2012:2435):
166:2 siu6A_0084.jpg (2023:2167):

&_des Pyramid description at level 3 {19-0} [10]

&_des 4 triangles around (pyramid) {16-0}~ [12]
4:2 siu4D_0006.jpg (2009:2310):
4:4 siu4D_0006.jpg (2171:2291):
48:2 siu4D_0072.jpg (2017:2473):
48:3 siu4D_0072.jpg (2181:2301):
82:2 siu5B_0030.jpg (1997:2321):
82:4 siu5B_0030.jpg (2205:2289):
140:2 siu6A_0045.jpg (2016:2308):
140:6 siu6A_0045.jpg (2182:2279):
168:2 siu6A_0087.jpg (2017:2301):
168:3 siu6A_0087.jpg (2037:2127):
170:2 siu6A_0090.jpg (2027:2305):
170:3 siu6A_0090.jpg (2031:2123):

&_des 5 faces (pyramid) {16-0}~ [24]
48:2 siu4D_0072.jpg (2017:2473):
48:5 siu4D_0072.jpg (2041:2133):
60:2 siu4D_0090.jpg (2018:2324):
60:3 siu4D_0090.jpg (2023:2143):
82:2 siu5B_0030.jpg (1997:2321):
82:3 siu5B_0030.jpg (2045:2153):
86:2 siu5B_0036.jpg (2049:2325):
86:3 siu5B_0036.jpg (2057:2157):
88:2 siu5B_0039.jpg (2054:2334):
88:4 siu5B_0039.jpg (2224:2294):
116:2 siu6A_0009.jpg (2027:2290):
116:6 siu6A_0009.jpg (2190:2264):
130:2 siu6A_0030.jpg (2019:2167):
130:5 siu6A_0030.jpg (2041:2134):
132:2 siu6A_0033.jpg (2007:2311):
132:4 siu6A_0033.jpg (2057:2144):
136:2 siu6A_0039.jpg (2018:2284):
136:3 siu6A_0039.jpg (2041:2124):
138:2 siu6A_0042.jpg (2030:2171):
138:5 siu6A_0042.jpg (2060:2138):
140:2 siu6A_0045.jpg (2016:2308):
140:3 siu6A_0045.jpg (2031:2134):
144:2 siu6A_0051.jpg (2013:2310):
144:3 siu6A_0051.jpg (2023:2203):

&_des 5 vertices (pyramid) {16-0} [22]
88:2 siu5B_0039.jpg (2054:2334):
88:3 siu5B_0039.jpg (2071:2141):
116:2 siu6A_0009.jpg (2027:2290):
116:5 siu6A_0009.jpg (2049:2135):
122:2 siu6A_0018.jpg (2038:2179):
122:3 siu6A_0018.jpg (2068:2149):
124:2 siu6A_0021.jpg (1993:2319):
124:4 siu6A_0021.jpg (2026:2141):
126:2 siu6A_0024.jpg (2038:2312):
126:3 siu6A_0024.jpg (2049:2149):
130:2 siu6A_0030.jpg (2019:2167):
130:3 siu6A_0030.jpg (2034:2130):
132:2 siu6A_0033.jpg (2007:2311):

132:5 siu6A_0033.jpg (2188:2274):
138:2 siu6A_0042.jpg (2030:2171):
138:3 siu6A_0042.jpg (2049:2138):
144:2 siu6A_0051.jpg (2013:2310):
144:4 siu6A_0051.jpg (2018:2171):
150:2 siu6A_0060.jpg (2008:2168):
150:3 siu6A_0060.jpg (2048:2128):
170:2 siu6A_0090.jpg (2027:2305):
170:5 siu6A_0090.jpg (2208:2297):
&_des 8 edges (pyramid) {18-0} [26]
88:2 siu5B_0039.jpg (2054:2334):
88:5 siu5B_0039.jpg (2058:2131):
116:2 siu6A_0009.jpg (2027:2290):
116:4 siu6A_0009.jpg (2038:2131):
122:2 siu6A_0018.jpg (2038:2179):
122:4 siu6A_0018.jpg (2053:2138):
124:2 siu6A_0021.jpg (1993:2319):
124:3 siu6A_0021.jpg (2015:2149):
126:2 siu6A_0024.jpg (2038:2312):
126:4 siu6A_0024.jpg (2060:2134):
130:2 siu6A_0030.jpg (2019:2167):
130:4 siu6A_0030.jpg (2045:2138):
132:2 siu6A_0033.jpg (2007:2311):
132:3 siu6A_0033.jpg (2037:2144):
136:2 siu6A_0039.jpg (2018:2284):
136:4 siu6A_0039.jpg (2024:2131):
138:2 siu6A_0042.jpg (2030:2171):
138:4 siu6A_0042.jpg (2049:2141):
140:2 siu6A_0045.jpg (2016:2308):
140:4 siu6A_0045.jpg (2027:2131):
144:2 siu6A_0051.jpg (2013:2310):
144:5 siu6A_0051.jpg (2171:2310):
150:2 siu6A_0060.jpg (2008:2168):
150:4 siu6A_0060.jpg (2015:2128):
170:2 siu6A_0090.jpg (2027:2305):
170:4 siu6A_0090.jpg (2038:2127):
&_des Egypt (pyramid) {8-0}~ [6]
122:2 siu6A_0018.jpg (2038:2179):
122:6 siu6A_0018.jpg (2065:2141):
126:2 siu6A_0024.jpg (2038:2312):
126:6 siu6A_0024.jpg (2050:2148):
150:2 siu6A_0060.jpg (2008:2168):
150:5 siu6A_0060.jpg (2032:2145):
&_des Funnel and others (pyramid) {3-0}~ [2]
86:2 siu5B_0036.jpg (2049:2325):
86:4 siu5B_0036.jpg (2201:2285):
&_des Mistaken 4 vertices (pyramid) {2-0} [2]
136:2 siu6A_0039.jpg (2018:2284):
136:5 siu6A_0039.jpg (2046:2133):
&_des Pyramid description {85-0} [19]
4:2 siu4D_0006.jpg (2009:2310):
48:2 siu4D_0072.jpg (2017:2473):
60:2 siu4D_0090.jpg (2018:2324):
82:2 siu5B_0030.jpg (1997:2321):
86:2 siu5B_0036.jpg (2049:2325):
88:2 siu5B_0039.jpg (2054:2334):
116:2 siu6A_0009.jpg (2027:2290):
122:2 siu6A_0018.jpg (2038:2179):
124:2 siu6A_0021.jpg (1993:2319):
126:2 siu6A_0024.jpg (2038:2312):
130:2 siu6A_0030.jpg (2019:2167):
132:2 siu6A_0033.jpg (2007:2311):
136:2 siu6A_0039.jpg (2018:2284):
138:2 siu6A_0042.jpg (2030:2171):
140:2 siu6A_0045.jpg (2016:2308):
144:2 siu6A_0051.jpg (2013:2310):
150:2 siu6A_0060.jpg (2008:2168):
168:2 siu6A_0087.jpg (2017:2301):
170:2 siu6A_0090.jpg (2027:2305):
&_des Square base (pyramid) {15-0} [14]
4:2 siu4D_0006.jpg (2009:2310):

4:3 siu4D_0006.jpg (2046:2175):
48:2 siu4D_0072.jpg (2017:2473):
48:4 siu4D_0072.jpg (2173:2309):
60:2 siu4D_0090.jpg (2018:2324):
60:4 siu4D_0090.jpg (2037:2148):
82:2 siu5B_0030.jpg (1997:2321):
82:5 siu5B_0030.jpg (2217:2305):
124:2 siu6A_0021.jpg (1993:2319):
124:5 siu6A_0021.jpg (2175:2301):
140:2 siu6A_0045.jpg (2016:2308):
140:5 siu6A_0045.jpg (2031:2142):
168:2 siu6A_0087.jpg (2017:2301):
168:4 siu6A_0087.jpg (2164:2294):

des_SOLO level %3 {43-0}~ [19]
4:2 siu4D_0006.jpg (2009:2310):
48:2 siu4D_0072.jpg (2017:2473):
60:2 siu4D_0090.jpg (2018:2324):
82:2 siu5B_0030.jpg (1997:2321):
86:2 siu5B_0036.jpg (2049:2325):
88:2 siu5B_0039.jpg (2054:2334):
116:2 siu6A_0009.jpg (2027:2290):
122:2 siu6A_0018.jpg (2038:2179):
124:2 siu6A_0021.jpg (1993:2319):
126:2 siu6A_0024.jpg (2038:2312):
130:2 siu6A_0030.jpg (2019:2167):
132:2 siu6A_0033.jpg (2007:2311):
136:2 siu6A_0039.jpg (2018:2284):
138:2 siu6A_0042.jpg (2030:2171):
140:2 siu6A_0045.jpg (2016:2308):
144:2 siu6A_0051.jpg (2013:2310):
150:2 siu6A_0060.jpg (2008:2168):
168:2 siu6A_0087.jpg (2017:2301):
170:2 siu6A_0090.jpg (2027:2305):

&_des Pyramid description at level 4 {2-0} [6]

&_des 4 triangles around (pyramid) {16-0}~ [4]
26:2 siu4D_0039.jpg (2027:2472):
26:4 siu4D_0039.jpg (2057:2153):
72:2 siu5B_0015.jpg (2009:2192):
72:4 siu5B_0015.jpg (2022:2127):

&_des 5 faces (pyramid) {16-0}~ [2]
26:2 siu4D_0039.jpg (2027:2472):
26:3 siu4D_0039.jpg (2049:2141):

&_des Pyramid description {85-0} [2]
26:2 siu4D_0039.jpg (2027:2472):
72:2 siu5B_0015.jpg (2009:2192):

&_des Roof of clock tower (pyramid) {1-0} [2]
72:2 siu5B_0015.jpg (2009:2192):
72:5 siu5B_0015.jpg (2041:2133):

&_des Square base (pyramid) {15-0} [4]
26:2 siu4D_0039.jpg (2027:2472):
26:5 siu4D_0039.jpg (2197:2289):
72:2 siu5B_0015.jpg (2009:2192):
72:3 siu5B_0015.jpg (2033:2124):

des_SOLO level %4 {3-0}~ [2]
26:2 siu4D_0039.jpg (2027:2472):
72:2 siu5B_0015.jpg (2009:2192):

Appendix G: Cooccurring Codes for Pyramid Drawings

HU: siu
File: [J:\study1\datacollection\SiuHonSum\siu.hpr5]
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Date/Time: 07/11/07 09:50:19 AM

&_draw Pyramid drawing at level 1 {26-0} [7]
- &_draw Mistaken as cone (pyramid) {4-0} [4]
  - 20:1 siu4D_0030.jpg (690:1509):
  - 38:1 siu4D_0057.jpg (1009:1657):
  - 52:1 siu4D_0078.jpg (856:1352):
  - 76:2 siu5B_0021.jpg (735:1711):
- &_draw Mistaken as tetrahedron (pyramid) {16-0} [16]
  - 24:2 siu4D_0036.jpg (782:1556):
  - 32:1 siu4D_0048.jpg (972:1305):
  - 40:1 siu4D_0060.jpg (1060:1421):
  - 58:1 siu4D_0087.jpg (778:1634):
  - 64:1 siu5B_0003.jpg (889:1500):
  - 66:1 siu5B_0006.jpg (847:1518):
  - 78:1 siu5B_0024.jpg (874:1433):
  - 80:1 siu5B_0027.jpg (700:1494):
  - 92:1 siu5B_0045.jpg (711:1312):
  - 100:1 siu5B_0057.jpg (889:1430):
  - 110:1 siu5B_0072.jpg (652:1372):
  - 112:1 siu6A_0003.jpg (930:1297):
  - 134:1 siu6A_0036.jpg (929:1215):
  - 142:1 siu6A_0048.jpg (900:1256):
  - 154:1 siu6A_0066.jpg (671:1588):
  - 158:1 siu6A_0072.jpg (870:1287):
- &_draw No structure of square base (pyramid) {8-0} [2]
  - 2:1 siu4D_0003.jpg (647:1694):
  - 56:1 siu4D_0084.jpg (972:1620):
- &_draw Pyramid drawing {85-0} [26]
  - 2:1 siu4D_0003.jpg (647:1694):
  - 20:1 siu4D_0030.jpg (690:1509):
  - 24:2 siu4D_0036.jpg (782:1556):
  - 32:1 siu4D_0048.jpg (972:1305):
  - 38:1 siu4D_0057.jpg (1009:1657):
  - 40:1 siu4D_0060.jpg (1060:1421):
  - 52:1 siu4D_0078.jpg (856:1352):
  - 56:1 siu4D_0084.jpg (972:1620):
  - 58:1 siu4D_0087.jpg (778:1634):
  - 62:1 siu4D_0093.jpg (597:1574):
  - 64:1 siu5B_0003.jpg (889:1500):
  - 66:1 siu5B_0006.jpg (847:1518):
  - 70:1 siu5B_0012.jpg (1041:1671):
  - 76:2 siu5B_0021.jpg (735:1711):
  - 78:1 siu5B_0024.jpg (874:1433):
  - 80:1 siu5B_0027.jpg (700:1494):
  - 92:1 siu5B_0045.jpg (711:1312):
  - 96:1 siu5B_0051.jpg (792:1699):
  - 100:1 siu5B_0057.jpg (889:1430):
  - 106:1 siu5B_0066.jpg (916:1402):
  - 110:1 siu5B_0072.jpg (652:1372):
  - 112:1 siu6A_0003.jpg (930:1297):
  - 134:1 siu6A_0036.jpg (929:1215):
  - 142:1 siu6A_0048.jpg (900:1256):
  - 154:1 siu6A_0066.jpg (671:1588):
  - 158:1 siu6A_0072.jpg (870:1287):
- draw_SOLO level %1 {34-1}~ [26]
  - 2:1 siu4D_0003.jpg (647:1694):
  - 20:1 siu4D_0030.jpg (690:1509):
  - 24:2 siu4D_0036.jpg (782:1556):
  - 32:1 siu4D_0048.jpg (972:1305):

38:1 siu4D_0057.jpg (1009:1657):
40:1 siu4D_0060.jpg (1060:1421):
52:1 siu4D_0078.jpg (856:1352):
56:1 siu4D_0084.jpg (972:1620):
58:1 siu4D_0087.jpg (778:1634):
62:1 siu4D_0093.jpg (597:1574):
64:1 siu5B_0003.jpg (889:1500):
66:1 siu5B_0006.jpg (847:1518):
70:1 siu5B_0012.jpg (1041:1671):
76:2 siu5B_0021.jpg (735:1711):
78:1 siu5B_0024.jpg (874:1433):
80:1 siu5B_0027.jpg (700:1494):
92:1 siu5B_0045.jpg (711:1312):
96:1 siu5B_0051.jpg (792:1699):
100:1 siu5B_0057.jpg (889:1430):
106:1 siu5B_0066.jpg (916:1402):
110:1 siu5B_0072.jpg (652:1372):
112:1 siu6A_0003.jpg (930:1297):
134:1 siu6A_0036.jpg (929:1215):
142:1 siu6A_0048.jpg (900:1256):
154:1 siu6A_0066.jpg (671:1588):
158:1 siu6A_0072.jpg (870:1287):

draw_Some or all seen faces are drawn in a 2D format {18-0}~ [2]
56:1 siu4D_0084.jpg (972:1620):
70:1 siu5B_0012.jpg (1041:1671):

Unable to describe/draw any features {37-0} [4]
2:1 siu4D_0003.jpg (647:1694):
62:1 siu4D_0093.jpg (597:1574):
96:1 siu5B_0051.jpg (792:1699):
106:1 siu5B_0066.jpg (916:1402):

&_draw Pyramid drawing at level 2 {15-0} [7]

&_draw No structure of square base (pyramid) {8-0} [7]
6:1 siu4D_0009.jpg (1060:1361):
12:2 siu4D_0018.jpg (915:1382):
14:1 siu4D_0021.jpg (963:1282):
14:2 siu4D_0021.jpg (1012:1249):
22:1 siu4D_0033.jpg (676:1649):
42:1 siu4D_0063.jpg (696:1593):
44:1 siu4D_0066.jpg (1007:1519):

&_draw Pyramid drawing {85-0} [15]
6:1 siu4D_0009.jpg (1060:1361):
8:1 siu4D_0012.jpg (708:1465):
12:2 siu4D_0018.jpg (915:1382):
14:1 siu4D_0021.jpg (963:1282):
16:1 siu4D_0024.jpg (1004:1490):
18:1 siu4D_0027.jpg (699:1134):
22:1 siu4D_0033.jpg (676:1649):
26:1 siu4D_0039.jpg (893:1264):
42:1 siu4D_0063.jpg (696:1593):
44:1 siu4D_0066.jpg (1007:1519):
46:1 siu4D_0069.jpg (1125:1490):
50:1 siu4D_0075.jpg (903:1449):
54:1 siu4D_0081.jpg (652:889):
102:1 siu5B_0060.jpg (792:1248):
108:1 siu5B_0069.jpg (833:1500):

draw_Hidden lines not in coordination {18-0} [4]
14:1 siu4D_0021.jpg (963:1282):
14:2 siu4D_0021.jpg (1012:1249):
108:1 siu5B_0069.jpg (833:1500):
108:2 siu5B_0069.jpg (1102:1278):

draw_Nontransparent {17-0}~ [4]
8:1 siu4D_0012.jpg (708:1465):
22:1 siu4D_0033.jpg (676:1649):
26:1 siu4D_0039.jpg (893:1264):
54:1 siu4D_0081.jpg (652:889):

draw_Not in perspective view {8-0}~ [3]
16:1 siu4D_0024.jpg (1004:1490):
18:1 siu4D_0027.jpg (699:1134):

22:1 siu4D_0033.jpg (676:1649):
draw_SOLO level %2 {32-1}~ [15]
6:1 siu4D_0009.jpg (1060:1361):
8:1 siu4D_0012.jpg (708:1465):
12:2 siu4D_0018.jpg (915:1382):
14:1 siu4D_0021.jpg (963:1282):
16:1 siu4D_0024.jpg (1004:1490):
18:1 siu4D_0027.jpg (699:1134):
22:1 siu4D_0033.jpg (676:1649):
26:1 siu4D_0039.jpg (893:1264):
42:1 siu4D_0063.jpg (696:1593):
44:1 siu4D_0066.jpg (1007:1519):
46:1 siu4D_0069.jpg (1125:1490):
50:1 siu4D_0075.jpg (903:1449):
54:1 siu4D_0081.jpg (652:889):
102:1 siu5B_0060.jpg (792:1248):
108:1 siu5B_0069.jpg (833:1500):
draw_Some or all seen faces are drawn in a 2D format {18-0}~ [7]
6:1 siu4D_0009.jpg (1060:1361):
12:2 siu4D_0018.jpg (915:1382):
14:1 siu4D_0021.jpg (963:1282):
42:1 siu4D_0063.jpg (696:1593):
44:1 siu4D_0066.jpg (1007:1519):
50:1 siu4D_0075.jpg (903:1449):
102:1 siu5B_0060.jpg (792:1248):

&_draw Pyramid drawing at level 3 {8-0} [4]

&_draw Pyramid drawing {85-0} [8]
10:1 siu4D_0015.jpg (882:1482):
28:1 siu4D_0042.jpg (759:1245):
36:1 siu4D_0054.jpg (805:1282):
68:1 siu5B_0009.jpg (940:1676):
72:1 siu5B_0015.jpg (1060:1301):
74:1 siu5B_0018.jpg (705:1674):
84:1 siu5B_0033.jpg (823:1484):
104:1 siu5B_0063.jpg (773:1551):
draw_Hidden lines not in coordination {18-0} [4]
10:1 siu4D_0015.jpg (882:1482):
10:2 siu4D_0015.jpg (952:1360):
68:1 siu5B_0009.jpg (940:1676):
68:2 siu5B_0009.jpg (1023:1486):
draw_Nontransparent {17-0}~ [5]
28:1 siu4D_0042.jpg (759:1245):
36:1 siu4D_0054.jpg (805:1282):
72:1 siu5B_0015.jpg (1060:1301):
74:1 siu5B_0018.jpg (705:1674):
84:1 siu5B_0033.jpg (823:1484):
draw_SOLO level %3 {36-2}~ [8]
10:1 siu4D_0015.jpg (882:1482):
28:1 siu4D_0042.jpg (759:1245):
36:1 siu4D_0054.jpg (805:1282):
68:1 siu5B_0009.jpg (940:1676):
72:1 siu5B_0015.jpg (1060:1301):
74:1 siu5B_0018.jpg (705:1674):
84:1 siu5B_0033.jpg (823:1484):
104:1 siu5B_0063.jpg (773:1551):

&_draw Pyramid drawing at level 4 {36-0} [3]

&_draw Pyramid drawing {85-0} [36]
4:1 siu4D_0006.jpg (810:1634):
30:1 siu4D_0045.jpg (1000:1440):
34:1 siu4D_0051.jpg (694:1606):
48:1 siu4D_0072.jpg (956:1368):
60:1 siu4D_0090.jpg (870:1435):
82:1 siu5B_0030.jpg (952:1685):
86:1 siu5B_0036.jpg (903:1384):
88:1 siu5B_0039.jpg (889:1569):
90:1 siu5B_0042.jpg (870:1203):

94:1 siu5B_0048.jpg (907:1187):
98:1 siu5B_0054.jpg (685:1639):
114:1 siu6A_0006.jpg (988:1280):
116:1 siu6A_0009.jpg (930:1296):
118:1 siu6A_0012.jpg (1151:1412):
120:1 siu6A_0015.jpg (845:1249):
122:1 siu6A_0018.jpg (937:1312):
124:1 siu6A_0021.jpg (893:1234):
126:1 siu6A_0024.jpg (1075:1427):
128:1 siu6A_0027.jpg (786:1289):
130:1 siu6A_0030.jpg (930:1278):
132:1 siu6A_0033.jpg (849:1308):
136:1 siu6A_0039.jpg (930:1310):
138:1 siu6A_0042.jpg (1080:1432):
140:1 siu6A_0045.jpg (986:1275):
144:1 siu6A_0051.jpg (958:1435):
146:1 siu6A_0054.jpg (736:1273):
148:1 siu6A_0057.jpg (824:1481):
150:1 siu6A_0060.jpg (911:1314):
152:1 siu6A_0063.jpg (811:1453):
156:1 siu6A_0069.jpg (912:1287):
160:1 siu6A_0075.jpg (1093:1345):
162:1 siu6A_0078.jpg (919:1397):
164:1 siu6A_0081.jpg (634:1249):
166:1 siu6A_0084.jpg (1023:1273):
168:1 siu6A_0087.jpg (1221:1387):
170:1 siu6A_0090.jpg (919:1204):
draw_Perfect drawing {28-0} [15]
30:1 siu4D_0045.jpg (1000:1440):
60:1 siu4D_0090.jpg (870:1435):
86:1 siu5B_0036.jpg (903:1384):
88:1 siu5B_0039.jpg (889:1569):
114:1 siu6A_0006.jpg (988:1280):
120:1 siu6A_0015.jpg (845:1249):
124:1 siu6A_0021.jpg (893:1234):
130:1 siu6A_0030.jpg (930:1278):
132:1 siu6A_0033.jpg (849:1308):
136:1 siu6A_0039.jpg (930:1310):
138:1 siu6A_0042.jpg (1080:1432):
148:1 siu6A_0057.jpg (824:1481):
150:1 siu6A_0060.jpg (911:1314):
156:1 siu6A_0069.jpg (912:1287):
166:1 siu6A_0084.jpg (1023:1273):
draw_SOLO level %4 {68-2}~ [36]
4:1 siu4D_0006.jpg (810:1634):
30:1 siu4D_0045.jpg (1000:1440):
34:1 siu4D_0051.jpg (694:1606):
48:1 siu4D_0072.jpg (956:1368):
60:1 siu4D_0090.jpg (870:1435):
82:1 siu5B_0030.jpg (952:1685):
86:1 siu5B_0036.jpg (903:1384):
88:1 siu5B_0039.jpg (889:1569):
90:1 siu5B_0042.jpg (870:1203):
94:1 siu5B_0048.jpg (907:1187):
98:1 siu5B_0054.jpg (685:1639):
114:1 siu6A_0006.jpg (988:1280):
116:1 siu6A_0009.jpg (930:1296):
118:1 siu6A_0012.jpg (1151:1412):
120:1 siu6A_0015.jpg (845:1249):
122:1 siu6A_0018.jpg (937:1312):
124:1 siu6A_0021.jpg (893:1234):
126:1 siu6A_0024.jpg (1075:1427):
128:1 siu6A_0027.jpg (786:1289):
130:1 siu6A_0030.jpg (930:1278):
132:1 siu6A_0033.jpg (849:1308):
136:1 siu6A_0039.jpg (930:1310):
138:1 siu6A_0042.jpg (1080:1432):
140:1 siu6A_0045.jpg (986:1275):
144:1 siu6A_0051.jpg (958:1435):
146:1 siu6A_0054.jpg (736:1273):
148:1 siu6A_0057.jpg (824:1481):

150:1 siu6A_0060.jpg (911:1314):
152:1 siu6A_0063.jpg (811:1453):
156:1 siu6A_0069.jpg (912:1287):
160:1 siu6A_0075.jpg (1093:1345):
162:1 siu6A_0078.jpg (919:1397):
164:1 siu6A_0081.jpg (634:1249):
166:1 siu6A_0084.jpg (1023:1273):
168:1 siu6A_0087.jpg (1221:1387):
170:1 siu6A_0090.jpg (919:1204):

Appendix H: Cooccurring Codes for Cylinder Descriptions

HU: wu
File: [J:\study1\datacollection\WuMienTuen\wu.hpr5]
Edited by: swpun
Date/Time: 07/11/07 09:51:58 AM

%_des Cylinder description at level 1 {42-0} [7]
- %_des Cylinder description {103-0} [42]
  - 4:1 wu4A_0004.jpg (443:577):
  - 16:1 wu4A_0016.jpg (367:621):
  - 24:1 wu4A_0024.jpg (464:770):
  - 44:1 wu4A_0044.jpg (399:695):
  - 48:1 wu4A_0048.jpg (490:778):
  - 60:1 wu4A_0060.jpg (414:596):
  - 68:1 wu4A_0068.jpg (433:608):
  - 80:1 wu4A_0080.jpg (402:596):
  - 84:1 wu4A_0084.jpg (437:589):
  - 88:1 wu4A_0088.jpg (417:594):
  - 96:1 wu4A_0096.jpg (443:681):
  - 108:1 wu4A_0108.jpg (410:584):
  - 112:1 wu4A_0112.jpg (440:846):
  - 156:1 wu5A__0004.jpg (436:831):
  - 164:1 wu5A__0012.jpg (432:820):
  - 172:1 wu5A__0020.jpg (414:687):
  - 176:1 wu5A__0024.jpg (394:697):
  - 184:1 wu5A__0032.jpg (446:592):
  - 188:1 wu5A__0036.jpg (417:592):
  - 192:1 wu5A__0040.jpg (406:566):
  - 204:1 wu5A__0052.jpg (411:581):
  - 220:1 wu5A__0068.jpg (421:576):
  - 240:1 wu5A__0088.jpg (442:592):
  - 248:1 wu5A__0096.jpg (443:557):
  - 268:1 wu5A__0116.jpg (433:839):
  - 272:1 wu5A__0120.jpg (448:884):
  - 284:1 wu6A__0012.jpg (457:586):
  - 288:1 wu6A__0016.jpg (429:697):
  - 304:1 wu6A__0032.jpg (449:603):
  - 312:1 wu6A__0040.jpg (364:877):
  - 320:1 wu6A__0048.jpg (425:619):
  - 332:1 wu6A__0060.jpg (443:589):
  - 340:1 wu6A__0068.jpg (417:820):
  - 348:1 wu6A__0076.jpg (406:597):
  - 356:1 wu6A__0084.jpg (402:588):
  - 376:1 wu6A__0104.jpg (437:600):
  - 380:1 wu6A__0108.jpg (434:589):
  - 388:1 wu6A__0116.jpg (451:586):
  - 396:1 wu6A__0124.jpg (443:606):
  - 404:1 wu6A__0132.jpg (417:697):
  - 408:1 wu6A__0136.jpg (430:617):
  - 412:1 wu6A__0140.jpg (408:581):
- %_des Mistaken as 2 edges (cylinder) {3-0} [4]
  - 192:1 wu5A__0040.jpg (406:566):
  - 192:2 wu5A__0040.jpg (449:526):
  - 304:1 wu6A__0032.jpg (449:603):
  - 304:2 wu6A__0032.jpg (469:563):
- %_des Mistaken as 4 edges (cylinder) {3-0} [4]
  - 284:1 wu6A__0012.jpg (457:586):
  - 380:1 wu6A__0108.jpg (434:589):
  - 412:1 wu6A__0140.jpg (408:581):
  - 412:2 wu6A__0140.jpg (476:546):
- %_des Mistaken as a sphere (cylinder) {2-0} [3]
  - 44:1 wu4A_0044.jpg (399:695):
  - 44:2 wu4A_0044.jpg (550:664):
  - 60:1 wu4A_0060.jpg (414:596):

des_Few information in description {33-2}~ [11]
68:1 wu4A_0068.jpg (433:608):
80:1 wu4A_0080.jpg (402:596):
88:1 wu4A_0088.jpg (417:594):
172:1 wu5A__0020.jpg (414:687):
176:1 wu5A__0024.jpg (394:697):
184:1 wu5A__0032.jpg (446:592):
188:1 wu5A__0036.jpg (417:592):
204:1 wu5A__0052.jpg (411:581):
320:1 wu6A__0048.jpg (425:619):
340:1 wu6A__0068.jpg (417:820):
408:1 wu6A__0136.jpg (430:617):
des_SOLO level %1 {99-0}~ [42]
4:1 wu4A_0004.jpg (443:577):
16:1 wu4A_0016.jpg (367:621):
24:1 wu4A_0024.jpg (464:770):
44:1 wu4A_0044.jpg (399:695):
48:1 wu4A_0048.jpg (490:778):
60:1 wu4A_0060.jpg (414:596):
68:1 wu4A_0068.jpg (433:608):
80:1 wu4A_0080.jpg (402:596):
84:1 wu4A_0084.jpg (437:589):
88:1 wu4A_0088.jpg (417:594):
96:1 wu4A_0096.jpg (443:681):
108:1 wu4A_0108.jpg (410:584):
112:1 wu4A_0112.jpg (440:846):
156:1 wu5A__0004.jpg (436:831):
164:1 wu5A__0012.jpg (432:820):
172:1 wu5A__0020.jpg (414:687):
176:1 wu5A__0024.jpg (394:697):
184:1 wu5A__0032.jpg (446:592):
188:1 wu5A__0036.jpg (417:592):
192:1 wu5A__0040.jpg (406:566):
204:1 wu5A__0052.jpg (411:581):
220:1 wu5A__0068.jpg (421:576):
240:1 wu5A__0088.jpg (442:592):
248:1 wu5A__0096.jpg (443:557):
268:1 wu5A__0116.jpg (433:839):
272:1 wu5A__0120.jpg (448:884):
284:1 wu6A__0012.jpg (457:586):
288:1 wu6A__0016.jpg (429:697):
304:1 wu6A__0032.jpg (449:603):
312:1 wu6A__0040.jpg (364:877):
320:1 wu6A__0048.jpg (425:619):
332:1 wu6A__0060.jpg (443:589):
340:1 wu6A__0068.jpg (417:820):
348:1 wu6A__0076.jpg (406:597):
356:1 wu6A__0084.jpg (402:588):
376:1 wu6A__0104.jpg (437:600):
380:1 wu6A__0108.jpg (434:589):
388:1 wu6A__0116.jpg (451:586):
396:1 wu6A__0124.jpg (443:606):
404:1 wu6A__0132.jpg (417:697):
408:1 wu6A__0136.jpg (430:617):
412:1 wu6A__0140.jpg (408:581):
Unable to describe/draw any features {49-2} [25]
4:1 wu4A_0004.jpg (443:577):
16:1 wu4A_0016.jpg (367:621):
24:1 wu4A_0024.jpg (464:770):
44:1 wu4A_0044.jpg (399:695):
48:1 wu4A_0048.jpg (490:778):
84:1 wu4A_0084.jpg (437:589):
96:1 wu4A_0096.jpg (443:681):
108:1 wu4A_0108.jpg (410:584):
112:1 wu4A_0112.jpg (440:846):
156:1 wu5A__0004.jpg (436:831):
164:1 wu5A__0012.jpg (432:820):
220:1 wu5A__0068.jpg (421:576):
240:1 wu5A__0088.jpg (442:592):
248:1 wu5A__0096.jpg (443:557):
268:1 wu5A__0116.jpg (433:839):

272:1 wu5A__0120.jpg (448:884):
288:1 wu6A__0016.jpg (429:697):
312:1 wu6A__0040.jpg (364:877):
332:1 wu6A__0060.jpg (443:589):
348:1 wu6A__0076.jpg (406:597):
356:1 wu6A__0084.jpg (402:588):
376:1 wu6A__0104.jpg (437:600):
388:1 wu6A__0116.jpg (451:586):
396:1 wu6A__0124.jpg (443:606):
404:1 wu6A__0132.jpg (417:697):

%_des Cylinder description at level 2 {43-0} [11]

%_des 2 bases (cylinder) {1-0} [2]
28:1 wu4A_0028.jpg (444:833):
28:3 wu4A_0028.jpg (463:532):
%_des Circle (cylinder) {26-0}~ [36]
36:1 wu4A_0036.jpg (440:602):
36:2 wu4A_0036.jpg (463:544):
64:1 wu4A_0064.jpg (403:574):
64:2 wu4A_0064.jpg (460:543):
104:1 wu4A_0104.jpg (418:591):
104:2 wu4A_0104.jpg (458:546):
116:1 wu4A_0116.jpg (403:574):
116:2 wu4A_0116.jpg (420:554):
136:1 wu4A_0136.jpg (448:563):
136:2 wu4A_0136.jpg (463:538):
148:1 wu4A_0148.jpg (457:715):
148:2 wu4A_0148.jpg (589:672):
160:1 wu5A__0008.jpg (433:563):
160:2 wu5A__0008.jpg (476:546):
180:1 wu5A__0028.jpg (421:586):
180:2 wu5A__0028.jpg (468:538):
208:1 wu5A__0056.jpg (399:588):
208:2 wu5A__0056.jpg (417:550):
232:1 wu5A__0080.jpg (357:577):
232:2 wu5A__0080.jpg (414:537):
244:1 wu5A__0092.jpg (436:584):
244:2 wu5A__0092.jpg (480:547):
252:1 wu5A__0100.jpg (434:557):
252:2 wu5A__0100.jpg (480:546):
292:1 wu6A__0020.jpg (463:581):
292:2 wu6A__0020.jpg (483:541):
308:1 wu6A__0036.jpg (391:596):
308:2 wu6A__0036.jpg (421:550):
324:1 wu6A__0052.jpg (402:725):
324:3 wu6A__0052.jpg (425:566):
328:1 wu6A__0056.jpg (410:649):
328:2 wu6A__0056.jpg (463:558):
344:1 wu6A__0072.jpg (418:713):
344:2 wu6A__0072.jpg (606:688):
400:1 wu6A__0128.jpg (432:603):
400:2 wu6A__0128.jpg (469:557):
%_des Circles as bases (cylinder) {17-0}~ [15]
8:1 wu4A_0008.jpg (390:853):
8:2 wu4A_0008.jpg (571:671):
120:1 wu4A_0120.jpg (446:597):
120:2 wu4A_0120.jpg (466:560):
128:1 wu4A_0128.jpg (330:596):
128:2 wu4A_0128.jpg (372:528):
132:1 wu4A_0132.jpg (380:692):
132:2 wu4A_0132.jpg (432:523):
196:1 wu5A__0044.jpg (417:574):
200:1 wu5A__0048.jpg (441:601):
200:2 wu5A__0048.jpg (466:538):
256:1 wu5A__0104.jpg (354:567):
256:2 wu5A__0104.jpg (414:524):
300:1 wu6A__0028.jpg (394:706):
300:2 wu6A__0028.jpg (457:572):
%_des Curved surface (cylinder) {1-0} [2]
28:1 wu4A_0028.jpg (444:833):

28:2 wu4A_0028.jpg (567:671):
%_des Cylinder associated with shapes in daily life (cylinder) {16-0}~ [16]
40:1 wu4A_0040.jpg (393:611):
40:2 wu4A_0040.jpg (430:522):
72:1 wu4A_0072.jpg (383:611):
92:1 wu4A_0092.jpg (388:588):
120:1 wu4A_0120.jpg (446:597):
120:3 wu4A_0120.jpg (474:549):
124:1 wu4A_0124.jpg (448:583):
124:3 wu4A_0124.jpg (458:546):
152:1 wu4A_0152.jpg (476:696):
260:1 wu5A__0108.jpg (406:592):
260:3 wu5A__0108.jpg (440:552):
276:1 wu6A__0004.jpg (440:667):
296:1 wu6A__0024.jpg (449:695):
296:2 wu6A__0024.jpg (586:660):
372:1 wu6A__0100.jpg (446:596):
384:1 wu6A__0112.jpg (423:576):
%_des Cylinder description {103-0} [43]
8:1 wu4A_0008.jpg (390:853):
12:1 wu4A_0012.jpg (421:822):
20:1 wu4A_0020.jpg (428:602):
28:1 wu4A_0028.jpg (444:833):
36:1 wu4A_0036.jpg (440:602):
40:1 wu4A_0040.jpg (393:611):
64:1 wu4A_0064.jpg (403:574):
72:1 wu4A_0072.jpg (383:611):
92:1 wu4A_0092.jpg (388:588):
100:1 wu4A_0100.jpg (444:600):
104:1 wu4A_0104.jpg (418:591):
116:1 wu4A_0116.jpg (403:574):
120:1 wu4A_0120.jpg (446:597):
124:1 wu4A_0124.jpg (448:583):
128:1 wu4A_0128.jpg (330:596):
132:1 wu4A_0132.jpg (380:692):
136:1 wu4A_0136.jpg (448:563):
140:1 wu4A_0140.jpg (437:577):
148:1 wu4A_0148.jpg (457:715):
152:1 wu4A_0152.jpg (476:696):
160:1 wu5A__0008.jpg (433:563):
180:1 wu5A__0028.jpg (421:586):
196:1 wu5A__0044.jpg (417:574):
200:1 wu5A__0048.jpg (441:601):
208:1 wu5A__0056.jpg (399:588):
216:1 wu5A__0064.jpg (423:677):
232:1 wu5A__0080.jpg (357:577):
244:1 wu5A__0092.jpg (436:584):
252:1 wu5A__0100.jpg (434:557):
256:1 wu5A__0104.jpg (354:567):
260:1 wu5A__0108.jpg (406:592):
276:1 wu6A__0004.jpg (440:667):
292:1 wu6A__0020.jpg (463:581):
296:1 wu6A__0024.jpg (449:695):
300:1 wu6A__0028.jpg (394:706):
308:1 wu6A__0036.jpg (391:596):
324:1 wu6A__0052.jpg (402:725):
328:1 wu6A__0056.jpg (410:649):
344:1 wu6A__0072.jpg (418:713):
352:1 wu6A__0080.jpg (426:732):
372:1 wu6A__0100.jpg (446:596):
384:1 wu6A__0112.jpg (423:576):
400:1 wu6A__0128.jpg (432:603):
%_des Mistaken as 2 edges (cylinder) {3-0} [2]
136:1 wu4A_0136.jpg (448:563):
136:3 wu4A_0136.jpg (466:521):
%_des Mistaken the middle of the shape as rectangle (cylinder) {1-0} [2]
244:1 wu5A__0092.jpg (436:584):
244:3 wu5A__0092.jpg (474:545):
%_des Prism (Cylinder) {19-0}~ [16]
20:1 wu4A_0020.jpg (428:602):
20:2 wu4A_0020.jpg (451:552):

100:1 wu4A_0100.jpg (444:600):
100:2 wu4A_0100.jpg (467:562):
124:1 wu4A_0124.jpg (448:583):
124:2 wu4A_0124.jpg (461:543):
140:1 wu4A_0140.jpg (437:577):
140:2 wu4A_0140.jpg (454:540):
216:1 wu5A__0064.jpg (423:677):
216:2 wu5A__0064.jpg (446:532):
260:1 wu5A__0108.jpg (406:592):
260:2 wu5A__0108.jpg (452:534):
324:1 wu6A__0052.jpg (402:725):
324:2 wu6A__0052.jpg (425:562):
352:1 wu6A__0080.jpg (426:732):
352:2 wu6A__0080.jpg (449:552):
des_Describing with 2D terms {37-2}~ [5]
8:1 wu4A_0008.jpg (390:853):
8:3 wu4A_0008.jpg (567:660):
12:1 wu4A_0012.jpg (421:822):
12:2 wu4A_0012.jpg (693:804):
140:1 wu4A_0140.jpg (437:577):
des_SOLO level %2 {82-0}~ [43]
8:1 wu4A_0008.jpg (390:853):
12:1 wu4A_0012.jpg (421:822):
20:1 wu4A_0020.jpg (428:602):
28:1 wu4A_0028.jpg (444:833):
36:1 wu4A_0036.jpg (440:602):
40:1 wu4A_0040.jpg (393:611):
64:1 wu4A_0064.jpg (403:574):
72:1 wu4A_0072.jpg (383:611):
92:1 wu4A_0092.jpg (388:588):
100:1 wu4A_0100.jpg (444:600):
104:1 wu4A_0104.jpg (418:591):
116:1 wu4A_0116.jpg (403:574):
120:1 wu4A_0120.jpg (446:597):
124:1 wu4A_0124.jpg (448:583):
128:1 wu4A_0128.jpg (330:596):
132:1 wu4A_0132.jpg (380:692):
136:1 wu4A_0136.jpg (448:563):
140:1 wu4A_0140.jpg (437:577):
148:1 wu4A_0148.jpg (457:715):
152:1 wu4A_0152.jpg (476:696):
160:1 wu5A__0008.jpg (433:563):
180:1 wu5A__0028.jpg (421:586):
196:1 wu5A__0044.jpg (417:574):
200:1 wu5A__0048.jpg (441:601):
208:1 wu5A__0056.jpg (399:588):
216:1 wu5A__0064.jpg (423:677):
232:1 wu5A__0080.jpg (357:577):
244:1 wu5A__0092.jpg (436:584):
252:1 wu5A__0100.jpg (434:557):
256:1 wu5A__0104.jpg (354:567):
260:1 wu5A__0108.jpg (406:592):
276:1 wu6A__0004.jpg (440:667):
292:1 wu6A__0020.jpg (463:581):
296:1 wu6A__0024.jpg (449:695):
300:1 wu6A__0028.jpg (394:706):
308:1 wu6A__0036.jpg (391:596):
324:1 wu6A__0052.jpg (402:725):
328:1 wu6A__0056.jpg (410:649):
344:1 wu6A__0072.jpg (418:713):
352:1 wu6A__0080.jpg (426:732):
372:1 wu6A__0100.jpg (446:596):
384:1 wu6A__0112.jpg (423:576):
400:1 wu6A__0128.jpg (432:603):

%_des Cylinder description at level 3 {17-0} [7]

%_des 3 faces (cylinder) {1-0} [2]
56:1 wu4A_0056.jpg (391:953):
56:2 wu4A_0056.jpg (410:569):
%_des Circle (cylinder) {26-0}~ [16]

144:1 wu4A_0144.jpg (367:575):
144:2 wu4A_0144.jpg (444:540):
212:1 wu5A__0060.jpg (423:591):
212:2 wu5A__0060.jpg (456:548):
228:1 wu5A__0076.jpg (411:578):
228:3 wu5A__0076.jpg (437:519):
236:1 wu5A__0084.jpg (402:600):
236:3 wu5A__0084.jpg (425:535):
264:1 wu5A__0112.jpg (376:543):
264:2 wu5A__0112.jpg (402:528):
280:1 wu6A__0008.jpg (414:566):
280:3 wu6A__0008.jpg (469:563):
360:1 wu6A__0088.jpg (463:576):
360:3 wu6A__0088.jpg (481:553):
364:1 wu6A__0092.jpg (440:564):
364:3 wu6A__0092.jpg (453:522):
%_des Circles as bases (cylinder) {17-0}~ [14]
32:1 wu4A_0032.jpg (465:688):
32:2 wu4A_0032.jpg (603:673):
52:1 wu4A_0052.jpg (372:858):
56:1 wu4A_0056.jpg (391:953):
76:1 wu4A_0076.jpg (414:588):
76:3 wu4A_0076.jpg (448:516):
224:1 wu5A__0072.jpg (380:693):
224:2 wu5A__0072.jpg (426:548):
316:1 wu6A__0044.jpg (412:726):
316:2 wu6A__0044.jpg (469:566):
336:1 wu6A__0064.jpg (394:703):
336:2 wu6A__0064.jpg (569:660):
392:1 wu6A__0120.jpg (426:712):
392:2 wu6A__0120.jpg (460:540):
%_des Cylinder associated with shapes in daily life (cylinder) {16-0}~ [10]
52:1 wu4A_0052.jpg (372:858):
52:2 wu4A_0052.jpg (558:725):
236:1 wu5A__0084.jpg (402:600):
236:2 wu5A__0084.jpg (421:554):
316:1 wu6A__0044.jpg (412:726):
316:3 wu6A__0044.jpg (472:563):
336:1 wu6A__0064.jpg (394:703):
336:3 wu6A__0064.jpg (434:552):
368:1 wu6A__0096.jpg (414:697):
368:2 wu6A__0096.jpg (603:672):
%_des Cylinder description {103-0} [17]
32:1 wu4A_0032.jpg (465:688):
52:1 wu4A_0052.jpg (372:858):
56:1 wu4A_0056.jpg (391:953):
76:1 wu4A_0076.jpg (414:588):
144:1 wu4A_0144.jpg (367:575):
212:1 wu5A__0060.jpg (423:591):
224:1 wu5A__0072.jpg (380:693):
228:1 wu5A__0076.jpg (411:578):
236:1 wu5A__0084.jpg (402:600):
264:1 wu5A__0112.jpg (376:543):
280:1 wu6A__0008.jpg (414:566):
316:1 wu6A__0044.jpg (412:726):
336:1 wu6A__0064.jpg (394:703):
360:1 wu6A__0088.jpg (463:576):
364:1 wu6A__0092.jpg (440:564):
368:1 wu6A__0096.jpg (414:697):
392:1 wu6A__0120.jpg (426:712):
%_des Prism (Cylinder) {19-0}~ [21]
32:1 wu4A_0032.jpg (465:688):
32:3 wu4A_0032.jpg (611:666):
56:1 wu4A_0056.jpg (391:953):
56:3 wu4A_0056.jpg (687:801):
76:1 wu4A_0076.jpg (414:588):
76:2 wu4A_0076.jpg (444:535):
144:1 wu4A_0144.jpg (367:575):
212:1 wu5A__0060.jpg (423:591):
212:3 wu5A__0060.jpg (463:548):
228:1 wu5A__0076.jpg (411:578):

228:2 wu5A__0076.jpg (430:530):
264:1 wu5A__0112.jpg (376:543):
264:3 wu5A__0112.jpg (425:520):
280:1 wu6A__0008.jpg (414:566):
280:2 wu6A__0008.jpg (474:549):
360:1 wu6A__0088.jpg (463:576):
360:2 wu6A__0088.jpg (488:541):
364:1 wu6A__0092.jpg (440:564):
364:2 wu6A__0092.jpg (478:547):
368:1 wu6A__0096.jpg (414:697):
368:3 wu6A__0096.jpg (597:669):

des_SOLO level %3 {23-0}~ [17]

32:1 wu4A_0032.jpg (465:688):
52:1 wu4A_0052.jpg (372:858):
56:1 wu4A_0056.jpg (391:953):
76:1 wu4A_0076.jpg (414:588):
144:1 wu4A_0144.jpg (367:575):
212:1 wu5A__0060.jpg (423:591):
224:1 wu5A__0072.jpg (380:693):
228:1 wu5A__0076.jpg (411:578):
236:1 wu5A__0084.jpg (402:600):
264:1 wu5A__0112.jpg (376:543):
280:1 wu6A__0008.jpg (414:566):
316:1 wu6A__0044.jpg (412:726):
336:1 wu6A__0064.jpg (394:703):
360:1 wu6A__0088.jpg (463:576):
364:1 wu6A__0092.jpg (440:564):
368:1 wu6A__0096.jpg (414:697):
392:1 wu6A__0120.jpg (426:712):

%_des Cylinder description at level 4 {1-0} [4]

%_des Circles as bases (cylinder) {17-0}~ [2]

168:1 wu5A__0016.jpg (426:686):
168:2 wu5A__0016.jpg (440:540):

%_des Cylinder description {103-0} [1]

168:1 wu5A__0016.jpg (426:686):

%_des The shape formed by scrolling a rectangle (cylinder) {1-0} [2]

168:1 wu5A__0016.jpg (426:686):
168:3 wu5A__0016.jpg (437:537):

des_SOLO level %4 {2-0}~ [1]

168:1 wu5A__0016.jpg (426:686):

Appendix I: Cooccurring Codes for Cylinder Drawings

HU: wu
File: [J:\study1\datacollection\WuMienTuen\wu.hpr5]
Edited by: swpun
Date/Time: 07/11/07 09:53:08 AM

%_draw Cylinder drawing at level 1 {2-0} [3]
- %_draw Cylinder drawing {103-0} [2]
  - 15:1 wu4A_0015.jpg (1227:1711):
  - 403:1 wu6A__0131.jpg (903:1568):
- draw_SOLO level %1 {7-0}~ [2]
  - 15:1 wu4A_0015.jpg (1227:1711):
  - 403:1 wu6A__0131.jpg (903:1568):
- Unable to describe/draw any features {49-2} [2]
  - 15:1 wu4A_0015.jpg (1227:1711):
  - 403:1 wu6A__0131.jpg (903:1568):

%_draw Cylinder drawing at level 2 {13-0} [7]
- %_draw Circle as base (cylinder) {36-0} [14]
  - 35:1 wu4A_0035.jpg (860:1358):
  - 35:2 wu4A_0035.jpg (884:1034):
  - 63:1 wu4A_0063.jpg (839:1016):
  - 63:2 wu4A_0063.jpg (859:914):
  - 67:1 wu4A_0067.jpg (801:1590):
  - 67:2 wu4A_0067.jpg (1347:1537):
  - 71:1 wu4A_0071.jpg (755:1803):
  - 71:2 wu4A_0071.jpg (763:1112):
  - 299:1 wu6A__0027.jpg (854:1116):
  - 299:2 wu6A__0027.jpg (881:949):
  - 375:1 wu6A__0103.jpg (812:1374):
  - 375:3 wu6A__0103.jpg (827:972):
  - 407:1 wu6A__0135.jpg (735:1512):
  - 407:2 wu6A__0135.jpg (760:946):
- %_draw Cylinder drawing {103-0} [13]
  - 35:1 wu4A_0035.jpg (860:1358):
  - 63:1 wu4A_0063.jpg (839:1016):
  - 67:1 wu4A_0067.jpg (801:1590):
  - 71:1 wu4A_0071.jpg (755:1803):
  - 111:1 wu4A_0111.jpg (816:1378):
  - 139:1 wu4A_0139.jpg (1063:1486):
  - 151:1 wu4A_0151.jpg (864:1624):
  - 267:1 wu5A__0115.jpg (888:1545):
  - 299:1 wu6A__0027.jpg (854:1116):
  - 375:1 wu6A__0103.jpg (812:1374):
  - 379:1 wu6A__0107.jpg (839:1560):
  - 395:1 wu6A__0123.jpg (863:1278):
  - 407:1 wu6A__0135.jpg (735:1512):
- %_draw Four edges (cylinder) {4-0} [7]
  - 35:1 wu4A_0035.jpg (860:1358):
  - 35:3 wu4A_0035.jpg (1042:1335):
  - 299:1 wu6A__0027.jpg (854:1116):
  - 299:3 wu6A__0027.jpg (896:1081):
  - 379:1 wu6A__0107.jpg (839:1560):
  - 395:1 wu6A__0123.jpg (863:1278):
  - 395:2 wu6A__0123.jpg (897:1218):
- %_draw Three edges (cylinder) {1-0} [2]
  - 407:1 wu6A__0135.jpg (735:1512):
  - 407:3 wu6A__0135.jpg (980:1458):
- draw_Nontransparent {34-1}~ [2]
  - 63:1 wu4A_0063.jpg (839:1016):
  - 71:1 wu4A_0071.jpg (755:1803):
- draw_Perpendicular edges {15-1}~ [8]

139:1 wu4A_0139.jpg (1063:1486):
139:2 wu4A_0139.jpg (1329:1415):
151:1 wu4A_0151.jpg (864:1624):
151:2 wu4A_0151.jpg (1451:1597):
267:1 wu5A__0115.jpg (888:1545):
267:2 wu5A__0115.jpg (1302:1446):
375:1 wu6A__0103.jpg (812:1374):
375:2 wu6A__0103.jpg (1215:1344):
draw_SOLO level %2 {48-0}~ [13]
35:1 wu4A_0035.jpg (860:1358):
63:1 wu4A_0063.jpg (839:1016):
67:1 wu4A_0067.jpg (801:1590):
71:1 wu4A_0071.jpg (755:1803):
111:1 wu4A_0111.jpg (816:1378):
139:1 wu4A_0139.jpg (1063:1486):
151:1 wu4A_0151.jpg (864:1624):
267:1 wu5A__0115.jpg (888:1545):
299:1 wu6A__0027.jpg (854:1116):
375:1 wu6A__0103.jpg (812:1374):
379:1 wu6A__0107.jpg (839:1560):
395:1 wu6A__0123.jpg (863:1278):
407:1 wu6A__0135.jpg (735:1512):

%_draw Cylinder drawing at level 3 {33-0} [5]
%_draw Circle as base (cylinder) {36-0} [58]
3:1 wu4A_0003.jpg (1027:1701):
3:2 wu4A_0003.jpg (1047:1284):
23:1 wu4A_0023.jpg (1001:1247):
23:2 wu4A_0023.jpg (1117:1204):
47:1 wu4A_0047.jpg (862:1404):
47:2 wu4A_0047.jpg (900:1082):
51:1 wu4A_0051.jpg (976:1174):
51:2 wu4A_0051.jpg (996:1056):
55:1 wu4A_0055.jpg (877:1287):
55:2 wu4A_0055.jpg (892:1025):
79:1 wu4A_0079.jpg (717:1111):
79:2 wu4A_0079.jpg (720:844):
83:1 wu4A_0083.jpg (956:1818):
83:2 wu4A_0083.jpg (987:1161):
91:1 wu4A_0091.jpg (854:1750):
91:2 wu4A_0091.jpg (896:1127):
103:1 wu4A_0103.jpg (1161:1450):
103:2 wu4A_0103.jpg (1188:1294):
107:1 wu4A_0107.jpg (972:1488):
107:2 wu4A_0107.jpg (1298:1450):
115:1 wu4A_0115.jpg (1012:1409):
115:2 wu4A_0115.jpg (1049:1152):
123:1 wu4A_0123.jpg (797:1157):
123:2 wu4A_0123.jpg (834:977):
127:1 wu4A_0127.jpg (1103:1526):
127:2 wu4A_0127.jpg (1123:1249):
131:1 wu4A_0131.jpg (884:1359):
131:2 wu4A_0131.jpg (1177:1332):
163:1 wu5A__0011.jpg (851:1475):
163:2 wu5A__0011.jpg (899:1064):
179:1 wu5A__0027.jpg (930:1370):
179:2 wu5A__0027.jpg (953:1127):
207:1 wu5A__0055.jpg (877:1446):
207:2 wu5A__0055.jpg (911:1013):
227:1 wu5A__0075.jpg (930:1499):
227:2 wu5A__0075.jpg (941:1104):
243:1 wu5A__0091.jpg (778:1340):
243:2 wu5A__0091.jpg (1169:1336):
255:1 wu5A__0103.jpg (767:1723):
255:2 wu5A__0103.jpg (789:979):
259:1 wu5A__0107.jpg (846:1617):
259:2 wu5A__0107.jpg (877:1123):
263:1 wu5A__0111.jpg (789:1771):
263:2 wu5A__0111.jpg (804:1082):
287:1 wu6A__0015.jpg (1063:1476):

287:2 wu6A__0015.jpg (1078:1207):
303:1 wu6A__0031.jpg (755:1275):
303:2 wu6A__0031.jpg (770:1002):
311:1 wu6A__0039.jpg (820:1579):
311:2 wu6A__0039.jpg (873:1139):
327:1 wu6A__0055.jpg (862:1738):
327:2 wu6A__0055.jpg (884:1142):
335:1 wu6A__0063.jpg (800:1349):
335:2 wu6A__0063.jpg (815:920):
363:1 wu6A__0091.jpg (837:1386):
363:2 wu6A__0091.jpg (860:989):
411:1 wu6A__0139.jpg (1002:1526):
411:2 wu6A__0139.jpg (1355:1511):
%_draw Cylinder drawing {103-0} [33]
3:1 wu4A_0003.jpg (1027:1701):
19:1 wu4A_0019.jpg (899:1381):
23:1 wu4A_0023.jpg (1001:1247):
39:1 wu4A_0039.jpg (907:1451):
47:1 wu4A_0047.jpg (862:1404):
51:1 wu4A_0051.jpg (976:1174):
55:1 wu4A_0055.jpg (877:1287):
79:1 wu4A_0079.jpg (717:1111):
83:1 wu4A_0083.jpg (956:1818):
91:1 wu4A_0091.jpg (854:1750):
103:1 wu4A_0103.jpg (1161:1450):
107:1 wu4A_0107.jpg (972:1488):
115:1 wu4A_0115.jpg (1012:1409):
123:1 wu4A_0123.jpg (797:1157):
127:1 wu4A_0127.jpg (1103:1526):
131:1 wu4A_0131.jpg (884:1359):
163:1 wu5A__0011.jpg (851:1475):
179:1 wu5A__0027.jpg (930:1370):
207:1 wu5A__0055.jpg (877:1446):
227:1 wu5A__0075.jpg (930:1499):
243:1 wu5A__0091.jpg (778:1340):
255:1 wu5A__0103.jpg (767:1723):
259:1 wu5A__0107.jpg (846:1617):
263:1 wu5A__0111.jpg (789:1771):
275:1 wu6A__0003.jpg (801:1594):
287:1 wu6A__0015.jpg (1063:1476):
303:1 wu6A__0031.jpg (755:1275):
311:1 wu6A__0039.jpg (820:1579):
327:1 wu6A__0055.jpg (862:1738):
335:1 wu6A__0063.jpg (800:1349):
339:1 wu6A__0067.jpg (897:1351):
363:1 wu6A__0091.jpg (837:1386):
411:1 wu6A__0139.jpg (1002:1526):
%_draw Ellipse as base (cylinder) {57-0} [4]
19:1 wu4A_0019.jpg (899:1381):
19:2 wu4A_0019.jpg (971:1104):
39:1 wu4A_0039.jpg (907:1451):
39:2 wu4A_0039.jpg (922:1103):
draw_Nontransparent {34-1}~ [4]
19:1 wu4A_0019.jpg (899:1381):
39:1 wu4A_0039.jpg (907:1451):
275:1 wu6A__0003.jpg (801:1594):
339:1 wu6A__0067.jpg (897:1351):
draw_SOLO level %3 {78-0}~ [33]
3:1 wu4A_0003.jpg (1027:1701):
19:1 wu4A_0019.jpg (899:1381):
23:1 wu4A_0023.jpg (1001:1247):
39:1 wu4A_0039.jpg (907:1451):
47:1 wu4A_0047.jpg (862:1404):
51:1 wu4A_0051.jpg (976:1174):
55:1 wu4A_0055.jpg (877:1287):
79:1 wu4A_0079.jpg (717:1111):
83:1 wu4A_0083.jpg (956:1818):
91:1 wu4A_0091.jpg (854:1750):
103:1 wu4A_0103.jpg (1161:1450):
107:1 wu4A_0107.jpg (972:1488):
115:1 wu4A_0115.jpg (1012:1409):

123:1 wu4A_0123.jpg (797:1157):
127:1 wu4A_0127.jpg (1103:1526):
131:1 wu4A_0131.jpg (884:1359):
163:1 wu5A__0011.jpg (851:1475):
179:1 wu5A__0027.jpg (930:1370):
207:1 wu5A__0055.jpg (877:1446):
227:1 wu5A__0075.jpg (930:1499):
243:1 wu5A__0091.jpg (778:1340):
255:1 wu5A__0103.jpg (767:1723):
259:1 wu5A__0107.jpg (846:1617):
263:1 wu5A__0111.jpg (789:1771):
275:1 wu6A__0003.jpg (801:1594):
287:1 wu6A__0015.jpg (1063:1476):
303:1 wu6A__0031.jpg (755:1275):
311:1 wu6A__0039.jpg (820:1579):
327:1 wu6A__0055.jpg (862:1738):
335:1 wu6A__0063.jpg (800:1349):
339:1 wu6A__0067.jpg (897:1351):
363:1 wu6A__0091.jpg (837:1386):
411:1 wu6A__0139.jpg (1002:1526):

%_draw Cylinder drawing at level 4 {55-0} [4]

%_draw Cylinder drawing {103-0} [55]

7:1 wu4A_0007.jpg (880:1505):
11:1 wu4A_0011.jpg (884:1671):
27:1 wu4A_0027.jpg (957:1318):
31:1 wu4A_0031.jpg (1026:1329):
43:1 wu4A_0043.jpg (835:1624):
59:1 wu4A_0059.jpg (896:1651):
75:1 wu4A_0075.jpg (941:1507):
87:1 wu4A_0087.jpg (975:1427):
95:1 wu4A_0095.jpg (1237:1613):
99:1 wu4A_0099.jpg (1112:1814):
119:1 wu4A_0119.jpg (862:1237):
135:1 wu4A_0135.jpg (901:1334):
143:1 wu4A_0143.jpg (849:1435):
147:1 wu4A_0147.jpg (814:1076):
155:1 wu5A__0003.jpg (941:1450):
159:1 wu5A__0007.jpg (1097:1457):
167:1 wu5A__0015.jpg (1029:1647):
171:1 wu5A__0019.jpg (816:1750):
175:1 wu5A__0023.jpg (808:1321):
183:1 wu5A__0031.jpg (778:1473):
187:1 wu5A__0035.jpg (891:1214):
191:1 wu5A__0039.jpg (857:1100):
195:1 wu5A__0043.jpg (812:1750):
199:1 wu5A__0047.jpg (877:1492):
203:1 wu5A__0051.jpg (1268:1503):
211:1 wu5A__0059.jpg (774:1594):
215:1 wu5A__0063.jpg (755:1055):
219:1 wu5A__0067.jpg (918:1716):
223:1 wu5A__0071.jpg (820:1306):
231:1 wu5A__0079.jpg (865:1750):
235:1 wu5A__0083.jpg (1036:1590):
239:1 wu5A__0087.jpg (895:1149):
247:1 wu5A__0095.jpg (926:1492):
251:1 wu5A__0099.jpg (854:1184):
271:1 wu5A__0119.jpg (941:1446):
279:1 wu6A__0007.jpg (1067:1476):
283:1 wu6A__0011.jpg (832:1060):
291:1 wu6A__0019.jpg (1092:1366):
295:1 wu6A__0023.jpg (782:1594):
307:1 wu6A__0035.jpg (964:1712):
315:1 wu6A__0043.jpg (869:1352):
319:1 wu6A__0047.jpg (827:1708):
323:1 wu6A__0051.jpg (881:1336):
331:1 wu6A__0059.jpg (816:1674):
343:1 wu6A__0071.jpg (846:1442):
347:1 wu6A__0075.jpg (884:1609):
351:1 wu6A__0079.jpg (860:1446):

355:1 wu6A__0083.jpg (1021:1336):
359:1 wu6A__0087.jpg (892:1465):
367:1 wu6A__0095.jpg (1135:1343):
371:1 wu6A__0099.jpg (843:1366):
383:1 wu6A__0111.jpg (941:1431):
387:1 wu6A__0115.jpg (888:1598):
391:1 wu6A__0119.jpg (862:1461):
399:1 wu6A__0127.jpg (744:1659):
%_draw Ellipse as base (cylinder) {57-0} [109]
7:1 wu4A_0007.jpg (880:1505):
7:2 wu4A_0007.jpg (1273:1462):
11:1 wu4A_0011.jpg (884:1671):
27:1 wu4A_0027.jpg (957:1318):
27:2 wu4A_0027.jpg (972:1092):
31:1 wu4A_0031.jpg (1026:1329):
31:2 wu4A_0031.jpg (1060:1140):
43:1 wu4A_0043.jpg (835:1624):
43:2 wu4A_0043.jpg (865:968):
59:1 wu4A_0059.jpg (896:1651):
59:2 wu4A_0059.jpg (1389:1609):
75:1 wu4A_0075.jpg (941:1507):
75:2 wu4A_0075.jpg (987:1131):
87:1 wu4A_0087.jpg (975:1427):
87:2 wu4A_0087.jpg (1006:1074):
95:1 wu4A_0095.jpg (1237:1613):
95:2 wu4A_0095.jpg (1264:1404):
99:1 wu4A_0099.jpg (1112:1814):
99:2 wu4A_0099.jpg (1636:1791):
119:1 wu4A_0119.jpg (862:1237):
119:2 wu4A_0119.jpg (1082:1203):
135:1 wu4A_0135.jpg (901:1334):
135:2 wu4A_0135.jpg (1141:1244):
143:1 wu4A_0143.jpg (849:1435):
143:2 wu4A_0143.jpg (856:988):
147:1 wu4A_0147.jpg (814:1076):
147:2 wu4A_0147.jpg (845:922):
155:1 wu5A__0003.jpg (941:1450):
155:2 wu5A__0003.jpg (1245:1419):
159:1 wu5A__0007.jpg (1097:1457):
159:2 wu5A__0007.jpg (1131:1423):
167:1 wu5A__0015.jpg (1029:1647):
167:2 wu5A__0015.jpg (1461:1605):
171:1 wu5A__0019.jpg (816:1750):
171:2 wu5A__0019.jpg (820:968):
175:1 wu5A__0023.jpg (808:1321):
175:2 wu5A__0023.jpg (835:972):
183:1 wu5A__0031.jpg (778:1473):
183:2 wu5A__0031.jpg (820:956):
187:1 wu5A__0035.jpg (891:1214):
187:2 wu5A__0035.jpg (1084:1181):
191:1 wu5A__0039.jpg (857:1100):
191:2 wu5A__0039.jpg (1000:1038):
195:1 wu5A__0043.jpg (812:1750):
195:2 wu5A__0043.jpg (858:1104):
199:1 wu5A__0047.jpg (877:1492):
199:2 wu5A__0047.jpg (1298:1404):
203:1 wu5A__0051.jpg (1268:1503):
203:2 wu5A__0051.jpg (1294:1454):
211:1 wu5A__0059.jpg (774:1594):
211:2 wu5A__0059.jpg (801:979):
215:1 wu5A__0063.jpg (755:1055):
215:2 wu5A__0063.jpg (801:900):
219:1 wu5A__0067.jpg (918:1716):
219:2 wu5A__0067.jpg (953:1169):
223:1 wu5A__0071.jpg (820:1306):
223:2 wu5A__0071.jpg (1131:1275):
231:1 wu5A__0079.jpg (865:1750):
231:2 wu5A__0079.jpg (892:1070):
235:1 wu5A__0083.jpg (1036:1590):
235:2 wu5A__0083.jpg (1431:1545):
239:1 wu5A__0087.jpg (895:1149):

239:2 wu5A__0087.jpg (1080:1132):
247:1 wu5A__0095.jpg (926:1492):
247:2 wu5A__0095.jpg (1355:1473):
251:1 wu5A__0099.jpg (854:1184):
251:2 wu5A__0099.jpg (877:972):
271:1 wu5A__0119.jpg (941:1446):
271:2 wu5A__0119.jpg (964:1085):
279:1 wu6A__0007.jpg (1067:1476):
279:2 wu6A__0007.jpg (1347:1454):
283:1 wu6A__0011.jpg (832:1060):
283:2 wu6A__0011.jpg (875:926):
291:1 wu6A__0019.jpg (1092:1366):
291:2 wu6A__0019.jpg (1218:1292):
295:1 wu6A__0023.jpg (782:1594):
295:2 wu6A__0023.jpg (820:1051):
307:1 wu6A__0035.jpg (964:1712):
307:2 wu6A__0035.jpg (975:1173):
315:1 wu6A__0043.jpg (869:1352):
315:2 wu6A__0043.jpg (892:995):
319:1 wu6A__0047.jpg (827:1708):
319:2 wu6A__0047.jpg (1480:1666):
323:1 wu6A__0051.jpg (881:1336):
323:2 wu6A__0051.jpg (1188:1306):
331:1 wu6A__0059.jpg (816:1674):
331:2 wu6A__0059.jpg (839:968):
343:1 wu6A__0071.jpg (846:1442):
343:2 wu6A__0071.jpg (854:960):
347:1 wu6A__0075.jpg (884:1609):
347:2 wu6A__0075.jpg (915:1063):
351:1 wu6A__0079.jpg (860:1446):
351:2 wu6A__0079.jpg (877:1006):
355:1 wu6A__0083.jpg (1021:1336):
355:2 wu6A__0083.jpg (1029:1290):
359:1 wu6A__0087.jpg (892:1465):
359:2 wu6A__0087.jpg (941:1048):
367:1 wu6A__0095.jpg (1135:1343):
367:2 wu6A__0095.jpg (1152:1220):
371:1 wu6A__0099.jpg (843:1366):
371:2 wu6A__0099.jpg (873:960):
383:1 wu6A__0111.jpg (941:1431):
383:2 wu6A__0111.jpg (967:1134):
387:1 wu6A__0115.jpg (888:1598):
387:2 wu6A__0115.jpg (941:1165):
391:1 wu6A__0119.jpg (862:1461):
391:2 wu6A__0119.jpg (896:994):
399:1 wu6A__0127.jpg (744:1659):
399:2 wu6A__0127.jpg (782:1051):
draw_Perfect drawing {7-1} [2]
279:1 wu6A__0007.jpg (1067:1476):
359:1 wu6A__0087.jpg (892:1465):
draw_SOLO level %4 {73-0}~ [55]
7:1 wu4A_0007.jpg (880:1505):
11:1 wu4A_0011.jpg (884:1671):
27:1 wu4A_0027.jpg (957:1318):
31:1 wu4A_0031.jpg (1026:1329):
43:1 wu4A_0043.jpg (835:1624):
59:1 wu4A_0059.jpg (896:1651):
75:1 wu4A_0075.jpg (941:1507):
87:1 wu4A_0087.jpg (975:1427):
95:1 wu4A_0095.jpg (1237:1613):
99:1 wu4A_0099.jpg (1112:1814):
119:1 wu4A_0119.jpg (862:1237):
135:1 wu4A_0135.jpg (901:1334):
143:1 wu4A_0143.jpg (849:1435):
147:1 wu4A_0147.jpg (814:1076):
155:1 wu5A__0003.jpg (941:1450):
159:1 wu5A__0007.jpg (1097:1457):
167:1 wu5A__0015.jpg (1029:1647):
171:1 wu5A__0019.jpg (816:1750):
175:1 wu5A__0023.jpg (808:1321):
183:1 wu5A__0031.jpg (778:1473):

187:1 wu5A__0035.jpg (891:1214):
191:1 wu5A__0039.jpg (857:1100):
195:1 wu5A__0043.jpg (812:1750):
199:1 wu5A__0047.jpg (877:1492):
203:1 wu5A__0051.jpg (1268:1503):
211:1 wu5A__0059.jpg (774:1594):
215:1 wu5A__0063.jpg (755:1055):
219:1 wu5A__0067.jpg (918:1716):
223:1 wu5A__0071.jpg (820:1306):
231:1 wu5A__0079.jpg (865:1750):
235:1 wu5A__0083.jpg (1036:1590):
239:1 wu5A__0087.jpg (895:1149):
247:1 wu5A__0095.jpg (926:1492):
251:1 wu5A__0099.jpg (854:1184):
271:1 wu5A__0119.jpg (941:1446):
279:1 wu6A__0007.jpg (1067:1476):
283:1 wu6A__0011.jpg (832:1060):
291:1 wu6A__0019.jpg (1092:1366):
295:1 wu6A__0023.jpg (782:1594):
307:1 wu6A__0035.jpg (964:1712):
315:1 wu6A__0043.jpg (869:1352):
319:1 wu6A__0047.jpg (827:1708):
323:1 wu6A__0051.jpg (881:1336):
331:1 wu6A__0059.jpg (816:1674):
343:1 wu6A__0071.jpg (846:1442):
347:1 wu6A__0075.jpg (884:1609):
351:1 wu6A__0079.jpg (860:1446):
355:1 wu6A__0083.jpg (1021:1336):
359:1 wu6A__0087.jpg (892:1465):
367:1 wu6A__0095.jpg (1135:1343):
371:1 wu6A__0099.jpg (843:1366):
383:1 wu6A__0111.jpg (941:1431):
387:1 wu6A__0115.jpg (888:1598):
391:1 wu6A__0119.jpg (862:1461):
399:1 wu6A__0127.jpg (744:1659):

Appendix J: IFI-ability about the Four 3D Geometrical Shapes

IFI-ability about cubes

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 05:53:59 PM

Codes (6):
#_des 12 edges (cube) {57-2}~
#_des 6 faces (cube) {121-4}~
#_des 8 vertices (cube) {58-2}~
#_des Box and others (cube) {33-2}~
#_des Prism (cube) {17-1}~
#_des Squares (cube) {103-3}~

IFI-ability about triangular prism

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 05:55:18 PM

Codes (7):
^_des 5 faces (triangular prism) {49-3}~
^_des 6 vertices (triangular prism) {25-3}~
^_des 9 edges (triangular prism) {27-3}~
^_des Chocolate bar (triangular prism) {23-2}
^_des Prism (triangular prism) {44-3}~
^_des Rectangle (triangular prism) {39-2}~
^_des Triangle (triangular prism) {70-3}~

IFI-ability about pyramid

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 05:56:08 PM

Codes (8):
&_des 4 triangles around (pyramid) {16-0}~
&_des 5 faces (pyramid) {16-0}~
&_des 5 vertices (pyramid) {16-0}
&_des 8 edges (pyramid) {18-0}
&_des Egypt (pyramid) {8-0}~
&_des Funnel and others (pyramid) {3-0}~
&_des Roof of clock tower (pyramid) {1-0}
&_des Square base (pyramid) {15-0}

IFI-ability about cylinder

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 05:56:37 PM

Codes (7):

%_des 2 bases (cylinder) {1-0}
%_des 3 faces (cylinder) {1-0}
%_des Circles as bases (cylinder) {17-0}~
%_des Curved surface (cylinder) {1-0}
%_des Cylinder associated with shapes in daily life (cylinder) {16-0}~
%_des Prism (Cylinder) {19-0}~
%_des The shape formed by scrolling a rectangle (cylinder) {1-0}

Appendix K: Difficulties in IFI-ability about the Four 3D Geometrical Shapes

Difficulties in IFI-ability found in all the four shapes

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:12:47 PM

Codes (4):
des_Describing with 2D terms {71-4}~
des_Few information in description {94-4}~
des_Incorrect description (general) {43-3}~
Unable to describe/draw any features {96-4}

Difficulties in IFI-ability about cubes

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:06:00 PM

Codes (6):
#_des Mistaken 3 faces (cube) {2-2}~
#_des Mistaken 4 faces (cube) {4-0}~
#_des Mistaken 5 faces (cube) {1-0}~
#_des Mistaken 6 edges (cube) {3-1}~
#_des Mistaken parallelogram (cube) {3-0}~
#_des Mistaken rectangle (cube) {8-0}~

Difficulties in IFI-ability about triangular prism

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:08:14 PM

Codes (4):
^ Triangular prism as tetrahedron {5-2}~
^_des Mistaken 4 faces (triangular prism) {1-1}~
^_des Mistaken parallelogram (triangular prism) {8-2}~
^_des Mistaken trapezium (triangular prism) {4-1}~

Difficulties in IFI-ability about pyramid

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:08:54 PM

Codes (8):

&_des Mistaken 4 faces (pyramid) {1-0}
&_des Mistaken 4 vertices (pyramid) {1-0}
&_des Mistaken 7 edges (pyramid) {1-0}
&_des Mistaken 9 edges (pyramid) {1-0}
&_des Mistaken as cone (pyramid) {1-0}~
&_des Mistaken as tetrahedron (pyramid) {6-0}
&_des Mistaken square base as parallelogram (pyramid) {2-0}
&_des Mistaken square base as rectangle (pyramid) {1-0}

Difficulties in IFI-ability about cylinder

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:09:40 PM

Codes (4):

%_des Mistaken as 2 edges (cylinder) {3-0}
%_des Mistaken as 4 edges (cylinder) {3-0}
%_des Mistaken as a sphere (cylinder) {2-0}
%_des Mistaken the middle of the shape as rectangle (cylinder) {1-0}

Appendix L: Difficulties in VP-ability about the Four 3D Geometrical Shapes

Difficulties in VP-ability found in all the four shapes

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:14:31 PM

Codes (6):
draw_Hidden lines not in coordination {57-2}~
draw_Incomplete drawing of hidden lines {38-2}~
draw_Nontransparent {110-2}~
draw_Not in perspective view {54-3}~
draw_Perpendicular edges {33-1}~
draw_Some or all seen faces are drawn in a 2D format {44-2}~

Difficulties in VP-ability about pyramid

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:18:19 PM

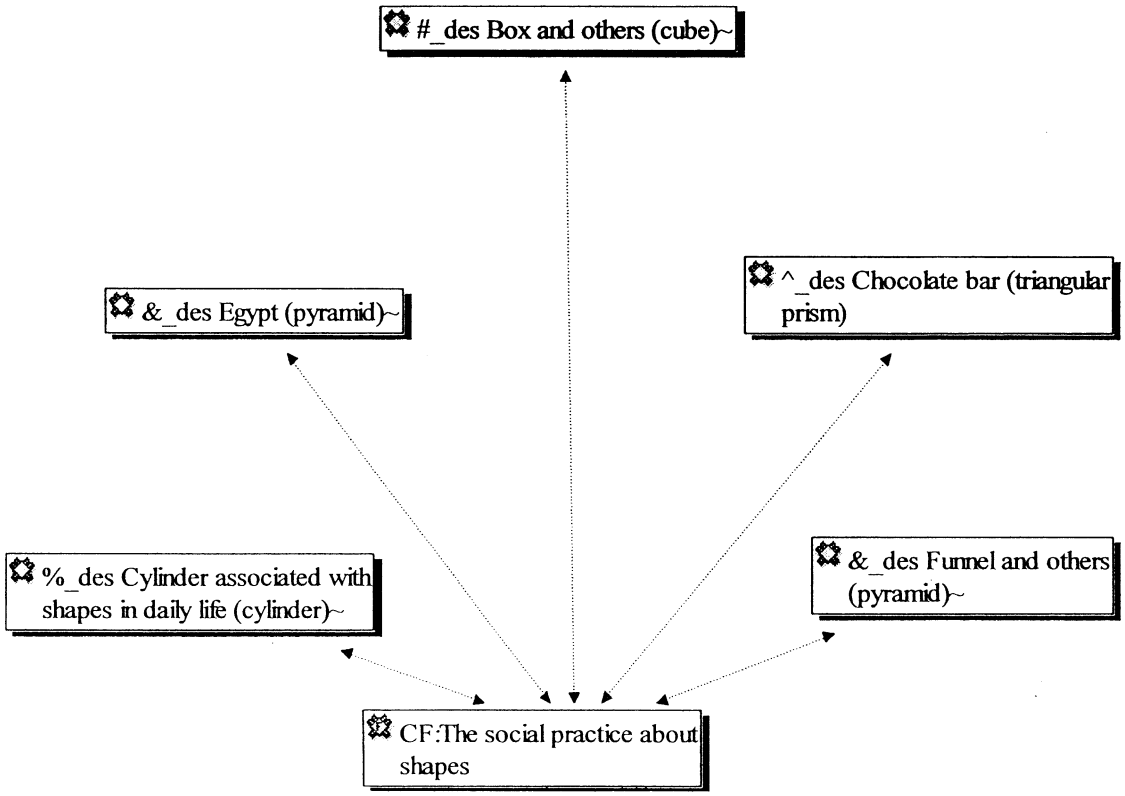
Codes (3):
&_draw Mistaken as cone (pyramid) {4-0}
&_draw Mistaken as tetrahedron (pyramid) {16-0}
&_draw No structure of square base (pyramid) {8-0}

Difficulties in VP-ability about cylinder

HU: merger
File: [J:\study1\datacollection\merger.hpr5]
Edited by: swpun
Date/Time: 30/11/07 06:19:02 PM

Codes (3):
%_draw Circle as base (cylinder) {36-0}
%_draw Four edges (cylinder) {4-0}
%_draw Three edges (cylinder) {1-0}

Appendix M: The Network View of the Social Practice about the Shapes



Appendix N: The Network View of Unaware of the Drawing Conventions of the Shapes

