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ABSTRACT

A study determined if using specific reading strategies would improve students' grades in science. Subjects, 21 fifth-grade students in an urban area school, studied four units of science--two units using the strategies outlined in the series teacher's manual, and two units using semantic mapping, cloze exercises, graphic aids, and vocabulary games. The unit tests from the series were administered after each chapter was completed. Results indicated no significant difference in students' scores on the unit tests. (Contains 19 references and 1 table of data. Two appendixes of data are attached.) (RS)

# CONTENT VOCABULARY, GRAPHIC AIDS, AND COMPREHENSION IN SCIENCE AND RELATED LITERATURE

by

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ABSTRACT

This was a study of twenty-one fifth grade students in an urban area school. They studied four units of Science: two units using the strategies outlined in the series teacher's manual, and two units using semantic mapping, cloze exercises, graphic aids, and vocabulary games. The unit tests from the series were administered after each chapter was completed. The purpose of the study was to determine if using specific reading strategies would improve grades in Science. The hypothesis that no significant difference would be found was supported.

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I would like to thank Professor Richard Walters (Professor in the Communication Sciences Department) for sharing his knowledge, anecdotal stories, and delightful sense of humor related to the study of reading, coping with children, and life in general. I would also like to thank Dr. Albert J. Mazurkiewicz (Chairperson of the Department of Communication Sciences at Kean Colege) for his infinite wisdom related to reading, incredible memory, and assistance in writing this paper.

## DEDICATION

I dedicate this paper to my husband, Charlie, and to my mother, who have given me continual support, and a sympathetic ear for the past five years. I also dedicate it to my children, Michael and Jennifer, who have offered me much advice in studying for tests, and in writing papers.

# CONTENT VOCABULARY, GRAPHIC AIDS, AND COMPREHENSION IN SCIENCE, AND RELATED LITERATURE

Students have difficulty understanding and learning from informational text. This is a finding of the National Assessment of Educational Progress (Applebee, Linger, and Nulls, 1989). Research suggests two reasons why students may have this problem. One, they spend most reading time on narrative material in the elementary school. Most students learn to read from basal readers. And most selections are of the narrative type (Flood and Lapp, 1987). The expository selections found in basal readers are short, are unrelated to other stories in the text, and are about unusual topics of high interest to children. This kind of text organization bears no resemblance to text in the content areas, which is filled with information.

In our present visual society, students spend much time watching T.V., and playing video games. For many elementary students, what they read in their basal readers during school makes up most of their total reading (Anderson, Hiebert, Scott, and Wilkinson, 1985). Most students get little practice in reading informational text, either in or out of school, and the text is not like that in their content area textbook.

A second reason for this problem, is that students depend on the teacher, not the textbook, as

the primary source of information (Goodlad, 1984). The teachers find the students have difficulty reading the material independently. Therefore, when they are used, the textbooks are read in small segments by students reading aloud. This kind of instruction does not foster the development of conceptual understanding and learning from informational text (Durkin, 1978-79). Teachers are concerned with covering content and having children master the facts, rather than teaching and practicing comprehension skills.

Another problem is the type of question most elementary teachers use in their lessons, which are factual or memory type questions (Pearson and Gallagher, 1983). Current cognitive theory (Prawat, 1989) suggests that factual memory type questions are not the type of question that are likely to promote conceptual understanding and meaningful learning.

Because of these factors, students reach middle school unprepared for working fully in the content areas. The teachers assume the students have been taught the necessary strategies to succeed in their subject, and therefore concentrate on their particular area of expertise. The textbooks become more difficult than the basals to which the students are accustomed.

As a result many students are faced with a problem.

Elementary teachers need to begin teaching and modeling the necessary strategies starting from the primary grades. Two important strategies students need to know are vocabulary comprehension and the ability to read and interpret graphic aids because it is believed that students' reading comprehension in science will improve after instruction in content vocabulary and in the use of graphic aids.

## Hypothesis

The use of vocabulary instruction and graphic aids will not affect the students' reading comprehension in science.

## Methods and Procedures

One fifth grade class was selected to participate in this study. The class contained 21 students and was heterogenously grouped. The students in the class had similar characteristics - including age, socio-economic status, and educational experience. They were representative of an inner-city elementary school fifth grade.

The sample was instructed by the same teacher,

utilizing two different strategies for the four units of study. In Units I and III, the instructor utilized suggestions found in the teacher's manual, Gateways to Science (McGraw Hill, 1985). In Units II and IV, the instructor utilized semantic mapping, modified cloze exercises, and graphic aids to emphasize specialized vocabulary.

Upon completion of each unit, the sample was given the unit test, which accompanies the series. The scores of the units tests were compiled, mean decided, and compared, using t tests.

## Definitions

Semantic mapping - a diagram depicting the interrelationships and hierarchies of concepts in a lesson.

Cloze exercise - an important passage from the text in key words are deleted.

Graphic aids - illustrations, diagrams, charts, and tables found in the text.

## Results

Table I shows that there was a standard deviation of 4.45 between the samples.

Table I

Means, Standard Deviations, and t between Samples

| | M | SD | t |
|---|---|---|---|
| Experimental Group | 77.67 | 14.97 | .92 |
| Control Group | 73.21 | 16.49 | |

NS

The results between the samples at the conclusion of this study on the unit tests, were in favor of the experimental sample. The difference, however, was not large enough to produce statistical significance.

## Conclusions and Implications

The hypothesis that there would be no significant difference between the samples, as a result of different strategies of instruction, was supported. There was no significant increase in reading comprehension in science, as measured by the unit tests.

Two reasons for this may be 1) the unit tests from the text Gateways to Science may be unreliable, and 2) since each unit focused on a different topic in science, student interest level may have varied

with each unit.

Since there are positive results of 4.45 in the mean between the experimental group and the control group, perhaps the difference would become more significant, if the study were continued over a longer period of time.

In 1978 Dolores Durkin defined comprehension instruction as "the explicit teaching of how to accomplish a particular comprehension skill". Using this definition she observed almost no comprehension instruction in either reading or social studies or science lessons. In her 1978-79 study "None of the observed teachers saw the science or social studies period as a time to improve children's comprehension abilities. Instead, all were concerned about covering content and with having children master facts." Reading was neglected, and often replaced by filmstrips and other media.

Why do students have difficulty learning from informational text? There are many contributing factors, - including motivational, situational, and cognitive factors. According to cognitive theorist, Linda Meyer, meaningful learning depends on three basic processes: selecting, organizing, and integrating information.

The first process, selecting, involves paying attention to the information in the text, and focusing attention on information that is relevant to the goals or task demands of the learning situation. The second process, organizing, involves arranging the units of

selected information into a coherent mental structure. The third process, integrating, involves connecting the coherently organized information to existing cognitive structures - linking information from the text to information internal to the reader.

According to Mayer, expert or skilled readers are adept at all these basic cognitive processes, but novice, younger, or poorer readers are not. Children in the middle grades - 4 through 9 - often appear to have difficulty with these three processes when attempting to learn from informational text. It is in these grades that informational text becomes a significant element in classroom instruction and learning, in the form of content area textbooks. From about fourth grade on, textbooks play an increasingly important role in learning in the content areas.

Taylor (1980) and McGee (1982) found that as students matured they made greater use of the author's text structure and recalled more idea units than younger students who were given the same task with material on their level.

Their studies suggest that age and reading ability are highly correlated with recall of informational material. If the ability to select and

organize information is related to learning from text, it follows that instruction that fosters selection and organization should enhance such learning, namely, the use of graphic organizers.

According to Herber (1970), "There is a need for a whole new strategy in teaching reading through content areas, a strategy that uses what we know about the direct teaching of reading, but adapts that knowledge to fit the structure of and responsibilities for the total curriculum in each content area".

Michael McKenna (1990) defined content literacy as the ability to use reading and writing for the acquisition of new content in a given discipline. Such ability included three principal cognitive components: general literacy skills, content-specific literacy skills, such as map reading in social studies, and prior knowledge of content. Content literacy represents skills needed to acquire knowledge of content.

According to McKenna, reading and writing are complementary tasks in content literacy. Content area teachers may use these tasks to enhance student comprehension of their particular subject. However, these teachers are not responsible for teaching the mechanics of reading and writing. They need to focus

on the meaning, the mechanics of the process. This should not take time away from instruction of content. Rather, the use of reading and writing should enhance the teachers' lectures, because the potential of these processes for improving content acquisition is increased by the knowledge-building effects of day-to-day instruction.

Content alone can be learned from direct teaching by the instructor. However, students who have been given the opportunities to become content literate will be better able to use this skill as a means of extending their knowledge of a discipline, even after they have completed a given subject or course.

In 1991 Armbruster, Anderson, Armstrong, Wise, Janisch, and Meyer did a study to investigate how and when content area textbooks are used, and what kinds of questions are being asked by teachers. The subjects were 9 fourth grade teachers from two Illinois school districts, with a diverse population.

Their findings were: first, when textbooks were used during instruction, students did not do very much reading, and the reading they did was round-robin oral reading. Second, the teachers asked a large number of questions, but very few came from the textbook. The

teachers made up about 90% of their own questions. Of the type of questions asked by teachers, most were text implicit, requiring answers found in a single sentence. Only about 10% of teacher questions were text explicit, requiring students to make inferences from the text.

These researchers concluded that teachers need to teach students how to read informational text from the earlier grades. They need to encourage students to read a great deal of informational text. Finally, teachers need to ask questions that promote conceptual understanding and meaningful learning.

In 1991 Mary Olson researched the reasons for young children's difficulties with expository text. She found the following factors : students may possess limited background knowledge. Texts written to inform rather than to entertain may lower motivation to read for some children. Unfamiliar text organizational structures are difficult to follow. Writing that lacks logical connectives and transition words requires increased cognitive effort. Also, an inability to recognize many words in print hinders comprehension for young readers. Olson concluded that children need much guidance and many experiences reading expository text in order to deal successfully with content books.

Olson surveyed 47 primary grade teachers to find out what strategies they found to be most effective for working in the content areas with primary students. These teachers found the following strategies to be most effective: semantic mapping, K-W-L, manipulatives, and paragraph frames. Semantic mapping encourages vocabulary and concept development by graphically displaying words in categories, and showing how they are related to one another. The active participation of the children and the discussion are critical components of this strategy. The discussion and questions the teacher asks as the map is completed are the heart of the strategy.

K-W-L includes opportunities for children to brainstorm, and to preview vocabulary and concepts. The teacher needs to model the procedures children should use when reading content texts.

Using manipulatives provides for vocabulary and concept development, and enhances visualizations. They are more effective when they precede textbook reading.

Use of expository frames helps in review and reinforcement of specific content. It also familiarizes students with the different ways in which authors organize material.

Gertrude Hildreth (1958) writes,"The middle-grade pupil can expect to meet new words he has never seen before in the proportion of about 1 in 10, even in material prepared for his age group, and a still larger proportion of strange words in difficult texts."

Arthur Heilman (1961) states that in the primary grades, teachers are alerted to these strange words - abstract words, idiomatic expressions, and new connotations for words met earlier - in the teaching manuals accompanying the basal reader series used. With the shift to separate textbooks in the content areas, there tends to be less emphasis on helping pupils with meaning difficulties, where help is most needed.

Heilman gives examples of difficult concepts from fourth and fifth grade science books. He states, "Teachers found that many students did not understand these concepts, even after the material had been assigned and covered in class."

1. Blood is carried through other branching tubes called veins.
2. When you are frightened, your pupils get bigger.
3. You bite and chew your food with the crowns of your teeth.

Heilman recommends using the unit approach to teaching science. "In the primary and intermediate grades the experience approach will give students a

shared, common experience, upon which the teacher may build a better understanding of the subject matter, and new specialized vocabulary. In the intermediate grades, wide reading is recommended. However, the teacher needs to employ direct teaching to students of specialized vocabulary."

Richardson and Morgan (1990) emphasize that vocabulary knowledge is the key to understanding concepts in all content classes. They feel vocal instruction should be provided in a systematic manner prior to reading, during reading, and after reading. They state, " Each content field has unique terms and specialized vocabulary, whose meanings lead the reader to the core of conceptual understanding of the text."

For students who are functioning on a thinking level of three to seven year olds, teachers need to present concepts in a very concrete manner through direct and purposeful experiences. When hands on experiences are not possible, students need activities of observation, such as field trips, demonstrations, graphics, or visuals.

Morgan and Richardson recommend the following four strategies to solidify the relationship between

what the student already knows and what the teacher or text is presenting: structured overview, modified cloze exercises, semantic mapping, and network diagrams.

Constance Weaver (1988) believes a graphic organizer can be utilized as a scheme for visualizing the information in the text. It provides a view of the whole, and the relationship of the elements within the whole. Different kinds can be used for different content areas: time lines in history, diagrams in science, and charts and graphs as they are appropriate. Vaughan (1982) states, "The strategies that demonstrate their success in empirical studies are those that involve interaction between teachers and students, and those that are modeled and monitored regularly over a substantial period of time."

In 1990 Medo and Ryder researched 31 matched pairs of eighth grade students attending a middle school in a midwestern city, to investigate the effects of teaching text specific vocabulary on eighth graders comprehension of expository text, and their ability to make causal connections.

On the first day the treatment group was given instruction in text specific vocabulary. On the second

day, this group reviewed words, and made semantic maps. The control group received no special instruction. On the third day, both groups were given sample passages to read.

The researchers found that the students receiving vocabulary instruction scored significantly higher than the control group. They concluded that vocabulary instruction prior to reading increases students' ability to understand expository text.

Mancy Pruit (1990) conducted a study with two fourth grade classes in a middle class suburban community. One group was taught a social studies chapter, by reading the chapter and having a class discussion. The second group read the same chapter, but completed teacher-made graphic organizers. The g aphic organizer was modeled to the students by the teacher. Both groups were given the chapter test from the textbook.

Pruit found that the group using graphic organizers scored significantly higher than the group who read and discussed the chapter. She concluded that the use of graphic organizers increases students' ability to understand expository text.

Emerald Dechant (1964) also feels that reading

is not a generalized ability that a student learns once, and is able to transfer from one situation to another. Rather, "Reading is a composite of many skills,each varying with the situation". For example, the vocabulary is usually specific to the area in which one is reading. Early in the elementary years, pupils are required to deal with a technical vocabulary. Common words take on a specialized meaning. The student may be able to pronounce the word, but may miss the meaning, and therefore, have no comprehension of what he/she is reading. Dechant states," It is not what to teach, but how to teach the skills that cause difficulty. One of the primary tasks of the elementary school is that of teaching the student how to learn."

Boothby and Alverman (1984) trained fourth grade students to help them remember what they read in social studies textbooks. Students who were taught to use instructional graphics to extract main-idea information from their regular social studies textbooks, recalled a greater number of idea units from a target passage, both immediately and after a 48 hour delay, than did a control group.

This study indicates instructional graphics can help middle-grade students learn from reading

informational text. The effectiveness of the instructional graphics is due to their role in helping students select and organize information in text.

Harlan Shores (1943) conducted a study to determine the relationship between reading and study skills, and reading comprehension with scientific material; to explore the relationship between a vocabulary of words frequently found in scientific materials and reading comprehension in science; and to determine the area of the population responsible for these relationships.

He tested the entire first term ninth-grade population of a junior high school in the mid-west. A total of 380 complete cases resulted. This group included students of a wide range of intelligence, socio-economic status, reading ability, and achievement.

Shores concluded that those students with average or superior mental age and ability to read literature had enough of the skill and specialized vocabulary necessary for effective reading of science. However, those students with average or below average reading ability would benefit from direct instruction by content area teachers in the specific skills and

vocabulary, needed for effective comprehension in science.

Shores stated that the ninth grade teacher of science is well acquainted with the materials and requirements of specific skills and vocabulary. It stands to reason that this individual needs to teach these students the essential skills, and to give them many opportunities to practice them during science class.

Sarah Guri-Rozenblit (1991) examined the effect of a tree diagram on college students' comprehension of main ideas in a social science expository text. 160 undergraduates participated in this study. The text appeared in four versions, with or without a tree diagram, and with or without verbal explanation.

Overall, subjects who received the tree diagram performed significantly better on comprehension of main idea and on recall of the relations between various elements in the text. The students who received both the tree diagram plus an accompanying explanation performed better than the other three groups.

Armbruster, Anderson, and Ostertag (1987) conducted a study in which fifth grade students were taught a problem/solution main idea text structure

using

instructional graphics. The teacher instructed the students to recognize the problem/solution structure in their social studies textbook, to record notes on a graphic representation of the structure - semantic mapping -, and then to write a summary from the graphic.

The students were given a main idea essay question and written summaries of two passages to complete. The students' ability to complete these tasks independently was improved by the graphics-based training.

Taylor, Olson, Prenn, Rybczynski, and Zakaluk (1985) conducted a study to determine if students who are taught to find the main idea of a paragraph through practicing reading skill sheets, found in basal readers, would be able to transfer this skill when reading for main idea in their content textbooks.

The 85 fifth grade students of average ability attended a suburban elementary school. They were asked to read eight paragraphs on the basal worksheets and to select the main idea for each paragraph from among four choices. Next, the students were asked to read a three page excerpt from their social studies textbook, and

again to find the main idea for each paragraph from among four choices.

The students mean score on the basal worksheets was 81% correct. Their mean score on questions concerning their social studies textbook was 45% correct. These means suggest that students were having difficulty understanding the main idea of the social studies material. It was concluded that students need to be taught specific strategies and need direct instruction when reading for main idea in content textbooks.

Armbruster, Anderson, and Meyer (1991) conducted a study to provide a valid test of the effectiveness of using a particular type of instructional graphic, a frame,on fourth and fifth grade students' ability to learn from reading their social studies textbooks. A frame is a visual representation of the organization of important ideas in a text.

Six fourth and six fifth grade teachers taught social studies using either frames or ideas found in the teachers' edition of the texts. The treatment was repeated in four rounds during the school year.Each teacher and each student participated in both conditions in each round.

The results obtained from the fourth grade students were inconclusive. One reason researchers give for this is the art of completing a frame requires higher abstract thinking, which fourth graders may have difficulty doing, because of their lack of maturity. However, the combined analysis of recall and recognition suggested that for fifth grade students, framing was a more effective instructional technique than that found in the teachers edition.

Researchers wanted to see whether the use of a specific instructional intervention by real teachers in real classrooms, using real textbooks, over a substantial period of time could improve learning.

A reading strategy is an action or series of actions that is employed to construct meaning. When readers encounter obstacles to their comprehension, they need to utilize strategies to overcome their difficulties. Sharon Klitzen (1991) did a study of 48 U.S. high school students of average ability, half were good comprehenders, and half were poor comprehenders. The students were asked to read three expository passages of increasing difficulty. The good readers read the original passages; the poor comprehenders read revised versions, so the passages would be of the same

relative difficulty.

In each passage students were asked to fill blanks left randomly deleted. The subjects were asked to explain their reasoning process for these cloze responses. All subjects reported depending heavily on using key vocabulary, rereading, making inferences, and using previous experience in constructing responses for all three passages.

When compared directly, the two groups used the same type and number of strategies on the easy passage. But as the passage difficulty increased, good comprehenders used more types of strategies and used them more frequently than the poor comprehenders did.

Klitzien feels that further research needs to address developmental issues, such as at what point in their reading development, students begin to use particular strategies, and whether the strategy use is the same for all students at the same level.

For greater effectiveness, Klitzien feels that strategies need to be taught in the context of real reading selections, and students need to be given control over the strategies , so they can use them independently when needed.

According to Cindy Gillespie (1993) the ability

to read and interpret graphic displays is important in all content areas. Graphic literacy is defined as the ability to interpret charts, maps, graphs, and other pictorial presentations used to supplement the prose in textbooks, nonfiction tradebooks, and newspapers.

Researchers conclude that maps, charts/tables, and graphs are the dominant types of graphic displays in content area textbooks (Fry 1981). Graphic aids have a variety of functions in content area books. Some provide information not discussed in the text. Other reinforce the text by repeating key information.

The attributes of graphic displays make it easier for people to understand and learn information. Students can scan the display rapidly to discover patterns that are meaningful. In addition, graphic displays allow students to use alternative systems of logic; they make relationships among concepts explicit and meaningful; they emphasize pattern recognition, geometric shape recognition, and right brain processing.

The National Assessment of Educational Progress reports suggest that U.S. students need training in reading graphic displays. Of the 17 year old students tested between 1971-1984, only 4% had mastered reading

graphic forms at the advanced level of proficiency. A similar study of young adults, whose ages ranged 21-25, indicated that 57% were successful at the adept level. However, at the advanced level, only 21% performed adequately.

The researchers suggested two reasons for students experiencing difficulties in reading graphic displays. 1. The displays themselves present a problem, and 2. Teachers and students are not as familiar with reading graphic displays as they should be.

The implications for teachers are these: when graphic displays appear in the textbook, teachers need to draw students' attention to these displays, and teachers must provide instruction in how to read and interpret graphic aids.

It is important to teach students to read graphic displays, but also to provide them with relevant content, so they may apply what has been learned to meaningful reading situations. Reinking (1986) discusses the need for instructional activities to help students make connections among the text, the graphic displays, and the reader's prior knowledge. Graphic displays, if used effectively and interpreted correctly, can significantly improve comprehension,

retention, and enjoyment of the material.

Kenneth Purnell and Robert Solman (1991) conducted five experiments to examine the use of illustrations in the comprehension of technical material by Australian high school students of good to very good reading ability. In Experiment I, the same basic geographical text was read by three groups of 25 students each,additional related content was presented as an illustration, as text, or as both text and illustration. The group that received the additional content as both text and illustration, outperformed the other two groups on that content.

These results were examined further in four more experiments involving 204 students. The results suggest that technical content that lends itself to presentation as an illustration will be comprehended better as an illustration than as text, and will be comprehended best if presented in both forms. These results have important implications for the design of textbooks and other presentations of technical material. Authors need to take as much care in the drawing of illustrations as they take in the writing of text. Teachers need to show students the importance of using this strategy in comprehending material found in

expository text.

Research clearly shows that students' comprehension and retention of expository material increases when they use specific strategies before, during and after reading. These strategies need to be introduced in the primary grades, in a simplified manner. The students need to be told the purpose of the strategy, while the teacher models it over and over again. The students need to practice the particular strategies many different times while reading expository material. Hence, the students need to read their content area text. It may be supplemented by other activities. However, in order for students to become proficient in their comprehension of this type of material, they must read these texts consistently. These strategies need to be reintroduced on a higher level in the middle grades and high school. Students need a wide variety of strategies from which to choose if they encounter a problem while reading expository text. They may then choose the one which will help solve their immediate reading problem on an independent level.

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# APPENDICES

## Appendix A

# Scores of Control Group

| Student # | Unit I | Unit III | Average Score |
|---|---|---|---|
| I | 88 | 86 | 87 |
| II | 61 | 62 | 61.5 |
| III | 60 | 60 | 60 |
| IV | 85 | 58 | 71.5 |
| V | 63 | 61 | 62 |
| VI | 76 | 60 | 68 |
| VII | 75 | 54 | 64.5 |
| VIII | 82 | 80 | 81 |
| IX | 75 | 85 | 80 |
| X | 69 | 70 | 69.5 |
| XI | 65 | 69 | 67 |
| XII | 89 | 90 | 89.5 |
| XIII | 97 | 95 | 96 |
| XIV | 21 | 49 | 35 |
| XV | 42 | 48 | 45 |
| XVI | 72 | 57 | 64.5 |
| XVII | 100 | 100 | 100 |
| XVIII | 70 | 74 | 72 |
| XIX | 94 | 95 | 94.5 |
| XX | 94 | 72 | 83 |
| XXI | 97 | 75 | 86 |

## Appendix B

# Scores of Experimental Group

| Student # | Unit II | Unit IV | Average Score |
|---|---|---|---|
| I | 90 | 95 | 92.5 |
| II | 83 | 82 | 81.5 |
| III | 60 | 60 | 60 |
| IV | 58 | 75 | 66.5 |
| V | 61 | 62 | 61.5 |
| VI | 58 | 76 | 67 |
| VII | 52 | 76 | 64 |
| VIII | 90 | 91 | 90.5 |
| IX | 90 | 95 | 92.5 |
| X | 75 | 77 | 76 |
| XI | 83 | 82 | 81.5 |
| XII | 92 | 94 | 93 |
| XIII | 98 | 98 | 98 |
| XIV | 50 | 63 | 56.5 |
| XV | 50 | 61 | 55.5 |
| XVI | 52 | 76 | 64 |
| XVII | 100 | 100 | 100 |
| XVIII | 70 | 75 | 72.5 |
| XIX | 100 | 100 | 100 |
| XX | 67 | 84 | 75.5 |
| XXI | 67 | 96 | 81.5 |