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ABSTRACT

Texas State Technical College in Waco (TSTCW) entered into a partnership with ServiceMaster, one of the largest maintenance companies in the world, to develop a contextual-based videodisc curriculum for facility maintenance workers intended to increase math literacy. TSTCW developed a task analysis, a curriculum, and evaluation measures for the training of facilities maintenance workers in math concepts, from which a workbook and scripting activities for the videodisc were developed. Thirty physical plant employees volunteered for the training, and were divided into three skill levels determined by an assessment test: Level 1, grades zero through four; Level 2, grades five through eight; and Level 3, grades nine and above. After establishing a pretest score, each participant received training from the videodisc, as well as reinforcement exercises from the workbook assignments. The average program completion time was 60 hours, while Level 3 participants completed the training much more quickly than the Level 1 group, . Pretest and posttest scores indicated that most participants' scores increased following program completion, with Levels 1 and 2 showing the most significant changes. The Level 1 group averaged a 27-point increase in number operations and an 18-point increase in problem solving, while the Level 2 group averaged a 28-point increase in number operations and a 5-point increase in problem solving. No significant performance differences were found based on gender or age. A review of the literature, a selected bibliography, extensive demographic information and detailed data tables are included. (MAB)

Improving Math Literacy for the Facilities Maintenance Industry:

A Multimedia Approach

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Improving Math Literacy for the Facilities Maintenance Industry:

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Introduction

As shown in a variety of publications to include the Hudson Institute's Workplace 2000 and the SCANS Report, the United States faces a crisis in the workplace, and one industry needing workers with basic literacy skills is the facilities maintenance business sector. Toxic chemicals, safety reports, and computerization issues all add to a facilities maintenance workplace that is rapidly changing and necessitates a skilled workforce to accommodate that change. Chemicals mixed in the wrong formula, measurements not correctly read, and geometric shape miscalculation contribute to lower productivity and increased service cost. With these problems noted, ServiceMaster, one of the largest facility maintenance companies in the world, partnered with Texas State Technical College Waco to develop a contextual-based videodisc curriculum for facility maintenance workers intended to increase math literacy skills.

Texas State Technical College Waco had been pioneering several applied curriculum delivery methods through the Center for Applied Learning and developing technology-enhanced curriculum and training through the IDEAS Center. Research and application found that a comprehensive interactive delivery system with the appropriate peripherals could provide the delivery strategy necessary to increase literacy scores for the facilities maintenance scores. The questions, then, to resolve in this study were: (a) Would a contextual multimedia training program increase math literacy levels for facilities maintenance personnel who most need help; and (b), would there be any differences

regarding age and gender. The appropriate parties completed the partnership agreements, and the program began in April, 1991.

Review of the Literature

Instructional Technology. Interactive multimedia has consistently shown to be a very diverse instructional technology medium (Bosco, 1986). When appropriately designed and implemented, test results have shown to be positive in comparison to traditional delivery systems when adults are the target audience (Hannafin & Colamaio, 1987; Hannafin & Phillips, 1987; and Ziegler, 1990).

Adult Literacy. Adult literacy programs have, in general, been delivered in traditional formats (Campbell & Sechler, 1987). Many studies (Long, 1980; Lotto, 1983) have shown successful results in delivering contextual literacy training, yet, traditional methodologies have remained the delivery focus. According to Campbell and Sechler (1987), recommendations for research include:

1. Conduct systematic research of the basic skills as they apply to occupational of adult basic education.

2. Identify and assess alternative delivery practices for adult basic literacy.

This research agenda hints at two questions concerning all education: (a) what to teach and (b) how to teach it. This study, then, set forth to determine if interactive multimedia (how to teach) could produce positive results in literacy programs (what to teach) and answer the questions set forth by the research agenda of Campbell and Sechler (1987).

Methodology

Product Development. Staff from Texas State Technical College Waco developed a task analysis, curriculum, and evaluation measures for the training of facilities maintenance workers in math concepts. From this, the appropriate instructional design, workbook activities, and scripting activities for the videodisc were developed. Synergistic Educational Technology Systems served as the production group for both the videodisc and software. Shot on location with Texas State Technical College Waco physical plant employees as actors, development time took four months for a usable training product.

Audience. As shown in Figures 1, 2, and 3, the total population reflected a diverse ethnic population in a variety of age categories with a variety of levels of education. The sample mirrored that population (Figures 4, 5, and 6). Using the SelectABLE as an assessment tool, the results suggested three distinct groups: (a) 0 - 4th grade level; (b) 5th to 8th grade level; and (c), 9th and above. Thirty physical plant employees volunteered for training and participated based on their level as determined by the assessment.

Implementation. Each group was further assessed using the ABLE test to establish a pretest score. From here, each participant received training from the videodisc. As this was an individualized program, each participant worked in a prescribed lesson plan six hours per week as dictated by the videodisc's pretest. Upon completion of each videodisc unit, the participants undertook accompanying workbook exercises for additional practice. Level 3 participants completed the training much more quickly than the Level 1 group as they originally could master more of the math competencies. Average completion time of the program was 60 hours. The ABLE test was administered to determine posttest scores.

Variables. For this study, posttest scores (number operations and problem solving) on the ABLE test were used as the dependent variables. Independent variables were age and gender. The pretest served as the covariate.

Data Analysis

Determination of Effectiveness. Looking over the posttest scores (Figures 7, 8, and 9), one can see that program did bring many of the participants up in regards to mastery level in their assigned level. Further investigation into Levels 1 and 2 indicate these groups had the highest level of increase. Level 1 averaged a twenty-seven point increase in number operations and an eighteen point increase in problem solving. The Level 2 group averaged a twenty-eight point increase in number operations and a five point increase in problem solving. Therefore, using interactive video as a delivery medium with the appropriate contextual instructional design does assist in increasing math literacy levels.

Gender and Age Differences. To determine if any gender or age differences existed, two 3 x 2 ANCOVAs were used with age and gender as the independent variables while the pretest served as covariate. Looking at number operations (Table 1), there were no significant differences between the groups, $F(1, 30) = .291$, $p < .05$. Using the same ANCOVA structure with problem solving as the dependent variable (Table 2), there was once again no significant differences among the groups, $F(1, 30) = .678$, $p < .05$. No significant differences were found in either case. The videodisc performed the same for each participant regardless of age or gender.

Table 1

ANCOVA Summary Table for Hypotheses using Number Operations as the Dependent Variable.

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
		Covariates			
PRETEST	235.674	1	235.674	2.468	.130
	235.674	1	235.674	2.468	.130
		Main Effects			
Main Effects	83.246	3	27.749	.291	.832
AGE	81.059	2	40.529	.424	.659
SEX	4.814	1	4.814	.050	.824
		Two-Way Interactions			
2-Way Interactions	238.884	2	119.442	1.251	.305
AGE X SEX	238.884	2	119.442	1.251	.305

Note. *p<.05.

Table 2

ANCOVA Summary Table for Hypotheses using Problem Solving as the Dependent Variable.

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
		Covariates			
Pretest	5165.807	1	5165.807	26.307	
.000					
	5165.807	1	5165.807	26.307	
.000					
		Main Effects			
Main Effects	399.297	3	133.099	.678	.575
AGE	322.931	2	161.465	.822	.452
SEX	39.158	1	39.158	.199	.659
		Two-Way Interactions			
2-Way Interactions	251.267	2	125.634	.640	.537
AGE x SEX	251.267	2	125.634	.640	.537

Note. *$p < .05$.

Further testing. TSTC Waco and Ivy Tech cooperated on another pilot project to determine the effectiveness of the videodisc using just the videodisc pre and post tests as the evaluation instrument. This showed the reliability of the test to be .66 using the Spearman-Brown prophecy formula, and the Kuder-Richardson 20 method determined Coefficent alpha to be .71. As reflected in the posttest scores($M = 82.5$, $SD = 4.6$, $n = 27$) the average gain was 4.4 points. Those students who scored below 70 on the pretest above the 80 level on the posttest score. This indicated that the videodisc met its goal of achieving 80% mastery upon completion. Once again, student evaluation of the videodisc showed it to be helpful, energetic, and useful instruction for the workplace.

Discussion

Conclusions. The results of the study showed that a contextual videodisc-based instructional delivery system yields positive results in adult literacy programs. Both Levels 1 and 2 improved their scores in number operations and problem solving. While scores increased, the training did not have any bias towards age and gender in regards to number operations ($F(1, 30) = .291$, $p < .05$) and problem solving scores ($F(1, 30) = .678$, $p < .05$).

Implications and Recommendations. This study has direct implications for workplace literacy programs. Using the technology to deliver the literacy training allows workers to complete training regardless of the presence of an instructor. This means that training can take place twenty-four hours a day, and the trainer can spend more time developing curriculum as well as materials. Using the technology also enhances the opportunities for contextual-based learning versus the traditional system. This allows learners to become more involved with the learning as it reflects their everyday occupation

rather with some distant environment with which they could not relate. This ownership of learning is possibly seen in the increase in posttest scores by Levels 1 and 2.

In regards to recommendations, further study needs to be done in the use of technology in a variety of workplace literacy programs. Literacy issues may be a result of changing learning styles rather than disabled or slow learners. Testing technology in a variety of settings will help validate this process. One must remember, however, that it is the instructional design, not the hardware/software that dictates the success of the program. Secondly, continual testing of literacy programs using technology would enable more people to experience the changes in the workplace. This could drive increased academic as well as technical literacy as the United States tries to upgrade the skill of its workforce.
In a global market with international implications for all business and industry, the United States must encourage efforts to increase literacy skills in order to achieve a dominant role in the world economy.

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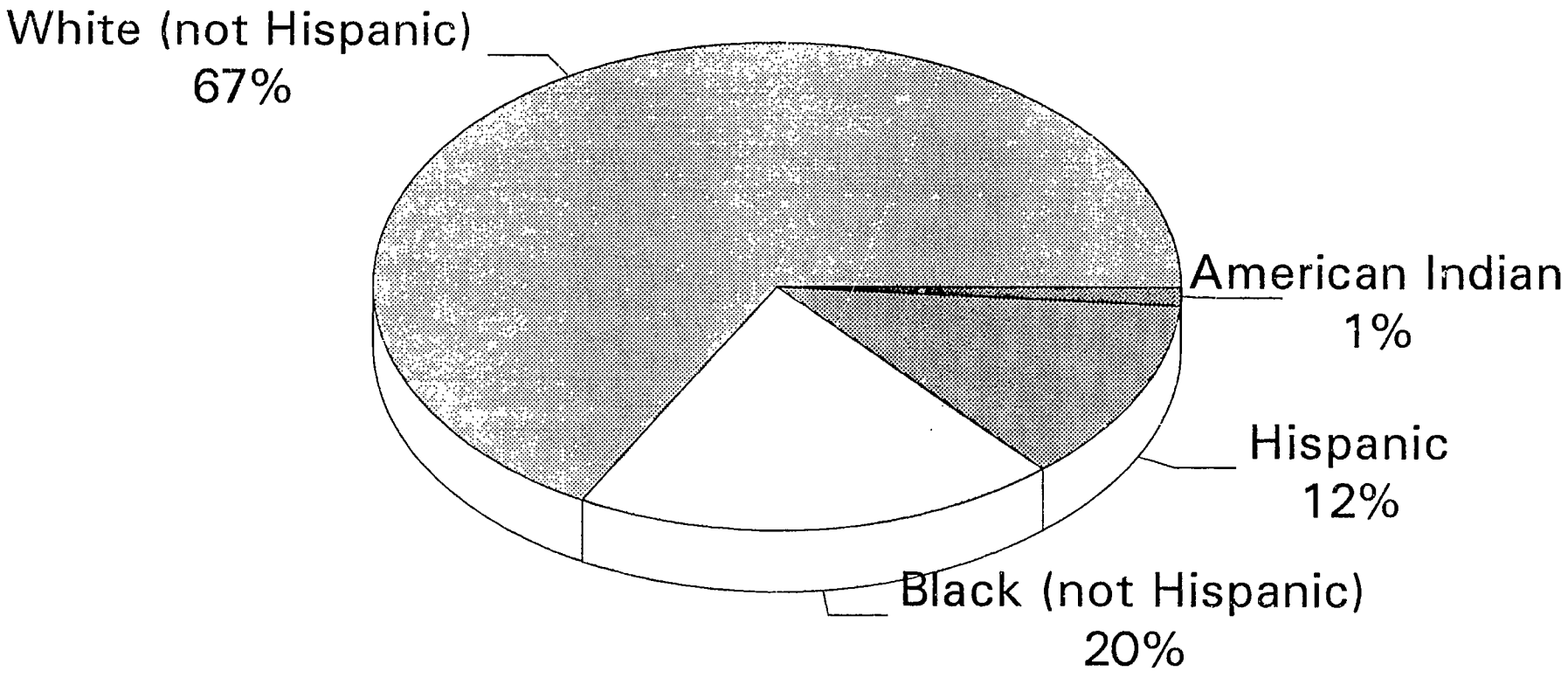
Fig. 1 Facilities Maintenance Demographic Survey

Total Facilities Maintenance Population TSTC Waco

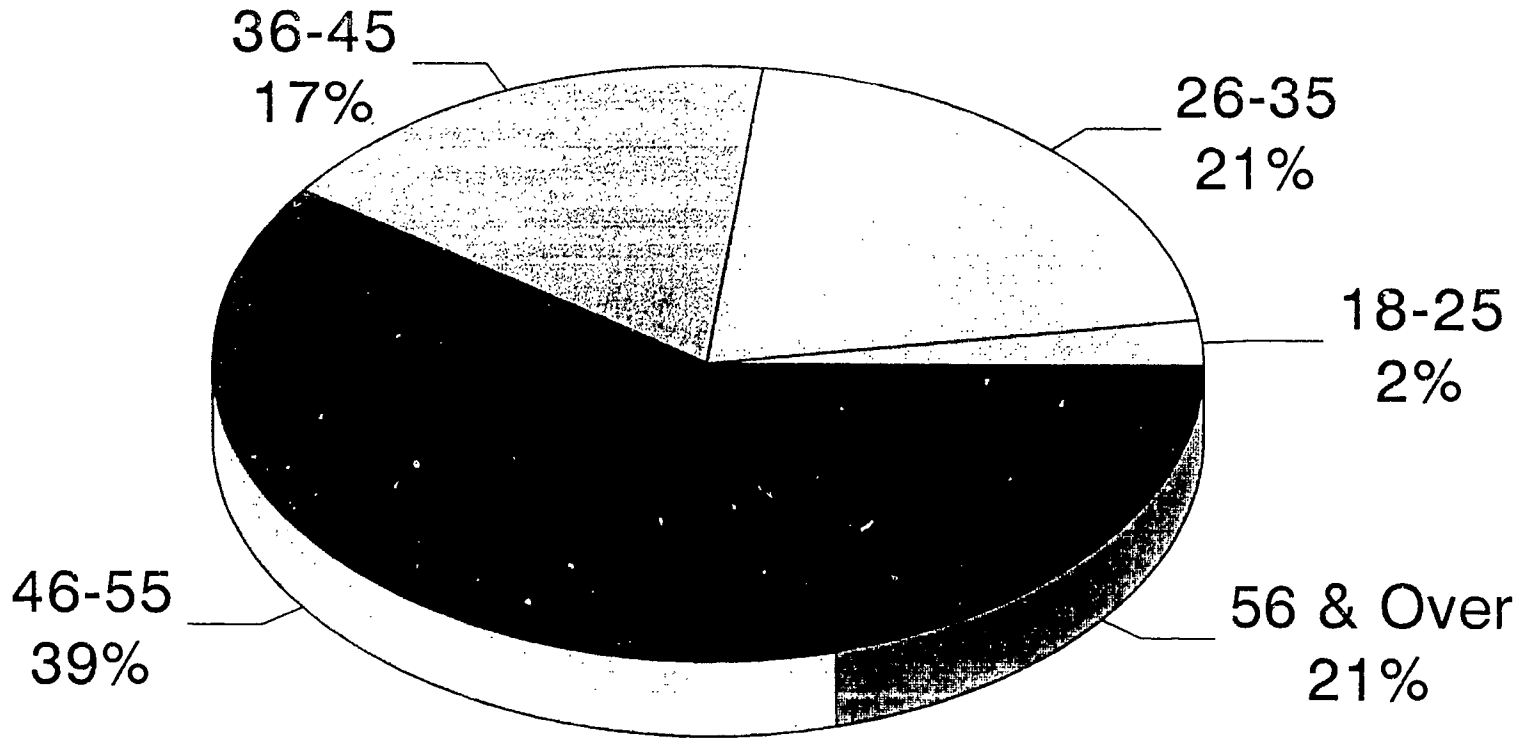


Race/Ethnic Status

N = 82

Fig. 2 Facilities Maintenance Demographic Survey

Total Facilities Maintenance Population TSTC Waco

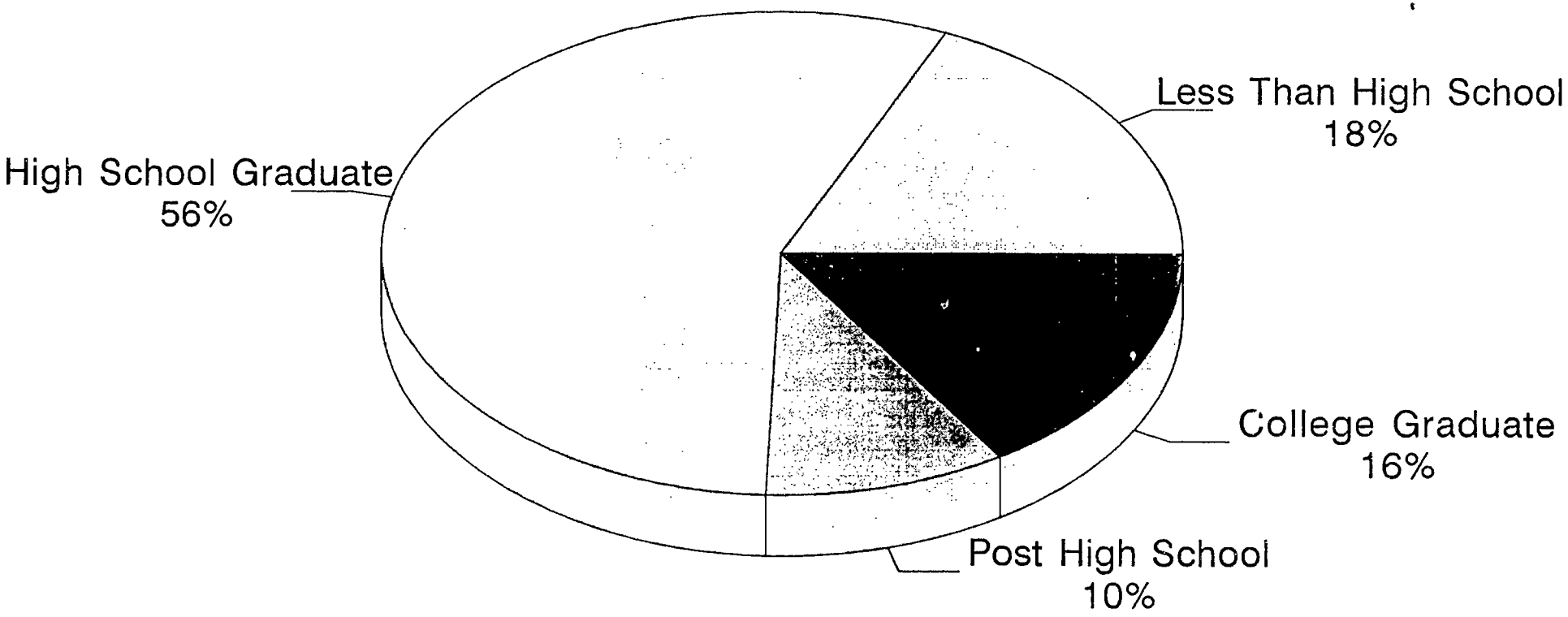


Age

N = 82

Fig. 3 Facilities Maintenance Demographic Survey

Total Facilities Maintenance Population TSTC Waco

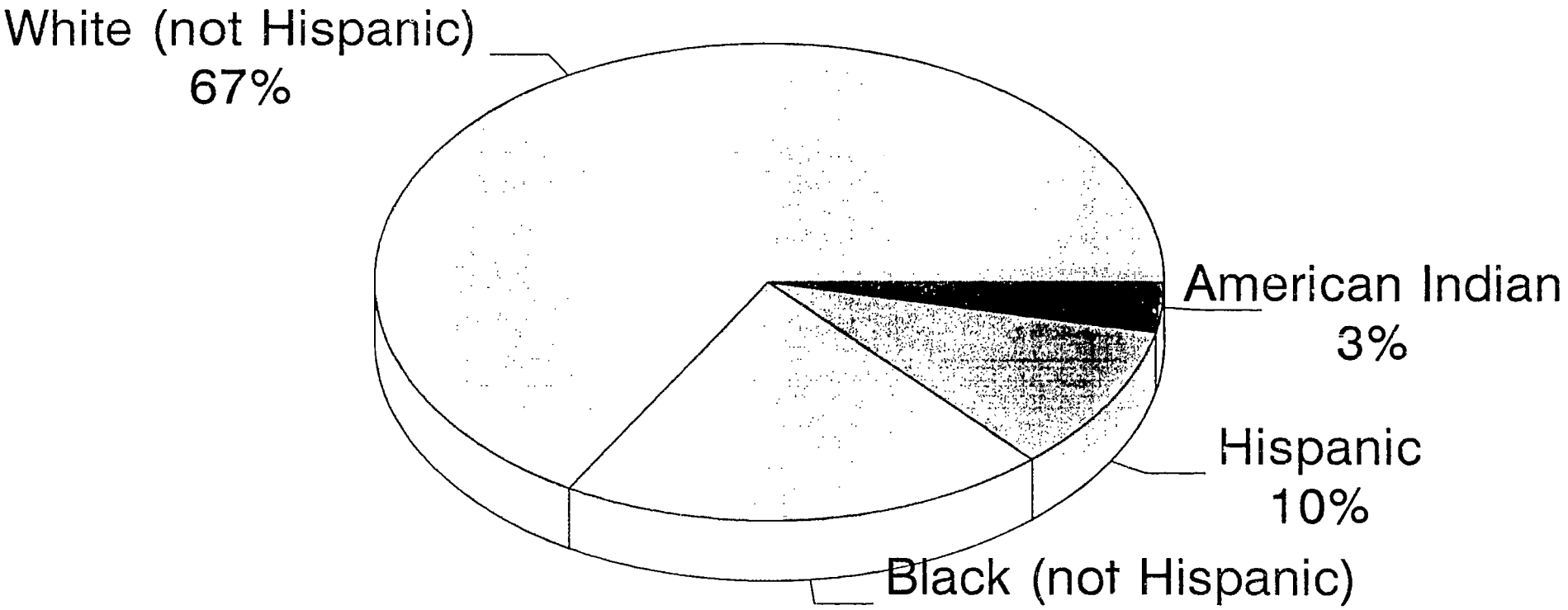


Completed Educational Status

N = 82

Fig. 4 West Student Demographic Survey

Facilities Maintenance Student Population TSTC Waco

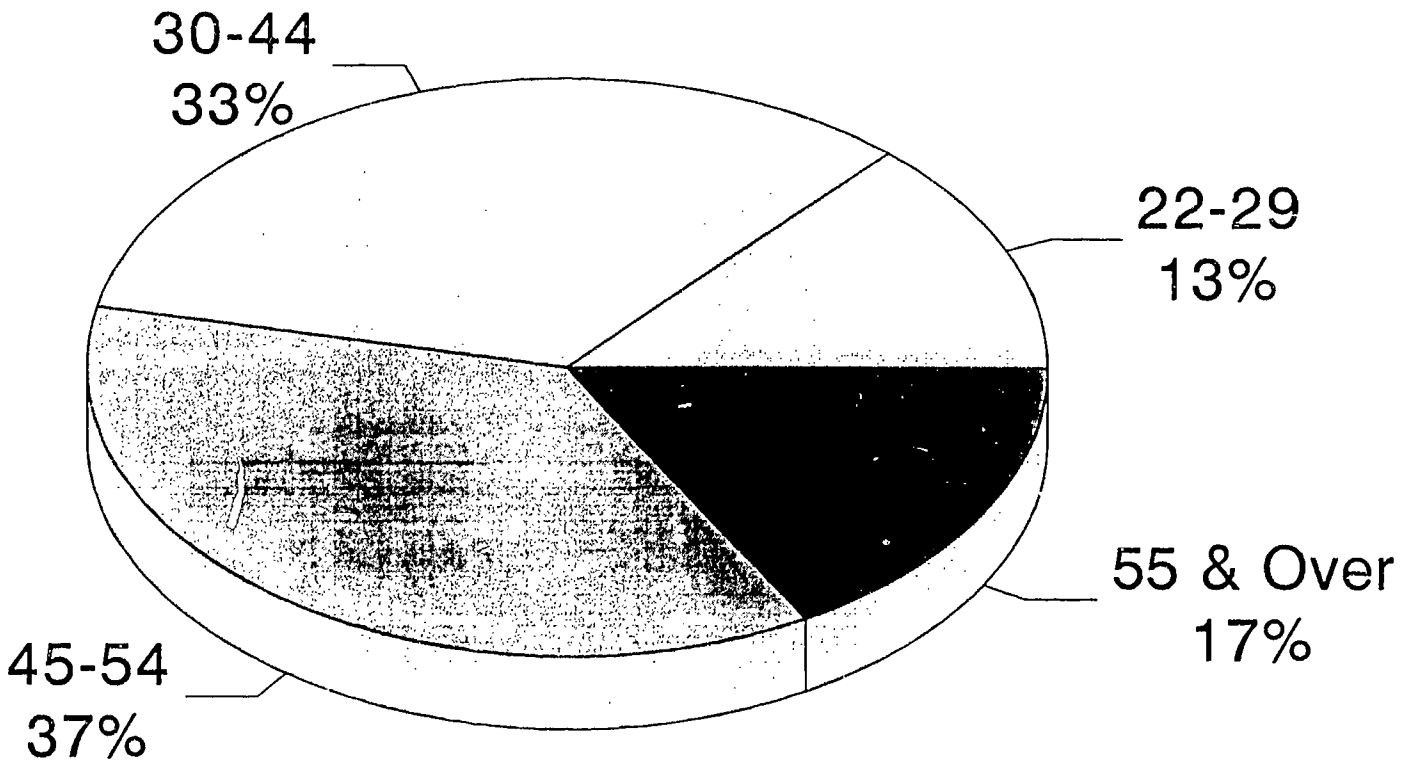


Race/Ethnic Status

N = 30

Fig. 5 West Student Demographic Survey

Facilities Maintenance Student Population TSTC Waco

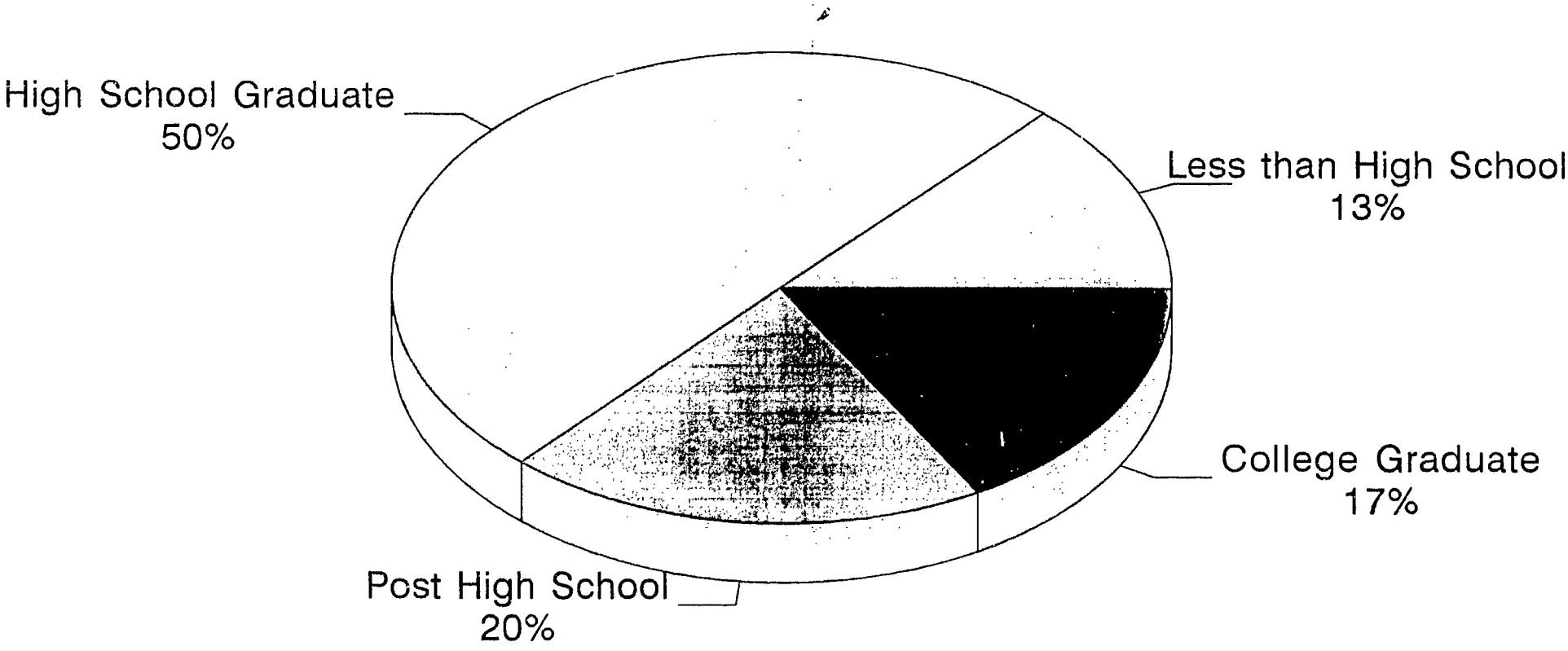


Age

N = 30

Fig. 6 West Student Demographic Survey

Facilities Maintenance Student Population TSTC Waco

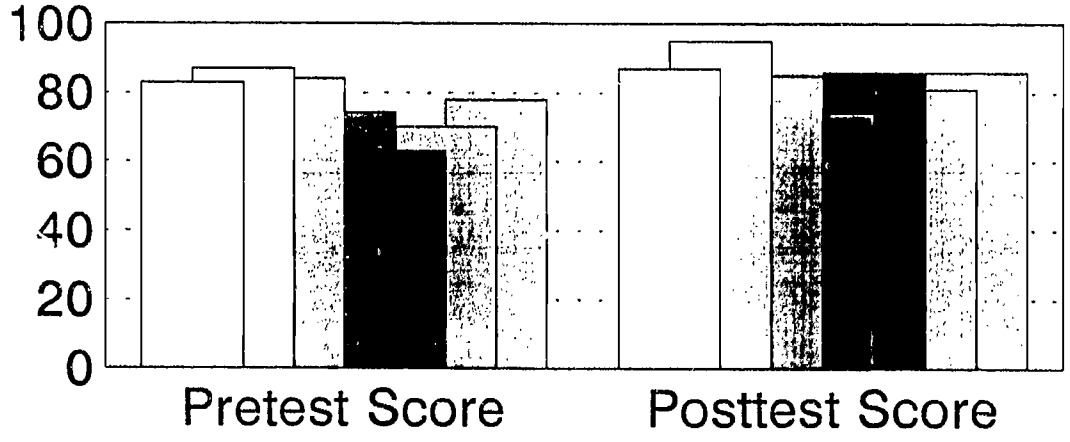


Completed Educational Status

N = 30

Fig. 7 Pretest/Posttest Comparison

Total Facilities Maintenance Student Population TSTC Waco

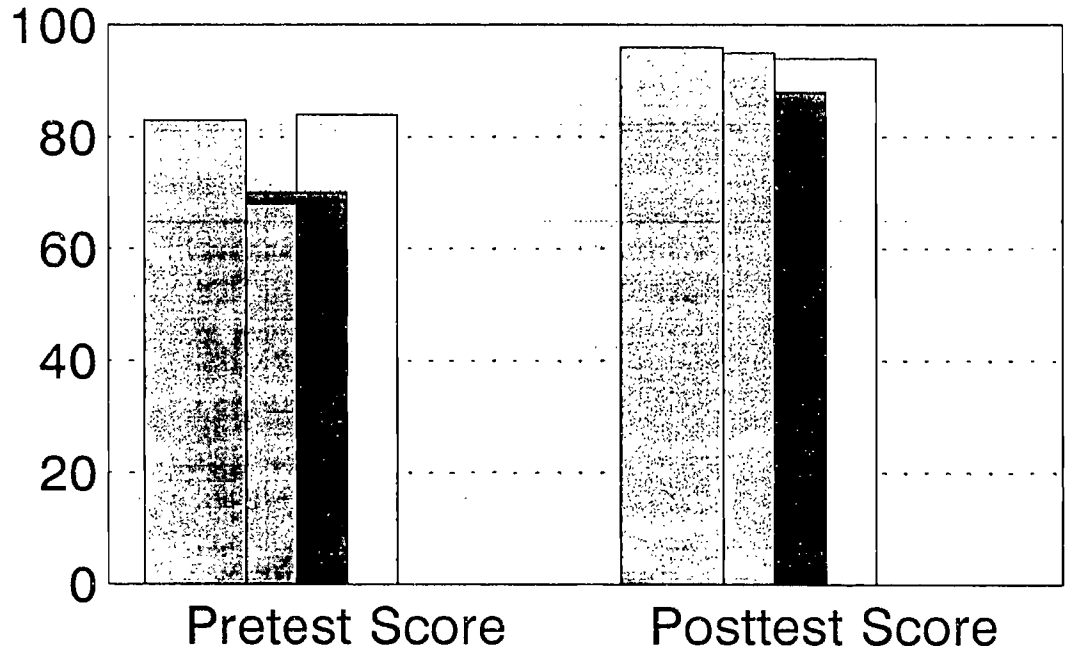


	Pretest Score	Posttest Score
Vocabulary	83	87
Reading Comprehension	87	95
Spelling	84	85
Language	74	74
Number Operations	63	86
Problem Solving	70	81
Total	78	86

N = 30

Fig. 8 Pretest/Posttest Comparison

Level 1 Facilities Maintenance Student Population TSTC Waco

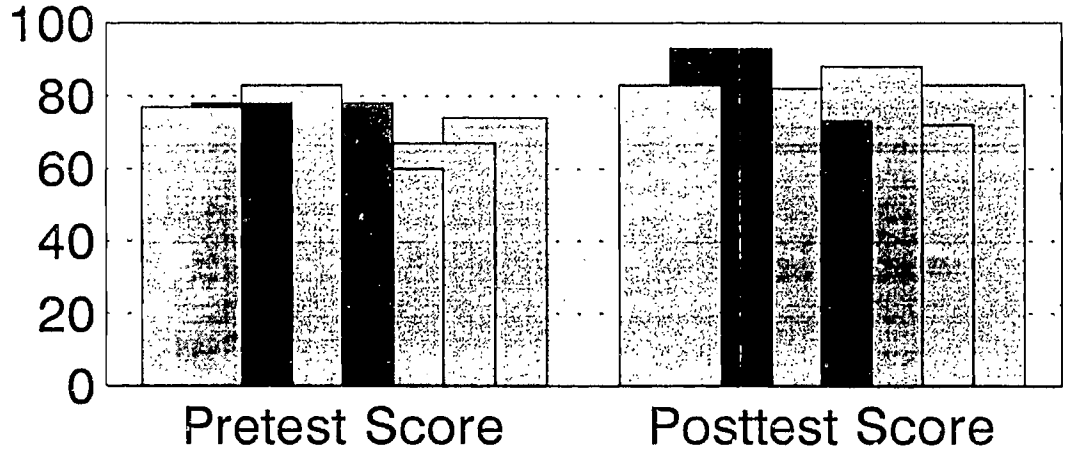


	Pretest Score	Posttest Score
Reading Comprehension	83	96
Number Operations	68	95
Problem Solving	70	88
Total	84	94

N = 4

Fig. 9 Pretest/Posttest Comparison

Level Two Facilities Maintenance Student Population TSTC Waco



	Pretest Score	Posttest Score
Vocabulary	77	83
Reading Comprehension	78	93
Spelling	83	82
Language	78	73
Number Operations	60	88
Problem Solving	67	72
Total	74	83

N = 12