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A Study to Compare the Effectiveness of Using Learning-Centered Instruction and Information-Centered Instruction

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A STUDY TO COMPARE THE EFFECTIVENESS

OF USING LEARNER-CENTERED INSTRUCTION AND

INFORMATION-CENTERED INSTRUCTION

A Research Paper Presented to the

Graduate Faculty of the Department of Occupational and Technical Studies

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In Partial Fulfillment of the Requirements

for the Master of Science

in Education Degree

By Stacy R. Page

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APPROVAL PAGE

This research paper was prepared by Stacy R. Page under the direction of Dr. John M. Ritz in OTED 636, Problems in Education. It was submitted to the Graduate Program Director as partial fulfillment of the requirements for the Degree of Master of Science Education.

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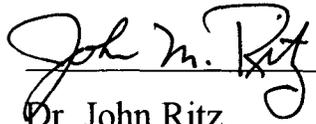
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Program Director

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER I

INTRODUCTION

Education was once a straight forward process - - teachers and trainers bestowed information upon students who were expected to absorb it or at least store it until they were asked to regurgitate it. Subject matter expertise was the thing. The trouble with this educational model is that it was designed to prepare trainees to become dutiful and unquestioning workers in factories and offices. Workers' roles have changed in organizations. Workers are now asked to solve problems, make decisions and improve quality.

The new skills of workers demand a different style of instruction from trainers. Adult learners have many different learning styles. The new role of the trainer is one of learner-centered training, to facilitate these different learning styles. Adults learn by doing. It is important for teachers and trainers to realize the characteristics of adult learners and to deliver learner-centered training through role plays and job aids to meet the learner's needs and improve performance. Teachers and trainers can improve their instruction through the use of learner-centered training. The outcomes of delivering learner-center instruction compared to information-centered training will be dealt with in this paper.

STATEMENT OF THE PROBLEM

The problem of the study was to compare the effectiveness of using learner-centered instruction and information-centered instruction with adult learners in a customer service center.

HYPOTHESIS

H1: Adult learners who receive learner-centered instruction using role plays and job aids will learn better than adult learners who receive information-centered instruction.

BACKGROUND AND SIGNIFICANCE

According to Scott Parry, Chairman of Training House, a Princeton, NJ, consulting firm, the learner centered instructor helps workers solve problems and make decisions on their own (Froiland, 1993, p. 56). Trainers are facing a brave new world in the work place. Companies like General Electric are investing time and resources into training employees. Companies look to their workers to solve problems and make decisions which is a big change from old style management.

In order to be a successful trainer, one must investigate various forms of instruction. Two forms of instruction are information-centered instruction and learner-centered instruction.

The objective of information-centered instruction is to cover all points, to get a lot of information across, to adhere to the lesson plan. Learner-centered instruction is a new and different method. The objective with learner-centered instruction is to change behavior and improve the performance of the learner (Froiland, 1993, p. 57). The role of the trainer in information-centered instruction is that of an expert and lecturer. In learner-centered instruction, the trainer arranges experiences and activities. The trainer plays the role of a facilitator.

One way to facilitate learner-centered instruction is through the use of role plays and job aids. Role plays are a very interactive part of the training. Role plays and games are easily one of the most popular ways trainers can review course material (Kruse, 1993, p. 7). Role plays make training more effective and fun.

Performance-based job aids are another effective part of learner-centered instruction. Job aids are very effective because people forget and job aids do not; job aids can reduce training time, they are more cost effective, and they reduce trainee anxiety related to recall (Courtney, 1991, p. 3).

Adult learners need clear instruction and "how to guides" and that is exactly what job aids provide. Understanding and remembering new information becomes more difficult with age, especially memorizing facts and figures. Learner-centered instruction, through the use of role plays and job aids, can provide the means for adult learner to learn, not by being told, but by experiencing. Adults learn best by doing.

LIMITATIONS

The limitations of this study were as follows:

1. The new hire training program for a General Electric customer service center was used for this study.

2. Participants used for this study were Customer Service Representatives.

3. Test groups for this study included two training classes consisting of ten participants each.

4. Each training class lasted five weeks in four hour day modules.

5. Total training hours was 104 hours for each participant.

6. Training units involved technical system skills and business procedures required to schedule service calls.

7. Instructional methods used were information-centered and learner-centered.

ASSUMPTIONS

This study was based on the following assumptions:

1. Participants differ widely in age, ability, job experience, education, and goals.

2. Participants may have been away from school for some period of time and may feel insecure about learning new skills.

3. The successful outcome of training will provide professional, knowledgeable customer service representatives.

PROCEDURES

Advanced Services Inc., a subsidiary of General Electric Appliances, was the site of this study. Two morning classes consisting of new hire customer service representatives made up the test groups for this study. The customer service representative had to successfully complete the 104 hours of new hire training. The participants of this study had little or no knowledge of the policies and procedures of the General Electric Company prior to training.

The focus of this study was on the instructional methods of technical system skills and business procedures. This training is over fifty percent of the new hire training program.

A pre/post-test was developed for the learning objectives of the technical system skills and business procedures module. Prior to any instruction given on this module, a pre-test was delivered to each participant in both of the classes used to make up the test groups for this study.

Class A then received information-centered instruction, while class B received learner-centered instruction. A post-test was administered to each participant at the end of the technical system skills module. Test scores were tabulated and data was presented comparing the results of delivering learner-centered instruction compared to delivering information-centered instruction in training.

DEFINITION OF TERMS

The following definitions should be applied when reading this research paper.

ASI	Advanced Services Incorporated, a customer service center that is a subsidiary of General Electric Appliances.
Job Aids	Instructional guides to be used during the performance of a task.
Role Plays	Acts of a real work situation to be used for practice and improvement.
Customer Service Representative	Representative who schedules GE Appliance service calls.
Technical System Skills	Any type of training that prepares a participant for a skill to work with computers.
Service Call	An appointment made for a customer who needs repair on a General Electric appliance.

OVERVIEW OF CHAPTERS

Chapter I provided an explanation for the need for research to be completed in the area of instructional methods for adult learners. The problem was stated with research goals and limitations and assumptions. The procedures for the research were briefly explained with related terms defined.

A review of the literature will be provided in Chapter II. Chapter III will provide an explanation of the methods and procedures used to obtain the research data, with Chapter IV stating the findings. Finally, Chapter V will provide a summary with conclusions and recommendations based on the findings of this study.

CHAPTER II

REVIEW OF LITERATURE

There have been many advances in adult learning. Chapter II of this study, Review of Literature, was conducted to examine these advances. To understand these, one must look at the basic psychological laws which control and affect adult students.

A number of basic psychological laws control and affect adult students in the learning process. The teachers of adults should understand these laws if they are to make learning experiences effective, lasting, and enjoyable for the students. The five laws are - - the law of effect, the law of primacy, the law of exercise, the law of disuse, and the law of intensity (Rothwell, 1992, p. 66). The law of effect states that people tend to accept and repeat those responses which are pleasant and satisfying and to avoid those which are annoying. The law of primacy states that first impressions are most lasting. The law of exercise states the more an act is repeated, the more quickly a habit is established. The law of disuse states that a skill not practiced or a knowledge not used will be largely lost or forgotten. Finally, the law of intensity states a vivid, dramatic, or exciting learning experience is more likely to be remembered than a routine or boring experience.

The following topics were explored in this Review of Literature. These included: 1) Adult Learning Styles, 2) Learner-Centered Instruction, 3) Information-Centered Instruction, and 4) Summary.

ADULT LEARNING STYLES

A learning style describes the way an individual tends to learn. It is the typical way a person behaves, feels, and processes information in learning situations. There are many ways to describe the different learning styles adults utilize when trying to take on new knowledge or develop new skills. A simple way of looking at these different learning styles is by breaking them into four main styles. Some adults learn best by feeling, some by thinking, others by watching and still others by doing. The following is an explanation of each:

Feeling - choosing and digesting information because it feels good. Adults use values, feelings and experiences in deciding what to do in situations and how to proceed.

Thinking - scrutinizing information, analyzing it, pulling it apart, and putting it back together logically.

Watching - using our imagination to choose and digest new materials or ideas by observing others, empathizing with their experiences, and taking note of how they perform a skill.

Doing - some adults learn best through action. Adults remember things best if they experience the content or skill directly, performing a task themselves.

It is important to note that participants will retain the most from training if instructors use a variety of training techniques to address these learning styles (Sims, 1993, p. 244). Following will be a discussion of two techniques to instruction. These include learner-centered and information-centered instruction.

LEARNER-CENTERED INSTRUCTION

Through learner-centered instruction, trainers can address many of the learning styles of adults. The goal of learner-centered instruction is to meet the learners' needs to improve performance (Froiland, 1993, p. 55). The role of the instructor is to arrange learning experiences and activities. The instructor asks questions and does no more than fifty percent of the talking. The instructor facilitates the learning by asking probing questions like "why do we do this" (Froiland, 1993, p. 55).

Adults learn by doing. Consequently, the role of the learner should be an active one. In learner-centered training, learners correct their own behavior because they are experiencing the results of their own actions. They receive these experiences through the use of role plays, activities, and instructional games.

The purpose of role playing is to help learners practice and rehearse specific behaviors. Key characteristics of role plays involve a description of the situation and characters, choices for the learners to make, and consequences resulting form those choices.

There are four types of role plays (Rothwell, 1992, p. 176):

Pairs -   Two characters confront each other.

Triad -   Two people role play, one person acts as an observer.

Fishbowl -   A small group role plays while the audience observes them.

Do It Yourself -   Ideal for self instruction; it can take place anywhere, at any time.

Activities and instructional games can be used to provide practice. Practice is the single most important variable in learner-centered instruction. It speeds learning, aids retention, and facilitates recall. Student participation through exercise, activities, and practice involve the learners in "doing" in such a way that they are active rather than passive. In learner-centered instruction it is good to use at least one activity per hour of instruction.

For example, in a effective communication course, learning activities in the form of games were used that provided drills and encouraged group support. The activities were identified to be an effective part of the training (Brod, 1987, p. 52).

Activities can be used to add appeal and interest and discover new ideas and relationships as well as to provide practice. Instructional games use the element of competition to practice behavior. Key characteristics involve competition, rules, procedures, and specified learning outcomes. A study of games as an instructional method in adult education classes found that participants valued the experience and would use the technique themselves (Somers, 1993, p. 244).

Group work is also another way learners receive experiences. The purpose of group work is to draw from the varied backgrounds of the group to arrive at the answers to open-ended questions. Key characteristics involve objectives or questions to be answered during the session, directions, and a debriefing method.

All of these types of performance related instruction are important in adult learning styles. Adults tend to remember 10 percent by reading, 20

percent by hearing, 30 percent by looking at pictures, 50 percent by watching a movie or watching a demonstration, 70 percent by participating in discussion or giving a presentation, and 90 percent by doing a dramatic presentation or doing the real thing. (Rothwell, 1993, p. 96). Adults are active learners. Most adults learn through experience. This is a reason why learner-centered instruction is so effective.

Another effective method of learner-centered training is the use of performance-based job aids. Job aids are instructional guides to be used during the performance of a task. Job aids include task classification, task related questions, flow charts, and tips and techniques (Lianeras, 1993, p. 7). Other examples include "if...then" tables and spiral bound handbooks. Job aids reduce the need for people to do tasks totally from memory. If trainees use job aids, they will make fewer errors for tasks that are complicated or done infrequently (Nelson, 1991, p. 6).

Job aids can be developed using the following steps (Courtney, 1991, p. 2):

       1) conduct a performance analysis,

       2) develop a job/task analysis,

       3) design the performance-based job aid, and

       4) do a reality test before distributing for general use.

Feedback is a very important part of the learner-centered instruction. The purpose of feedback in learner-centered instruction is to see if the trainee can apply what was just acquired, to see if the trainee needs more practice, and to provide additional instruction (Froiland, 1993, p. 56). The instructor gets feedback by giving trainees tasks or situations in which they must practice and apply their newly acquired skills, concepts, and procedures.

In learner-centered training, the instructor controls the learner through positive and negative reinforcement (Froiland, 1993, p. 56). Through praise and constructive criticism, instructors can develop the trainee. Awards are a good way to give positive reinforcement. Giving trainees awards creates a positive learning climate. "Lab awards" given by Celeste Roth in her computer programming course helped students relate to each other in their groups and to see themselves and others as positive contributors (Roth, 1994, p. 4).

The instructor's philosophy can become "We learn, not by being told, but by experiencing the consequences of our own action. Learning is an experiential process; we learn by doing" (Froiland, 1993, p. 56). As the familiar adage suggests, "I hear and I forget, I see and I remember, I do and I understand". Adult programs that employ experiential learning (learner-centered instruction) have been successful because they are relevant and adapted to the needs of the individuals (Barkatoolah, 1990, p. 8).

INFORMATION-CENTERED INSTRUCTION

The objective of information-centered instruction is to cover all points, to get information across, and to adhere to the lesson plan (Froiland, 1993, p. 55). The instructor is seen as the expert. The role of the instructor is to give information and to be a lecturer.

The methods instructors use in information-centered instruction are to talk, show, and tell. The role is much different from that of the learner-centered instructor where the instructor does no more than fifty percent of the talking. In information-centered training the instructor does ninety-five percent of the talking (Froiland, 1993, p. 55).

The learner's role is passive. The learner absorbs information and periodically repeats it to give the instructor feedback.

In information-centered instruction, the purpose of feedback is to see if the trainee understands the information, to test retention, and to see if the information should be repeated. The instructor gets feedback by asking questions and by asking trainees to repeat what the instructor has just explained.

The instructor controls the learner through reward and punishment. The basic philosophy of information-centered instruction is that "there's so much our trainees have got to know before they'll ever be able to do the job correctly, much repetition is necessary" (Frioland, 1993, p. 57). Through this explanation, the researcher has shown the different philosophy's that exist between learner-centered and information-centered instruction.

SUMMARY

Chapter II, Review of Literature, presented the different views about learner-centered and information-centered instruction. There was a lack of research in the literature comparing the two methods. The next chapter will present the methods and procedures utilized to compare the results of these two types of instructional methods.

14

CHAPTER III

METHODS AND PROCEDURES

Chapter III, Methods and Procedures, was to establish the procedures to be used to determine the effectiveness of using learner-centered instruction and information-centered instruction with adult learners in a customer service center. The topics that were explored in this chapter included: 1) Population, 2) Instrument Design, 3) Data Collection 4) Statistical Analysis, and 5) Summary.

POPULATION

The population for this study was made up of new hire customer service representatives. The selected sample within this population was two new hire training classes. Each class lasted five weeks. The curriculum consisted of training modules in communication skills, quality of service, introduction to computers, product training, technical system skills, and power talking. This study focused on the technical system skills module which was over 50 percent of the new hire training program. Each of the two classes had ten participants, so the total sample size was twenty. The ages of the participants in each class ranged from twenty-one to forty-five years of age. Each class was predominately female, with only three males total for both classes.

INSTRUMENT DESIGN

A written test was administered to the participants during the instruction of the technical system skills module. The test was developed around the learning objectives of the module. The learning objectives for the module were for the participants to learn both the technical systems skills and business policies and procedures required to schedule service calls and respond to customer requests for information. A copy of the objectives for the modules are found in Appendix A.

A performance test was developed with ten questions based upon the performance process of handling a service call. The test format consisted of eight multiple choice and two completion questions. All testing was conducted within a three week span for each class - - at the beginning and end of the module on technical system skills. Sample test items were found in Appendix B.

DATA COLLECTION

Both new hire training classes were used for data collection and statistical analysis. Before beginning the instruction of the technical system skills module, a pre-test was administered to the participants in each class. A pre-test was used to determine if there was a significant difference between the two classes. The test-retest method was used in this study. The same test was administered as a post-test at the end of the technical system skills module to each class. This post-test concluded the end of the five week training session for the new hire customer service representatives.

16

STATISTICAL ANALYSIS

Statistical analysis was done to compare the test results of each new hire training class. The measure of central tendency used was the mean to determine the average score in each class, as well as the mode to determine the most frequently occurring score in each class. The range of scores in each class was also compared. The t-test was applied to determine if there was a significant difference between the two sample means of each class.

SUMMARY

Chapter III presented a description of the population, instrument design, and data collection with statistical analysis to determine the effectiveness of using learner-centered instruction compared to information-centered instruction with adult learners in a customer service center. The next two chapters will present the findings, summary, conclusions, and recommendations of this study.

17

CHAPTER IV

FINDINGS

This study was conducted in order to determine if adult learners who receive learner-centered training learn better than adult learners who receive information-centered training. The topics that were explored in this chapter included: 1) Presentation of Data, 2) Comparison of Groups, and 3) Summary.

PRESENTATION OF DATA

There were two new hire training classes that were used in this study. Each training class was given a pre-test and post-test before beginning the technical system skills module. Figure 1 shows the pre-test and post-test results for each training class.

Measures of central tendency were calculated to find the mean and mode of the test results for each class. Figure 2 shows the mean, which is the average score for each class. Figure 3 shows the mode, which is the most frequently occurring score for each class. The mean score for the pre-test of the control group was 2.8; the mean score for the experimental group was 2.6. This shows that the initial knowledge-base of both groups were comparable.

The range was also calculated to determine the difference between the most extreme score in the distribution of test scores. Figure 4 shows the range for class A and class B using pre-test and post-test scores:

18

Figure 1

Pre and Post-Test Results For Class A

Pre and Post-Test Results For Class B
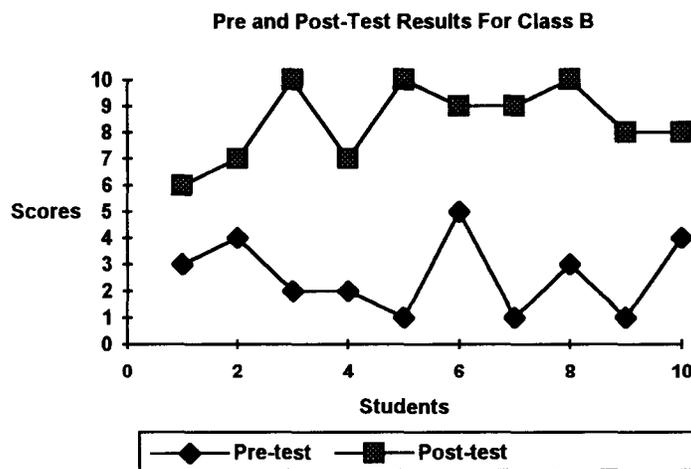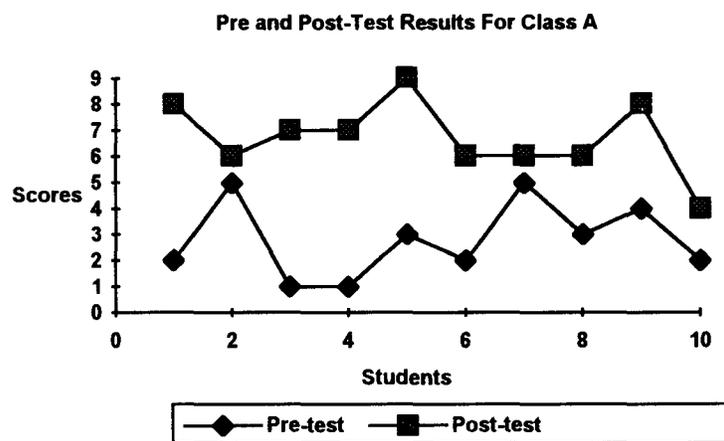
Note: Class A is the control group receiving information-
centered instruction. Class B is the experimental group
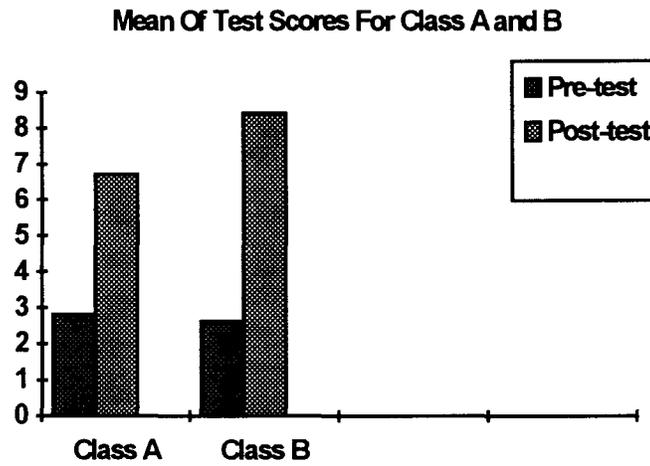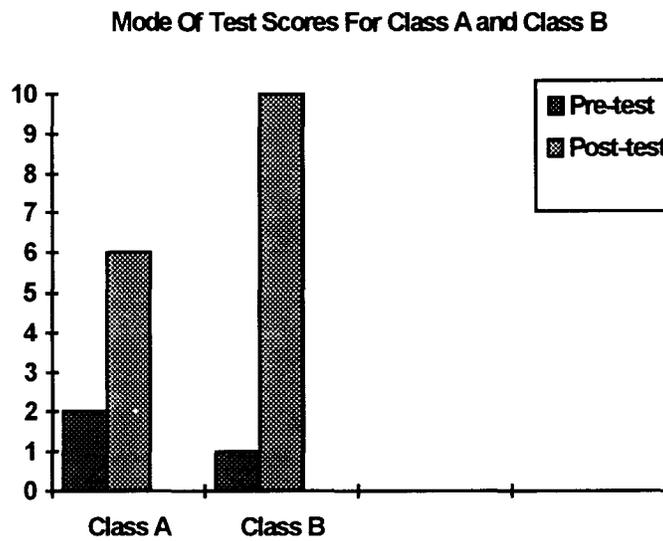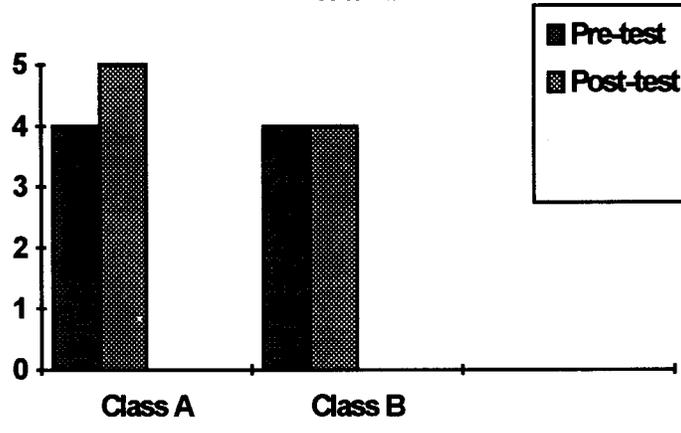receiving learner centered instruction.

Figure 2

Mean Of Test Scores For Class A and B

Figure 3

Mode Of Test Scores For Class A and Class B

Figure 4

Range Of Test Scores For Class A and Class B

COMPARISON OF GROUPS

Two t-tests were applied using the findings of this study. The t-test calculations can be found in Appendix C. The results were as follows:

1. Test 1, used to determine if there is a significant difference between the two sample means of the pre-test scores for class A, information-centered instruction, and class B, learner-centered instruction. The test shows no significant difference, .3152.

2. Test 2, used to determine if there is a significant difference between the two sample means of the post-test scores for class A, information-centered instruction, and class B, learner-centered instruction, had a t-test of -2.677, showing a significance at the .05 level. The negative sign is not relevant.

SUMMARY

This chapter has reported a comparison of the test results from two classes taught by using learner-centered training and information-centered training. Chapter V will analyze these findings as well as provide conclusions and recommendations.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter is to summarize previous chapters, to draw conclusions based on the data presented, to make recommendations and to suggest ideas for further study.

SUMMARY

This research was conducted to compare the effectiveness of using learner-centered instruction and information-centered instruction in adult learning. It was hypothesized that adult learners who receive learner-centered instruction using role plays and job aids will learn better than adult learners who receive information-centered instruction.

The limitations of this study are listed as follows: the new hire training program for General Electric Appliances was used for this study, two training classes consisting of ten participants each were used for the test groups, the training classes lasted five weeks, and both information-centered and learner-centered instructional methods were used.

A review of the literature showed the many advances in adult learning. Adult learning styles, learner-centered instruction, and information centered instruction were covered and the different views about the two types of instruction were presented.

The population of this study was limited to new hire customer services representatives. From this sample, the ages of participants in the two training classes ranged from twenty-one to forty-five years of age. Each training class was predominately female, with only three males total for both classes.

A performance test was administered to the participants during the instruction of the technical system skills module. The test had ten questions which were based around the performance objectives of handling a General Electric service call.

Both new hire training classes were used for data collection. Before beginning the instruction on the technical system skills module, a pre-test was administered to each participant to determine if there was a difference between the two classes. The same test was administered as a post-test at the end of the module to each participant.

Statistical analysis was completed to compare the test results of each new hire training class. Measures of central tendency were used as well as a t-test to determine if there was a significant difference between the two sample means for the classes.

CONCLUSIONS

The hypothesis in this study was that adult learners who receive learner-centered training using role plays and job aids will learn better than adult learners who receive information-centered training. Based on calculated

results, this hypothesis was found to be true. There was a significant difference at the .05 level between the class who receive learner-centered training and the class who received information-centered training.

RECOMMENDATIONS

Based on the results and conclusions of this study, the following recommendations were made:

1. Trainers and teachers should incorporate role plays in learning activities.
2. Trainer and teachers should provide job aids to be used during the performance of a task.
3. Further research should be conducted comparing learner-centered instruction and information-centered instruction.
4. Further study should include different ways to incorporate learner-centered instruction in training.

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APPENDICES

28

APPENDIX A

Learning Objectives For Technical System Skills and Business Policies and

Procedures

The goal of this module is to provide the students with both the technical systems skills and the knowledge of business policies and procedures required to schedule service calls and respond to customer requests for information efficiently and accurately.

APPENDIX B

Pre and Post-test

Pre-TEST

In this module of your training, you have learned both the technical systems skills and the business policies and procedures required to schedule service calls and respond to customer requests for information. Please complete this post-module worksheet. Indicate your response by circling or filling in the appropriate answer.

1. What is the transaction to schedule a service call?
   A. FS11
   B. FS0
   C. FS01
   D. FS01 OLD

2. What is the transaction to check on service already scheduled?
   A. FS0
   B. FS11
   C. FS01
   D. FS01 OLD

3. What are the four things needed on every Parts Intercept call?
   1. _____
   2. _____
   3. _____
   4. _____

4. How can you find a zip code if the consumer does not know it?
   A. WZIP
   B. Z11
   C. FS0
   D. G15 H

5. What transaction do you use to see a service contract?
   A. G 15 S
   B. WCON
   C. TQ1D
   D. TQ11

6. What does the FS05 line tell us?
   A. Time Spans
   B. Zone Restrictions
   C. No CE Service
   D. Customers Alternate Phone Number

7. What does it mean if you see the word "shop" on the FS0 screen?
     A. No Shop
     B. MA Shop
     C. CE Shop
     D. MA & CE Shop

8. What is the transaction you use to find out where the zone office is?
     A. WZIP
     B. G 15 S
     C. G 15 H
     D. MSG BC

9. What is the transaction to see what the shop works on?
     A. G 15 H
     B. G 15 S rrzz
     C. G 15 rac
     D. WCON

10. Indicate the Brand number for the following:
     A. GE or Hotpoint   _____
     B. JC Penney Appliance   _____
     C. RCA   _____

THANK YOU FOR YOUR PARTICIPATION!!

Post-TEST

In this module of your training, you have learned both the technical systems skills and the business policies and procedures required to schedule service calls and respond to customer requests for information. Please complete this post-module worksheet. Indicate your response by circling or filling in the appropriate answer.

1. What is the transaction to schedule a service call?
    A. FS11
    B. FS0
    C. FS01
    D. FS01 OLD

2. What is the transaction to check on service already scheduled?
    A. FS0
    B. FS11
    C. FS01
    D. FS01 OLD

3. What are the four things needed on every Parts Intercept call?
    1._____
    2._____
    3._____
    4._____

4. How can you find a zip code if the consumer does not know it?
    A. WZIP
    B. Z11
    C. FS0
    D. G15 H

5. What transaction do you use to see a service contract?
    A. G 15 S
    B. WCON
    C. TQ1D
    D. TQ11

6. What does the FS05 line tell us?
    A. Time Spans
    B. Zone Restrictions
    C. No CE Service
    D. Customers Alternate Phone Number

7. What does it mean if you see the word "shop" on the FS0 screen?
   A. No Shop
   B. MA Shop
   C. CE Shop
   D. MA & CE Shop

8. What is the transaction you use to find out where the zone office is?
   A. WZIP
   B. G 15 S
   C. G 15 H
   D. MSG BC

9. What is the transaction to see what the shop works on?
   A. G 15 H
   B. G 15 S rrzz
   C. G 15 rac
   D. WCON

10. Indicate the Brand number for the following:
    A. GE or Hotpoint   _____
    B. JC Penney Appliance   _____
    C. RCA   _____

THANK YOU FOR YOUR PARTICIPATION!!

APPENDIX C

T-test Calculations

T-test Calculations

Pre-test Results

s 1	2	.8	.64
s 2	5	-2.2	4.84
s 3	1	1.8	3.24
s 4	1	1.8	3.24
s 5	3	-.2	.04
s 6	2	.8	.64
s 7	5	-2.2	4.84
s 8	3	-.2	.04
s 9	4	-1.2	1.44
s 10	2	.8	.64

$E1=28$

$N1=10$

$M=2.8$

$ED\ 2=19.6$

s1	3	-.4	.16
s2	4	-1.4	1.96
s3	2	.6	.36
s4	2	.6	.36
s5	1	1.6	2.56
s6	5	-2.4	5.76
s7	1	1.6	2.56
s8	3	-.4	.16
s9	1	1.6	2.56
s10	4	-1.4	1.96

E2=26

N2=10

M2=2.6

ED 2=18.4

$$t = \frac{M1 - M2}{\sqrt{\left(\dfrac{ED\,2 + ED\,2}{N1 + N2 - 2}\right)\left(\dfrac{N1 + N2}{N1 \times N2}\right)}}$$

$$t = \frac{2.8 - 2.6}{\sqrt{\dfrac{19.6 + 18.4}{10 + 10 - 2} \quad \dfrac{10 + 10}{10 \times 10}}}$$

$$t = \frac{.2}{\sqrt{\left(\dfrac{38}{18}\right)\left(\dfrac{20}{100}\right)}}$$

$$t = \frac{.2}{(2.11)\,(.2)}$$

$$t = \frac{.2}{.422}$$

$$t = .3152$$

T-test Calculations

Post-test Results

s1	8	-1.3	1.69
s2	6	.7	.49
s3	7	-.3	.09
s4	7	-.3	.09
s5	9	-2.3	5.29
s6	6	.7	.49
s7	6	.7	.49
s8	6	.7	.49
s9	8	-1.3	1.69
s10	4	2.7	7.29

E1=67

N1=10

M1=6.7

ED 2=18.1

s1	6	2.4	5.76
s2	7	1.4	1.96
s3	10	-1.6	2.56
s4	7	1.4	1.96
s5	10	-1.6	2.56
s6	9	-.6	.36
s7	9	-.6	.36
s8	10	-1.6	2.56
s9	8	.4	.16
s10	8	.4	.16

$E2=84$

$N2=10$

$M2=8.4$

$ED2=18.4$

$$t = \frac{M1 - M2}{\sqrt{\dfrac{ED\,2 + ED\,2}{N1 + N2 - 2} \quad \dfrac{N1 + N2}{N1 \times N2}}}$$

$$t = \frac{6.7 - 8.4}{\sqrt{\dfrac{18.1 + 18.4}{10 + 10 - 2} \quad \dfrac{10 + 10}{10 \times 10}}}$$

$$t = \frac{-1.7}{\sqrt{\dfrac{36.5}{18} \quad \dfrac{20}{100}}}$$

$$t = \frac{-1.7}{2.02 \times 2}$$

$$t = \frac{-1.7}{.635}$$

$$t = -2.677$$