SMARTron Software Requirements Specification

Version 0.5

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Mission Statement

Creating a headless scantron analyzer that comes with a companion website which allows managing exams that have previously been scanned.

1 Introduction

1.1 Purpose

The purpose of this document is to give a detailed description of the requirements for the SMARTron software. It will illustrate the purpose and complete specifications for the development of the system. It will also explain the constraints, interfaces and interactions with other external applications. This document is primarily intended to be proposed to a stakeholder for its approval and a reference for developing the first version of the system for the development team.

1.2 Scope

SMARTron will be an automatic grading program maintaining compatibility with existing 200-answer Scantron answer sheets. The program will allow the user to maintain a familiar workflow of scanning answer sheets and receiving an email containing the results. This will be accomplished by a headless answer sheet analysis program that receives emails containing an answer key and student answer sheets from any scanner, and emails results to the instructor.

SMARTron will also include a web app providing benefits over the current Scantron workflow. Scanned exams are associated with an instructor's LakerNet ID, and they can log in to the web app to view and edit scanned exams. The web app will provide functionality to make corrections to answer keys and rename exams. Users will also have the option to create an answer key in-app and generate a custom answer sheet compatible with the analysis program.

1.3 Definitions, acronyms, and abbreviations

Term	**Definition**
User	An individual who utilizes the system
Scantron sheet	A paper form that contains fields for answering multiple choice

	questions with a fixed layout
PC	Personal Computer
SMARTron Analyzer	The headless application that receives and processes Scantron sheets and emails results
SMARTron Web App	The web app that provides the user interface for viewing and correcting scanned exams
LakerNet ID	The username/identification a user will provide, specific to SUNY Oswego
SRS	Software Requirements Specification
QMR	Quality Management Report

1.4 References

1.5 Overview

2 Overall Description

2.1 Product Perspective

2.1.1 User interfaces

The user will interact with a physical scantron sheet and a web-based client that allows for re-execution of the program with different inputs.

2.1.2 Hardware interfaces

The user will have access to and utilize a faculty scanner. There he will be able to scan all scantron sheets including the answer key without leaving his building. The user's PC is where he will interact with the email containing all data and statistics from the test results.

2.1.3 Software interfaces

The user will be able to utilize his existing Oswego email, which is a Google account, to initiate scanning the hard copy scantrons as well as receive the test results upon completion of the analysis by the program. The user will also be interacting with the SMARTron software in order to access results, create and edit answer keys. Microsoft Excel is the other software that the user wants to synchronize with SMARTron. Once the results have been emailed to the user, they should have the ability to upload/copy the results into a current Excel spreadsheet.

2.1.4 Communications interfaces

Computer
Email
Scanner

3 Specific Requirements

3.1 Functions

3.1.1 Automatic Scantron Analysis

FR-1: The SMARTron Analyzer shall load a PDF file of scanned Scantron sheets received via email.

FR-2: The SMARTron Analyzer shall extract the images of Scantron sheets from the received PDF

FR-3: The SMARTron Analyzer shall process each image.

FR-3.1: The SMARTron Analyzer shall convert the image to greyscale.

FR-3.2: The SMARTron Analyzer shall apply gaussian blur to the image.

FR-3.3: The SMARTron Analyzer shall create a copy of the image with the canny filter.

FR-3.4: The SMARTron Analyzer shall apply inverted threshold to original image.

FR-3.5: The SMARTron Analyzer shall find all edges on the canny image copy.

FR-3.6: The SMARTron Analyzer shall filter through all edges and detect circles.

FR-3.7: The SMARTron Analyzer shall sort the circles in rows and columns.

FR-3.8: The SMARTron Analyzer shall find question circle groups.

FR-3.9: The SMARTron Analyzer shall find name circle groups.

FR-3.10: The SMARTron Analyzer shall find date, ID, sex, and grade circle groups.

FR-3.11: The SMARTron Analyzer shall iterate through all groups recording the darkest circle.

FR-3.12: The SMARTron Analyzer shall store records of all detected fields.

3.1.2 Computing Statistics

FR-4: The SMARTron Analyzer shall compute the following statistics for a graded exam:

1. Mean score in both percentage and points
2. Median score in both percentage and points
3. Quartiles in points
4. Frequency of each response for each question
5. Lowest score
6. Highest score

7. Range of scores
8. Standard deviation of scores
9. Variation of scores
10. KR-20 reliability
11. KR-21 reliability
12. Coefficient (Cronbach) alpha reliability

FR-5: The SMARTron Analyzer shall request raw test data from the SMARTron Database when recomputing the statistics in FR-4.

3.1.3 Data Recording

FR-6: The SMARTron Analyzer shall create a blank CSV file.
FR-7: The SMARTron Analyzer shall produce columns in the CSV file for student name, ID, and score.
FR-8: The SMARTron Analyzer shall create rows in the CSV file for each student answer sheet associated with the exam.
FR-9: The SMARTron Analyzer shall send an email to the address associated instructor containing the generated CSV file and the statistics computed in FR-4.
FR-10: The SMARTron Analyzer shall send the raw test data to the SMARTron Database.

3.2 Use Cases

Use Case UC-1	**Email Scantron Sheets**
Related Use Cases	TBD
Initiating Actor	A User
Actor's Goal	To successfully email all scanned Scantron sheets to the SMARTron analyzer
Participating Actors	Scanner, SMARTron analyzer
Preconditions	There must be an existing scanner and Scantron sheets; the SMARTron analyzer must be running and have an associated email address
Postconditions	The Scantron sheets are successfully scanned and emailed to the SMARTron analyzer

	Flow of Events for Main Success Scenario
1.	The user arrives at the scanner and inputs the email address associated with the SMARTron Analyzer
2.	The user places all Scantron sheets into the scanner and presses the “start” button
3.	The scanner scans all the sheets
4.	The scanner emails the scanned files to the SMARTron analyzer

	Flow of Events for Exception Scenario
1.	The user arrives at the scanner and inputs their email
2.	The user places all Scantron sheets into the scanner and presses the “start” button
3.	The scanner scans all the sheets
4.	The scanner attempts to email the SMARTron analyzer the scanned files

5.	The SMARTron analyzer fails to receive the scanned files

Use Case UC-2	**Login to SMARTron Web App**
Related Use Cases	TBD
Initiating Actor	A User
Actor's Goal	To access the SMARTron web app
Participating Actors	The SMARTron web app
Preconditions	The user must have an existing LakerApps account
Postconditions	The user has access to the features of the SMARTron web app

	Flow of Events for Main Success Scenario
1.	The user opens the SMARTron website in their web browser
2.	The user is prompted to login to the SMARTron web app
3.	The user enters their proper credentials (email and password)
4.	The user is redirected to the Logged-In home page on the SMARTron website

	Flow of Events for Exception Scenario
1.	The user opens the SMARTron website in their web browser
2.	The user is prompted to login to the SMARTron web app
3.	The user enters their credentials (email and password)
4.	The SMARTron system displays an error message to the user that they entered an invalid username/password

Use Case UC-3	**Edit Answer Key**
Related Use Cases	TBD
Initiating Actor	A User
Actor's Goal	To successfully edit an existing answer key
Participating Actors	The SMARTron web app
Preconditions	There must be an existing account on SMARTron; there must be an existing answer key to edit
Postconditions	The answer key is edited to the user's preferences

	Flow of Events for Main Success Scenario
1.	The user logs into their SMARTron account
2.	The user navigates to their answer key file
3.	The user makes their desired changes to the answer key
4.	The user saves the changes to the answer key

	Flow of Events for Exception Scenario
1.	The user logs into their SMARTron account
2.	The user navigates to their answer key file
3.	The user attempts to makes their desired changes to the answer key
4.	The user saves the changes to the answer key
5.	The SMARTron system displays an error message to the user that the answer key could not be edited

Use Case UC-4	**Grade Exams**
Related Use Cases	TBD
Initiating Actor	Computer System
Actor's Goal	To successfully grade every test
Participating Actors	The SMARTron system
Preconditions	There must be an answer key to follow; There must be a test/tests sent to the SMARTron system.
Postconditions	The tests have the proper grades assigned.

	Flow of Events for Main Success Scenario
1.	The SMARTron receives all the students' tests.
2.	The SMARTron reads in the answer key.
3.	The SMARTron grades each test appropriately.

	Flow of Events for Exception Scenario
1.	The SMARTron receives all the students test.
2.	The SMARTron reads in the answer key.
3.	The SMARTron fails to grade each test appropriately.

Use Case UC-5	**Match Grades to Corresponding Student**
Related Use Cases	TBD
Initiating Actor	A User
Actor's Goal	To successfully track each answer given by a student.
Participating Actors	The SMARTron system, A User
Preconditions	There must be at least one graded test from the SMARTron system; The user must have received an email to view the SMARTron results.
Postconditions	The SMARTron system displays the students answers; A user can navigate to individual tests for a given student

	Flow of Events for Main Success Scenario
1.	The user receives an email from the SMARTron system
2.	The user opens the email from the SMARTron system
3.	The SMARTron system displays the test results
4.	The user navigates to given student's answers
5.	The SMARTron system displays the student's answers

	Flow of Events for Exception Scenario
1.	The user receives an email from the SMARTron system
2.	The user opens the email from the SMARTron system
3.	The SMARTron system displays the test results
4.	The user navigates to given student's answers
5.	The SMARTron system displays the student's grades but fails to provide the user with a student's answers

Use Case UC-6	**Email Results to User**
Related Use Cases	UC-1
Initiating Actor	SMARTron Analyzer
Actor's Goal	To automate grading of Scantron sheets.
Participating Actors	User
Preconditions	There must be an existing SMARTron system; the user must scan the Scantron sheets.
Postconditions	The user has received a CSV file of exam grades

	Flow of Events for Main Success Scenario
1.	The SMARTron system emails the user.
2.	The user opens the email from the SMARTron system.
3.	The email displays the test results.
4.	The user receives the grade spreadsheet as an email attachment.

	Flow of Events for Exception Scenario
1.	The SMARTron system emails the user.
2.	The user opens the email from the SMARTron system.
3.	The SMARTron system attempts to displays the test results
4.	The SMARTron system displays an error message to the user that the grades were not calculated

Use Case UC-7	**Analyze Data for Each Question**
Related Use Cases	TBD
Initiating Actor	The SMARTron system
Actor's Goal	To successfully analyze every question
Participating Actors	The SMARTron system; A User
Preconditions	There must be at least one test to analyze and an answer key
Postconditions	The test displays the results and information on each question

	Flow of Events for Main Success Scenario
1.	The SMARTron system receives a test to analyze
2.	The SMARTron system analyzes a test
3.	The SMARTron system returns the results of the test to the user
4.	The user can view data on each question of the test

	Flow of Events for Exception Scenario
1.	The SMARTron system receives a test to analyze
2.	The SMARTron system analyzes a test
3.	The SMARTron system attempts to returns the results of the test to the user
4.	The SMARTron system displays an error message to the user that the data is not currently available.

Use Case UC-8	**Generate Custom Exam Sheet**
Related Use Cases	TBD
Initiating Actor	The User
Actor's Goal	To create a customized exam sheet for a multiple-choice test
Participating Actors	The SMARTron web app
Preconditions	The user must have an existing LakerApps account registered to the SMARTron system; the user must be logged into their account
Postconditions	A custom exam sheet is generated for future use

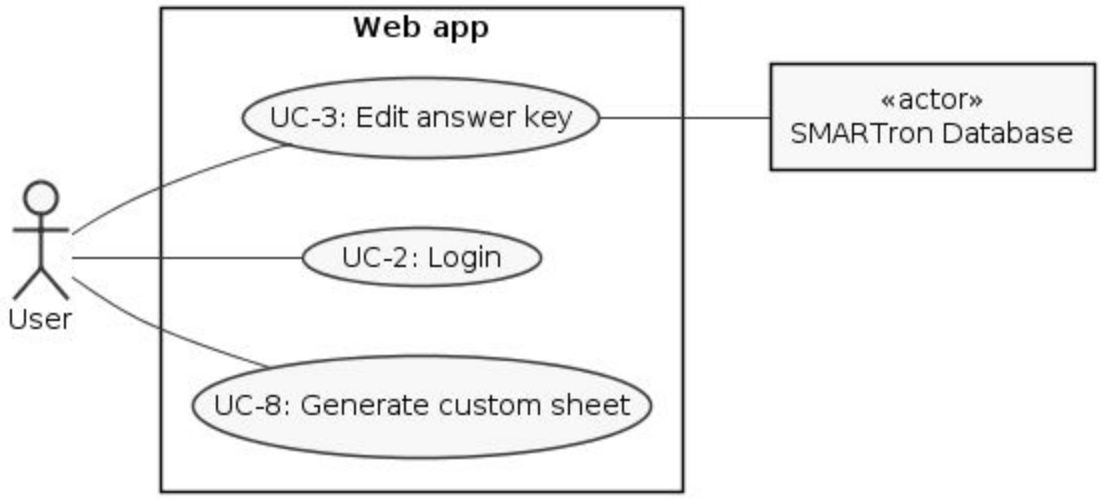
	Flow of Events for Main Success Scenario
1.	The user logs into the SMARTron web app
2.	The user navigates to the “create exam sheet” page
3.	The user customizes an exam sheet using the web app’s user interface
4.	The user saves the custom exam sheet

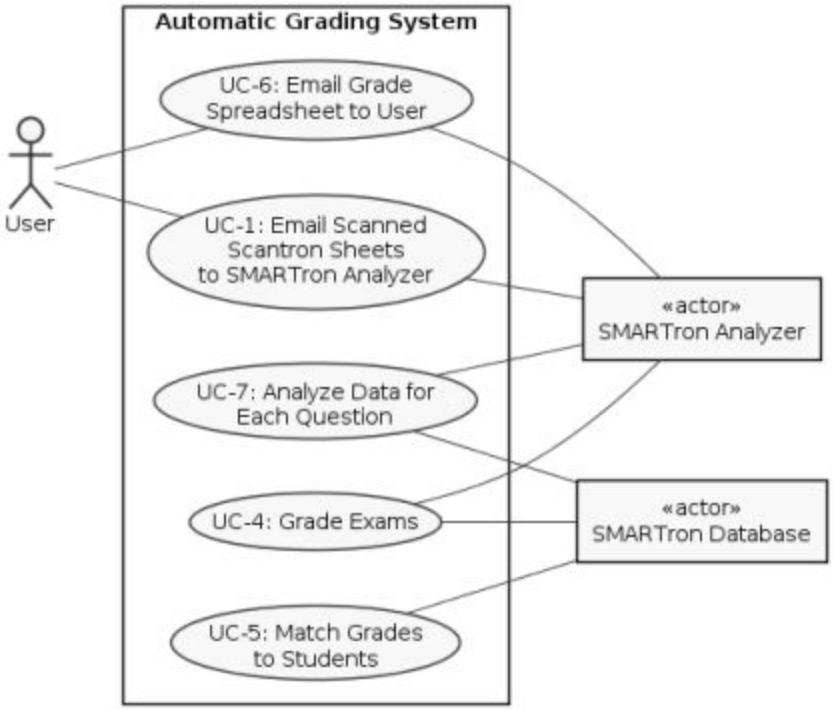
	Flow of Events for Exception Scenario
1.	The user logs into the SMARTron web app
2.	The user navigates to the “create exam sheet” page
3.	The user customizes an exam sheet using the web app’s user interface
4.	The SMARTron web app displays an error when the user attempts to save the custom exam sheet

Use Case UC-9	**Fix Unbalanced/Unfair Test Questions**
Related Use Cases	UC-7
Initiating Actor	A User
Actor's Goal	To change point values of questions
Participating Actors	The SMARTron system
Preconditions	There must be an existing account on SMARTron; there must be an existing answer key
Postconditions	The user can change the point value of any question determined unfit

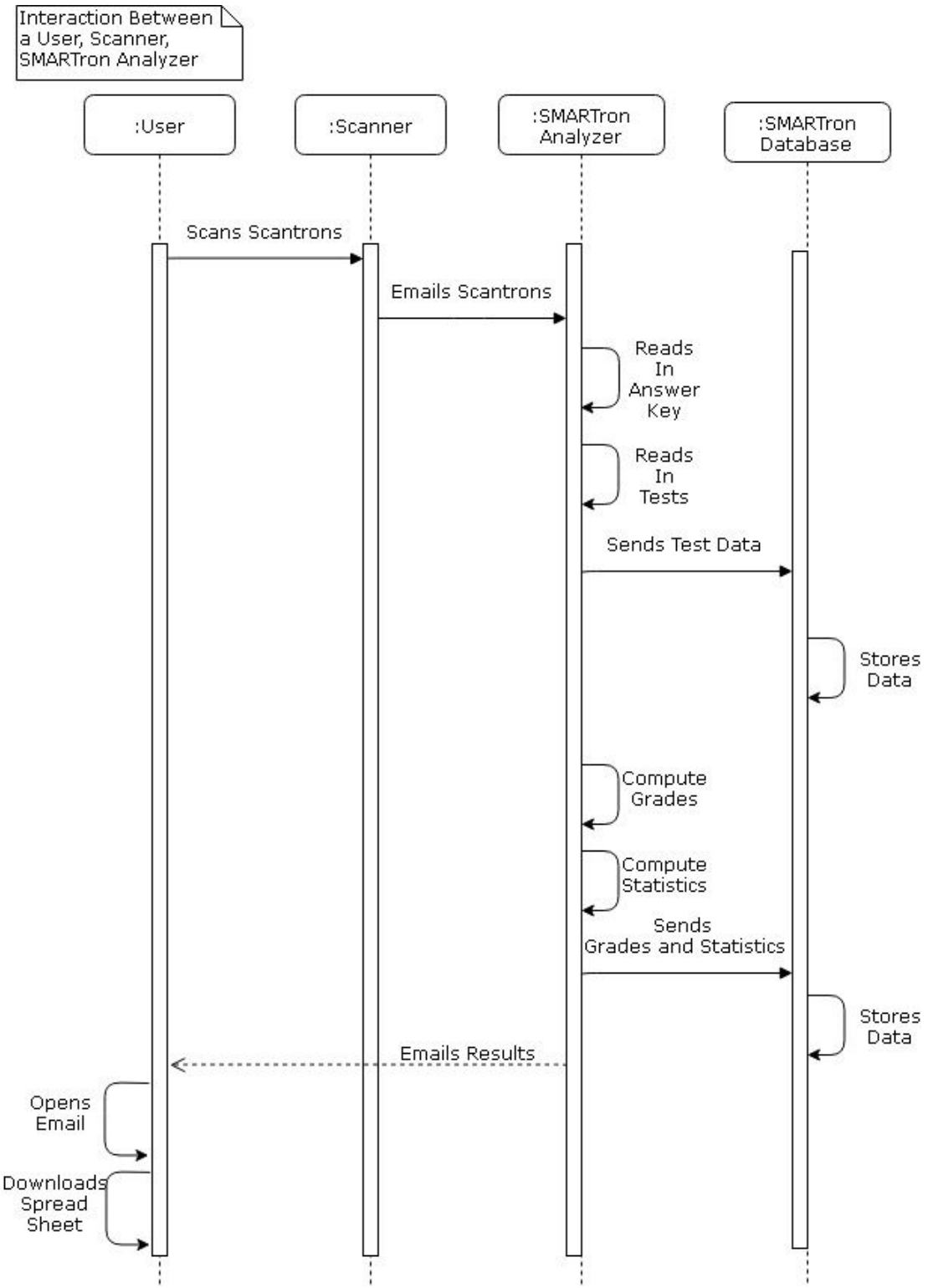
	Flow of Events for Main Success Scenario
1.	The user logs into their SMARTron account
2.	The user navigates to a “make changes” section
3.	The user chooses which data they would like to edit, question point values
4.	The user has the ability to change the point value associated with different questions

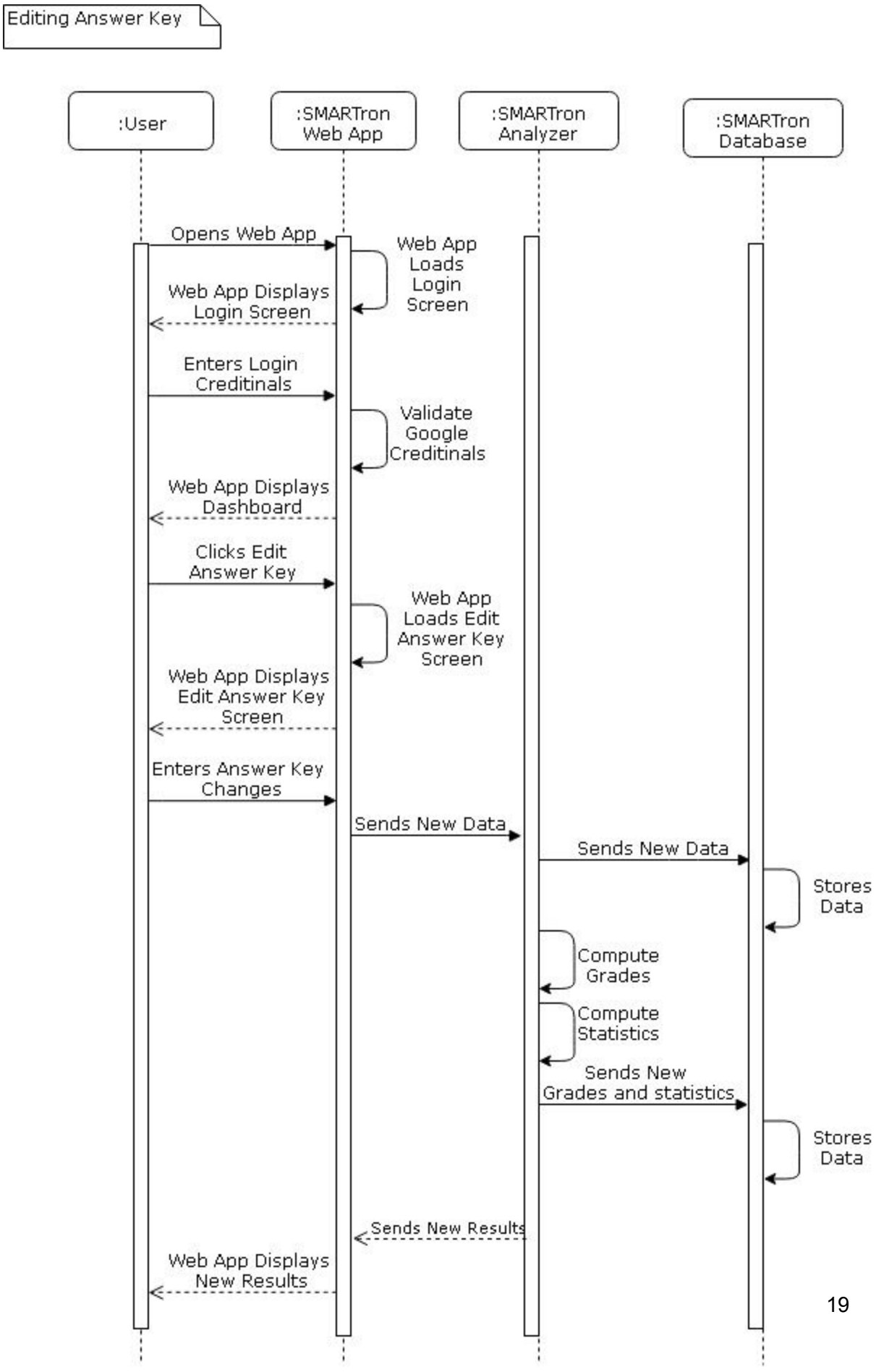
3.3 Use Case Diagrams



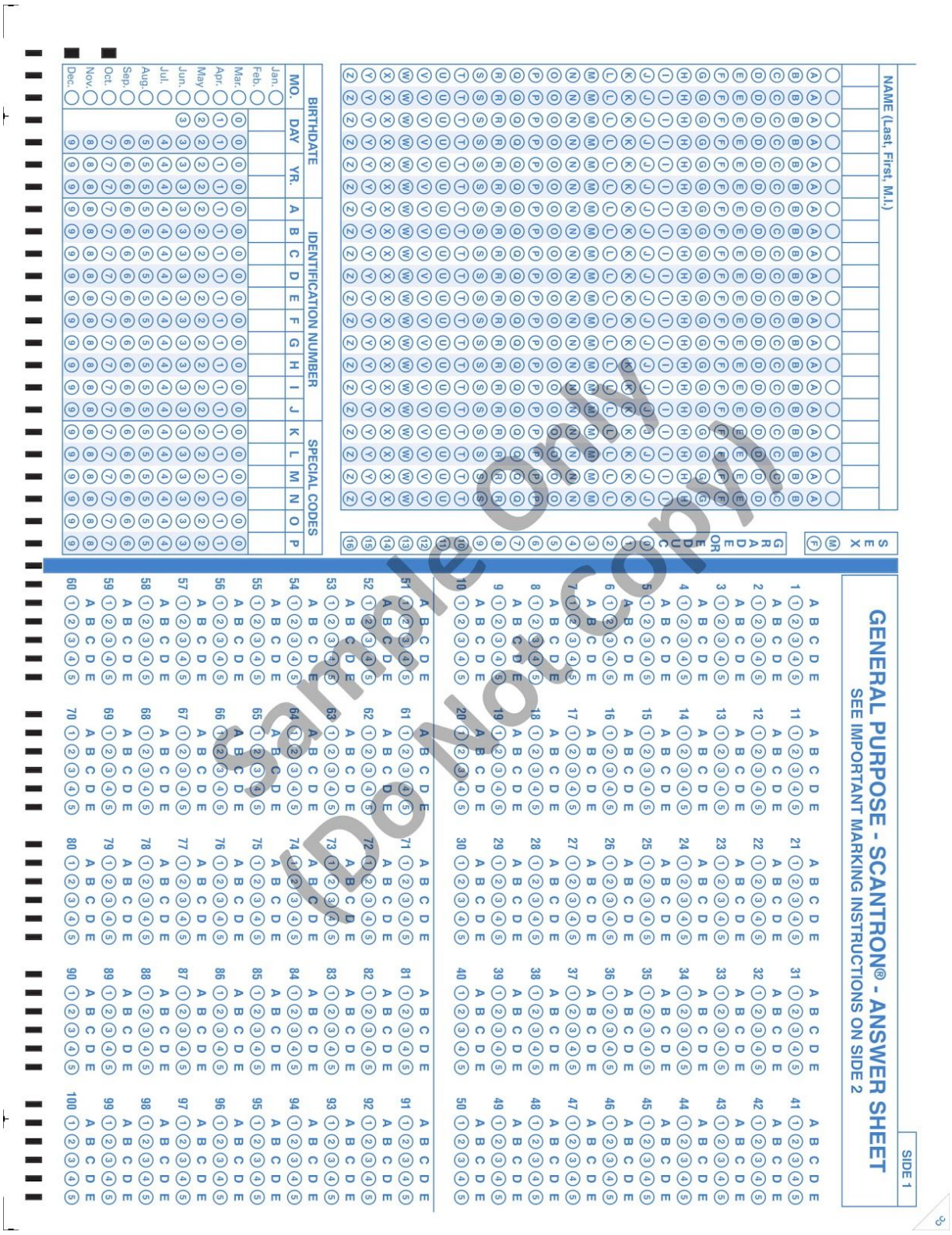


3.4 Sequence Diagrams



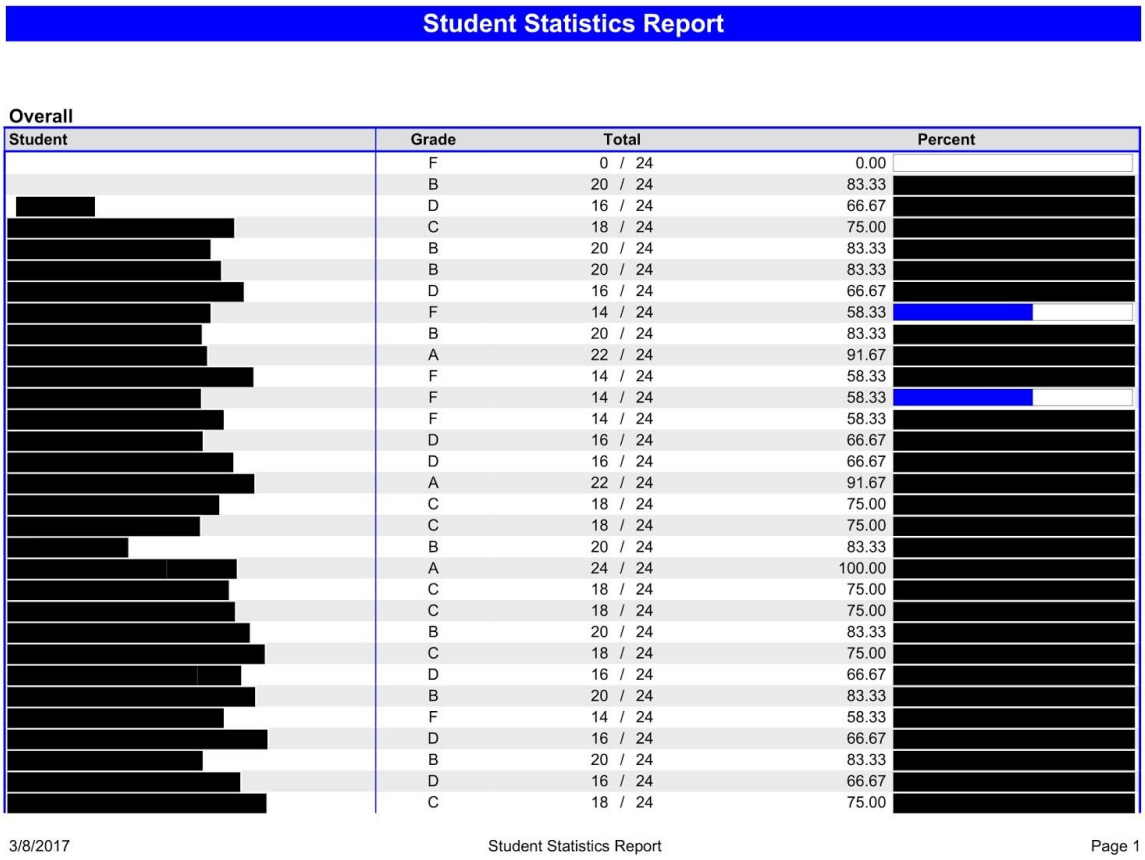

Editing Answer Key
:User
:SMARTron Web App
:SMARTron Analyzer
:SMARTron Database
Opens Web App
Web App Loads Login Screen
Web App Displays Login Screen
Enters Login Creditinals
Validate Google Creditinals
Web App Displays Dashboard
Clicks Edit Answer Key
Web App Loads Edit Answer Key Screen
Web App Displays Edit Answer Key Screen
Enters Answer Key Changes
Sends New Data
Sends New Data
Stores Data
Compute Grades
Compute Statistics
Sends New Grades and statistics
Stores Data
Sends New Results
Web App Displays New Results

Appendix A: 200 Question Scantron Sheet


GENERAL PURPOSE - SCANTRON® - ANSWER SHEET
SEE IMPORTANT MARKING INSTRUCTIONS ON SIDE 2
SIDE 1
NAME (Last, First, M.I.)
SEX
GRADE OR EDUCATION
BIRTHDATE
MO.
DAY
YR.
IDENTIFICATION NUMBER
SPECIAL CODES
Sample Only
Do Not Copy

SCANTRON®
GENERAL PURPOSE
ANSWER SHEET
form no. 4521
IMPORTANT DIRECTIONS
FOR MARKING ANSWERS
• Use #2 pencil only.
• Do NOT use ink or ballpoint pens.
• Make heavy black marks that fill the circle completely.
• Erase cleanly any answer you wish to change.
• Make no stray marks on the answer sheet.
EXAMPLES
WRONG
WRONG
WRONG
RIGHT
DO NOT WRITE
IN THIS SPACE
SCANTRON®
Reorder Form No. 4521
www.ScantronStore.com
800-722-6876
SIDE 2
SCANTRON Trans-Optic® EM-4521-5654321
© 2008 Scantron Corporation ALL RIGHTS RESERVED.
Sample
(Do Not Copy)

Appendix B: Sample Results



Student Statistics Report

Overall

Student	Grade	Total	Percent
	F	0 / 24	0.00
	B	20 / 24	83.33
	D	16 / 24	66.67
	C	18 / 24	75.00
	B	20 / 24	83.33
	B	20 / 24	83.33
	D	16 / 24	66.67
	F	14 / 24	58.33
	B	20 / 24	83.33
	A	22 / 24	91.67
	F	14 / 24	58.33
	F	14 / 24	58.33
	F	14 / 24	58.33
	D	16 / 24	66.67
	D	16 / 24	66.67
	A	22 / 24	91.67
	C	18 / 24	75.00
	C	18 / 24	75.00
	B	20 / 24	83.33
	A	24 / 24	100.00
	C	18 / 24	75.00
	C	18 / 24	75.00
	B	20 / 24	83.33
	C	18 / 24	75.00
	D	16 / 24	66.67
	B	20 / 24	83.33
	F	14 / 24	58.33
	D	16 / 24	66.67
	B	20 / 24	83.33
	D	16 / 24	66.67
	C	18 / 24	75.00

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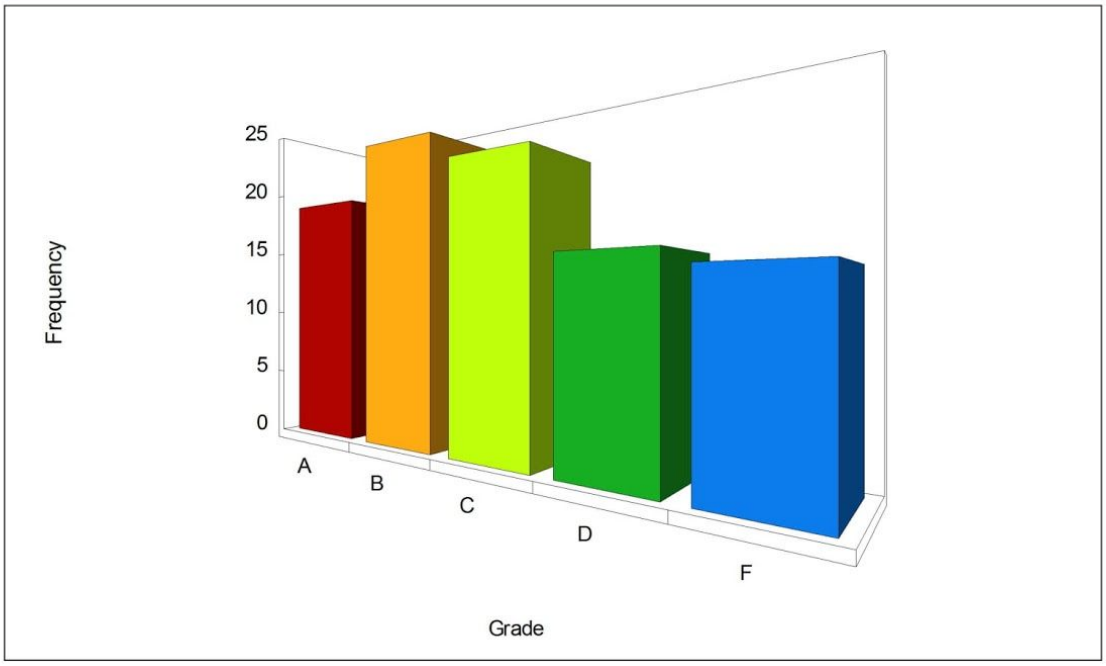
Class Frequency Distribution Report

Overall Mean Score: 76.02%

Grade	Percent Score	Raw Score	Frequency	Percent
A	90.00 - 100.00	21.60 - 24.00	19	21.11
B	80.00 - 89.99	19.20 - 21.59	23	25.56
C	70.00 - 79.99	16.80 - 19.19	21	23.33
D	60.00 - 69.99	14.40 - 16.79	14	15.56
F	0.00 - 59.99	0.00 - 14.39	13	14.44



3/8/2017 Class Frequency Distribution Report Page 1

Note: No 3D bar graphs!

Test Statistics Report

	Overall
Score Data	
Number of Graded Items	12
Total Points Possible	24
Maximum Score	24
Minimum Score	0
Statistics	
Mean Score	18.24
Mean Percent Score	76.02
Benchmark Score	-
Range of Scores	24.00
Standard Deviation	3.71
Variance	13.76
Percentiles	
Percentile (25)	16.00
Median Score	18.00
Percentile (75)	20.00
Inter Quartile Range	4.00
Confidence Intervals	
1%	17.22
5%	17.47
95%	19.02
99%	19.27
Test Reliability	
Kuder-Richardson Formula 20	0.57
Kuder-Richardson Formula 21	1.84
Coefficient (Cronbach) Alpha	0.57

Condensed Item Analysis Report

Legend: Correct: Incorrect: Distractors Chosen More than Correct Answer:

Question1

Response	Frequency	Percent
***A**	83	92.22
B	4	4.44
C	0	0.00
D	2	2.22
E	0	0.00
Missing	1	1.11

Question2

Response	Frequency	Percent
A	1	1.11
B	1	1.11
***C**	87	96.67
D	0	0.00
E	0	0.00
Missing	1	1.11

Question3

Response	Frequency	Percent
A	4	4.44
***B**	82	91.11
C	3	3.33
D	0	0.00
E	0	0.00
Missing	1	1.11

Question4

Response	Frequency	Percent
A	6	6.67
B	34	37.78
***C**	49	54.44
D	0	0.00
E	0	0.00
Missing	1	1.11

Question5

Response	Frequency	Percent
A	5	5.56
B	16	17.78
C	3	3.33
***D**	65	72.22
E	0	0.00
Missing	1	1.11

Question6

Response	Frequency	Percent
***A**	78	86.67
B	6	6.67
C	0	0.00
D	4	4.44
E	0	0.00
Missing	2	2.22

Question7

Response	Frequency	Percent
A	0	0.00
***B**	79	87.78
C	1	1.11
D	8	8.89
E	0	0.00
Missing	2	2.22

Question8

Response	Frequency	Percent
A	2	2.22
***B**	76	84.44
C	11	12.22
D	0	0.00
E	0	0.00
Missing	1	1.11

Question9

Response	Frequency	Percent
A	43	47.78
***B**	21	23.33
C	20	22.22
D	5	5.56
E	0	0.00
Missing	1	1.11

Question10

Response	Frequency	Percent
A	21	23.33
***B**	43	47.78
C	11	12.22
D	14	15.56
E	0	0.00
Missing	1	1.11

Question11

Response	Frequency	Percent
A	1	1.11
B	6	6.67
C	1	1.11
***D**	81	90.00
E	0	0.00
Missing	1	1.11

Question12

Response	Frequency	Percent
A	2	2.22
B	6	6.67
C	4	4.44
***D**	77	85.56
E	0	0.00
Missing	1	1.11

Test Item Statistics Report

Question		Summary Statistics				Reliability	
Question	Points	Graded	Correct	Incorrect	No Response	Point Biserial	Percent Correct
Question1	2	90	83	6	1	0.35	92.22
Question2	2	90	87	2	1	0.55	96.67
Question3	2	90	82	7	1	0.40	91.11
Question4	2	90	49	40	1	0.48	54.44
Question5	2	90	65	24	1	0.58	72.22
Question6	2	90	78	10	2	0.41	86.67
Question7	2	90	79	9	2	0.35	87.78
Question8	2	90	76	13	1	0.49	84.44
Question9	2	90	21	68	1	0.37	23.33
Question10	2	90	43	46	1	0.45	47.78
Question11	2	90	81	8	1	0.36	90.00
Question12	2	90	77	12	1	0.35	85.56