Questions 3 & 4:
A teacher wants to increase interest in STEM careers in middle school students (research has shown that this is a key time frame to introduce potential career paths). The teacher decides to test different types of STEM presentations to a group of boys and girls. The teacher gives the student a short questionnaire about careers in science before and after the presentations to assess the children's initial and subsequent views on STEM careers. The teacher presented students with either a professionally made video, another teacher, or an actual practicing STEM professional.

- Run a mixed factorial design (with pre/post as the repeated) measure and interpret the results of the analysis.

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
PPTest	Pillai's Trace	.706	57.684[b]	1.000	24.000	.000	.706
	Wilks' Lambda	.294	57.684[b]	1.000	24.000	.000	.706
	Hotelling's Trace	2.404	57.684[b]	1.000	24.000	.000	.706
	Roy's Largest Root	2.404	57.684[b]	1.000	24.000	.000	.706
PPTest * Gender3	Pillai's Trace	.491	23.156[b]	1.000	24.000	.000	.491
	Wilks' Lambda	.509	23.156[b]	1.000	24.000	.000	.491
	Hotelling's Trace	.965	23.156[b]	1.000	24.000	.000	.491
	Roy's Largest Root	.965	23.156[b]	1.000	24.000	.000	.491
PPTest * Presentation3	Pillai's Trace	.923	144.003[b]	2.000	24.000	.000	.923
	Wilks' Lambda	.077	144.003[b]	2.000	24.000	.000	.923
	Hotelling's Trace	12.000	144.003[b]	2.000	24.000	.000	.923
	Roy's Largest Root	12.000	144.003[b]	2.000	24.000	.000	.923
PPTest * Gender3 * Presentation3	Pillai's Trace	.565	15.593[b]	2.000	24.000	.000	.565
	Wilks' Lambda	.435	15.593[b]	2.000	24.000	.000	.565
	Hotelling's Trace	1.299	15.593[b]	2.000	24.000	.000	.565
	Roy's Largest Root	1.299	15.593[b]	2.000	24.000	.000	.565

a. Design: Intercept + Gender3 + Presentation3 + Gender3 * Presentation3
Within Subjects Design: PPTest

b. Exact statistic

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PPTest	Sphericity Assumed	286.017	1	286.017	57.684	.000	.706
	Greenhouse-Geisser	286.017	1.000	286.017	57.684	.000	.706
	Huynh-Feldt	286.017	1.000	286.017	57.684	.000	.706
	Lower-bound	286.017	1.000	286.017	57.684	.000	.706
PPTest * Gender3	Sphericity Assumed	114.817	1	114.817	23.156	.000	.491
	Greenhouse-Geisser	114.817	1.000	114.817	23.156	.000	.491
	Huynh-Feldt	114.817	1.000	114.817	23.156	.000	.491
	Lower-bound	114.817	1.000	114.817	23.156	.000	.491
PPTest * Presentation3	Sphericity Assumed	1428.033	2	714.017	144.003	.000	.923
	Greenhouse-Geisser	1428.033	2.000	714.017	144.003	.000	.923
	Huynh-Feldt	1428.033	2.000	714.017	144.003	.000	.923
	Lower-bound	1428.033	2.000	714.017	144.003	.000	.923
PPTest * Gender3 * Presentation3	Sphericity Assumed	154.633	2	77.317	15.593	.000	.565
	Greenhouse-Geisser	154.633	2.000	77.317	15.593	.000	.565
	Huynh-Feldt	154.633	2.000	77.317	15.593	.000	.565
	Lower-bound	154.633	2.000	77.317	15.593	.000	.565
Error(PPTest)	Sphericity Assumed	119.000	24	4.958			
	Greenhouse-Geisser	119.000	24.000	4.958			
	Huynh-Feldt	119.000	24.000	4.958			
	Lower-bound	119.000	24.000	4.958			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	PPTest	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PPTest	Linear	286.017	1	286.017	57.684	.000	.706
PPTest * Gender3	Linear	114.817	1	114.817	23.156	.000	.491
PPTest * Presentation3	Linear	1428.033	2	714.017	144.003	.000	.923
PPTest * Gender3 * Presentation3	Linear	154.633	2	77.317	15.593	.000	.565
Error(PPTest)	Linear	119.000	24	4.958			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	35575.350	1	35575.350	4706.772	.000	.995
Gender3	400.417	1	400.417	52.977	.000	.688
Presentation3	294.700	2	147.350	19.495	.000	.619
Gender3 * Presentation3	212.633	2	106.317	14.066	.000	.540
Error	181.400	24	7.558			

7. Gender3 * Presentation3 * PPTest

Measure: MEASURE_1

Gender3	Presentation3	PPTest	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Male	Video	1	16.400	.922	14.497	18.303
		2	32.400	1.286	29.746	35.054
	Teacher	1	19.800	.922	17.897	21.703
		2	19.400	1.286	16.746	22.054
	Scientist	1	18.400	.922	16.497	20.303
		2	24.200	1.286	21.546	26.854
Female	Video	1	17.800	.922	15.897	19.703
		2	34.400	1.286	31.746	37.054
	Teacher	1	30.400	.922	28.497	32.303
		2	15.600	1.286	12.946	18.254
	Scientist	1	30.200	.922	28.297	32.103
		2	33.200	1.286	30.546	35.854

Multiple Comparisons

Measure: MEASURE_1

	(I) Presentation3	(J) Presentation3	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Video	Teacher	3.9500*	.86939	.000	1.7789	6.1211
		Scientist	-1.2500	.86939	.338	-3.4211	.9211
	Teacher	Video	-3.9500*	.86939	.000	-6.1211	-1.7789
		Scientist	-5.2000*	.86939	.000	-7.3711	-3.0289
	Scientist	Video	1.2500	.86939	.338	-.9211	3.4211
		Teacher	5.2000*	.86939	.000	3.0289	7.3711

Based on observed means.
The error term is Mean Square(Error) = 3.779.

*. The mean difference is significant at the .05 level.

Part 2: Question 3: Interpretation

A mixed factorial analysis was conducted to investigate how gender (male or male), test (pre and post), and different presentations method influences middle school students' interest in STEM. The means and standard deviations for the learning recall are presented in Table 2.2 below. From within subject effects, the result of the analysis indicated a significant main effect for test, $F(1,24) = 57.684$, $p(0.000) < 0.05$, partial $\eta^2 = 0.706$. likewise, from between subject effects, there was a significant main effect for gender, $F(1,24) = 52.977$, $p(0.000) < 0.05$, partial $\eta^2 = 0.688$. Also, there was a significant main effect for presentation methods, $F(2,24) = 19.495$, $p(0.000) < 0.05$, partial $\eta^2 = 0.619$. Interms of interaction, there were significant interaction effects from both within and between subject effects. From within subject effects, there was a significant interaction effect for test and gender, $F(1,24) = 23.156$, $p(0.000) < 0.05$, partial $\eta^2 = 0.491$. Also, there was a significant interaction effect for test and presentation, $F(2,24) = 144.003$, $p(0.000) < 0.05$, partial $\eta^2 = 0.923$. At the same time, there was a significant interaction effect for test, gender and presentation, $F(2,24) = 15.593$, $p(0.000) < 0.05$, partial $\eta^2 = 0.565$.

Table 2.2. Mean and Standard Deviation for Question 3

Test	Gender	Presentation	M	SD
PreTest	Male	Video	16.4000	1.94936
		Teacher	19.8000	1.30384
		Scientist	18.4000	2.07364
	Female	Video	17.8000	2.16795
		Teacher	30.4000	2.70185
		Scientist	30.2000	1.92354
PostTest	Male	Video	32.4000	1.81659
		Teacher	19.4000	3.04959
		Scientist	24.2000	1.64317
	Female	Video	34.4000	2.07364
		Teacher	15.6000	4.61519
		Scientist	33.2000	2.94958

Because the interaction between test, gender and presentation was significant, we chose to ignore the test main effect and instead examined the test simple main effects - that is, the difference among pretest and posttest. Referring to the mean table above (Table 2.2), it is obvious that female that took the posttest questionnaire and watch the video presentation are more like to show more interest in STEM. Also, female that are present in the scientist presentations both during pretest and posttest and also took both pretest and posttest questionnaires are more likely to have more interest in STEM.

- Run these data with the pretest as a covariate (ANCOVA) and interpret the results of the analysis.

Tests of Between-Subjects Effects

Dependent Variable: PostTest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1592.610[a]	6	265.435	32.326	.000	.894
Intercept	80.439	1	80.439	9.796	.005	.299
PreTest	9.544	1	9.544	1.162	.292	.048
Gender3	.001	1	.001	.000	.992	.000
Presentation3	759.176	2	379.588	46.228	.000	.801
Gender3 * Presentation3	201.209	2	100.605	12.252	.000	.516
Error	188.856	23	8.211			
Total	22902.000	30				
Corrected Total	1781.467	29				

a. R Squared = .894 (Adjusted R Squared = .866)

3. Gender3 * Presentation3

Dependent Variable: PostTest

Gender3	Presentation3	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Male	Video	34.164[a]	2.078	29.865	38.463
	Teacher	20.124[a]	1.447	17.131	23.117
	Scientist	25.352[a]	1.669	21.900	28.804
Female	Video	35.736[a]	1.782	32.048	39.423
	Teacher	13.082[a]	2.664	7.570	18.593
	Scientist	30.743[a]	2.615	25.334	36.152

a. Covariates appearing in the model are evaluated at the following values: PreTest = 22.1667.

Part 2: Question 4: Interpretation

Analysis of covariance (ANCOVA) was conducted. The independent variables, gender, included two levels: male and female and presentation, included three levels: video, teacher, and scientist. The dependent variable was taken to be the posttest and the covariant was the pretest. The output of the analysis indicated that the relationship between the covariate (pretest) and the dependent variable (posttest) was significant as a function of the independent variables (gender*presentation), $F(2, 23) = 12.252$, $p(0.000) < 0.05$, partial $\eta^2 = 0.516$. likewise, the relationship between the dependent variable and presentation was significant, $F(2, 23) = 46.228$, $p(0.000) < 0.05$, partial $\eta^2 = 0.801$. We could notice that the strength of relationship between the presentation and dependent variable was very strong, as assessed by a partial η^2, with the presentation factor accounting for 80% of the variance. However, after accounting for covariant, the relationship between the dependent variable and gender was nonsignificant, F(1, 23) = 0.000, p(0.000) <0.05, partial η^2 = 0.00. The means of the posttest adjusted for presentation indicated that, female that watch video and engaged in posttest are more likely to show interest in STEM (M= 35.74), followed by male that watches video (M = 34.16).

- How does the outcome/interpretation of these data change between the two analyses?

  The outcome of this analysis makes it possible to find the relationship between the dependent variable and the independent variable while keeping covariant factor constant.

- Which approach do you think is more appropriate (and why)?

  ANCOVA approach is appropriate because it help to better understand how a factor impacts a dependent variable (DV) after accounting for some covariate(s).

Questions 5 & 6:
A researcher wants to examine the potential benefits of diet and exercise on two commonly used markers of health, weight and cholesterol levels. Participants were assigned to one of four combinations of diet/exercise (2 x 2) and had their weight (pounds) and cholesterol (LDL) measured.

- Run as a factorial design with a covariate (weight) and interpret the results.

Tests of Between-Subjects Effects

Dependent Variable: Cholesterol

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	27985.635[a]	4	6996.409	9.351	.000	.405
Intercept	132325.099	1	132325.099	176.855	.000	.763
WeightLost	264.918	1	264.918	.354	.554	.006
Diet	20262.854	1	20262.854	27.082	.000	.330
Exercise	5194.159	1	5194.159	6.942	.011	.112
Diet * Exercise	39.105	1	39.105	.052	.820	.001
Error	41151.615	55	748.211			
Total	1954191.000	60				
Corrected Total	69137.250	59				

a. R Squared = .405 (Adjusted R Squared = .361)

4. Diet * Exercise

Dependent Variable: Cholesterol

Diet	Exercise	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No Diet	No Exercise	186.348[a]	8.563	169.187	203.509
	20 min cardio 3x/week	207.439[a]	7.390	192.629	222.249
Reduced Calorie Diet	No Exercise	149.104[a]	7.795	133.483	164.725
	20 min cardio 3x/week	166.109[a]	7.091	151.899	180.319

a. Covariates appearing in the model are evaluated at the following values: WeightLost = 5.8333.

Part 2: Question 5: Interpretation

Analysis of covariance (ANCOVA) was conducted. The independent variables, diet, included two levels: no diet and reduced calorie diet, and exercise, included two levels: no exercise and 20 min cardio 3x/week. The dependent variable was taken to be the cholesterol and the covariant was weight. The output of the analysis indicated that the relationship between the covariant (weight) and the dependent variable (cholesterol) was nonsignificant as a function of the independent variables (diet*exercise), $F(1, 55) = 0.052$, $p(0.820) > 0.05$, partial $\eta^2 = 0.01$. However, the relationship between the dependent variable and exercise was significant, $F(1, 55) = 6.942$, $p(0.011) <0.05$, partial $\eta^2 = 0.112$. Furthermore, after accounting for covariant, the relationship between the dependent variable and diet was also significant, $F(1, 55) = 27.082$, $p(0.000) <0.05$, partial $\eta^2 = 0.330$. The means of the weight adjusted for the cholesterol indicated that, reduced calorie diet with 20min cardio 3x/week, yields a lesser and more reasonable cholesterol reduction ($M = 166.11$).