Students on Remote Learning

ISOM 6670B Behavioral Analytics

Group 8

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Executive Summary

Due to the COVID-19 pandemic, the 2020 spring semester has been conducted remotely for nearly all HK students regardless of education level. This is the first time in Hong Kong history that remote learning has been used so widely, and it presents a unique opportunity to study the reaction of students to this new learning mode.

284 students completed surveys on this topic. 10 sensitive questions were asked. To encourage truthful responses, Randomized Response Technique was used so that a portion of the respondents could answer innocuous questions. The respondents were divided into two cohorts based their binary selection of letters A and B. These cohorts were then forced into 2 different p-values based on a number selection and randomized matching process.

The results showed that a strong majority of students were opposed to Remote Learning when alternatives are available. Moreover, this opinion seems to be quite unanimous. Through correlation analysis it became clear that the root cause of this dissatisfaction with remote learning was in the lack of social interaction between students and teachers. These results may provide some cause for reservation about the continued proliferation of remote learning.

Data Collection

The data used for this project are collected from two online questionnaires, which were structured using the Randomized Response Techniques framework. Respondents are separated into two samples, Group A and Group B, based on their answer to the question: "Please choose A or B". A total of ten sensitive questions are contained in the questionnaire.

Implementing UQD, each sensitive question is paired with an innocuous question. Respondents are asked to pick a number from 1、2、3, and then compare this number with a number randomly generated from the survey system. For Group A, if the two numbers match, then they are required to answer the sensitive questions, if the numbers don't match, then they are asked to answer the innocuous questions. This sets the probability of answering sensitive questions (the p-value) is 1/3 for Group A. For Group B, the same randomization process is used, but the result is flipped. Those with *non-matching* numbers are asked to answer the sensitive questions, thus the p-value for Group B is 2/3.
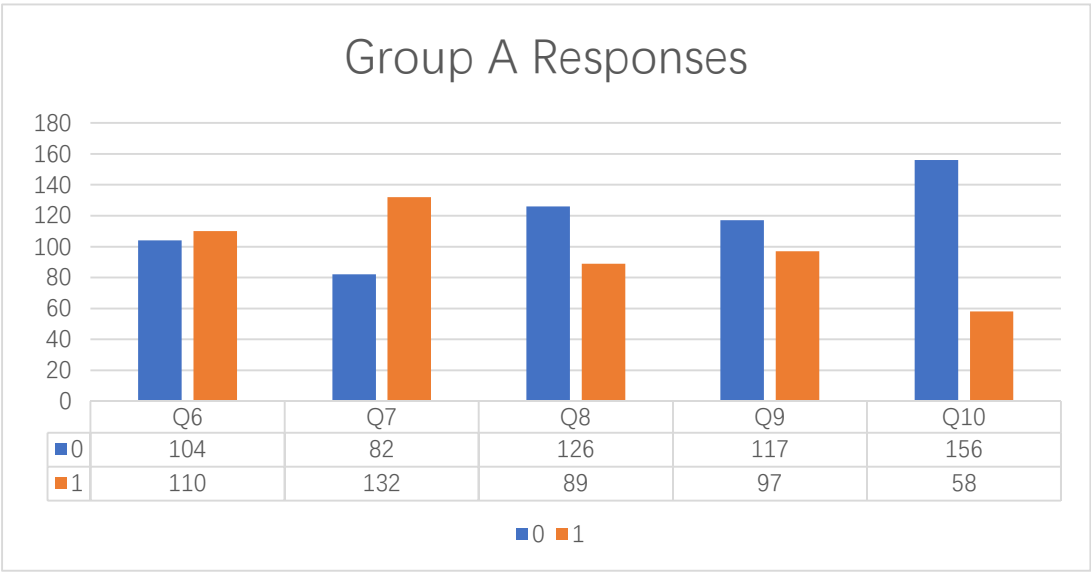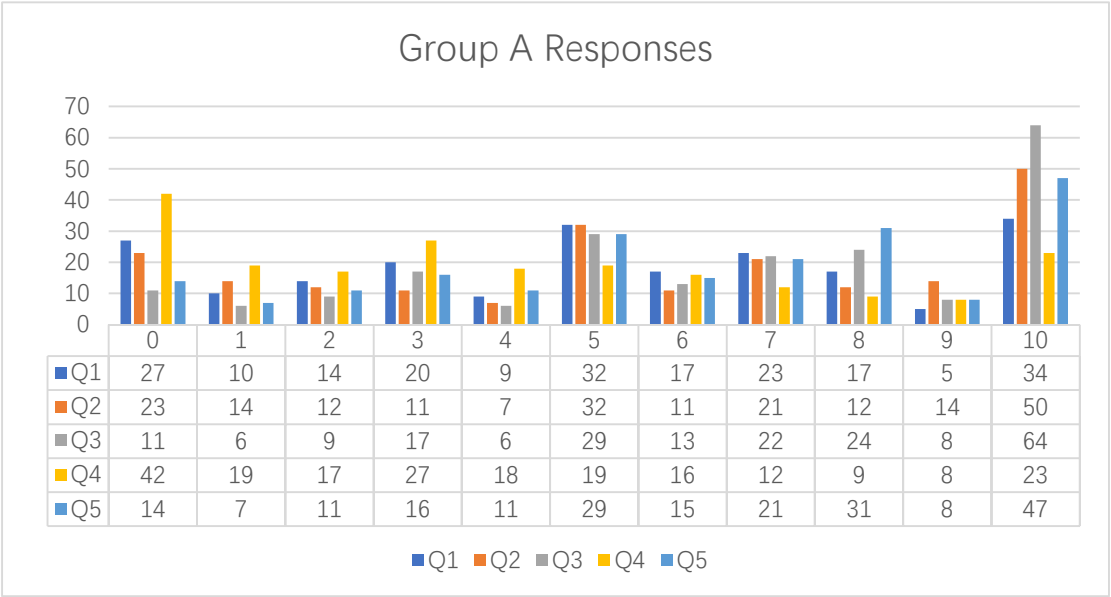
Data Description

A total of 284 valid responses were collected, 215 responses from Group A and 69 responses from Group B. 116 of the respondents were males, and 168 were female. The education level of the respondents was also gathered. 47.54% of respondents are graduate students, 26.06% middle-schoolers, 17.96% undergraduates, 4.58% were high-schoolers, and the remaining were MBA and PHD. The diversity of education levels eliminates bias in this dimension; our goal is to study student opinion on remote learning regardless of education level.
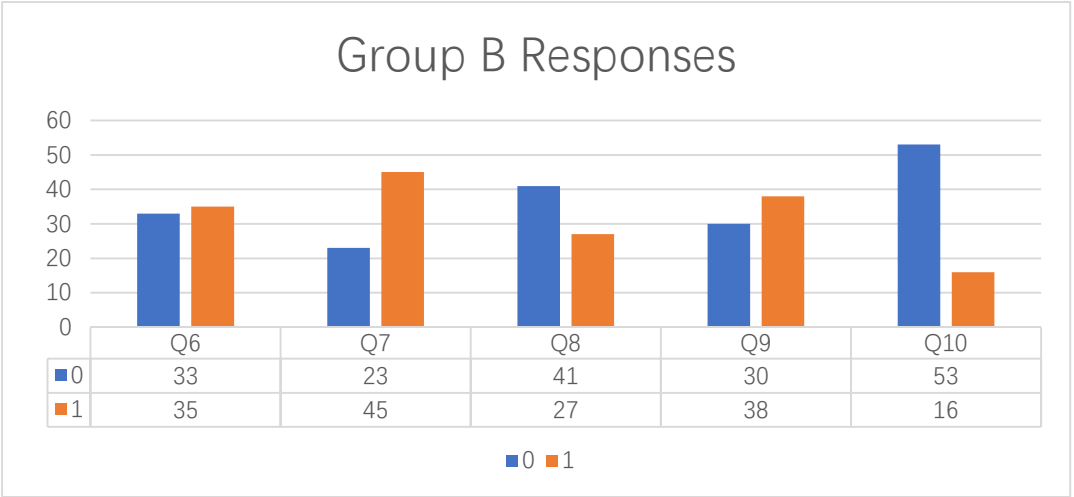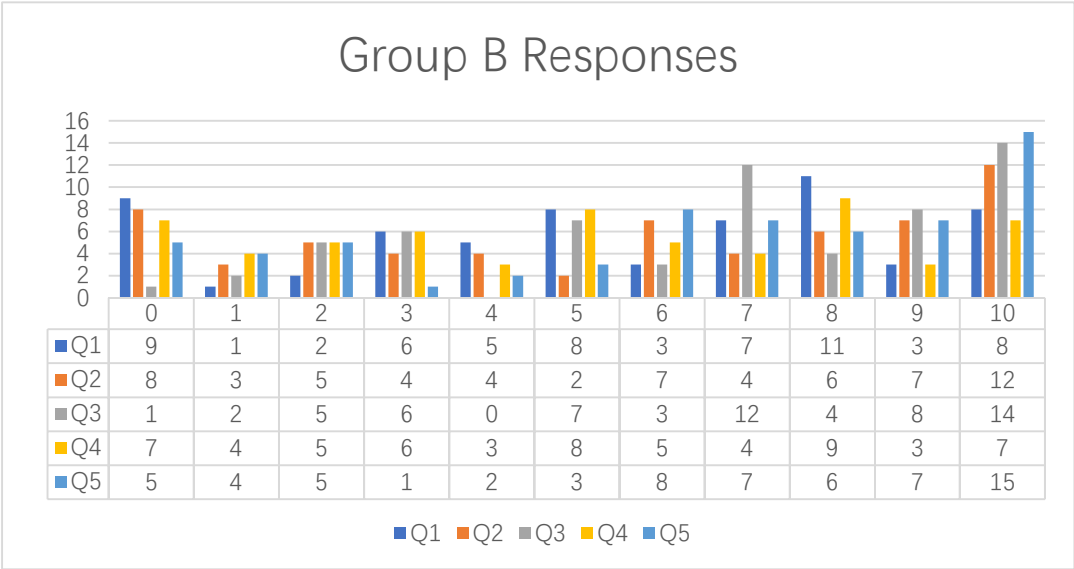
Summary statistics are shown below:

	A: Sensitive question B: Unrelated question	Mean	Standard Error	Median	Mode	Standard Deviation	Variance	Min	Max	Counts
				likert scale questions: 0-10				binary questions: 0/1		
Q1	A: I think the online class is very ineffective. B: I especially like milk tea.	5.376761	0.193865	5	10	3.2670789	10.6738	0	10	284
Q2	A: I'm more reluctant to ask questions in online classes than in live classes. B: I often go to bed after midnight.	5.901408	0.207402	6	10	3.4951958	12.21639	0	10	284
Q3	A: Compared to offline, I often wander off or get distracted, during online lessons. B: I prefer to study by myself.	6.693662	0.181113	7	10	3.0521663	9.315719	0	10	284
Q4	A: Online classes reduce the efficiency of group work, increase time costs, and discourage group participation. B: I often cook by myself.	4.429577	0.198586	4	0	3.3466356	11.19997	0	10	284
Q5	A: I think online teaching will alienate the relationship between students and professors. B: I think exercise can relieve stress.	6.271127	0.186987	7	10	3.1511528	9.929764	0	10	284
Q6	A: I think online teaching reduces teachers' emphasis on teaching quality. B: I am the only child in my family.	0.517606	0.029703	1	1	0.500572	0.250572	0	1	284
Q7	A: I don't want to enable my webcam during classes. B: I have pets at home.	0.630282	0.028695	1	1	0.4835805	0.23385	0	1	284
Q8	A: I never leave the lecture, but still remain online. B: I have a driving license.	0.411972	0.029258	0	0	0.4930589	0.243107	0	1	284
Q9	A: I think online teaching has reduced my personal learning time. B: I prefer Mac over Windows.	0.482394	0.029703	0	0	0.500572	0.250572	0	1	284
Q10	A: If I could choose, I would continue to choose the teaching mode based on online courses. B: I prefer Coke-Cola over Pepsi.	0.264085	0.026205	0	0	0.4416227	0.195031	0	1	284

Group A Responses

	0	1	2	3	4	5	6	7	8	9	10
Q1	27	10	14	20	9	32	17	23	17	5	34
Q2	23	14	12	11	7	32	11	21	12	14	50
Q3	11	6	9	17	6	29	13	22	24	8	64
Q4	42	19	17	27	18	19	16	12	9	8	23
Q5	14	7	11	16	11	29	15	21	31	8	47

■Q1 ■Q2 ■Q3 ■Q4 ■Q5

Group A Responses

	Q6	Q7	Q8	Q9	Q10
0	104	82	126	117	156
1	110	132	89	97	58

■0 ■1

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Group B

Group B Responses

	0	1	2	3	4	5	6	7	8	9	10
Q1	9	1	2	6	5	8	3	7	11	3	8
Q2	8	3	5	4	4	2	7	4	6	7	12
Q3	1	2	5	6	0	7	3	12	4	8	14
Q4	7	4	5	6	3	8	5	4	9	3	7
Q5	5	4	5	1	2	3	8	7	6	7	15

Group B Responses

	Q6	Q7	Q8	Q9	Q10
0	33	23	41	30	53
1	35	45	27	38	16

Data Analysis

Summary statistics table:

Type	Question	Sensitive Question	Mean	Variance
Likert	1	I think the online class is very ineffective.	6.22	9.68
Likert	2	I'm more reluctant to ask questions in online classes than in live classes.	6.10	12.59
Likert	3	Compared to offline, I often wander off or get distracted, during online lessons.	7.14	6.84
Likert	4	Online classes reduce the efficiency of group work, increase time costs, and discourage group participation.	6.66	6.52
Likert	5	I think online teaching will alienate the relationship between students and professors.	6.85	11.80
Binary	6	I think online teaching reduces teachers' emphasis on teaching quality. (Yes / No)	0.53	0.25
Binary	7	I don't want to enable my webcam during classes. (Yes / No)	0.71	0.20
Binary	8	I never leave the lecture, but still remain online. (Yes / No)	0.40	0.24
Binary	9	I think online teaching has reduced my personal learning time. (Yes / No)	0.67	0.22
Binary	10	If I could choose, I would continue to choose the teaching mode based on online courses. (Yes / No)	0.19	0.15

<u>Sample Mean</u>

The first 5 questions of each survey are Likert scale sensitive questions, and the last 5 questions are binary questions. To dig out the responses to sensitive questions, we used Method of Moment to estimate the mean and variance for each sensitive question.

From the table above, it can be seen that, among the Likert questions (questions 1 through 5), mean values lie between 6 and 7. This suggests that remote learning is viewed negatively by the respondents as a whole. The 7.14 mean value for question 3 is particularly troubling since it suggests that remote learning cannot retain students' attention when compared to traditional classroom instruction. Equally important is the 6.85 value for question 5. This suggests that inter-student social interactions are severely limited by remote learning.

The binary question mean results paint a similar picture. According to the 0.71 value for question 7, students are reluctant to turn on their camera. Question 8 tells us that remote

learning has reduced their overall learning times, and finally question 10's value of 0.19 indicates that few students would continue with remote learning if given the choice.

<u>Sample Variance</u>

After getting the estimated means, we also calculated the variance for each sensitive question using MoM.

Among Likert questions, the largest variance occurs in question 2 which had the lowest mean value (6.10) among the first 5 questions. This extremely high variance indicates that opinion on the topic of students' reluctance to ask question is highly divided. So while the majority of students do feel some reluctance to raise their hand, there are a considerable number who don't, at least not relative to traditional classroom instruction.

On the other end, the extremely low variance for question 10 (0.15) suggests that student unwillingness to choose remote learning is nearly unanimous. This combination of an extreme mean and variance value strongly suggests that students are largely in agreement that they do not prefer remote learning.

Conditional Probability

Question	Sensitive Question Pair	Conditional Probability
9	I think online teaching has reduced my personal learning time. = YES	0.84
Given 6	I think online teaching reduces teachers' emphasis on teaching quality. = YES	
10	If I could choose, I would continue to choose the teaching mode based on online courses. = NO	0.83
Given 8	I never leave the lecture, but still remain online. = NO	
7	I don't want to enable my webcam during classes. = YES	0.74
Given 8	I leave the lecture, but still remain online. = NO	
6	I think online teaching reduces teachers' emphasis on teaching quality. = NO	0.73
Given 9	I think online teaching has reduced my personal learning time. = NO	
10	If I could choose, I would continue to choose the teaching mode based on online courses. = NO	0.73
Given 6	I think online teaching reduces teachers' emphasis on teaching quality. = YES	
8	I never leave the lecture, but still remain online. = NO	0.63
Given 6	I think online teaching reduces teachers' emphasis on teaching quality. = YES	
8	I never leave the lecture, but still remain online. = NO	0.62
Given 7	I don't want to enable my webcam during classes. = YES	

After calculating the conditional probabilities for the binary questions, we chose the probabilities that were higher than 50% for further analysis.

Among the conditional probabilities, the highest value is $P(X9=1|X6=1)$ at 0.84. This value means that students who feeling their self-learning time is being reduced are highly likely to also feel that online teaching reduces teachers' emphasis on teaching quality. Conversely, the conditional probability that $P(X6=0|X9=0)$ of 0.73 implies that students who don't feel their self-study time is reduced, also don't believe that remote learning reduces emphasis on

teaching quality.

Unsurprisingly, there's also a close relationship between those students who don't want to enable their webcam and those who leave the session while still online. It would be much harder to leave the session when the webcam is enabled. This relationship is suggested by $P(X7=1|X8=0)$ being 0.74, quite a high value.

A slightly weaker relationship of 0.63 is shown by $P(X8=0|X6=1)$. This suggests that students who leave online classes are the also the ones who feel that quality of teaching is compromised. This relationship is quite intuitive.

Lastly, and perhaps most importantly, the high values of $P(X10=0|X6=1) = 0.73$ and $P(X10=0|X8=0) = 0.83$ suggest that the two strongest reasons for students not wanting more remote learning is that they're concerned with the reduced emphasis on teaching quality and the inability to concentrate.

Correlation Analysis

We examined the correlation between questions with related themes. The strongest correlations are summarized in the table below:

Question	Sensitive Question	Corr
1	I think the online class is very ineffective.	0.47
3	Compared to offline, I often wander off or get distracted, during online lessons.	
1	I think the online class is very ineffective.	0.63
4	Online classes reduce the efficiency of group work, increase time costs, and discourage group participation.	
2	I'm more reluctant to ask questions in online classes than in live classes.	0.49
5	I think online teaching will alienate the relationship between students and professors.	

The relatively high correlation coefficient between perceived ineffectiveness of remote learning and discouragement of group work is particularly strong. This may be highlighting the important role that social interactions play in the perceived effectiveness of classroom learning. This lack of social interaction theme persists in the other question pairs for Question

1. Students feeling more distracted correlates strongly with perceived ineffectiveness or remote learning.

The last question pair correlation strongly suggests that having a close student-teacher relationship is critical to students' willingness to participate and ask questions.

Group Analysis on Gender and Education Level

<u>Gender</u>

Male values minus Female values:

Type	Question	Sensitive Question	Mean	Variance
Likert	1	I think the online class is very ineffective.	-0.82	3.92
Likert	2	I'm more reluctant to ask questions in online classes than in live classes.	-0.46	0.30
Likert	3	Compared to offline, I often wander off or get distracted, during online lessons.	0.77	3.41
Likert	4	Online classes reduce the efficiency of group work, increase time costs, and discourage group participation.	-2.07	5.28
Likert	5	I think online teaching will alienate the relationship between students and professors.	-2.11	4.04
Binary	6	I think online teaching reduces teachers' emphasis on teaching quality. (Yes / No)	0.14	-0.01
Binary	7	I don't want to enable my webcam during classes. (Yes / No)	-0.56	0.16
Binary	8	I never leave the lecture, but still remain online. (Yes / No)	0.08	0.02
Binary	9	I think online teaching has reduced my personal learning time. (Yes / No)	-0.10	0.04
Binary	10	If I could choose, I would continue to choose the teaching mode based on online courses. (Yes / No)	0.10	0.06

The result shows that male respondents tend to have more positive attitudes toward online learning. The mean value of questions 1, 2, 4 and 5 are lower, but the variance is also higher, which means that the diversity of male responses' opinion is wider. Meanwhile, compared with female respondents, male respondents are more likely to get distracted during online courses, and they are more willing to turn on the webcam during classes.

<u>Education Level</u>

Postgrad values minus Non-postgrad values:

Type	Question	Sensitive Question	Mean	Variance
Likert	1	I think the online class is very ineffective.	-0.36	-0.74
Likert	2	I'm more reluctant to ask questions in online classes than in live classes.	-0.48	3.06
Likert	3	Compared to offline, I often wander off or get distracted, during online lessons.	1.48	3.04
Likert	4	Online classes reduce the efficiency of group work, increase time costs, and discourage group participation.	0.00	-1.92
Likert	5	I think online teaching will alienate the relationship between students and professors.	0.90	-1.44
Binary	6	I think online teaching reduces teachers' emphasis on teaching quality. (Yes / No)	0.03	0.00
Binary	7	I don't want to enable my webcam during classes. (Yes / No)	0.72	-0.17
Binary	8	I never leave the lecture, but still remain online. (Yes / No)	0.00	0.00
Binary	9	I think online teaching has reduced my personal learning time. (Yes / No)	0.25	-0.08
Binary	10	If I could choose, I would continue to choose the teaching mode based on online courses. (Yes / No)	0.32	0.20

For the most part, responses varied little across different levels of education. Only with the postgraduate cohort did we notice any significant differences. Overall, their opinion on remote learning is more positive than other education levels, regardless of gender. This attributable to the fact that older students are more developed and mature, so issues with social isolation and lack of direct teacher supervision are less impactful.

Another interesting data feature is that postgraduates are extremely unwilling to enable their webcam relative to lower education level students. This is perhaps just a result of older adults valuing their privacy more.

Conclusion

From the results, it can be seen that remote learning is perceived negatively overall among all types of students. There is a strong feeling on alienation both between students and teachers. This may be because many higher-level students in university never even got a chance to meet with their classmates face-to-face before the start of remote learning.

For younger students who are still developing their social skills, remote learning may be even more challenging and perhaps even damaging in the long-run. Lower level students also

need to spend more time in school, and now that time is spent in front of a camera, often with their parents (who are now working from home) in the same room. This combination of stresses may help to explain the strong reluctance to use cameras, among other negative attitudes towards online learning.

Beyond the social deficits, there's also the concern that students have with the quality of online teaching skills, and the subsequent lack of interest they have in the class (manifesting in them leaving the session). Forced webcam use will likely reduce this propensity, but it's not solving the underlying problems of teaching skills and lack of social interaction.

The business implications of this study are considerable. For more than a decade now, the proliferation of high-speed internet has popularized the concept of online learning, especially for cases where traditional logistics can be inefficient (teacher lives in different country) or costly (commuting in busy cities). Many traditional East Asian parents also favor online learning since it allows them to always be "in the classroom" with their kids, closely monitoring their progress. There's also the perceived benefit of not having other kids as distractions.

These favorable tailwinds have led to the rise of highly successful online learning companies like VIP Kid and Himalaya FM. Both specialize in bringing in teachers from Western countries to teach a wide-ranging selection of courses (though English language is still the focus).

The results of our wide-ranging survey show that these perceived benefits may have considerable downsides from the students' point of view. Students value social interactions not only with their classmates and friends, but also with their teachers. Child psychologists have known for decades that much of the practical learning and maturation that happens in children is not the direct result of their teachers or textbooks, but in their interactions with other students. The lack of this dimension in remote learning can have long-lasting implications of the development of children in the near future as remote learning becomes ever more popular, especially after the boost it has received from the current Covid-19 global quarantine.

Some partial remedies are to improve the quality of online teaching skills and force webcam use. Very few teachers are trained in this form of teaching. Many older teachers would have studied education sciences long before online teaching was even feasible. Obviously, this imposes some serious strains on resources as there's just so many teachers who would need this type of training, and very few people qualified to teach it.

Forcing webcam use is actually quite common now. However, it comes with its own set of challenges. The simple limitation of Zoom Webinar means that it's nearly impossible for a teacher to monitor whether all students have the camera on, and it's hard to say whether an

absent student is simply going to the restroom since there's no way to keep track of how long they've been away. There's also issues with whether webcam use within a private residence can even be forced from a legal standpoint as this is a clear imposition on privacy.

Appendix

Estimating the sample mean values for Y and U questions:

$$\hat{\mu}_Y = \frac{(1 - p_{(2)})\bar{Z}_{(1)} - (1 - p_{(1)})\bar{Z}_{(2)}}{p_{(1)} - p_{(2)}}$$

$$\hat{\mu}_U = \frac{p_{(1)}\bar{Z}_{(2)} - p_{(2)}\bar{Z}_{(1)}}{p_{(1)} - p_{(2)}}$$

Estimating the sample variance values for Y and U questions:

$$\begin{cases} E[Z^2_{(1)i}] = p_{(1)}(\sigma_{Y_iY_i} + \mu^2_{Y_i}) + (1 - P_{(1)})(\sigma_{U_iU_i} + \mu^2_{U_i}) \\ E[Z^2_{(2)i}] = p_{(2)}(\sigma_{Y_iY_i} + \mu^2_{Y_i}) + (1 - P_{(2)})(\sigma_{U_iU_i} + \mu^2_{U_i}) \end{cases}$$

Estimating covariance:

$$\begin{cases} E[Z_{(1)i}Z_{(1)j}] = p^2_{(1)}(\sigma_{Y_iY_j} + \mu_{Y_i}\mu_{Y_j}) + (1 - p_{(1)})p_{(1)}(\mu_{U_i}\mu_{Y_j} + \mu_{Y_i}\mu_{U_j}) + (1 - P_{(1)})^2(\sigma_{U_iU_j} + \mu_{U_i}\mu_{U_j}) \\ E[Z_{(2)i}Z_{(2)j}] = p^2_{(2)}(\sigma_{Y_iY_j} + \mu_{Y_i}\mu_{Y_j}) + (1 - p_{(2)})p_{(2)}(\mu_{U_i}\mu_{Y_j} + \mu_{Y_i}\mu_{U_j}) + (1 - P_{(2)})^2(\sigma_{U_iU_j} + \mu_{U_i}\mu_{U_j}) \end{cases}$$

Estimating correlation:

$$corr(X_i, X_j) = \frac{cov(X_i, X_j)}{\sqrt{var(X_i)}\sqrt{var(X_j)}}$$

Conditional probabilities:

$$\begin{cases} \mu_{X1} = 1 * P(X1 = 1) + 2 * P(X1 = 2) \\ P(X1 = 1) + P(X1 = 2) = 1 \end{cases}, \begin{cases} \mu_{X2} = 1 * P(X2 = 1) + 2 * P(X2 = 2) \\ P(X2 = 1) + P(X2 = 2) = 1 \end{cases}$$

Therefore, $\begin{cases} P(X1 = 1) = 2 - \mu_{X1} = \\ P(X1 = 2) = \mu_{X1} - 1 = \end{cases}$ $\begin{cases} P(X2 = 1) = 2 - \mu_{X2} = \\ P(X2 = 2) = \mu_{X2} - 1 = \end{cases}$

Then, we solve $P(X1 = 2 \cap X2 = 1)$

$$\begin{cases} P(X1 = 1) = P(X1 = 1 \cap X2 = 1) + P(X1 = 1 \cap X2 = 2) = 2 - \mu_{X1} \\ P(X1 = 2) = P(X1 = 2 \cap X2 = 1) + P(X1 = 2 \cap X2 = 2) = \mu_{X1} - 1 \\ P(X2 = 1) = P(X1 = 1 \cap X2 = 1) + P(X1 = 2 \cap X2 = 1) = 2 - \mu_{X2} \\ P(X2 = 2) = P(X1 = 1 \cap X2 = 2) + P(X1 = 2 \cap X2 = 2) = \mu_{X2} - 1 \end{cases}$$