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Emergency Remote Teaching and Program Intervention: Towards a Human-Machine Pedagogy based on Interactive Learning Documents

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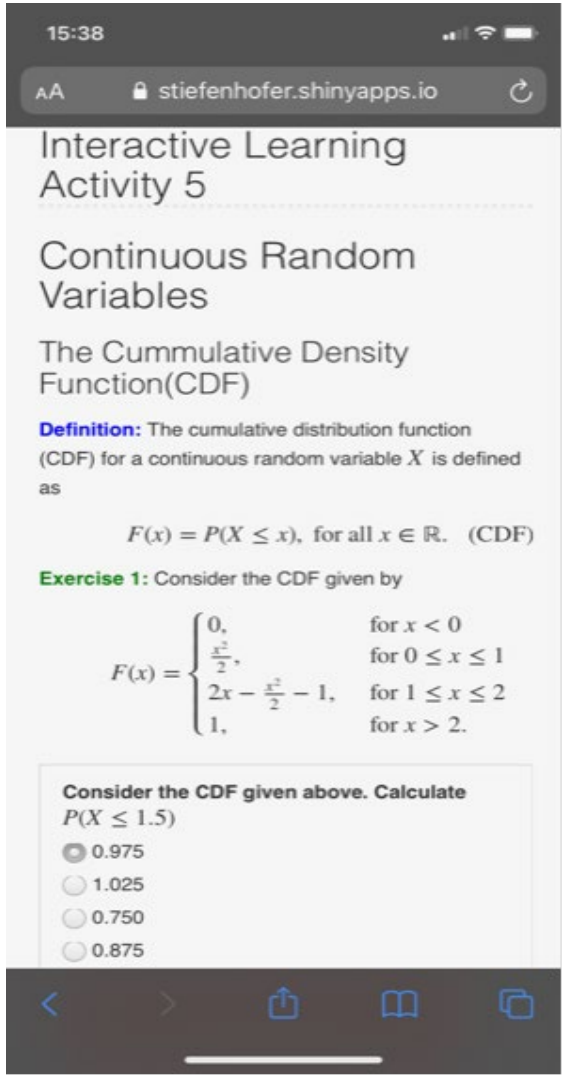


Motivation I

- Teaching restrictions, due to the covid-19 pandemic, have rapidly shifted the global learning environment demanding educators to implement technology-based solutions in their instruction.
- The first-year student university experience is of upmost importance for students and universities alike as it is inherently linked to student satisfaction, retention, and academic success(Schütze, Bartyn, and Tapsell 2021).
- While most students manage the transition into university life successfully, there is a significant minority (20–30%) who consistently experience academic and personal difficulties and for whom the change in academic culture is an unpleasant experience.
- To support these students and improve retention rates during the transition year, universities develop and implement local and institutional interventions (L. Thomas 2017).
- Generally, these programmes are designed for on-site in-person mentoring (R. McWilliams 2014; Curtis et al. 2017; O'Rourke et al. 2021) which, due to the rapid shift of the learning environment to emergency remote teaching caused by the COVID-19 pandemic, lack the usual effectiveness.
- Consequently, educators are now challenged to find innovative ways to integrate intervention mechanisms into their course curriculum to help alleviate the students' transition. In this paper we develop human-machine interactions that can be integrated as intervention mechanisms into a stage one statistics course to support students in their transition to a new learning environment.

Motivation II

- The widespread lockdowns of societies across the world resulted in universities being forced to rapidly close campuses and shift to emergency remote teaching at incredibly short notice. Neither students nor educators were well-prepared for this sudden shift to online teaching (Kyne and Thompson 2020).

- Jayalath et al. (Jayalath et al. 2020) study factors influencing a sudden transition to online teaching during the COVID-19 pandemic.

- Despite online statistics teaching pedagogies existing as a research domain since the late 90's and many universities already employing a blended learning approach with some degree of online teaching (Mills and Raju 2011), universities were generally not prepared for a sudden switch to full remote teaching.

- Pedagogical challenges arose due short transition times to remote teaching preventing students and educators from acquiring the necessary digital skills. Students also reported ineffective organisation of learning material (structured content versus an abundance of online resources), and a lack of opportunity for interactive learning (Johnson et al. 2009).

- We design an HTML interface, based on R-Markdown and R-Shiny technologies, enabling educators to efficiently organise large and complex quantities of learning material, and build specific pedagogical tools which will be used to engage students with a variety of dynamic interactive learning options.

Motivation III

- Further to the issues related to the transition into university education during a pandemic mentioned above, social science students often find little motivation and passion for the subject of statistics and struggle to successfully transition to university level statistics (Sizemore and Lewandowski 2009; Perlman and McCann 1999).

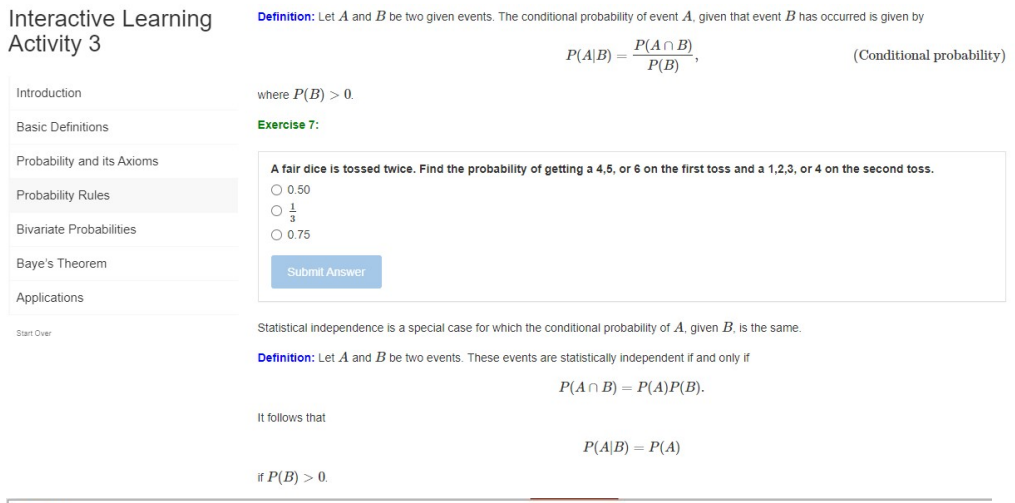
- Moreover, nearly 75% of students report some degree of statistics anxiety while enrolled in quantitative courses (Kinkead, Miller, and Hammett 2016; Onwuegbuzie and Wilson 2003).

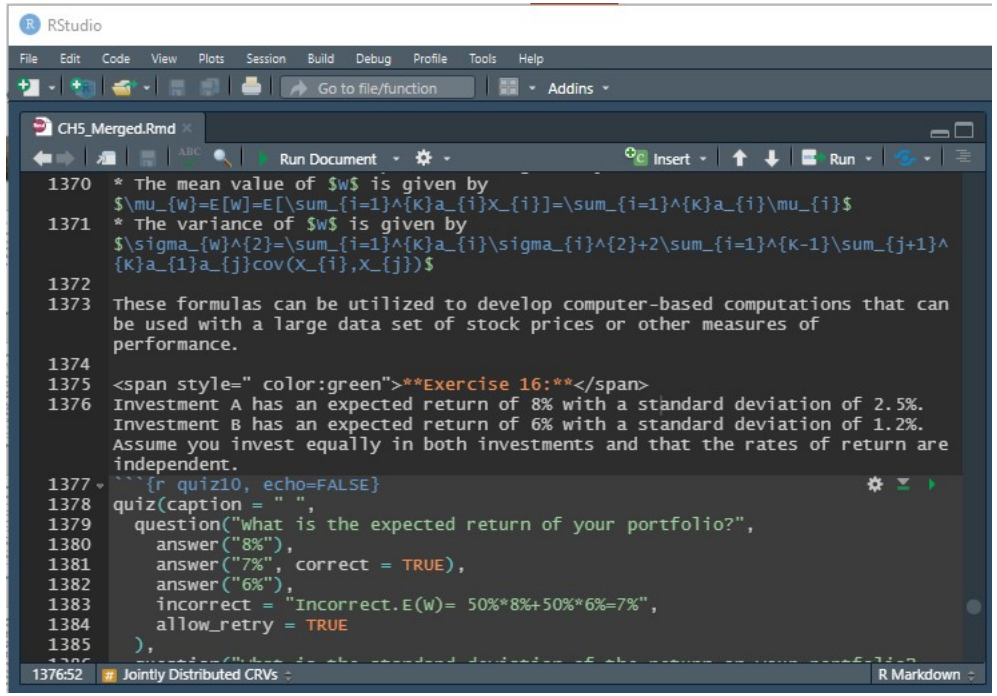
- The Affect dimension of the SATS survey measures student's feelings concerning statistics (Emmioğlu and Capa-Aydin 2012). According to Perloff (Perloff 2003) attitude is a mental condition shaped through experience that will influence a person's reaction towards an object or related phenomenon. Positive attitudes towards learning statistics are positively correlated with performance, student retention, student satisfaction, and student motivation to continue to engage with statistics (Ashaari et al. 2011; Vanhoof 2010; Rahnaward Ghulami, Hamid, and Zakaria 2015).

- These observations motivate us to develop human-machine based intervention strategies at course level to help students reduce statistics anxiety and increase student performance and retention during the transition year under the teaching restrictions imposed by the COVID-19 pandemic for social science students. We hypothesise that a carefully designed human-machine pedagogy based on Interactive Learning Documents, which addresses some of the dimensions of the SATS 36 survey (Schau et al. 1995; Schau 2003) and the factors of online system anxiety (Liu and Yuan 2021), will help social science students in reducing statistics anxiety during the transition to university under the conditions of a pandemic.

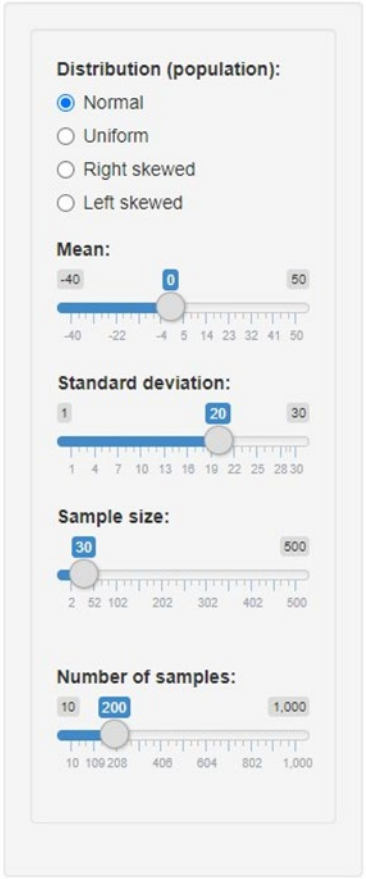
Developing ILDs

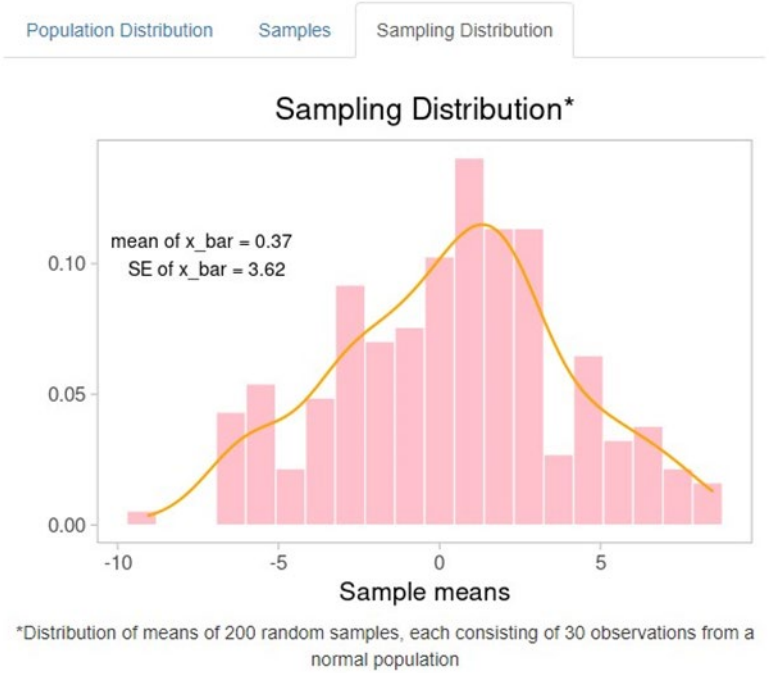
- ILDs based on R-Studio, R-language, “learnr” package.
  - Narrative, figures, illustrations, and equations
  - Code exercises (R code chunks that users can edit and execute directly)
  - Multiple choice quizzes
  - Videos (supported services include YouTube and Vimeo)
  - Interactive Shiny components

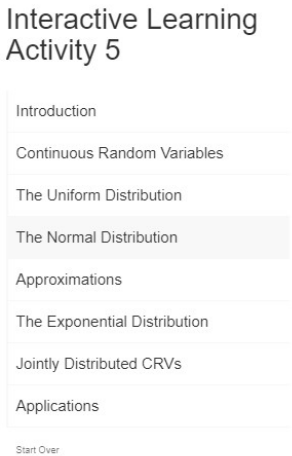


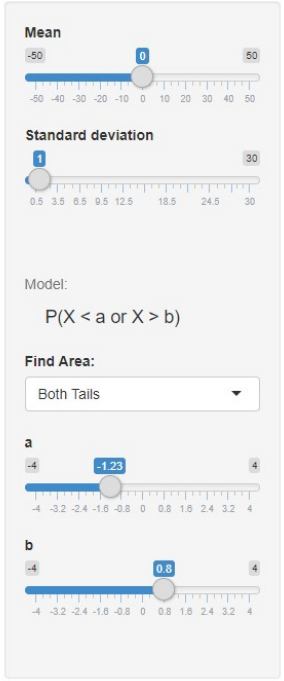


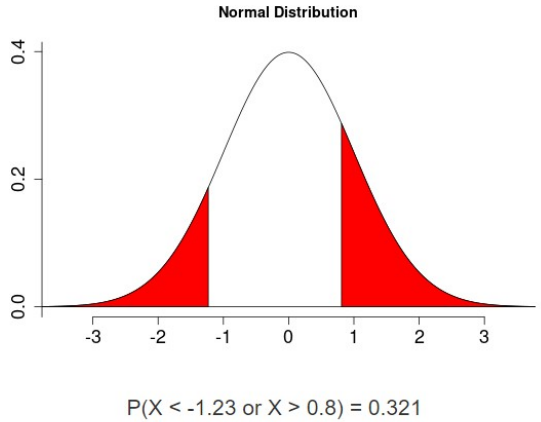
Developing ILDs











P(X < -1.23 or X > 0.8) = 0.321

Results: The Student Experience

Q 4: What sentences describe your experience with the Interactive Learning App?

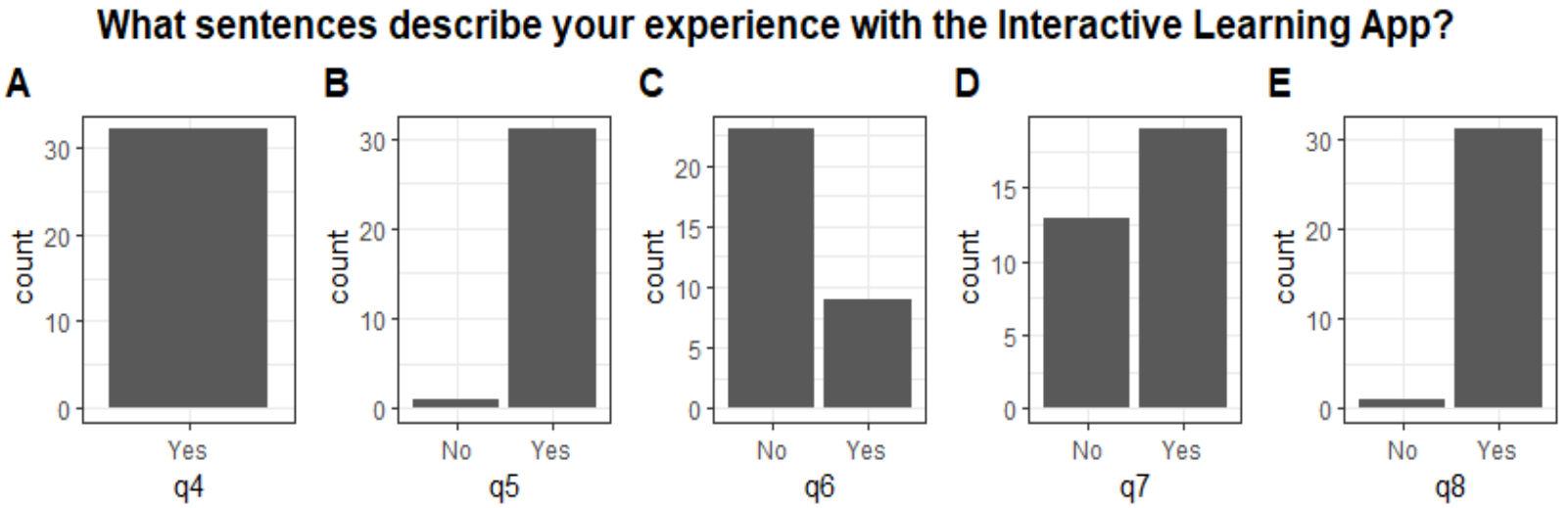
q4: [Its easy to use]

q5: [I feel engaged with my homework]

q6: [It's fun to use]

q7: [It's visually appealing]

q8: [It's easy to navigate]



The Student Experience

Q 5: Comment on the features of the Interactive Learning App (Recall that the App is expected to replace weekly homework activities and not substitute lectures/ tutorials/seminars).

q9: [Recall of definitions and results in compact form]

q10: [Short questions to check understanding of definitions]

q11: [Solutions to multiple choice questions]

q12: [Using pre-written R code to check solutions]

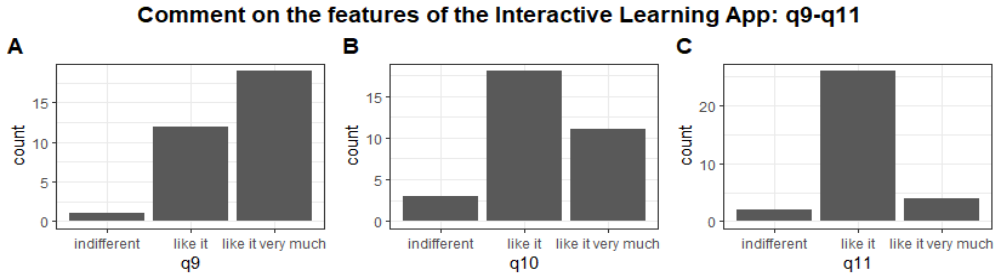
q13: [Embedded pdf files with detailed worked out examples]

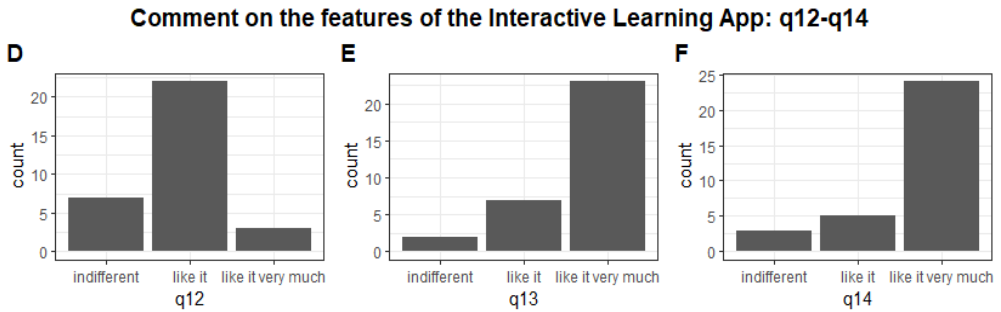
q14: [Interactive Dynamic Visualizations where I can choose parameters]

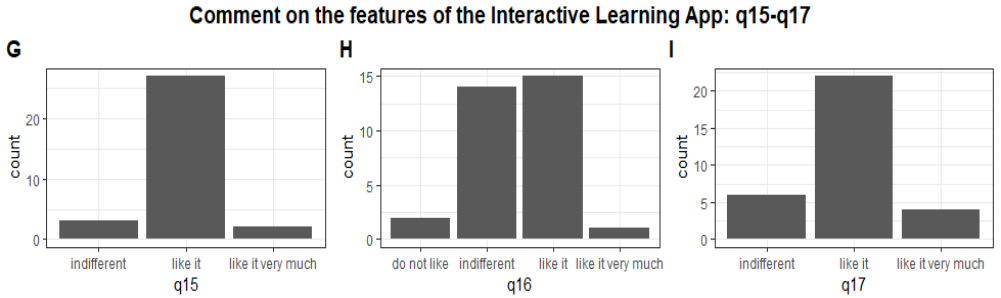
q15: [Applications with video solutions]

q16: [Code boxes (where I can use existing code or write own code)]

q17: [Pre-written code that generates graphs and solutions to problems]







The Student Experience

Q 7: Compared to this year's homework activity what is the expected effect of learning with Interactive Learning Apps on the following: q21-q26

q21: [I will like statistics]

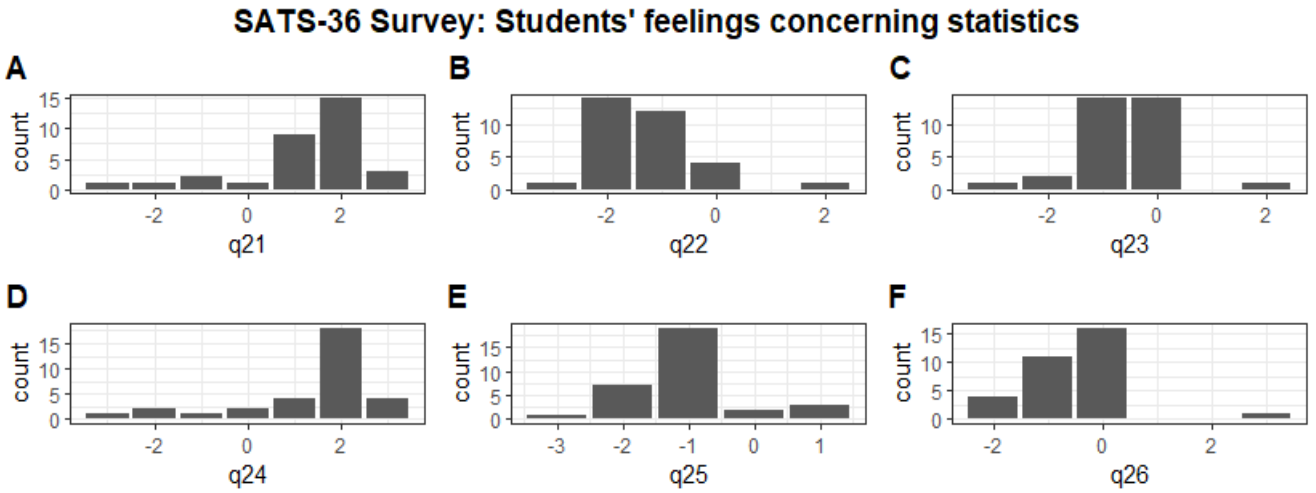
q22: [I will feel insecure when I have to do statistics problems]

q23: [I will get frustrated going over statistics tests in class]

q24: [I will enjoy taking statistics courses]

q25: [I'm scared by statistics]

q26: [I will be under stress during statistics class]



The Student Experience

Q 8: All questions are to be compared to this year's homework activity (quizzes without solutions, group chat room)

- q27: [I prefer Interactive Learning Apps (ILDs) to the existing homework type]
- q28: [Learning with ILDs improves my confidence]
- q29: [ILDs help me better prepare for exams]
- q30: [I learn more effectively with ILDs]
- q31: [ILDs better help understand difficult statistics concepts]
- q32: [ILDs provide more variation in learning]
- q33: [ILDs are more effective for exam revision]
- q34: [ILDs increase my learning motivation]

	Strongly Agree	Agree	Indifferent	Disagree	Strongly Disagree
q27	14 (44%)	15 (47%)	1 (3%)	2 (6%)	
q28	12 (38%)	16 (50%)	3 (9%)	1 (3%)	
q29	5 (16%)	23 (72%)	4 (13%)		
q30	5 (16%)	16 (50%)	10 (31%)	1 (3%)	
q31	5 (16%)	23 (72%)	4 (13%)		
q32	23 (72%)	8 (25%)	1 (3%)		
q33	14 (44%)	14 (44%)	3 (9%)	1 (3%)	
q34	5 (16%)	19 (59%)	6 (19%)	1 (3%)	1 (3%)

Some Further Analysis

Do ILD's help students reduce statistics anxiety?

Hypothesis: The mean of "Reduction of Statistics Anxiety" is equal to 3

- Cronbach's alpha: 99.17%
- Overall Satisfaction Rate: 76.88%
- Overall mean: 2.02 with variance 0.79
- K-S: D=0.23417, p-value=0.059882
- Data normally distributed
- t = -11.447, df = 31, p-value = 1.155e-12
- Reject Null Hypothesis
- CI 95% (1.844, 2.1935)

Table 1: Reduction of statistic anxiety

	1	2	3	4	5	Total	Mean	Variance	Statisfaction rate	Standard error
q21	18	9	1	2	2	32	1.78	1.36	84.38%	0.21
q22	14	12	4	0	2	32	1.88	1.11	81.25%	0.19
q23	3	14	14	0	1	32	2.44	0.62	53.13%	0.14
q24	22	4	2	1	3	32	1.72	1.64	81.25%	0.23
q25	8	19	2	3	0	32	2.00	0.69	84.38%	0.15
q26	4	11	16	0	1	32	2.47	0.69	46.88%	0.15
q28	12	16	3	1	0	32	1.78	0.55	87.50%	0.13
q29	5	23	4	0	0	32	1.97	0.28	87.50%	0.09
q31	5	23	4	0	0	32	1.97	0.28	87.50%	0.09
q34	5	19	6	1	1	32	2.19	0.71	75.00%	0.15
Total	96	150	56	8	10			7.92	76.88%	

Some Further Analysis

Do ILD's help students better manage large and complex quantities of learning material?

Hypothesis: The mean of "OrgInf" is equal to 3

- Cronbach's alpha: 99.19%
- Overall Satisfaction Rate: 87.5%
- Overall mean: 1.8 with variance 0.44
- K-S: D=0.21923, p-value=0.09229
- Data is normally distributed
- t = -15.864, df = 31, p-value = 2.2e-16
- Reject Null Hypothesis
- 95% CI (1.6422, 1,9515)

Table 2: Organization of learning context

	1	2	3	4	5	Total	Mean	Variance	Statisfaction rate	Standard error
q9	19	12	1	0	0	32	1.44	0.31	96.88%	0.10
q10	11	18	3	0	0	32	1.75	0.38	90.63%	0.11
q11	4	26	2	0	0	32	1.94	0.18	93.75%	0.08
q27	14	15	1	2	0	32	1.72	0.64	90.63%	0.14
q30	5	16	10	1	0	32	2.22	0.55	65.63%	0.13
q33	14	14	3	1	0	32	1.72	0.58	87.50%	0.13
Total	67	101	20	4	0			2.63	87.50%	

Some Further Analysis

Do ILD's help provide sufficient dynamic interactions for active learning?

Hypothesis: The mean of "DynIntLe" is equal to 3

- Cronbach's alpha: 83.04%
- Overall Satisfaction Rate: 87.5%
- Overall mean: 1.82 with variance 0.32
- K-S: D=0.21011, p-value=0.1185
- Data is normally distributed
- t = -17.508, df = 31, p-value = 2.2e-16
- Reject Null Hypothesis
- 95% CI (1.6846, 1,9591)

	1	2	3	4	5	Total	Mean	Variance	Statisfaction rate	Standard error
q12	3	22	7	0	0	32	2.13	0.30	78.13%	0.10
q13	23	7	2	0	0	32	1.34	0.35	93.75%	0.10
q14	24	5	3	0	0	32	1.34	0.41	90.63%	0.11
q15	2	27	3	0	0	32	2.03	0.16	90.63%	0.07
q16	1	15	14	2	0	32	2.53	0.44	50.00%	0.12
q17	4	22	6	0	0	32	2.06	0.31	81.25%	0.10
q32	23	8	1	0	0	32	1.31	0.28	96.88%	0.09
Total	80	106	36	2	0			2.24	83.04%	

Conclusion

- ILD's partially help students in their transition to university under the conditions of emergency remote teaching
- ILD's help educators effectively organize complex and large quantitates of learning material to be used in an online setting
- ILD's provide a large variety of interactive learning opportunities
- ILD's help students in reducing statistics anxiety
- Future Developments:
  - Link chapters with each other at the click of a button
  - Provide links to lecture material (slides)
  - Graded Exercises/Applications
  - Build Lecture ILDs (Currently Homework/ Remote Learning)
  - Provide Open Source Code for Educators
  - Optimize Dynamic Interactions (some real world examples)