

APPENDIX

Appendix A – Experimental Materials

Table1a. Growth and Environmental survey module (GEM – Savin et al., 2021) employed. On the left are the items participants saw in the first part of the experiment; on the right, the rephrased and reversed items were used in the second part to reduce consistency bias. ‘R’ indicates the items that require reverse coding.

GEM items used in pre-task survey	GEM items used in pre-task survey
1. Continued economic growth is essential for improving people’s life satisfaction	1. Increasing people’s well-being requires continued economic growth
2. Economic growth is necessary to finance public health and pension systems	2. Sustaining funding of public health and pensions system requires economic growth
3. Without economic growth, a country’s economy will become less stable	3. Stability of a country’s economy does not depend on economic growth (R)
4. Economic growth is necessary to finance environmental protection	4. Economic growth is not necessary to support environmental protection (R)
5. In view of limited natural resources, rich countries may have to give up their economic growth to assure that all poor people in the world can reach a fair standard of living (R)	5. Assuming limited natural resources, richer regions may have need to abandon economic growth so that people living in poor regions can escape from poverty (R)

Table2a. Text shown to participants to explain the experimental task and manipulate the goal clarity

Manipulation	Text shown to participants
Unclear Goal	<p>In the virtual game you are now going to play, humanity has colonised a new planet light years away from Earth, called Planet X, and you have been appointed as the sole leader.</p> <p>You have to decide how to allocate the available budget of \$100 million (in Space dollars) for the year 2030 between two strategic priorities: productivity improvements (i.e., higher economic production - Gross Domestic Product (GDP) - per person) and pollution reduction (i.e., lower pollution emitted per person). This is a one-time decision and will affect the planet for the next century. All strategies are acceptable; e.g., you can allocate everything to one type of investment, or nothing to both.</p> <p>In order for you to assess the impact of your decision, your staff has developed a simulator through which you can explore the long-term impact of the different strategies on the planet.</p> <p><u>Your final goal is to lead Planet X to a thriving future. There are no right or wrong decisions as the definition of ‘thriving future’ depends only on what you think is a good state of society.</u></p>
Clear Goal	<p>In the virtual game you are now going to play, humanity has colonised a new planet light years away from Earth, called Planet X, and you have been appointed as the sole leader.</p> <p>You have to decide how to allocate the available budget of \$100 million (in Space dollars) for the year 2030 between two strategic priorities: productivity improvements (i.e., higher economic production - Gross Domestic Product (GDP) - per person) and pollution reduction (i.e., lower pollution emitted per person). This is a one-time decision and will affect the planet for the next century. All strategies are acceptable; e.g., you can allocate everything to one type of investment, or nothing to both.</p> <p>In order for you to assess the impact of your decision, your staff has developed a simulator through which you can explore the long-term impact of the different strategies on the planet.</p> <p><u>Your final goal is to maximise the Perceived Quality of Life indicator that you will see in the dashboard provided in the virtual environment. This indicator captures the citizens’ perceived quality of life depending on Planet X’s economic and environmental conditions.</u></p>

Table3a. Text shown to participants to explain the alternative dashboard and additional information presented to the groups

Manipulation	Text showed to participants
Extended Dashboard	<p>The simulator shows the effect of your allocation decisions on six indicators:</p> <ul style="list-style-type: none"> - <i>Population</i>: number of people living on Planet X. - <i>Economic Capital</i>: total economic and physical capital stock in Planet X (e.g., money, industries, infrastructures, machinery, buildings) measured in Space \$. - <i>Material Standard of Living</i>: index of people’s wealth on Planet X, where 1 is equivalent to the average wealth people enjoy on Earth today. - <i>Perceived Quality of Life</i>: Planet X inhabitants' perception of their quality of life collected through surveys; an index accounting for economic and environmental conditions, where 1 is equivalent to the perceived quality of life on Earth today. - <i>Natural Resources</i>: percent of natural resources (e.g., oil, gas, timber) remaining on Planet X relative to the initial value in 2030. - <i>Pollution</i>: index of environmental pollution (e.g., water, air, soil), where 1 is equivalent to the initial pollution level on Planet X in 2030. <p>At the end, after exploring with the simulator, you will be asked to make a one-time decision on what you think is the best way to distribute the \$100 million in 2030. However, the simulator that you are about to use will allow you to first explore the impact of alternative allocations in detail, advancing step-by-step 10 years at a time. Keep in mind a delay exists between your decisions to invest and their full impact on Planet X. You can use the simulator three times before making your final decision.</p>
Limited Dashboard	<p>The simulator shows the effect of your allocation decisions on four indicators:</p> <ul style="list-style-type: none"> - <i>Population</i>: number of people living on Planet X. - <i>Economic Capital</i>: total economic and physical capital stock in Planet X (e.g., money, industries, infrastructures, machinery, buildings) measured in Space \$. - <i>Material Standard of Living</i>: index of people’s wealth on Planet X, where 1 is equivalent to the average wealth people enjoy on Earth today. - <i>Perceived Quality of Life</i>: Planet X inhabitants' perception of their quality of life collected through surveys; an index accounting for economic and environmental conditions, where 1 is equivalent to the perceived quality of life on Earth today. <p>At the end, after exploring with the simulator, you will be asked to make a one-time decision on what you think is the best way to distribute the \$100 million in 2030. However, the simulator that you are about to use will allow you to first explore the impact of alternative allocations in detail, advancing step-by-step 10 years at a time. Keep in mind a delay exists between your decisions to invest and their full impact on Planet X. You can use the simulator three times before making your final</p>

Appendix B – Experimental Task

To adjust the updated version (Ríos-Ocampo & Gary, 2022) of the World Dynamics model (Forrester, 1971) to the scope and needs of the experiment, we implemented four variations. Note that those variations are ‘peripheral’, as they do not alter by no means the main model dynamics.

- 1) First, “*QLC quality of life from crowding*” and “*QLF quality of life from food*” do not affect “*QL quality of life*” variable anymore. Specifically, the old equation was:

QoL quality of life

$$\begin{aligned} &= \textit{QLM quality of life from material} * \textit{QLS QUALITY OF LIFE STANDARD} \\ &* \textit{QLP quality of life from pollution} * \textit{QLC quality of life from crowding} \\ &* \textit{QLF quality of life from food} \end{aligned}$$

The new equation is:

QoL quality of life

$$\begin{aligned} &= \textit{QLM quality of life from material} * \textit{QLS QUALITY OF LIFE STANDARD} \\ &* \textit{QLP quality of life from pollution} \end{aligned}$$

This change was made to ensure that the quality of life indicator is dependent only on model components under close control by players, has a significant and coherent meaning for participants, and fits the purpose of the experimental task.

- 2) The “*quality of life from pollution*” function has been changed from the original logistic form (Ríos-Ocampo & Gary, 2022) to a logarithmic one to increase the premium on the quality of life for low levels of pollution (i.e., POLR) and have a steeper penalty for increasing levels of pollution (Fig 1). The “*quality of life from pollution*” function simulation working space in this experimental task is between 0.2 and 10 (preventing the model from calculating LN of 0, which is incomputable).

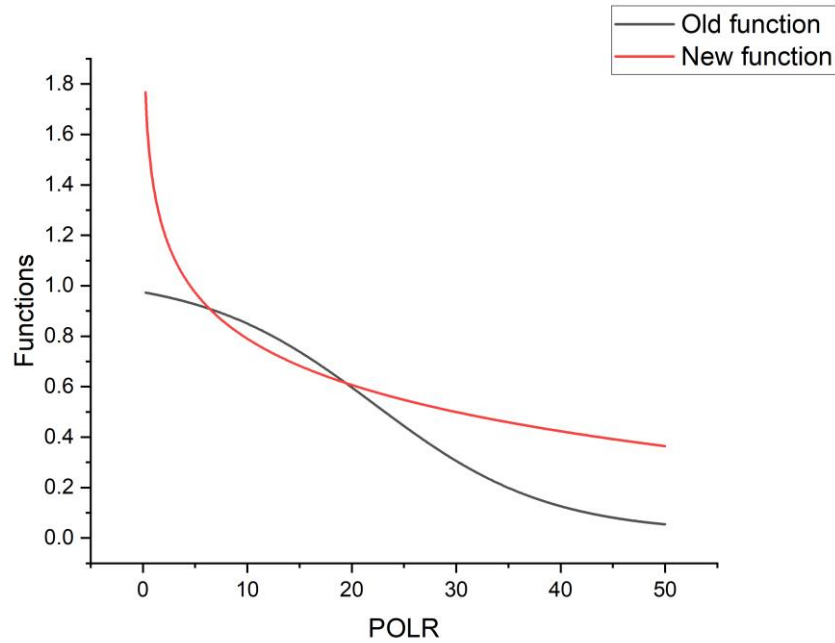


Fig. 1b. “quality of life from pollution” functions in the original and new version of the World Model used for the experiment

- 3) Three variables have been recalibrated because they needed to be rescaled to provide meaningful outcomes and fit the experimental narrative (Table 1b below)

Table 1b. Recalibrated values of the world model

Variable name	Previous value	Experiment value	Motivation
<i>PI Population Initial</i>	1.65e+09	1.2e+09	Initial value of the Population stock. It has been rescaled to avoid the initial minor decrease in population endogenous in the model that could confuse the participants and make the population smaller and more suitable for the colonised planet narrative we proposed.
<i>POLI</i>	2e+08	1.4e+09	<i>POLI</i> is the initial pollution stock value. Rescaled for the same reasons as above but related to pollution
<i>POLS POLLUTION STANDARD</i>	3.6e+09	5e+09	Rescaled to make sure it triggers the right effect at the right time

- 4) While the original model runs from 1900 to 2100, the experimental tasks run from 2030 to 2130, which is 100 years instead of 200. There are two reasons for this choice. First, we wanted to keep the time horizon meaningful for the participants, namely, whereas asking the participants to imagine thinking about the development of the fictional world years 100 years ahead is already challenging, asking to foresee the unfolding of imaginary events 200 years in advance could have been to intangible. Secondly, the model's main behaviour is that humanity exceeds Earth's carrying capacity, which leads the planet to collapse. We did not want the participants to experience the disintegration part of the model as it may drag them towards more conservative or more environmentally inclined decision behaviours than they would have been. Third, the simulation starting has been shifted from 1900 to 2030 to relate the model to the experimental task participants have to solve and make the decision process more about future decisions than past events as this is believed to give them more freedom in their decisions.

Overall, those values and the policy effects per unit of resources allocated have been identified through manual sensitivity analysis (Barlas & Diker, 1996; Sterman, 2000), namely, parameter variations to explore their impact of variables on the system behaviour. They have been selected because they provide meaningful outputs, which are variations in the system's behaviour that can be easily spotted by participants but not to the point that they are so extreme that they trigger collapse trends during the simulation time span so that the participants do not experience any oscillation in the stocks in this time frame.

Participants saw the model output as reported in Table 2b, where we connected the model variables to the dashboard presented. Compared to the original variables in the model, nomenclature and computation have been slightly changed to make the decision output more visible to participants (a problem that emerged during pilot tests) and more in line with current general understanding.

Table 2b. Model variables in relation to the indicators shown to participants

Variable in the model	Indicators visible to participants	Comment
<i>P Population</i>	Population	The indicator presented to participants shows the value of the population stock.
<i>CI Capital investment</i>	Economy Capital	The variable <i>CI Capital Investment</i> represents the model's economic capital (e.g., money industries, infrastructures, machinery, buildings, etc.). However, the name is not intuitive and related to common understanding. So, we opted for Economic Capital to make it easier for participants.
<i>displayed material standard of living</i>	Material Standard of Living	The displayed material standards of living variable is just the material standards of living variable increased by a constant. We did so to ensure that even in the case in which 0 resources are allocated to productivity, the material standard of living reaches 1; otherwise, seeing low values could influence and bias participants and push them to allocate more to growth.
<i>normalised quality of life</i>	Perceived Quality of Life	To increase the variability in the output values of “QL quality of life,” we report a normalised version of the variable to participants.
<i>normalised natural resources</i>	% Natural resources	Within the task's time range and with the policy effects, the variation in natural resources appeared not to be recognisable by the participants in the pilot tests. So, we identified a meaningful lower limit (“ <i>normalised natural resources lower limit</i> ”) based on the variable range within which the variable operates in the task, and then we normalised the variable to make changes more visible to participants.
<i>pollution index</i>	Pollution index	The pollution stock in the model is measured in pollution units, which may not be very meaningful to the participants. So, we opted to provide them with an index calculated based on the initial value in 2030 (“ <i>POLP</i> ” variable).

Appendix C – Simulator interface

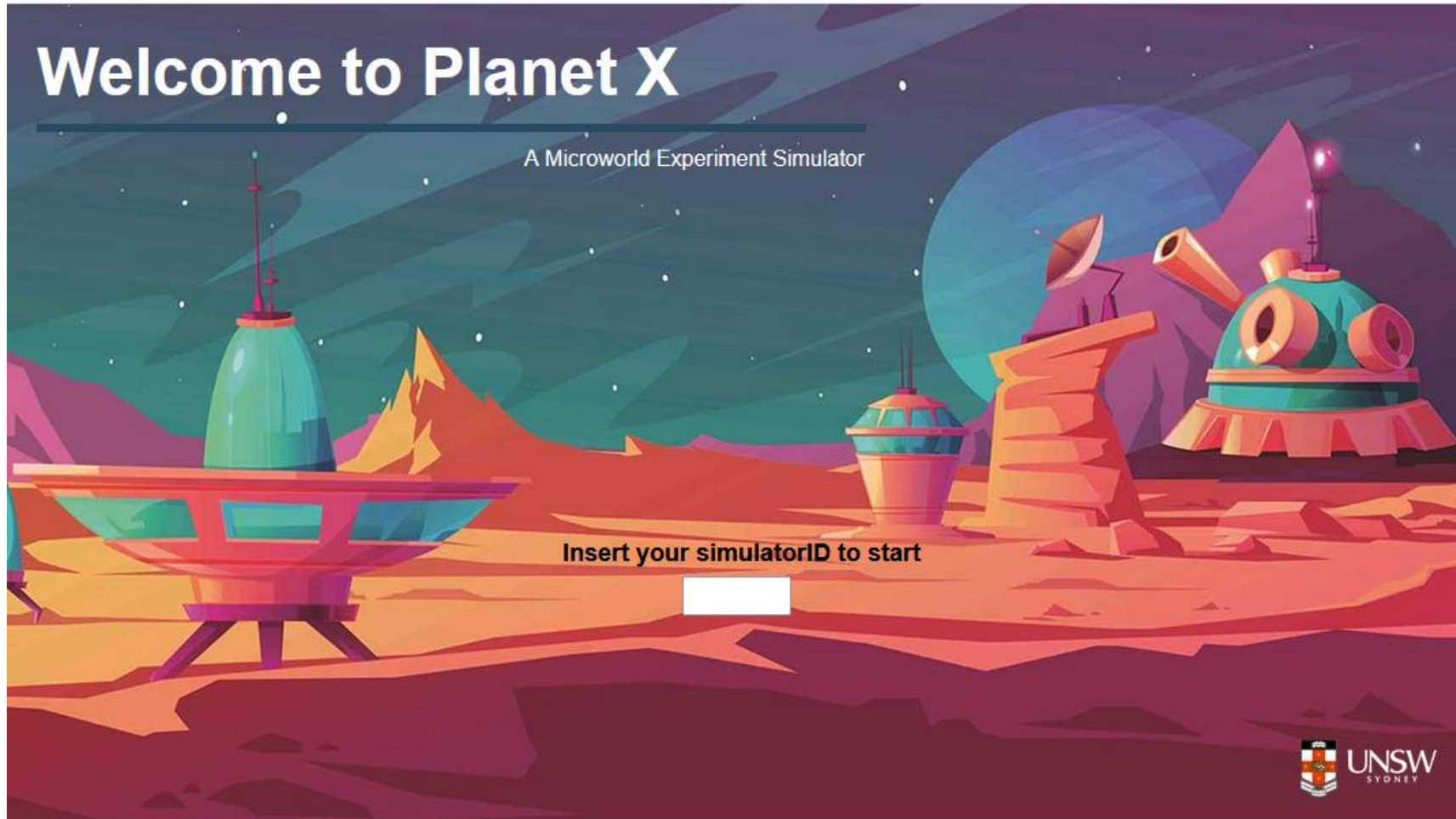


Figure 1c. Page 1/ Landing Page

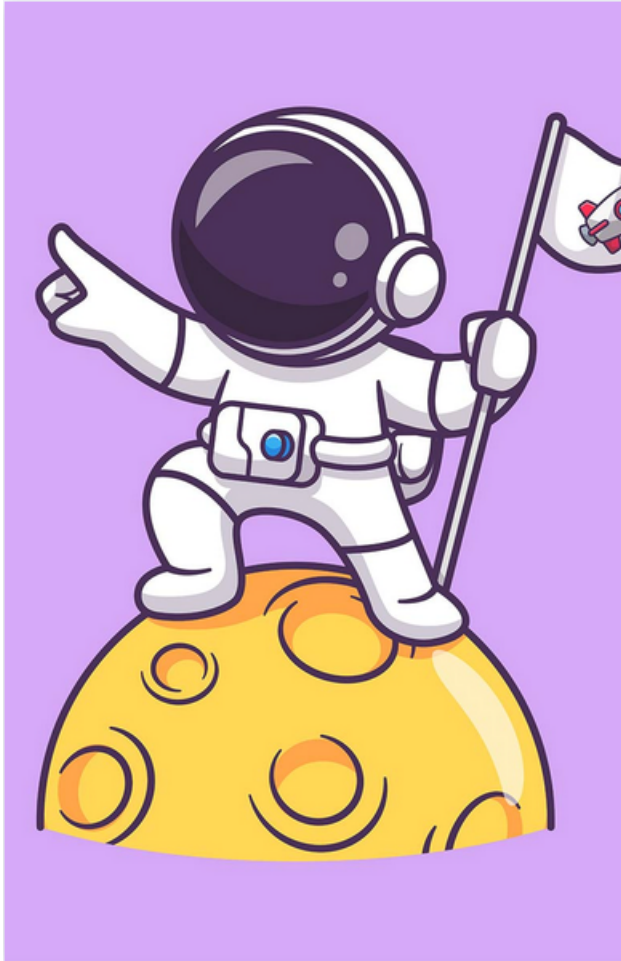
Humanity has colonised a new planet light years away from Earth, called Planet X, and you have been appointed as the sole leader.

You have to decide how to allocate the upcoming available budget of \$100 million (in Space dollars) for the year 2030 between two strategic priorities, i.e., productivity improvements and pollution reduction. This is a one-time decision and will affect the planet for the next century. Your goal is to lead Planet X to a thriving future. There are no right or wrong decisions as the definition of 'thriving future' depends only on what you think is a good state of society. .

Given the importance of this decision for Planet X, your staff has developed a simulator in which you can explore step by step the impact of the different strategies on the planet and that you can use three times before making your decision.



Figure 2c. Page 2



Your Goal

You have to decide how to allocate the upcoming available budget of \$100 million (in Space dollars) between two strategic priorities. The strategic priorities consist of investments to increase productivity (i.e., higher economic production - Gross Domestic Product (GDP) - per person) and to develop more environmentally friendly technology (i.e., lower pollution emitted per person). This is a one-time decision and will affect the planet for the next century. All the strategies are acceptable; for example, you can allocate everything to one type of investment or maybe decide not to allocate anything to both.

Your goal is to lead Planet X to a thriving future. There are no right or wrong decisions as the definition of 'thriving future' depends only on what you think is a good state of society.

Given the importance of this decision for Planet X, your staff has developed a simulator in which you can explore step by step the impact of the different strategies on the planet and that you can use three times before making your final decision. Each time, you will play 10 rounds, deciding how to allocate the resources available every 10 years to explore the impact of the decision on the simulator. The simulator has a dashboard of indicators to support you and show you the potential outcomes of your decisions.

Whereas the simulator allows you to explore step-by-step the alternative strategies to give you more insights into Planet X functioning, in the end, you will have to make just a one-time decision of what you think is the best way to distribute the \$100 million budget between the two priorities in 2030.

Lastly, keep in mind a delay exists between your decisions to invest and their full impact on Planet X.

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Figure 3c. Page 3

Indicators

The simulator shows the effect of your allocation decisions on six indicators:

- *Population*: number of people living on Planet X.
- *Economic Capital*: total economic and physical capital stock in Planet X (e.g., money, industries, infrastructures, machinery, buildings) measured in Space \$.
- *Material Standard of Living*: index of people's wealth on Planet X, where 1 is equivalent to the average wealth people enjoy on Earth today.
- *Perceived Quality of Life*: Planet X inhabitants' perception of their quality of life collected through surveys; an index accounting for economic and environmental conditions, where 1 is equivalent to the perceived quality of life on Earth today.
- *Natural Resources*: percent of natural resources (e.g., oil, gas, timber) remaining on Planet X relative to the initial value in 2030.
- *Pollution*: index of environmental pollution (e.g., water, air, soil), where 1 is equivalent to the initial pollution level on Planet X in 2030.

The indicators show low starting values as Planet X has only been colonised recently and is currently growing.

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Figure 4c. Page 4

Strategic Decisions (first training round)

Space \$

Investments in productivity: 0 25 50 75 100

Investments in pollution reduction: 0 25 50 75 100

Time: 2030

Advance 10 years

Revisit goal Revisit indicators

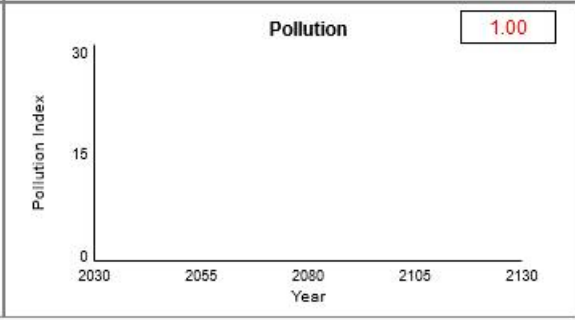
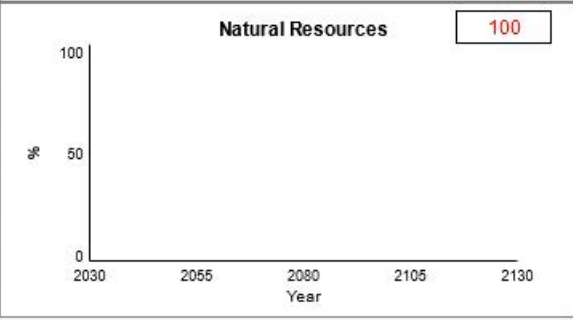
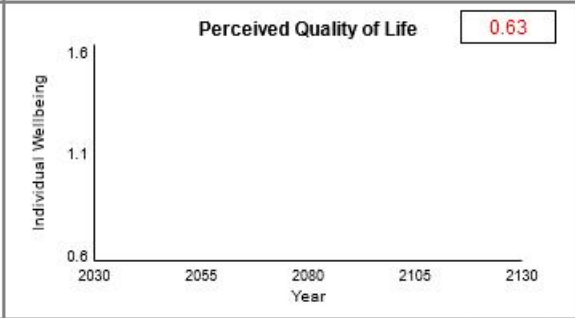
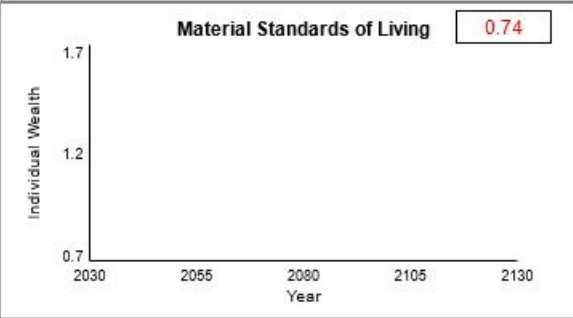
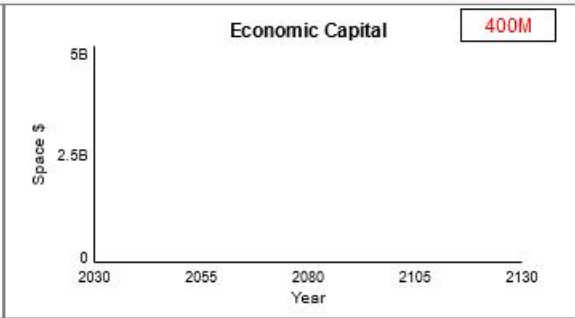
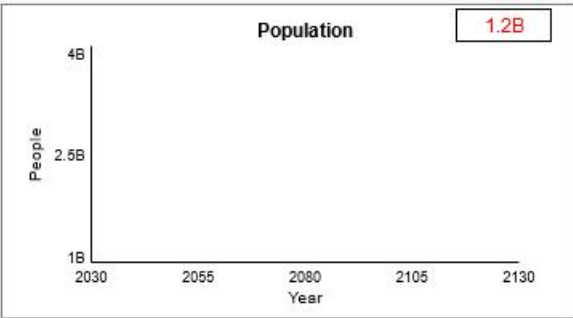


Figure 5c. Page 5

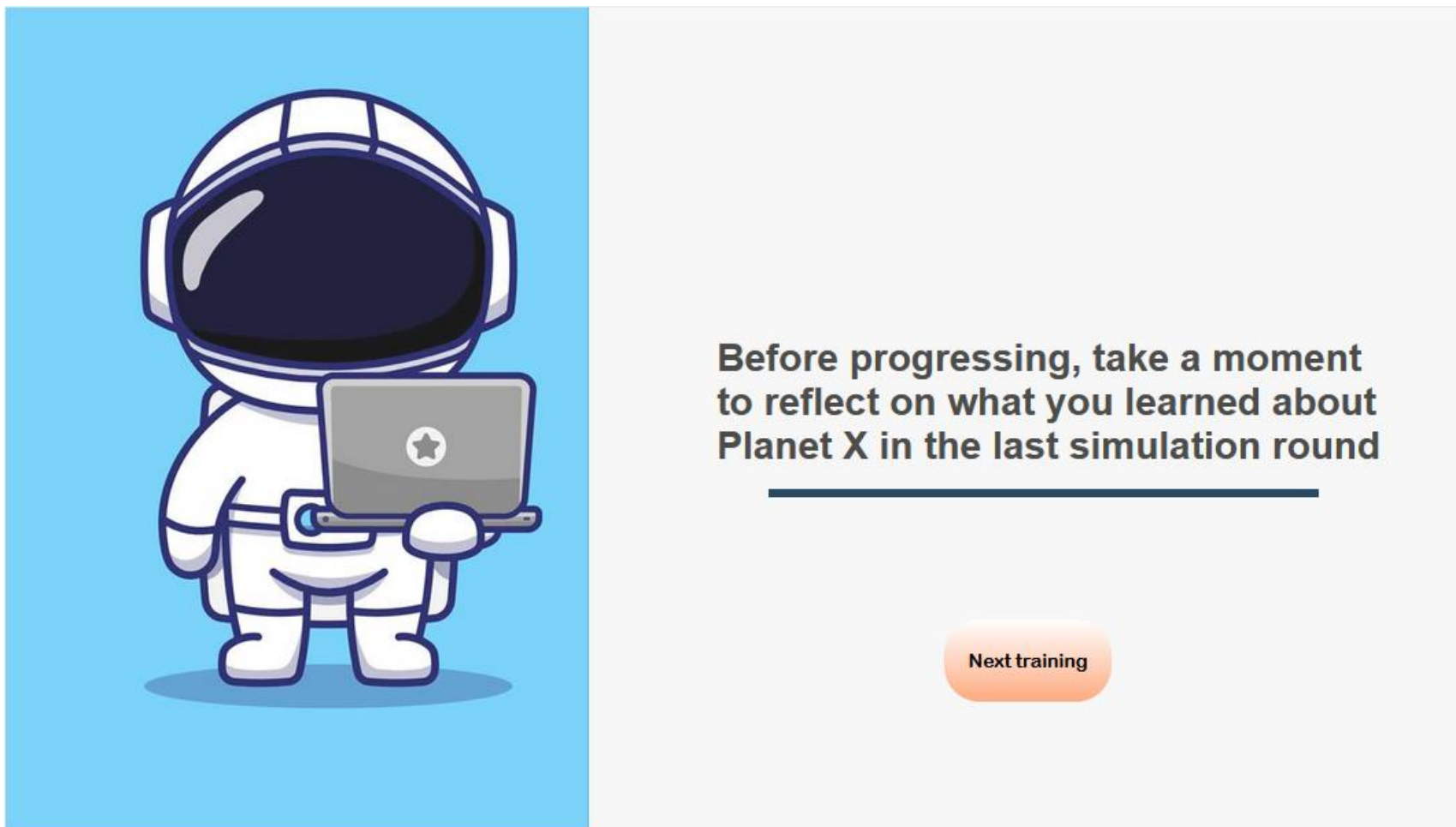
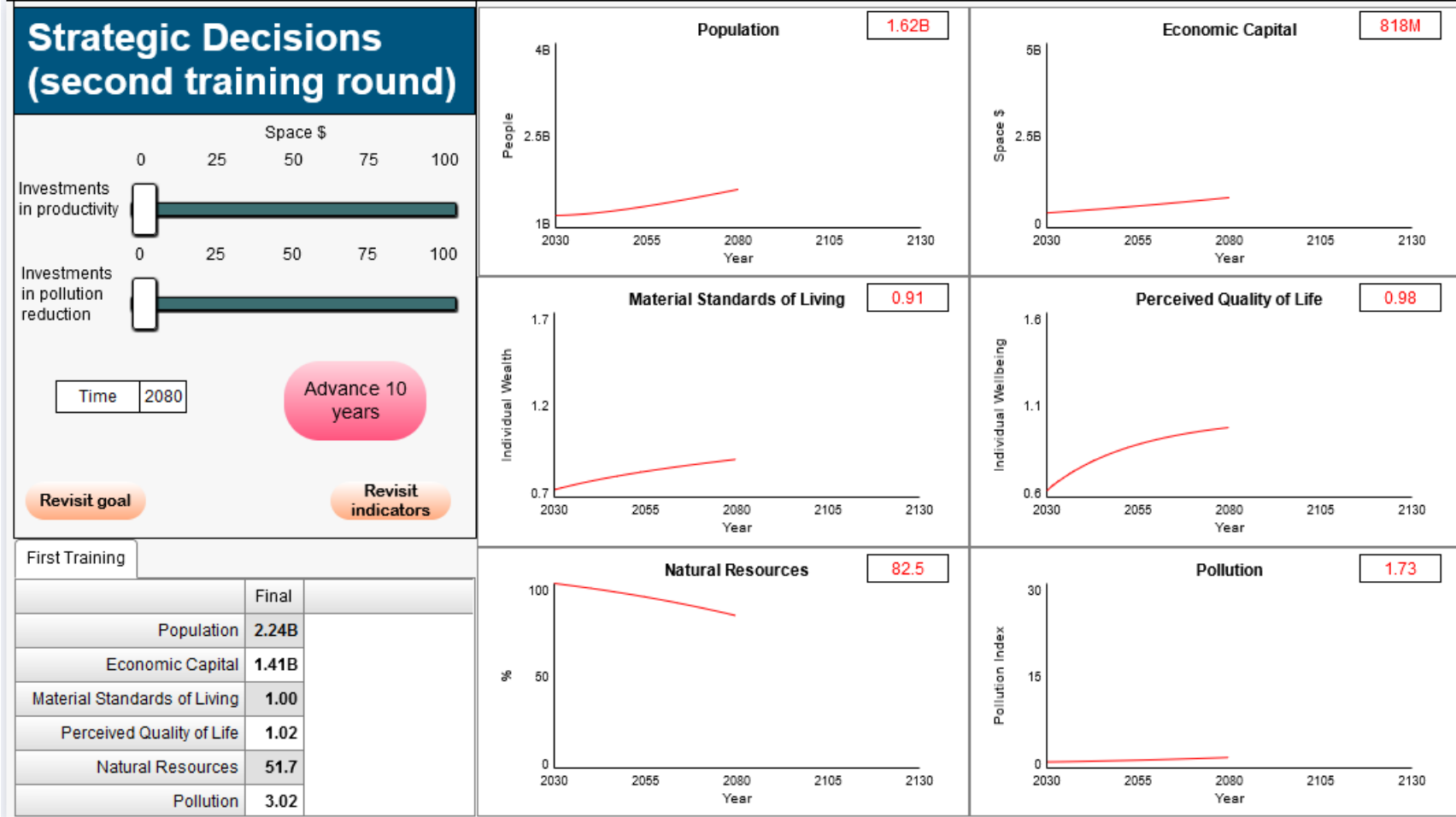


Figure 6c. Page 6



Before progressing, take a moment to reflect on what you learned about Planet X in the last simulation round

Next training



Figure 8c. Page 8

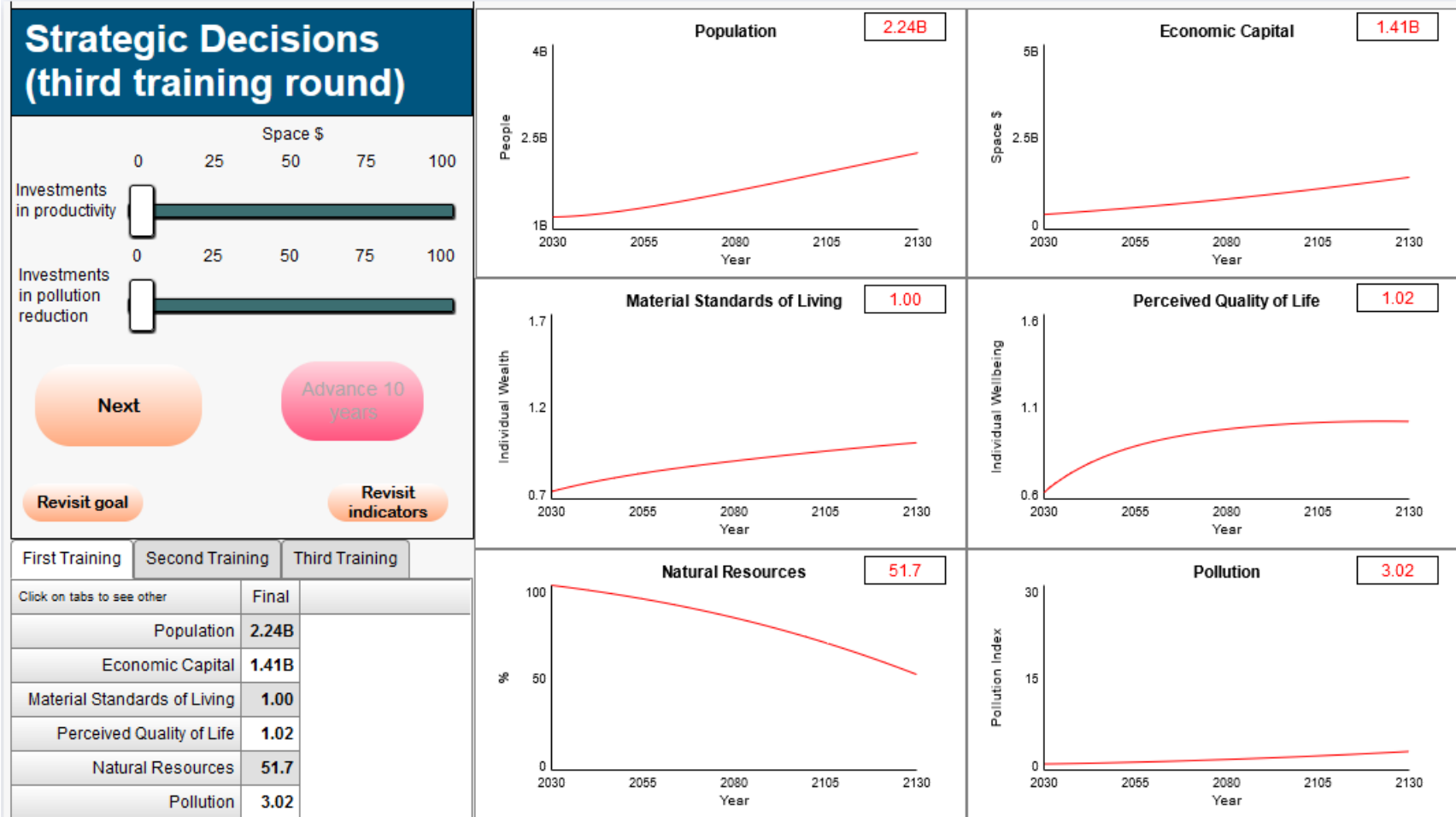
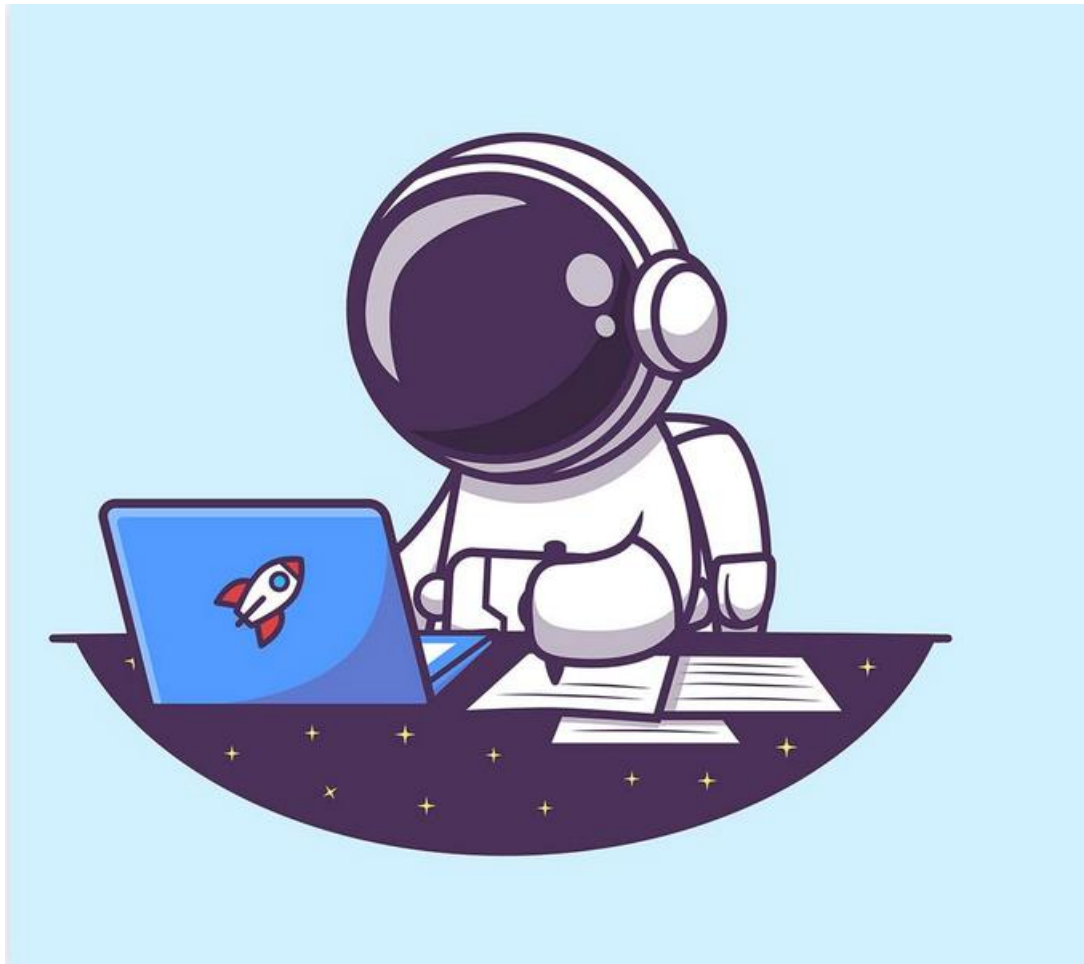


Figure 9c. Page 9



**Before progressing,
take a moment to reflect
on what you learned
about Planet X in the
last simulation round**

Next

Figure 10c. Page 10

Thanks for your service on behalf of Planet X!

Your training is done, you may now return to the Earth! Please now click on the 'Survey' button below to open the short post-experiment survey where you will be asked to identify your optimal strategy to reach your goal and answer some questions.

Survey


A stylized space-themed illustration. In the upper left, a large Earth with orange and blue continents is shown. A white rocket with a yellow flame is flying towards the right. The background is a dark purple space filled with stars and a smaller orange planet. In the top right corner, the UNSW Sydney logo is visible.

Figure 11c. Page 11

Appendix D – Descriptive Statistics

Table 1d. Age Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	255	41.784	12.097	18	75

Table 2d. Country Tabulation

Country	Freq.	Percent	Cum.
Australia	25	9.80	9.80
Canada	6	2.35	12.16
Ireland	1	0.39	12.55
New Zealand	11	4.31	16.86
United Arab Emirates	1	0.39	17.25
United Kingdom of Great Britain and Northern Ireland	204	80.00	97.25
United States of America	7	2.75	100.00
Total	255	100.00	

Table 3d. JobRole Tabulation

JobRole	Freq.	Percent	Cum.
Clerical and Administrative Worker	14	5.49	5.49
Community and Personal Service Worker	5	1.96	7.45
Labourer	4	1.57	9.02
Machinery Operator and Driver	3	1.18	10.20
Manager and decision-maker	129	50.59	60.78
Professional	76	29.80	90.59
Retired	2	0.78	91.37
Sales Worker	7	2.75	94.12
Student	3	1.18	95.29
Technician and Trades Worker	12	4.71	100.00
Total	255	100.00	

Table 3d. Organisation Type Tabulation

OrganisationType	Freq.	Percent	Cum.
Not working currently	2	0.78	0.78
Not-for-profit sector	16	6.27	7.06
Private sector	148	58.04	65.10
Public sector	89	34.90	100.00
Total	255	100.00	

Appendix E –Results

Table 1e. H1 statistical test

Two-sample t test with equal variances						
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf. interval]	
Extended	128	45.80469	1.918814	21.7089	42.0077	49.60167
Limited	127	55.41732	1.621104	18.26891	52.20921	58.62544
Combined	255	50.59216	1.290071	20.60078	48.05156	53.13275
diff		-9.612635	2.513626		-14.56293	-4.662338
diff = mean(Extended) - mean(Limited)				t =	-3.8242	
H0: diff = 0				Degrees of freedom =	253	
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.0001		Pr(T > t) = 0.0002		Pr(T > t) = 0.9999		

Table 2e. H2a statistical test

Source	SS	df	MS	Number of obs	=	255
				F(1, 253)	=	9.28
Model	3815.14597	1	3815.14597	Prob > F	=	0.0026
Residual	103980.438	253	410.989875	R-squared	=	0.0354
				Adj R-squared	=	0.0316
Total	107795.584	254	424.392064	Root MSE	=	20.273

Productivive	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
Worldviews	4.105091	1.347357	3.05	0.003	1.451626	6.758556
_cons	29.55477	7.02055	4.21	0.000	15.72861	43.38094

Table 3e. H2b statistical test

Two-sample t test with equal variances						
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf. interval]	
Extended	128	-.703125	.0852274	.9642375	-.8717746	-.5344754
Limited	127	-.5511811	.0834129	.9400157	-.7162528	-.3861094
Combined	255	-.627451	.0597054	.9534187	-.7450317	-.5098703
diff		-.1519439	.1192655		-.3868236	.0829358
diff = mean(Extended) - mean(Limited)				t =	-1.2740	
H0: diff = 0				Degrees of freedom =	253	
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.1019		Pr(T > t) = 0.2038		Pr(T > t) = 0.8981		

Table 10e. H4c statistical test

. regress ProductivityIncrease b2.GoalCategorical##c.Worldviews							
Source	SS	df	MS	Number of obs	=		
Model	6549.78728	3	2183.26243	F(3, 251)	=	255	
Residual	101245.797	251	403.369709	Prob > F	=	5.41	
				R-squared	=	0.0013	
				Adj R-squared	=	0.0608	
Total	107795.584	254	424.392064	Root MSE	=	20.084	

ProductivityIncrease	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
GoalCategorical Clear	36.34487	13.97456	2.60	0.010	8.82254	63.8672
Worldviews	7.177563	1.801747	3.98	0.000	3.629094	10.72603
GoalCategorical#c.Worldviews Clear	-6.802605	2.682479	-2.54	0.012	-12.08564	-1.519568
_cons	13.03282	9.415579	1.38	0.168	-5.510788	31.57643

Table 11e. H4d statistical test

. regress ProductivityIncrease i.GoalCategorical##i.DashboardCategorical##c.Worldviews							
Source	SS	df	MS	Number of obs	=		
Model	13145.7624	7	1877.96606	F(7, 247)	=	255	
Residual	94649.8219	247	383.197659	Prob > F	=	4.90	
				R-squared	=	0.0000	
				Adj R-squared	=	0.1220	
Total	107795.584	254	424.392064	Root MSE	=	0.0971	

ProductivityIncrease	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
GoalCategorical Unclear	-42.43254	17.62453	-2.41	0.017	-77.14607	-7.71901
DashboardCategorical Limited	5.163355	21.70443	0.24	0.812	-37.58601	47.91272
GoalCategorical#DashboardCategorical Unclear#Limited	15.33321	28.4606	0.54	0.591	-40.7232	71.38962
Worldviews	.1992657	2.354823	0.08	0.933	-4.438829	4.83736
GoalCategorical#c.Worldviews Unclear	7.094831	3.420056	2.07	0.039	.3586383	13.83102
DashboardCategorical#c.Worldviews Limited	-.076075	4.164947	-0.02	0.985	-8.279416	8.127266
GoalCategorical#DashboardCategorical#c.Worldviews Unclear#Limited	-1.244644	5.455276	-0.23	0.820	-11.98944	9.500148
_cons	47.94759	12.14545	3.95	0.000	24.02573	71.86946

