The German Tank Problem

TEACHER INSTRUCTIONS

The purpose of this activity is to introduce students to the concept of an unbiased estimator of a population parameter. Students will develop a scheme for estimating a parameter and test it by running simulations of the estimation and comparing it to the true value.

Materials Needed:

- ☑ "Battlefield" of German Tank Serial Numbers. {Photocopy serial numbers in this packet onto cardstock. Cut out and place in a brown paper bag or envelope. There should be 342 numbers total.}
- ☑ Student Handout. {Photocopy 1 handout per student or one per group}
- ☑ Fathom Simulation File {See Fifty Fathoms for the original}

Setup:

Explain that German war equipment was manufactured with serial numbers that were printed in a numeric sequence. By assuming numbers started with 1, Allied forces were able to estimate the total number of equipment (tanks, artillery, etc.) by studying the serial numbers on captured/destroyed equipment.

Activity:

- ☑ Have students divide into groups of 4 Statisticians.
- ☑ Hand each group a packet of serial numbers and a handout. Don't tell them how many tanks there are!
- ☑ Instruct students to simulate capturing 5 tanks by mixing up the numbers and drawing 5 without replacement. {Explosions and other sounds of war are optional}
- ☑ Students should record the 5 numbers on their handout.
- ☑ Instruct students to use their 5 serial numbers to estimate the total number of tanks. Their method should be clearly explained on the handout {eg, calculate Q3+1.5 IQR, mean +3stddev,, max + min, 2 times the mean, etc.}
- ☑ Students should write their estimate on the board, along with a short formula describing how they arrived at the estimate...no guessing is allowed!
- ☑ Discuss which estimate is the "best"...how could we test which method gives us an accurate estimate?
    - ☑ Define "Bias" and "Variability"

Fathom Simulation:

- ☑ Run the Fathom Simulation that draws a sample of 5 tanks from a population of 342 and calculates an estimate based on the formulas presented by the class. Draw 100 samples, calculate, and plot estimates using each estimation scheme. Discuss the shape, center, spread of each distribution.
- ☑ What makes an estimator "unbiased"?
- ☑ Compare distributions for each estimator. Which one would the Allied forces prefer? Why?

German Tank Problem "WW11 Battlefield"

August, 1942 - Serial Numbers

According to German records, 342 tanks were produced in August, 1942.

Photocopy the following pages onto cardstock.

Cut out serial numbers.

Place in a "Battlefield" envelope or bag.

Create multiple sets so each group can have their own "Battlefield".

Have students mix up the numbers, select 5 without replacement, and construct their estimate of the number of tanks on the battlefield.

0001	0021	0041	0061	0081
0002	0022	0042	0062	0082
0003	0023	0043	0063	0083
0004	0024	0044	0064	0084
0005	0025	0045	0065	0085
0006	0026	0046	0066	0086
0007	0027	0047	0067	0087
0008	0028	0048	0068	0088
0009	0029	0049	0069	0089
0010	0030	0050	0070	0090
0011	0031	0051	0071	0091
0012	0032	0052	0072	0092
0013	0033	0053	0073	0093
0014	0034	0054	0074	0094
0015	0035	0055	0075	0095
0016	0036	0056	0076	0096
0017	0037	0057	0077	0097
0018	0038	0058	0078	0098
0019	0039	0059	0079	0099
0020	0040	0060	0080	0100

0101	0121	0141	0161	0181
0102	0122	0142	0162	0182
0103	0123	0143	0163	0183
0104	0124	0144	0164	0184
0105	0125	0145	0165	0185
0106	0126	0146	0166	0186
0107	0127	0147	0167	0187
0108	0128	0148	0168	0188
0109	0129	0149	0169	0189
0110	0130	0150	0170	0190
0111	0131	0151	0171	0191
0112	0132	0152	0172	0192
0113	0133	0153	0173	0193
0114	0134	0154	0174	0194
0115	0135	0155	0175	0195
0116	0136	0156	0176	0196
0117	0137	0157	0177	0197
0118	0138	0158	0178	0198
0119	0139	0159	0179	0199
0120	0140	0160	0180	0200

0201	0221	0241	0261	0281
0202	0222	0242	0262	0282
0203	0223	0243	0263	0283
0204	0224	0244	0264	0284
0205	0225	0245	0265	0285
0206	0226	0246	0266	0286
0207	0227	0247	0267	0287
0208	0228	0248	0268	0288
0209	0229	0249	0269	0289
0210	0230	0250	0270	0290
0211	0231	0251	0271	0291
0212	0232	0252	0272	0292
0213	0233	0253	0273	0293
0214	0234	0254	0274	0294
0215	0235	0255	0275	0295
0216	0236	0256	0276	0296
0217	0237	0257	0277	0297
0218	0238	0258	0278	0298
0219	0239	0259	0279	0299
0220	0240	0260	0280	0300

0301	0321	0341		
0302	0322	0342		
0303	0323			
0304	0324			
0305	0325			
0306	0326			
0307	0327			
0308	0328			
0309	0329			
0310	0330			
0311	0331			
0312	0332			
0313	0333			
0314	0334			
0315	0335			
0316	0336			
0317	0337			
0318	0338			
0319	0339			
0320	0340			