Answers

1. We have MS(class) = 136.94, MSE = 25.92, and r = 10. Thus the estimate of the component of variance due to class is (136.94 – 25.92)/10 = 11.10. The error component of variance is 25.92. This tells us that there is more variability among students within class (which is the what makes up the error) than there is among classes. Although these data are simulated, the results are typical of an educational situation. Students typically contribute more to variability in test scores than does the classroom, the variability of which is caused by such factors as teacher, time of day in which a class is taught, location of the classroom.

2. Here is the SAS code for GLM and MIXED.

```
data;
input Casting     Bar   Strength;
datalines;
1      1      88.0
1      2      88.0
1      3      94.8
  etc.
3      29     96.2
3      30     92.5
;
proc glm;
class casting;
model strength = casting/ss3;
run;
quit;

proc mixed;
class casting;
model strength = ;
random casting;
run;
quit;
```

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a. Here is the GLM ANOVA. We see that the variance of the random factor "Casting" is significantly different from 0 at the 5% level of significance because the p-value (.0001) is less than .05.

Dependent Variable: Strength

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	147.8846667	73.9423333	12.71	0.0001
Error	27	157.1020000	5.8185926		
Corrected Total	29	304.9866667			

R-Square	Coeff Var	Root MSE	Strength Mean
0.484889	2.654632	2.412176	90.86667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Casting	**2**	**147.8846667**	**73.9423333**	**12.71**	**0.0001**

b. The mean square for the casting is 73.942. The variability of the bars within each casting is what gives us the variance of error. Its mean square is 5.816. There are r = 10 metal bars for each casting. Thus the component of variance for casting is (73.942 – 5.816)/10 = 6.81. The contribution to the of the variance of casting (6.81) is just a bit larger than the contribution to the variance of error, i.e. the bars within casting (5.816).

c. Here is an edited version of the MIXED output. The "residual" in MIXED is the same as "error" in GLM. The components of variance are the same as we determined from GLM.

Covariance Parameter Estimates

Cov Parm	Estimate
Casting	6.8124
Residual	5.8186