In [66]:
```
import numpy as np
import pandas as pd
import statsmodels.api as sm
import matplotlib.pyplot as plt
from patsy import dmatrices
from sklearn.linear_model import LogisticRegression
from sklearn.cross_validation import train_test_split
from sklearn import metrics
from sklearn.cross_validation import cross_val_score
dta = sm.datasets.fair.load_pandas().data
```

In [67]:
```
# add "affair" column: 1 represents having affairs, 0 represents not
dta['affair'] = (dta.affairs > 0).astype(int)
```

Out[67]:

	rate_marriage	age	yrs_married	children	religious	educ	occupation	occupation_husb	affairs	affair
0	3.0	32.0	9.0	3.0	3.0	17.0	2.0	5.0	0.111111	1
1	3.0	27.0	13.0	3.0	1.0	14.0	3.0	4.0	3.230769	1
2	4.0	22.0	2.5	0.0	1.0	16.0	3.0	5.0	1.400000	1
3	4.0	37.0	16.5	4.0	3.0	16.0	5.0	5.0	0.727273	1
4	5.0	27.0	9.0	1.0	1.0	14.0	3.0	4.0	4.666666	1

In [68]:
```
#data exploration
```

Out[68]:

affair	rate_marriage	age	yrs_married	children	religious	educ	occupation	occupation_husb	affa
0	4.329701	28.390679	7.989335	1.238813	2.504521	14.322977	3.405286	3.833758	0.0000
1	3.647345	30.537019	11.152460	1.728933	2.261568	13.972236	3.463712	3.884559	2.1872

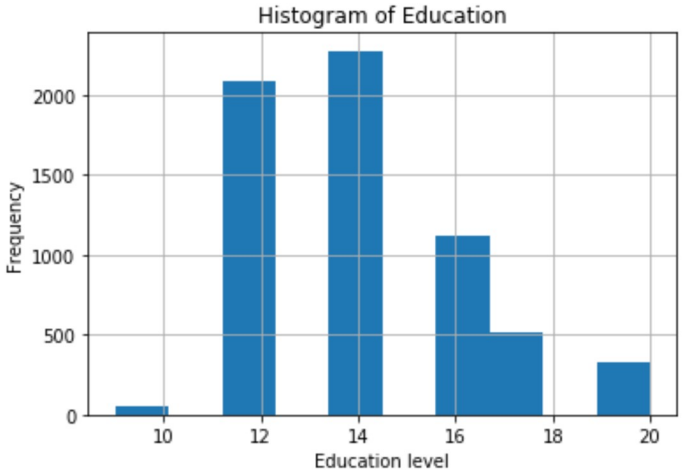
In [69]:
```
#groupby rate_marriage
```

Out[69]:

rate_marriage	age	yrs_married	children	religious	educ	occupation	occupation_husb	affairs	
1.0	33.823232	13.914141	2.308081	2.343434	13.848485	3.232323	3.838384	1.201671	0.7
2.0	30.471264	10.727011	1.735632	2.330460	13.864943	3.327586	3.764368	1.615745	0.6
3.0	30.008056	10.239174	1.638469	2.308157	14.001007	3.402820	3.798590	1.371281	0.5
4.0	28.856601	8.816905	1.369536	2.400981	14.144514	3.420161	3.835861	0.674837	0.3
5.0	28.574702	8.311662	1.252794	2.506334	14.399776	3.454918	3.892697	0.348174	0.1

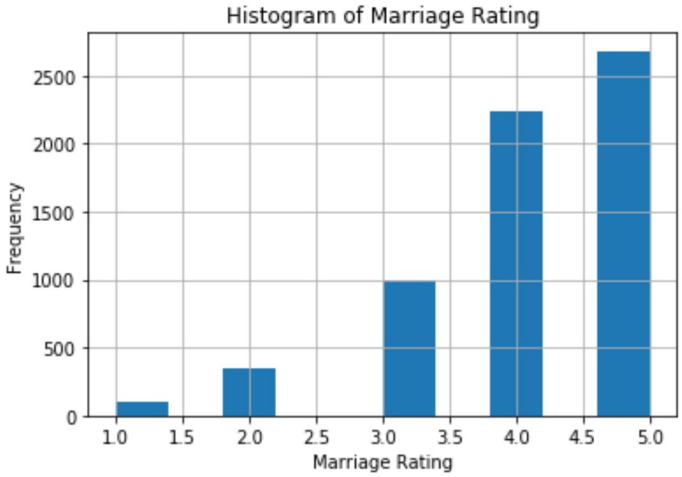
In [70]:
```
#show plots in notebook
%matplotlib inline
#histogram of education
dta.educ.hist()
plt.title('Histogram of Education')
plt.xlabel('Education level')
plt.ylabel('Frequency')
```

Out[70]:
```
Text(0,0.5,'Frequency')
```



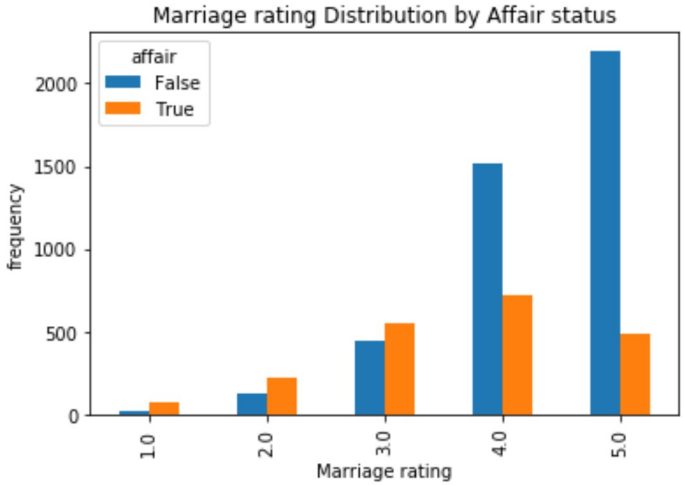
In [71]:
```
#histogram of marriage rating
dta.rate_marriage.hist()
plt.title('Histogram of Marriage Rating')
plt.xlabel('Marriage Rating')
```

Out[71]:
```
Text(0,0.5,'Frequency')
```



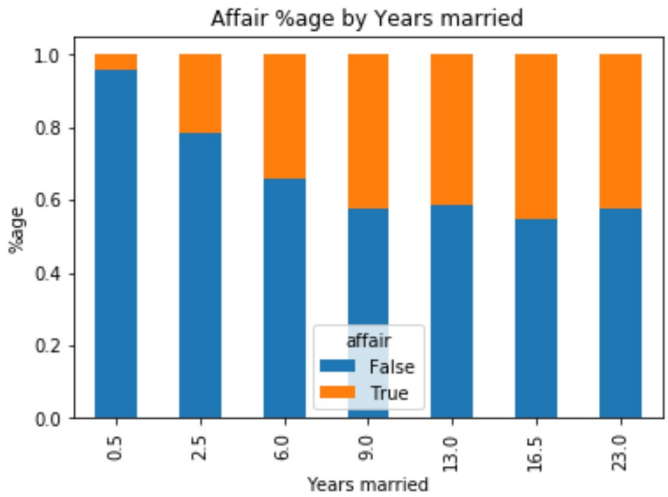
In [72]:
```
#barplot - marriage rating grouped by affair(true or false)
pd.crosstab(dta.rate_marriage,dta.affair.astype(bool)).plot(kind='bar')
plt.title('Marriage rating Distribution by Affair status')
plt.xlabel('Marriage rating')
```

Out[72]:
```
Text(0,0.5,'frequency')
```



In [73]:
```
affair_yrs_married=pd.crosstab(dta.yrs_married,dta.affair.astype(bool))
affair_yrs_married.div(affair_yrs_married.sum(1).astype(float),axis=0).plot(kind='bar'
plt.title('Affair %age by Years married')
plt.xlabel('Years married')
```

Out[73]:
```
Text(0,0.5,'%age')
```



In [84]:
```
# create dataframes with an intercept column and dummy variables for
# occupation and occupation_husb
y, X = dmatrices('affair ~ rate_marriage + age + yrs_married + children + \
 religious + educ + C(occupation) + C(occupation_husb)',
 dta, return_type="dataframe")
X.columns
```

Out[84]:
```
Index(['Intercept', 'C(occupation)[T.2.0]', 'C(occupation)[T.3.0]',
       'C(occupation)[T.4.0]', 'C(occupation)[T.5.0]', 'C(occupation)[T.6.0]',
       'C(occupation_husb)[T.2.0]', 'C(occupation_husb)[T.3.0]',
       'C(occupation_husb)[T.4.0]', 'C(occupation_husb)[T.5.0]',
       'C(occupation_husb)[T.6.0]', 'rate_marriage', 'age', 'yrs_married',
       'children', 'religious', 'educ'],
      dtype='object')
```

In [75]:
```
#fix column names of X
X = X.rename(columns = {'C(occupation)[T.2.0]':'occ_2',
 'C(occupation)[T.3.0]':'occ_3',
 'C(occupation)[T.4.0]':'occ_4',
 'C(occupation)[T.5.0]':'occ_5',
 'C(occupation)[T.6.0]':'occ_6',
 'C(occupation_husb)[T.2.0]':'occ_husb_2',
 'C(occupation_husb)[T.3.0]':'occ_husb_3',
 'C(occupation_husb)[T.4.0]':'occ_husb_4',
 'C(occupation_husb)[T.5.0]':'occ_husb_5',
 'C(occupation_husb)[T.6.0]':'occ_husb_6'})
y = np.ravel(y)#flatten y into a 1-D array
```

```
Index(['Intercept', 'occ_2', 'occ_3', 'occ_4', 'occ_5', 'occ_6', 'occ_husb_2',
       'occ_husb_3', 'occ_husb_4', 'occ_husb_5', 'occ_husb_6', 'rate_marriage',
       'age', 'yrs_married', 'children', 'religious', 'educ'],
      dtype='object')
```

In [76]:
```
# instantiate a logistic regression model, and fit with X and y
model = LogisticRegression()
model = model.fit(X, y)

# check the accuracy on the training set
```

Out[76]:
```
0.7258875274897895
```

In [77]:
```
# what percentage had affairs?
```

Out[77]:
```
0.3224945020420987
```

In [78]:
```
# examine the coefficients
```

Out[78]:

	0	1
0	Intercept	[1.4898837940684415]
1	occ_2	[0.18804558415678518]
2	occ_3	[0.4989262655812233]
3	occ_4	[0.25064649147289303]
4	occ_5	[0.838982945050265]
5	occ_6	[0.8339212391042999]
6	occ_husb_2	[0.19054686815178645]
7	occ_husb_3	[0.2977445887809447]
8	occ_husb_4	[0.16131946301637926]
9	occ_husb_5	[0.18768301823819164]
10	occ_husb_6	[0.1939168489133963]
11	rate_marriage	[-0.703119603499751]
12	age	[-0.05841783528509794]
13	yrs_married	[0.10567682016383156]
14	children	[0.016919793262707174]
15	religious	[-0.37113489383148257]
16	educ	[0.004015980233691873]

In [79]:
```
# evaluate the model by splitting into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=
)
model2 = LogisticRegression()
model2.fit(X_train, y_train)
```

Out[79]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l2', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False)
```

In [80]:
```
# predict class labels for the test set
predicted = model2.predict(X_test)
```

Out[80]:
```
array([1., 0., 0., ..., 0., 0., 0.])
```

In [57]:
```
# generate class probabilities
probs = model2.predict_proba(X_test)
probs
```

Out[57]:
```
array([[0.35146331, 0.64853669],
       [0.90955083, 0.09044917],
       [0.72567332, 0.27432668],
       ...,
       [0.55727384, 0.44272616],
       [0.81207045, 0.18792955],
       [0.74734598, 0.25265402]])
```

In [81]:
```
# generate evaluation metrics
print(metrics.accuracy_score(y_test, predicted))
```

```
0.7298429319371728
0.745950606950631
```

In [62]:
```
#confusion matrix and a classification report with other metrics.
print(metrics.confusion_matrix(y_test, predicted))
print(metrics.classification_report(y_test, predicted))
```

```
[[1169  134]
 [ 382  225]]
             precision    recall  f1-score   support

        0.0       0.75      0.90      0.82      1303
        1.0       0.63      0.37      0.47       607

avg / total       0.71      0.73      0.71      1910
```

In [82]:
```
# evaluate the model using 10-fold cross-validation
scores = cross_val_score(LogisticRegression(), X, y, scoring='accuracy', cv=10)
```

Out[82]:
```
(array([0.72100313, 0.70219436, 0.73824451, 0.70597484, 0.70597484,
        0.72955975, 0.7327044 , 0.70440252, 0.75157233, 0.75      ]),
 0.7241630685514876)
```

In [83]:
```
#the probability of an affair for a random woman not present in the dataset.
#She's a 25-year-old teacher who graduated college, has been married for 3 years, has
#rates herself as strongly religious, rates her marriage as fair, and her husband is a
```

Out[83]:
```
array([[0.77472345, 0.22527655]])
```