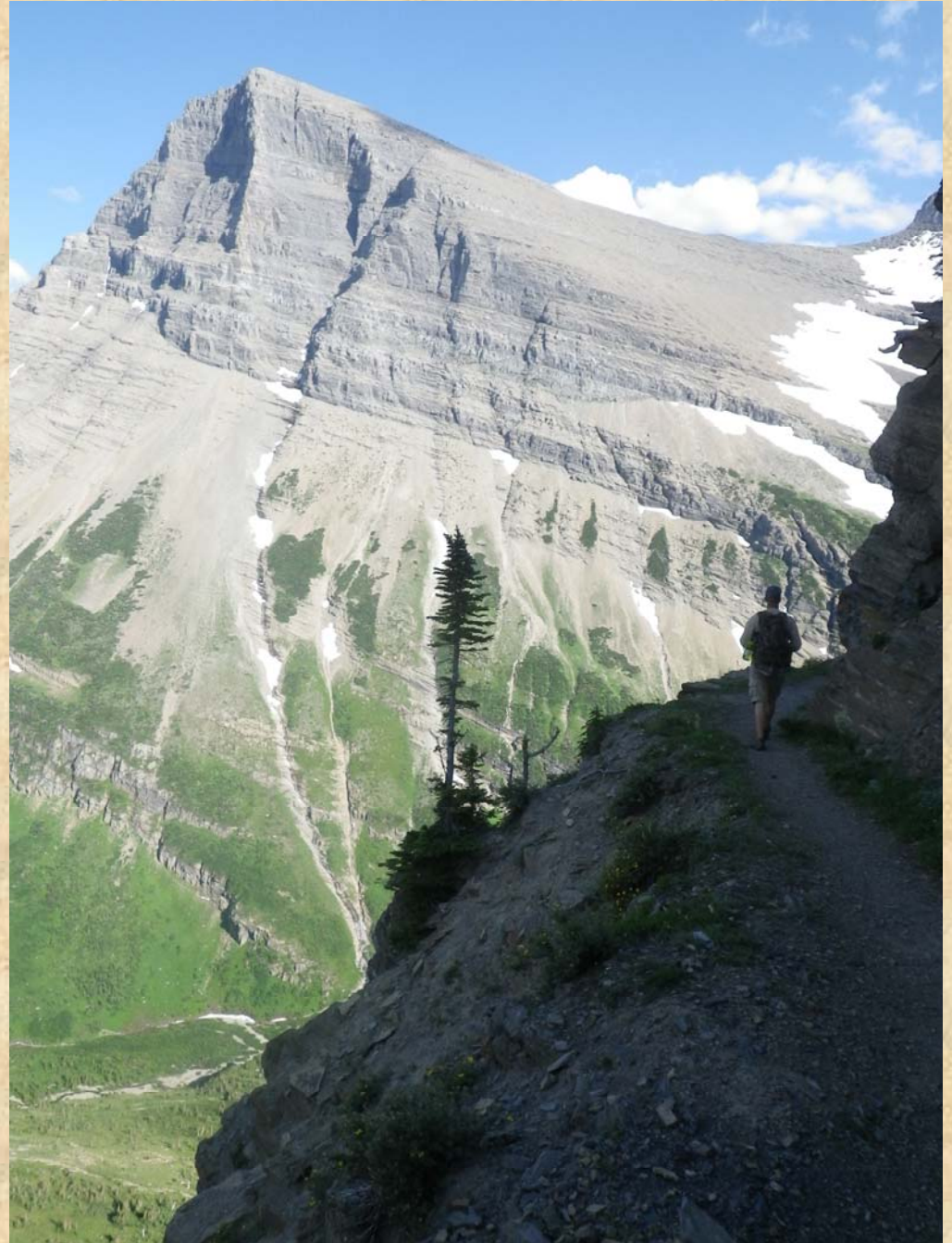


Montana Early Warning System

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What Is the Montana EWS?

- A statistical model that can use readily available school, student, and other live data to identify students who are at risk of dropping out of school **before** they drop out.
- The EWS allows educators to intervene early on during the process before a student has reached the point of no return.

How is the EWS developed?

- Compare data from dropouts to the data from high school graduates from the school years 2007-2014
- Model is found using Logistic Regression

$$\pi(x) = \frac{e^{\alpha + \beta x_1 + \beta x_2 + \dots + \beta x_n}}{1 + e^{\alpha + \beta x_1 + \beta x_2 + \dots + \beta x_n}}$$

- $\pi(x)$ is the percent chance a student will drop out of school
- Separate model is developed for each grades 6, 7, 8 and for each year of high school.

What data is available for the model?

- Data stored by the State.

- Student Data

- SIS (AIM) Data
- Testing Data

- School data

- School Demographics
- Location

- Census Information

- Unemployment Rates
- Populations

- Data stored by the Schools

- Attendance
- Transcripts
- Grades
- Discipline

EWS Model Dataset

- Data from all Graduates and Dropouts from 2007-2014 school years at 13 school system's in Montana.
 - 13 school system's in Montana were sampled to give a good representation of schools across the state. (roughly 11,000 students per year, or about 1/6th of the statewide students in 6-12th grades)
- Data current for each student at the end of the enrollment (whether a dropout or graduate)
 - Previous term data is usually from the 3rd quarter of the year.
 - This creates an assumption in the model that on average a student's data is the same at the end of the year as it is throughout the school year.

Pilot Study

School Systems

- Arlee
- Belgrade
- Butte
- Columbus
- Corvallis
- Frenchtown
- Havre
- Lame Deer
- Laurel
- Lewistown
- Livingston
- Townsend
- Wolf Point

• Pilot Year 2012-2013

- For the 2012-2013 school year EWS Results were sent to each school for their students once a month, at the beginning of each month.
- EWS was changed and updated many times during the school year.

• 2nd Year of EWS 2013-2014

- Model was updated during the previous summer and remained unchanged throughout the 2013-2014 school year.

• 3rd Year of EWS 2014-2015

- Model updated again
- New model uses less variables that OPI does not collect (9 total)

Example EWS Results

SC	SchoolName	LE	LastName	FirstName	StateID	HSYears	Grade	DropoutProb	Change	Est.	Reasons
0499	Pleasantville School	0123	Anderson	Joel	12345678	5	12	36.0%	↓	*	Attendance Previous Grades Age Off Track Mobile
0499	Pleasantville School	0123	Smith	Maria	12345678	4	12	25.0%	↘		Attendance Behavior LEP
0499	Pleasantville School	0123	Lackey	Edin	12345678	4	12	0.1%	↓		
0499	Pleasantville School	0123	Underman	Hal	12345678	3	11	15.6%	↑		Attendance
0499	Pleasantville School	0123	Hinch	Joe	12345678	3	11	1.4%		*	Behavior
0499	Pleasantville School	0123	Grossman	Keith	12345678	3	11	0.8%			Special Ed
0499	Pleasantville School	0123	Caligher	Mary	12345678	2	10	72.3%	↑		Attendance Current Grades Age Off Track
0499	Pleasantville School	0123	Stein	Thomas	12345678	2	10	34.5%			Attendance Age
0499	Pleasantville School	0123	Banby	Shane	12345678	2	9	10.0%	↑		Behavior OffTrack LEP
0499	Pleasantville School	0123	Thompson	Jess	12345678	1	9	1.5%	↘		Current Grades
0499	Pleasantville School	0123	Smith	Jane	12345678	0	8	6.5%	↑		Attendance
0499	Pleasantville School	0123	Anderson	Mike	12345678	0	8	0.4%			Attendance Age
0499	Pleasantville School	0123	Player	Troy	12345678	0	8	0.3%	↘		Mobile
0499	Pleasantville School	0123	Cornrow	Mike	12345678	0	7	4.3%	↘	*	Current Grades Previous Grades
0499	Pleasantville School	0123	Abbott	Megan	12345678	0	7	0.2%			Current Grades

Reasons that can be listed: Attendance, Grades, Age, Off Track, Behavior, LEP, Mobile Student, Previous Dropout

Variables that are in the EWS Model

Collected by OPI

- Ever been LEP (Y or N)
- Moved this school year (Y or N)
- Moved from out of state (Y or N)
- Repeated a grade in K-8 (Y or N)
- Free/Reduced Meal Status (Y or N)
- Age Difference (July 15 cutoff date)*
- # of School Systems attended since 2007
- Gender

Not Collected by OPI

- Attendance Rate
- # of Previous Term F's
- # of Previous Term A's
- # of Behavior Events in last 120 days
- # of Out of School Suspension Events in last 3 years
- On Track (Y or N)
- # of Credits per year
- # of Absences in last 90 days
- # of Absences in last 60 days

Over 200 Variables have been analyzed.

Two parts to a good EWS Model

1

- The Model should assign a high dropout percentage to students who end up dropping out.
 - Low dropout percentage to those that eventually graduate.
 - Can be evaluated by:
 - R squared
 - C-statistic
 - ROC Curves
 - Model AIC

2

- Model should be efficient in identifying dropouts above the cut-off threshold for targeting a student as At-Risk
 - A high percentage of At-Risk students end up being dropouts.
 - Can be evaluated by:
 - Confusion Matrix

When is a student considered At Risk?

- At what dropout percentage should we be concerned about a student?
 - Depends on school
 - Depends on how many incorrect conclusions you will accept.
- We want to be able to identify as many dropouts as we possibly can.
- We want as many of the students as possible to be in one of the “True” boxes.
 - Small number of students in the “False” boxes.

True Negative Model: Graduate Student: Graduate	False Negative Model: Graduate Student: Dropout
False Positive Model: Dropout Student: Graduate	True Positive Model: Dropout Student: Dropout

EWS Model Examples

All Students are marked as At Risk

FirstName	DropoutProb	At Risk	Dropout
Joel	36.0%	Y	Y
Maria	25.0%	Y	
Edin	0.1%	Y	
Hal	15.6%	Y	Y
Joe	1.4%	Y	
Keith	0.8%	Y	
Mary	72.3%	Y	Y
Thomas	34.5%	Y	Y
Shane	10.0%	Y	
Jess	1.5%	Y	

<p>True Negative</p> <p>Model: Graduate Student: Graduate</p> <p>0 0%</p>	<p>False Negative</p> <p>Model: Graduate Student: Dropout</p> <p>0 0%</p>
<p>False Positive</p> <p>Model: Dropout Student: Graduate</p> <p>6 60%</p>	<p>True Positive</p> <p>Model: Dropout Student: Dropout</p> <p>4 40%</p>

- Dropouts found - 100%
- Graduates found - 0%
- Accuracy - 40%

EWS Model Examples

No Students are marked as At Risk

FirstName	DropoutProb	At Risk	Dropout
Joel	36.0%		Y
Maria	25.0%		
Edin	0.1%		
Hal	15.6%		Y
Joe	1.4%		
Keith	0.8%		
Mary	72.3%		Y
Thomas	34.5%		Y
Shane	10.0%		
Jess	1.5%		

<p>True Negative</p> <p>Model: Graduate Student: Graduate</p> <p>6 60%</p>	<p>False Negative</p> <p>Model: Graduate Student: Dropout</p> <p>4 40%</p>
<p>False Positive</p> <p>Model: Dropout Student: Graduate</p> <p>0 0%</p>	<p>True Positive</p> <p>Model: Dropout Student: Dropout</p> <p>0 0%</p>

- Dropouts found - 0%
- Graduates found - 60%
- Accuracy - 60%

EWS Model Examples

Marked as At Risk when >20%

FirstName	DropoutProb	At Risk	Dropout
Joel	36.0%	Y	Y
Maria	25.0%	Y	
Edin	0.1%		
Hal	15.6%		Y
Joe	1.4%		
Keith	0.8%		
Mary	72.3%	Y	Y
Thomas	34.5%	Y	Y
Shane	10.0%		
Jess	1.5%		

<p>True Negative</p> <p>Model: Graduate Student: Graduate 5 50%</p>	<p>False Negative</p> <p>Model: Graduate Student: Dropout 1 10%</p>
<p>False Positive</p> <p>Model: Dropout Student: Graduate 1 10%</p>	<p>True Positive</p> <p>Model: Dropout Student: Dropout 3 30%</p>

- Dropouts found - 75%
- Graduates found - 83%
- Accuracy - 80%

EWS Model Examples

Marked as At Risk when >15%

FirstName	DropoutProb	At Risk	Dropout
Joel	36.0%	Y	Y
Maria	25.0%	Y	
Edin	0.1%		
Hal	15.6%	Y	Y
Joe	1.4%		
Keith	0.8%		
Mary	72.3%	Y	Y
Thomas	34.5%	Y	Y
Shane	10.0%		
Jess	1.5%		

<p>True Negative</p> <p>Model: Graduate Student: Graduate</p> <p>5 50%</p>	<p>False Negative</p> <p>Model: Graduate Student: Dropout</p> <p>0 0%</p>
<p>False Positive</p> <p>Model: Dropout Student: Graduate</p> <p>1 10%</p>	<p>True Positive</p> <p>Model: Dropout Student: Dropout</p> <p>4 40%</p>

- Dropouts found - 100%
- Graduates found - 83%
- Accuracy - 90%

EWS Model Examples

Looking at Beginning of the Year EWS Results from 2009-2010

Only including students that had **all** data elements needed for the EWS. (2940 students total)

Must look at 2009-2010 to include 8th, 9th, 10th, 11th, and 12th grade students and allow time for them to graduate.

325 Dropouts from group of students that were in school 2009-2010 in the Pilot Schools

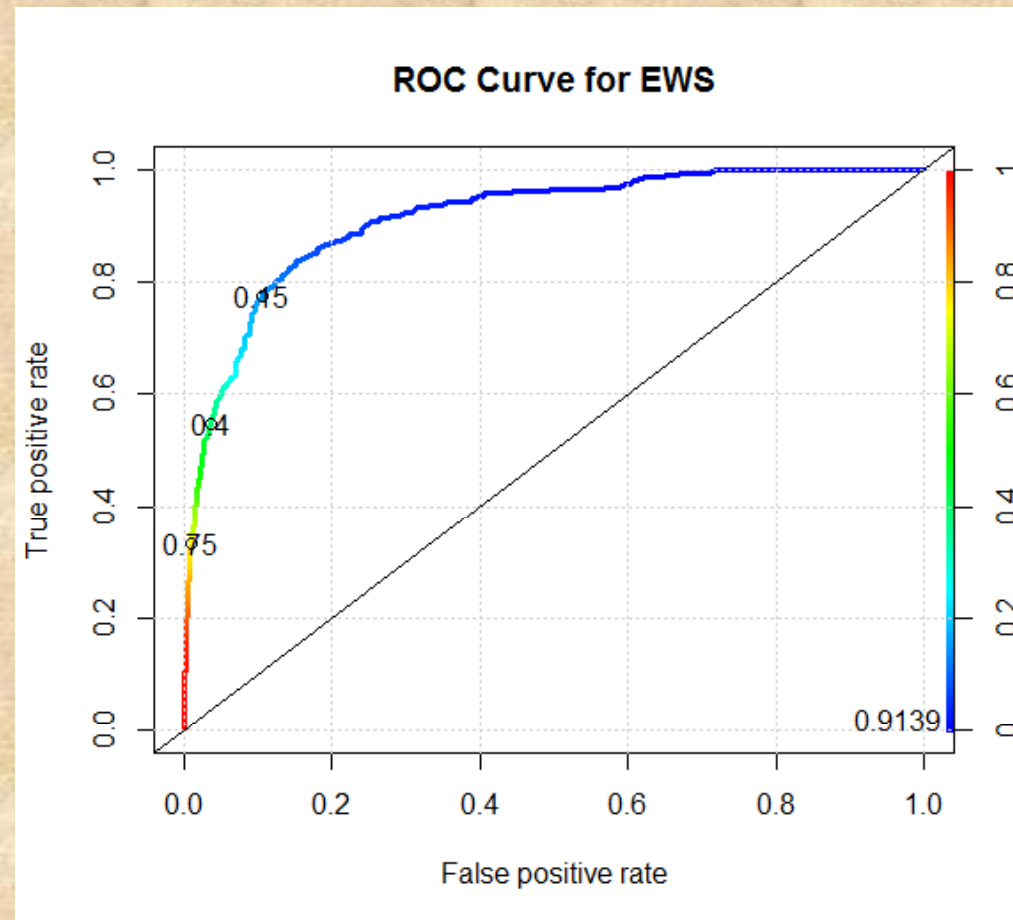
Marked as At Risk when >15%

True Negative Model: Graduate Student: Graduate 2339 79.5%	False Negative Model: Graduate Student: Dropout 73 2.5%
False Positive Model: Dropout Student: Graduate 276 9.4%	True Positive Model: Dropout Student: Dropout 252 8.6%

- Dropouts found – 77.5%
- Graduates found – 89.4%
- Accuracy – 88.1%

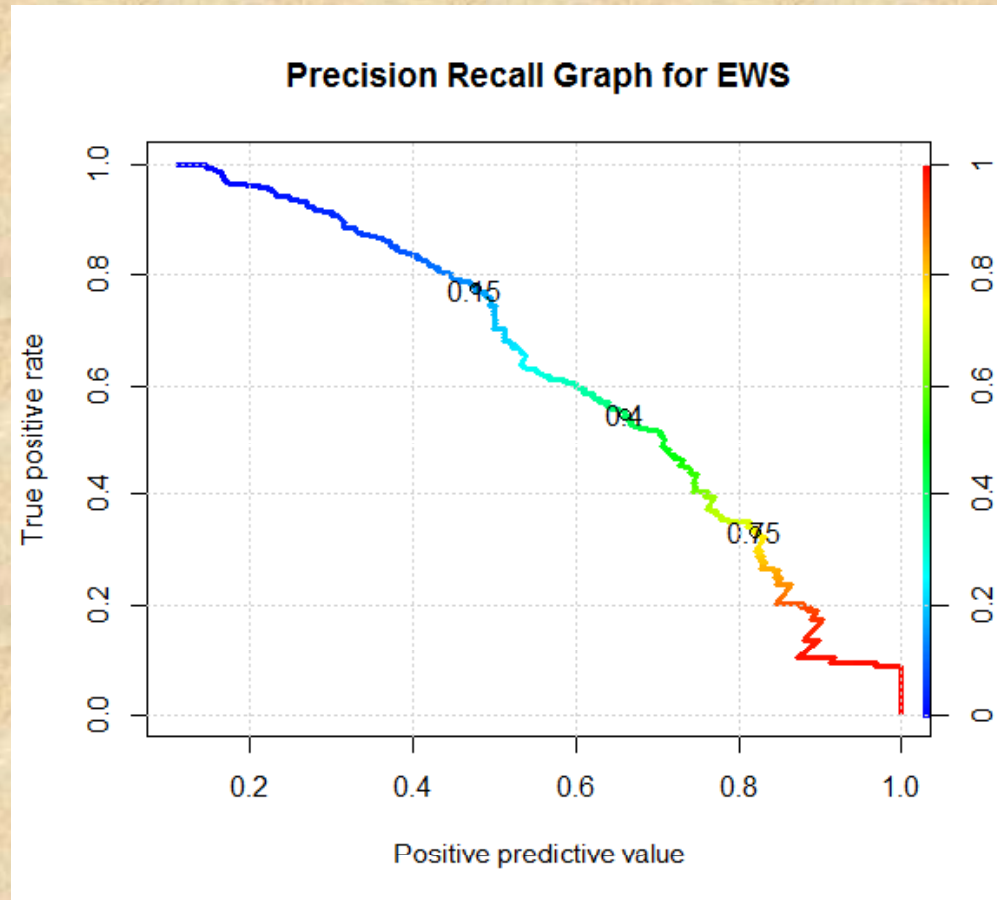
EWS Model Diagnostics

- ROC Curve and c-statistic
 - Graph of Sensitivity (True Positive Rate, % of Graduates correct) vs 1-Specificity (False Positive Rate, % of Dropouts correct)
 - Probability the model will assign a higher score to a randomly chosen dropout than to a randomly chosen graduate.



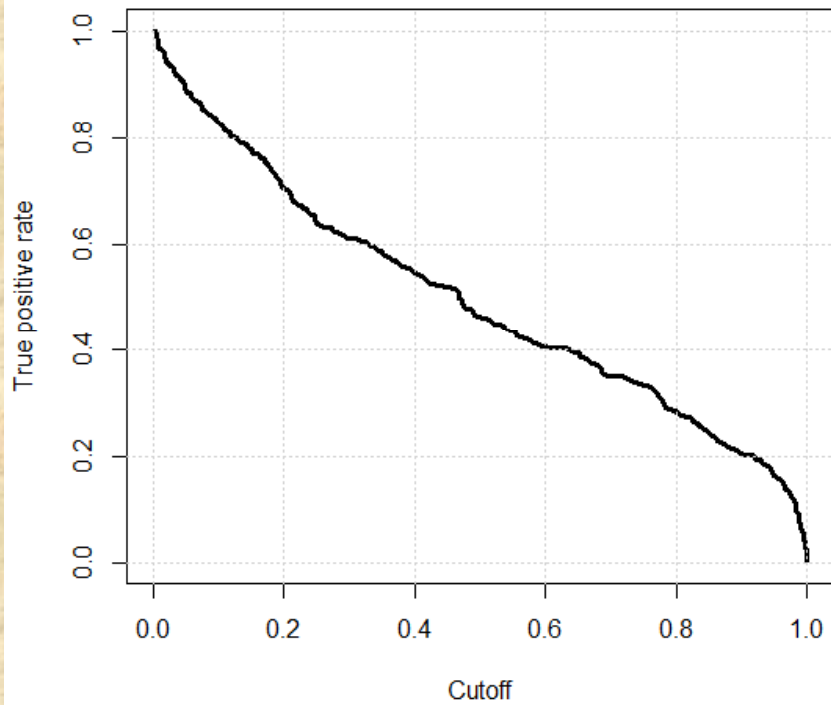
EWS Model Diagnostics

- Precision Recall Graph
 - Horizontal Axis – Percentage of at risk individuals that are dropouts
 - Vertical Axis – Percentage of dropouts the model finds.

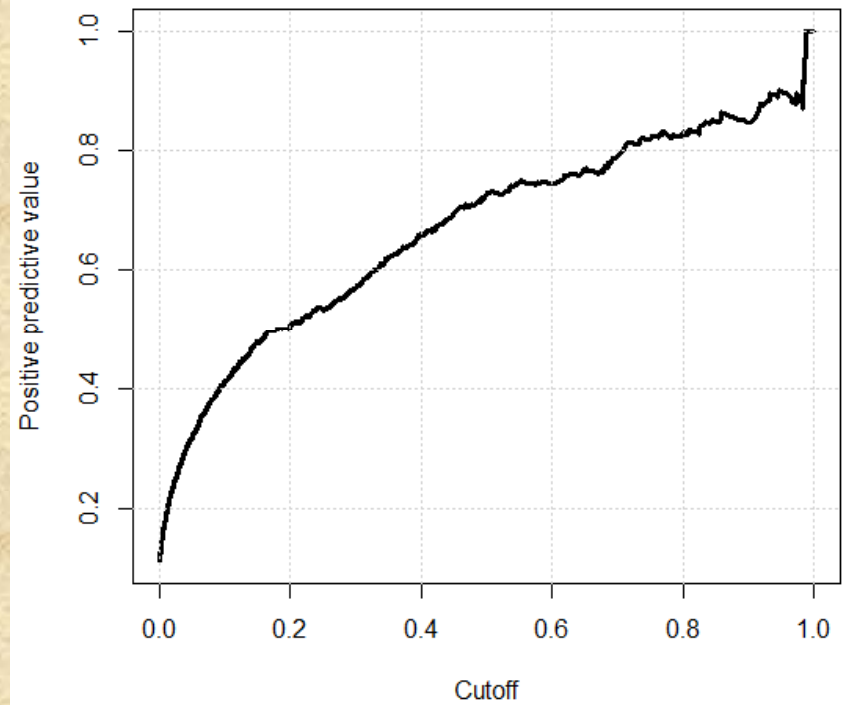


EWS Model Diagnostics

% Dropouts Identified



% Identified Students Dropout



Full Model Diagnostics

- R-squared
 - Measure of the fit of the model to data
 - Works a little different with logistic regression but similar to the r squared used with linear regression
- C-statistic
 - Probability a higher dropout value is assigned to a dropout than to a graduate.

<u>Year</u>	<u>R squared</u>	<u>c-stat</u>
6 th Grade	0.656	0.926
7 th Grade	0.622	0.919
8 th Grade	0.567	0.913
1 st Year HS	0.596	0.921
2 nd Year HS	0.705	0.953
3 rd Year HS	0.735	0.969
4 th Year HS	0.777	0.988
5+ Years HS	0.809	0.969

2013-2014 School Year EWS Results

- Median Dropout percentage for all students in pilot schools for 5/1/14 results was 3.5% (Which was actually the dropout rate for Montana during 2012-2013)
- 331 Dropouts at Pilot Schools
 - 239 Dropouts total with EWS results on 7/15/2013
- 196 of the dropouts had dropout percentages of greater than 15%
 - Would have been targeted as At-Risk
 - 82.0% of Dropouts would have been identified at the beginning of the school year.
- Most had much higher percentages.
 - Median Dropout Percentage of 239 dropouts was 71.1%
 - 75 of the 239 dropouts had over 90%

So what's next?

- EWS to be placed on GEMS website for the entire state to use
 - Will require upload of some data
 - Hopefully by November of 2014-2015 school year. Process has been started
 - Will include data so you can also look at district wide dropout percentages.
 - By School
 - By Grade
 - Compare to Statewide
 - Look at At-Risk reasons (Odds Ratios)
- Develop a similar model for younger students
 - 3rd – 5th grade students
- Keep re-evaluating the models each summer
 - More data will result in better models.
 - Investigate new variables



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