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Identifying Indicators for an Early Warning System

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# Background

The Colorado Department of Education requested information on research conducted to identify key indicators for Early Warning Systems (EWS). In response to this request, REL Central at McREL conducted a literature search for articles that described the identification of indicators that could be used as part of an EWS. This search specifically targeted articles that describe the methodology used in the creation of these systems and a description of the choices made when creating models and in the final selection of indicators.

The articles varied in the details describing the methodologies used to identify indicators. The articles (e.g., Nelid and Balfanz, 2006) provided general guidance that would make replication of the methodologies more difficult for districts. Despite the difference in the level of detail provided, the authors of each article described two similar steps needed to develop indicators of an EWS. The first step recommended by the authors was to provide a general description of the student samples, because the student population may vary within districts or states, leading to a corresponding difference in potential indicators. In the first set of articles, all articles reported the percentage of graduates and dropouts by demographic categories to descriptively examine the characteristics of the students in the sample who drop out of school and the students in the sample who graduate. Second, the authors identified the student characteristics that they felt best predicted the likelihood of a student dropping out of school. In addition to these two steps, three of the reviewed articles provided definitions of indicator threshold values to help identify students at risk for dropping out of school. These threshold values represent tipping points in the indicators; in other words, students with characteristics that fall above these values are at high risk of dropping out, based on the statistical model used by the authors. For example, Balfanz et al. (2010).reported a threshold value of two for suspensions, indicating that a student with two or more suspensions is at a higher risk of dropping out then a student who has not been suspended. These threshold values can be used by districts to identify students who are candidates for dropout prevention programs.

Each of the reviewed articles discussed the following common considerations:

* The recommended indicators and thresholds that resulted from the models are based on the sample data put into the model. For example, MacIver et al. (2009a) ran the same logistic regression models on four student samples from different school districts. The indicators that the model identified as statistically significant varied slightly for each district. All authors of reviewed recommend that districts run their own data through the models to verify the indicators function similarly for their sample.
* The researchers also discussed the importance of clearly defining both outcome and input variables used in the models. For example, attendance is often proposed as a possible dropout indicator, but often, studies, including those reviewed here, use slightly different definitions of attendance. Allensworth and Easton (2007) define attendance as course attendance, whereas MacIver et al. (2009) define attendance as daily attendance. The different definitions used for both outcome and input variables are likely the result of variations in data collection and school district policies. The differences are not a reason to exclude variables as potential drop-out indicators. However, when reviewing the literature, caution should be taken when comparing values reported across articles, as variations in these definitions will affect the interpretation of recommendations regarding these indicators.
* These articles propose indicators based on an analysis of existing data but do not provide evidence of how these proposed systems would work in practice. In the IES practice guide, Dynarski et al. (2008) recommend the use of data systems to diagnose and identify students at risk of dropping out. However, they rate the level of evidence to support this recommendation as low because they could not identify studies that evaluate district or school use of these data systems.

# Review of Articles

The remainder of this report summarizes the information from the reviewed articles. We first present a summary of variables used to initially describe the sample characteristics. The second section summarizes the variables identified as potential indicators for an EWS. The third section summarizes the threshold values, when available, recommended by the researchers. A conclusion section summarizes the indicators most frequently recommended by the articles’ authors.

## Describing the Sample

The articles reviewed for this summary began with a description of the characteristics of dropouts and graduates in their sample. The authors used these descriptive examinations as a first look at the differences between the two groups to begin to describe the characteristics of a “typical” dropout. For example, MacIver et Al. (2009b) noted that 75%% of the dropouts in their sample failed one or more semester courses in ninth grade. This descriptive analysis helped the authors decide which variables may be important to include in their predictive models. When there were strong differences in the demographic characteristics between dropouts and graduates, the authors used that difference as evidence to include the characteristic in the predictive model. It is important to note that there none of the articles reviewed included a standard definition of dropout or graduate; rather, each article had slightly different criteria for identifying a student as a dropout or a graduate. The definitions were primarily determined by the way that each district or school defined dropout in the dataset available to the researchers. This variation across articles was also true for many of the student characteristic variables used to describe the sample. For example, course grades were recorded as letter grades in some databases, and as GPA in others.

Table 1 summarizes the demographic variables used to describe the differences between dropouts and graduates in each article. Most of the articles examined the trends in their samples for gender and ethnicity separately, as well as the combination of these two student characteristics (e.g., the percent of African American male graduates in the sample).

**Table 1: Variables Used to Initially Describe Student Sample by Article**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Gender | Ethnicity | English/Language Arts Grades | Math Grades | General GPA | Number of Course Failures | Repeated Grade/  Overage | Attendance/Absence | School Type | Special Education | Discipline | Other |
| Allensworth and Easton (2007) | *√* |  |  |  | *√* | *√* |  | *√* |  |  |  | School Climate |
| Nelid and Balfanz (2006) | *√* | *√* |  |  |  |  |  | *√* | *√\*\*\** |  |  | Poverty |
| MacIver et Al. (2009a and 2009b)\* | *√* | *√* |  |  |  |  |  | *√* |  | *√* | *√\*\** | Semester Failures |
| Balfanz et al. (2010) | *√* | *√* | *√* | *√* |  | *√* | *√* | *√* |  |  |  | Proficiency on State Assessments |
| ELL Status |
| Student Mobility |

*\*These two articles are combined because 2009a is a smaller report that is a subset of the results reported in 2009b \*\*Suspensions only \*\*Charter School and Regular Public Schools.\*\*\*Magnet, Vocational, Neighborhood and Disciplinary schools.*

## Predictive Analyses

In three of the articles, the descriptive analysis was followed by a predictive analysis that resulted in recommendations for indicators. Table 2 shows the type of model used in the analysis and the final list of EWS indicators recommended for use in each article. Balfanz et al. (2010) classified their recommended indicators as either primary or secondary. The primary indicators represent the characteristics that, at minimum, should be included in the model because they were the most accurate predictors of student dropout. Primary predictors were seen by the authors as essential indicators, whereas secondary indicators were important but not essential. However, no details on the criteria in dividing the indicators into primary and secondary categories was provided by the authors.. The general explanation provided was that the primary predictors have strong evidence of accurate prediction (i.e. statistical significance) and explain most of the variance in outcome measures of their models, whereas the secondary indicators have strong evidence of prediction but do not explain much of the variance in the outcome measure when used in models with the primary indicators. Several articles (e.g., Allensworth and Easton, 2007) used gender and ethnicity as controls in their models but never included these categories as recommended indicators for an EWS, so although these variables were included in their models, they are not included in Table 2.

Allensworth and Easton (2007) did not include a final list of recommendations for indicators in an EWS; as a result, their research is not included in the table. Some measure of attendance was recommended as a primary indicator in all articles. All articles also reported that an academic indicator should be included; however, how that indicator was defined depended on the article. For example, some articles included math grades while others included course failures as an academic indicator.

**Table 2: Recommended Indicators by Article**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Article | Model used | English/Language Arts Grades | Math Grades | Course Failures | Repeated Grade/  Overage | Attendance | Number of Suspensions | ELL Status | Other Secondary Indicators |
| Nelid and Balfanz (2006) | Predictive\* | P | P | S |  | P |  |  |  |
| MacIver et al. (2009a and 2009b)\*\* | Logistic Regression |  |  | P |  | P |  |  |  |
| Balfanz et al. (2010) | Logistic Regression |  |  | P | S | P | P | S | >2 transfers |

*P= primary indicator, S=secondary indicator, \*Method not clearly explained, \*\*Authors did not provide a clear set of final indicators; the indicators in this table are the ones that the authors listed as their recommendations as behavioral risk factors.*

## Threshold Values

As part of the creation of an EWS, decisions must be made about the threshold values associated with indicators that will be used to identify students at risk of dropping out. These threshold values represent minimum levels of the indicators that districts can use to identify students at risk of dropping out. For example, Nelid and Balfanz (2006)found that 9th graders who attend less than 80% of required school days are at a high risk of dropping out as compared 9th graders who attend more than 80% of the required school days. Therefore, they recommend that 9th grade students with attendance of less than 80% in their 9th grade year be identified as candidates for dropout intervention programs. Table 3 provides information about the threshold values recommended in the three reviewed articles that provided thresholds and the method used to determine these values. The methods for determining threshold values were not well defined, so replication on other data sets would be difficult. Further, the authors also varied in how universal the indicators could be for students as they progressed through high school. Balfanz et al. (2010) generated recommendations that could be used for high school students in any grade (e.g. a student whose daily attendance rate at any point during high school is below 85% is at risk for dropping out). Nelid and Balfanz (2006) provide recommendations that are specific and sometimes unique to different high school grade levels (e.g. a 10th grade student enrolled in less than 5 course credits is in danger of dropping out, but a 12th grade student enrolled in less than three course credits is in danger of dropping out) . The blank cells in the table indicate that the authors did not report threshold values for a particular indicator (e.g. only Balfanz et. al. reported a threshold valued related to student suspensions). The table also includes the default threshold levels for the National High School Center Early Warning System High School Tool. This free tool is an excel file to be used as an EWS. In default mode, it is is designed to run analyses to identify students at risk of dropping out, based on the thresholds reported in . The technical manual of this tool provided these threshold values but did not describe their methodology for determining the values. None of the authors provided information on the accuracy of their proposed threshold vales.

**Table 3: Recommended Threshold Value by Article**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Article | Method used to determine threshold | Grade(s) to apply recommendation | Course Failure(s)  (Any Subject) | English/ Language Arts Grades | Math Grades | Daily  Attendance | Number of Suspensions | Course Credits | Other Indicators |
| Nelid and Balfanz (2006) | Not clearly defined | 9\* |  | 8th Grade Failure | 8th Grade Failure | <80% in 8th grade |  |  |  |
| 10\*\* |  |  |  | <80% |  | <5 Credits | Had a baby |
| Placed in 24 hour juvenile justice program |
| 11\*\* |  |  |  | <60% |  |  |
| 12\*\* |  |  |  | <30% |  | <3 Credits |  |
| Balfanz et al. (2010) | Not clearly defined | 9-12 | ≥2 |  |  | <85% | ≥2 |  |  |
| National High School Center Early Warning System Tool 2.0 | Not clearly defined | N/A | 1 or more per grading period |  |  |  |  | Less than 1/3 the total number of course credits student should have at their grade level. | Less than ½ the available GPA |
| Missed >10% of instructional time |

*\* Nelid and Balfanz (2006) based their ninth grade predictions on 8th grade student information.\*\* Nelid and Balfanz (2006) based 10-12th grade information on information from the student's "current" grade. Note: Blank cells indicate threshold value was not reported by the authors for the indicator.*

# Summary

The articles reviewed provide methodologies and recommendations for indicators that districts can use in an EWS. All articles include a descriptive overview of their sample. This overview compared the general characteristics of graduates versus dropouts in the sample. The article authors then analyzed which of these general characteristics was able to most accurately predict students at risk of drop out. These variables become the authors’ recommendations for indicators to include in an EWS. Although the specific definitions of student dropout and the key indicators vary among the articles, two categories emerge across the articles as key indicators to include in an EWS. These categories are attendance and a measure of academic performance.

A limitation of the majority of these studies is the lack of detail provided describing the methodologies used to both determine recommended indicators and the indicator thresholds. The majority of the articles state that they used a series of logistic regression models to select their indicators but never fully specify the models or model-building procedures. Without these model-building procedures, there is no information on the criteria used to either add or subtract indicators from successive models. For example, Balfanz et al. (2010) initially included mathematics grades in their models but did not explain the criteria they used to exclude it from their final model. Therefore, a district will not be able to use the same criteria when recreating their analyses. Although the final models can be inferred by the results tables in the technical appendix, little information is available to re-create the intermediate model. These intermediate models and associated explanations could provide information on why some demographics were included in earlier models but were ultimately ruled out as strong indicator. Information regarding the decisions behind selecting the threshold values is also vague.

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