The use of multilevel modeling and the level two residual file to explore the relationship between middle years programme student performance and diploma programme student performance

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ABSTRACT

Multilevel modeling has recently found a substantial niche in the context of educational research, although several details about the methodological application of these models have yet to be explored in an achievement data framework. This paper makes use of data provided by the International Baccalaureate (IB) in order to investigate modeling decisions and certain applications of the level two residual file in an effort to increase understanding about the way linear and logistic multilevel models function. The focus of this research is on the relationship between performances in two IB programmes: the Middle Years Programme (MYP) and the Diploma Programme (DP). The impact of predictors on the interpretation of the unconditional and conditional variance-covariance matrix as well as the reliability coefficients is discussed. Empirical findings suggest that students who perform better during MYP moderation tend to perform better on DP exams.

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1. Introduction

1.1. Multilevel modeling

Multilevel modeling (MLM) has found its place in social science research due to the desire to differentiate between individual effects and institutional effects, as well as the obvious hierarchical structure of certain types of data. This type of modeling is optimal for educational research, where students often have similarities to their peers due to organizational factors such as having the same teacher or attending the same school in the same country. Contextual analysis is one form of multilevel modeling which allows the researcher to determine if social context (the aggregate of an individual level variable) can have an impact on the individual behavior above and beyond the individual level effects (level one) (Raudenbush and Bryk, 2002). When there is a hierarchical structure in the data, the assumption of independence between the outcome scores is violated and thus the standard errors of the coefficients are negatively biased (Snijders and Bosker, 2012). This could lead to regression coefficients that are determined to be statistically significant when they actually are not. The use of a MLM assures the researcher that the standard errors are properly estimated which in turn allows the researcher to trust the statistical significance of each parameter in the model (Snijders and Bosker, 2012).

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One benefit of creating a multilevel model in the software HLM is easy access to the level two residual file. The level two residual file offers additional valuable information about each level two unit (here, the schools) which allows the researcher to better understand how and why the model functions the way that it does. The fixed effects of the model only provide the average value of each school intercept and slope, so it is important to understand the variation of the individual intercepts and slopes across schools when they do significantly vary (Snijders and Bosker, 2012). The addition of good predictor variables on both level one and level two creates a more accurate model, but can make the interpretation of the variables in the level two residual file much more complicated. This article focuses on the proper use and interpretation of a two-level model with level one and two predictors.

Another important reason to examine the level two residual file is to ensure that the tau matrix and the reliability coefficients are properly interpreted, and to examine the difference between a conditional and unconditional tau matrix. A discussion of the tau matrix is integral to multilevel modeling, as the creation of random effects and therefore the tau matrix is what makes multilevel modeling unique. The tau matrix houses the coefficients for the error variances of all of the random coefficients in the models, as well as their covariances (when they are allowed to co-vary). Generally, it is recommended that the covariance between the intercept and the random slopes are always included. However, the covariances in the tau matrix are rarely interpreted, and often not included in final tables. As the covariances can be quite large and significant, they are still typically included in the models (Hox, 2010). It is critical that the researcher understands the difference between the conditional and unconditional tau matrix so that when they choose to interpret and include the tau matrix in their research, they do so correctly. Finally, the level two residual file allows the researcher to check some of the model assumptions (see Appendix A).

1.2. The International Baccalaureate

The data for this study was provided by International Baccalaureate (IB). The IB offers four educational programmes for a worldwide community of schools, aiming to create a better, more peaceful world. While there is a common, strong philosophy underpinning the programmes, each one has distinct characteristics designed to meet the developmental needs of students at particular stages. All programmes have a strong international dimension and draw on content from educational cultures around the world. The IB offers the Primary Years Programme (PYP) designed for students aged 3–12, the Middle Years Programme (MYP) designed for students aged 11–16, the Diploma Programme (DP) designed for students aged 16–19, and the IB Career-related Certificate (IBCC) designed for students aged 16–19 who wish to engage in career-related learning. This study focuses on the relationship between performance in the MYP and the DP.

1.2.1. The IB middle years programme

Coursework for the MYP consists of eight subject groups integrated through five areas of interaction that provide a framework for learning within and across the subjects. Students are required to study their mother tongue, a second language, humanities, sciences, mathematics, arts, physical education and technology. The emphasis is on the fluidity of the curricular framework and the interrelatedness of the subjects. In particular, the framework is flexible enough to allow a school to include other subjects not determined by the IB but which may be required by state or national authorities.

1.2.1.1. Assessment. At the time of this research, the IB does not provide external assessments for the MYP.[1] However, many IB World Schools offering the MYP request the optional official IB-validated grades for their students in the final year of the programme. When schools participate in moderation the IB is able to track MYP scores. Participation in MYP moderation does not ensure or preclude admission into the DP.

1.2.1.2. Scores. Scores from 1 (lowest achievement) to 7 (highest achievement) are awarded to final-year students, for each of their eight subjects and for their personal project, according to pre-defined grade boundaries based on the levels students have achieved. As a result, the total moderation score for a MYP student can range from 9 to 63. The MYP certificate is awarded to students who obtain at least 36 points on their moderation, and submit to certain standards regarding the personal project, individual subject grades, programme participation, and community and service.

1.2.2. The IB diploma programme

The IB Diploma Programme (DP), for students aged 16–19, is an academically challenging and balanced programme of education with internal assessments and final examinations that prepares students for success at university and life beyond.

1.2.2.1. Assessment. DP students study six courses at higher level and/or standard level. Students must choose one subject from each of groups 1–5, thus ensuring breadth of experience in languages, social studies, the experimental sciences and mathematics. The sixth subject may be an arts subject chosen from group 6, or the student may choose another subject from groups 1–5. At least three and not more than four subjects are taken at higher level, the others at standard level. In addition,

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[1] The IB is currently reviewing the design of the MYP and it is expected that an optional external e-assessment will available for MYP exams starting in 2016. There would no longer be moderation for subject groups, but mandatory moderation for the MYP personal project.