Predictors of teacher burnout during the COVID-19 pandemic with machine learning

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Boston University
Predictors of Teacher Burnout During the COVID-19 Pandemic with Machine Learning

Efe I Shavers*, Hayoung Kim Donnelly, Kimberly A S Howard and V Scott H Solberg
Wheelock College of Education and Human Development, Boston University, USA

*Corresponding author: Efe I Shavers, Wheelock College of Education and Human Development, Boston University, USA

Abstract
Existing literature has attempted to understand what factors contribute to teacher burnout and the 2020 COVID-19 pandemic provided a unique opportunity for researchers to better understand factors specific to a global pandemic that might contribute to teacher burnout. Utilizing data from the 2020 ATP COVID-19 response survey from American Educational Panel (AEP) and using Machine Learning with R, we addressed the following research questions; R1. Which factors of teacher, school, student, teaching, resources, and needs are most relevant to the burnout of teachers during COVID-19? And R2. How is a level of predictor different between teachers with and without burnout?. Results of this study indicate that several personal and work-related concerns specific to living and teaching during a pandemic predicted teacher burnout. Specifically, teachers were more likely to report concerns about burnout, when they had more personal concerns (i.e., the health of their own and loved ones, caring others, job security), experienced information overload, or spent more time for providing instruction and grading.

Keywords: Teachers; Burnout; Machine Learning; COVID-19

Predictors of Teacher Burnout During the COVID-19 Pandemic

In the height of the COVID-19 pandemic, many essential or frontline workers were hailed as superheroes and thanked profusely in person, through social media, and colorfully on the front lawns of many American homes. These frontline workers include doctors, EMTs, grocery store cashiers, janitors, agricultural workers, and truck drivers [1]. PK-12 teachers were only briefly included in that list, despite their tireless efforts to work from home or in hybrid settings, with many risking their lives to teach double the amount of lessons as they adapted to teaching both virtually and in person. Yet, despite their lack of recognition as essential workers, former President Trump and education secretary Betsy DeVos mandated that teachers return to the classroom regardless of their social-emotional or medical status and threatened to withhold federal funding from schools if his mandate wasn’t met [2]. The insensitive expectation that teachers will continue to perform at consistent and high levels in the face of challenges and crises is not unique to the COVID-19 pandemic and has long been linked to teacher burnout rates [3].

The dismissive and often isolating treatment of teachers is not only inconsiderate but also illogical if the goal is to provide quality educational experiences to students. According to Bronfenbrenner’s system of ecological systems of development [4], schools are dynamic, ecological systems that play a vital role in the lives of our students. The ability of these dynamic educational systems to facilitate learning and achievement depends upon the skills of the teachers within them [5,6]. Consistent, encouraging interactions with teachers support the social-emotional success of students. Without positive teacher-student relationships, students are challenged to build social capital and invest in their education [7,8]. Thus, when teacher stress leads to work dissatisfaction and turnover (one possible direct result of teacher burnout), the educational process may be disrupted for students and can limit their access to effective instruction [9].

According to Dorman [10], there has been a sizable increase in the research of burnout since Fredenberger’s conceptualization of the term “burnout” in 1974, particularly with respect to employment. Fredenberger described burnout as “the inability to function effectively in one’s job as a consequence of prolonged and extensive job related stress” [10]. Over the years, teacher burnout has been systematically studied, as it is a profession already rife with high levels of stress, leading to physical and emotional exhaustion [11]. However, during the (mandatory) quarantined months of
COVID-19, teachers, like much of the workforce, were separated from their mentors and other teachers—individuals who might have otherwise provided intellectual stimulation or comfort during this time [12]. While many such as Maclach and Leiter [13] and Seidman and Zager [14] have studied the conditions associated with burnout amongst teachers, it is unclear what effect the COVID-19 pandemic has had on teachers’ experiences of burnout. Thus, the purpose of this study is to examine the factors associated with teacher burnout during the COVID-19 pandemic, using a nationally representative sample of U.S. educators.

**Research Design**

Machine learning is a branch of computational algorithms designed to assess and predict outcomes by pattern recognition from the use of big data with applications in fields like medicine, engineering, finance, and entertainment [15]. Only a few existing studies have linked teachers’ lives outside of the classroom to burnout rates [11], fewer still have connected the effects of the COVID-19 pandemic with teacher burnout [3], and even fewer have achieved this feat using machine learning. Given the grave concern of potential teacher shortages as a result of pandemic-associated stresses, [16], analysis techniques that allow us to assess the association of a broad range of variables on teachers’ experiences of burnout may be particularly useful. In this paper, we aim to identify the important predictors of teacher burnout that occurred during and following the COVID-19 pandemic. Utilizing data from the 2020 ATP COVID-19 response survey from American Educational Panel (AEP), we address the following research questions:

- R1. Which factors of teacher, school, student, teaching, resources, and needs are most relevant to the burnout of teachers during COVID-19?
- R2. How is a level of predictor different between teachers with and without burnout?

**Method**

Participant responses (1,000) were collected between April and May of 2020 as a part of the 2020 ATP COVID-19 response survey in the American Educational Panel (AEP). The ATP is a nationally representative data set composed of public K-12 teachers collected annually since 2014 and uses probability sampling at the state and national levels to include a representative sample of teachers within the United States [17]. After excluding respondents with missing values across the variables of this study, 936 teachers were included in this study.

**Instruments**

To measure burnout, teachers were asked to report the extent to which becoming burnt out was a concern for them. Further, a total of 51 work and life experiences organized into 11 categories were used as predicting factors of burnout during the COVID-19 pandemic [18]. The 11 categories of predictors of burnout include the following:

- **Instruction method**: Teachers indicate if they engage in synchronous or asynchronous teaching.
- **Grading**: Teachers indicate if grading is a letter, pass/fail, no grade but providing feedback, or no grading with no feedback.
- **Training received**: In the areas of student learning, student engagement, Emotional and Social Learning (SEL), technology, increasing accessibility of students, academic support for families, non-academic support for families, and other resources for families.
- **Received training and guidelines for special populations**: such as students with mild to moderate disabilities, students with severe disabilities, students experiencing homelessness, students in poverty, ELL students, and other marginalized students.
- **Providing family support**: in regard to students’ learning, students’ physical activity, students’ social-emotional needs, discussing COVID-19 with students, and other resources.
- **Needs in teaching**: such as the needs in student engagement strategies, hands-on learning resources, SEL assessment tools and resources, technical support, lesson planning for distance learning, needs for counselors/psychologists, needs for increased internet access for teachers, needs for networking with other teachers, curriculum for distance learning, academic learning assessment, and electric devices for teachers.
- **Current personal concerns**: the teachers might have, including concerns for their own or loved ones’ health, paying bills, job security, caring for loved ones, and for students' academic and personal well-being.
- **Employment status**: such as probationary or professional status which might have been changed during the pandemic.
- **Information overload**: which might have been an issue experienced during the pandemic.
- **Strategies for reopening after the pandemic**: which could cause more anxiety with the teachers thinking of returning back to school.
- **School composition**: wherein the school size, demographics, and the location of the school (urban, suburban, or rural) were identified, class make up, which identifies if the class is a general education classroom, a special education class, or an ELL classroom.

In the 2020 ATP COVID-19 dataset, predictors of burnout item variables were coded using varying types of scales for each subset of predictors. In order to standardize the data responses for analysis, all 51 were re-coded so that all responses were now represented as binary code. If the original items were assessed using a Likert scale, those data were reclassified into a binary scale, while those that were originally assessed using a binary scale remained unchanged. For example, for some items, response options included ‘4’ for major concern, ‘3’ for moderate concern, ‘2’
for minor concern, and ‘1’ for no concern. These were then coded binarily so that ‘1’ represented major or moderate concern and ‘0’ represented minor to no concerns. This was done uniformly for all variables to standardize the dataset [18]. Participant demographic information was not included in the publicly available data set of 2020 ATP COVID-19.

**Data Analysis**

For the primary analysis, the machine learning classification model with a random forest algorithm was employed to identify the most relevant factors for teacher burnout with multiple steps. In this analysis, the weight provided by AEP was applied to reduce sample error and provide generalizable information about the U.S. teacher population. For step 1 as a hold-out approach, data was divided into two data sets (70% for the train dataset and 30% for test dataset). For step 2, optimal hyperparameters of random forests were identified by conducting a grid search with the train data. For step 3, using the optimal hyperparameters identified in step 2, a 10-fold cross-validation was performed to prevent overfitting and examine the generalizability of the model by using train dataset and validation dataset for each fold. For step 4, we examined how well the trained random forests model explains teachers’ burnout from the test dataset. In step 5, the random forests model reported good performance in predicting teacher burnout (as indicated by AUC is greater than 70, [19]) with the top 10 dominant predictors identified out of 51 predictors based on the results of random forests.

**Results**

As a result of random forest, the AUC from 10-fold validation (train dataset and validation dataset) and hold-out (test dataset) were as follows: 0.99 as train result, 0.77 as validation result, and 0.71 as test result. Therefore, this machine learning model is a fair classification model (greater than 0.7 for both validation and test results) in distinguishing teachers with high and low burnout concerns. The identified optimal hyperparameter was as follows: mtry = 14.28, ntree = 200, maxdepth = 3. Figure 1 shows the relatively ranked importance of features in predicting teacher burnout. Out of 51 predictors, concern for own/loved ones’ health, information overload, concerns about caring for loved ones, providing video instruction to students, grading with a letter, synchronous teaching, school composition, concern about job security, school location, and strategies for reopening were ranked as top 10 dominant predictors of teacher burnout.

![Figure 1: Importance of 51 predictors in Predicting Teachers’ Burnout.](image-url)
In a post-hoc analysis, Table 1 shows the results of the logistic regression with the top 10 predictors and teachers’ burnout. There are statistically significant effects of 6 predictors in teachers’ burnout. Teachers with concern for their own and their loved ones’ health during the pandemic are 1.8 times more likely to report concerns about burnout than their counterparts ($\beta = 0.60, p < 0.01$), while those experiencing information overload are over 2.6 times more likely to have concerns about burnout than those who didn’t experience information overload ($\beta = 0.96, p < 0.001$). Teachers with concerns about caring for their loved ones are 1.7 times more likely to have concerns about burnout than those that didn’t report concerns about job security ($\beta = 0.53, p < 0.01$). Teachers providing letter grades to students are 1.63 times more likely to have concerns about burnout than those who didn’t provide it ($\beta = 0.41, p = 0.05$). Teachers with concern about job security are 1.76 times more likely to have concerns about burnout than those that didn’t report concerns about job security ($\beta = 0.57, p < 0.05$). However, synchronous teaching, school composition, school location, strategies for reopening did not report a significant predictive effect on teacher burnout in the logistic regression result.

### Table 1: Logistic Regression with Top 10 Predictors.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$</th>
<th>S.E.</th>
<th>Odds Ratio (OR)</th>
</tr>
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<tbody>
<tr>
<td>Concern in own/loved ones’ health</td>
<td>0.60***</td>
<td>0.18</td>
<td>1.81</td>
</tr>
<tr>
<td>Information overload</td>
<td>0.96***</td>
<td>0.16</td>
<td>2.61</td>
</tr>
<tr>
<td>Concerns in caring loved ones</td>
<td>0.53**</td>
<td>0.18</td>
<td>1.7</td>
</tr>
<tr>
<td>Providing video instruction to students</td>
<td>0.49*</td>
<td>0.19</td>
<td>1.63</td>
</tr>
<tr>
<td>Grading with letter</td>
<td>0.41*</td>
<td>0.17</td>
<td>1.51</td>
</tr>
<tr>
<td>Synchronous teaching</td>
<td>0.35</td>
<td>0.2</td>
<td>1.42</td>
</tr>
<tr>
<td>School composition</td>
<td>-0.32</td>
<td>0.16</td>
<td>0.73</td>
</tr>
<tr>
<td>Concern in job security</td>
<td>0.57*</td>
<td>0.23</td>
<td>1.76</td>
</tr>
<tr>
<td>School location</td>
<td>-0.23</td>
<td>0.18</td>
<td>0.8</td>
</tr>
<tr>
<td>Strategies for reopening</td>
<td>-0.01</td>
<td>0.16</td>
<td>0.99</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.47***</td>
<td>0.28</td>
<td>0.08</td>
</tr>
</tbody>
</table>

** $p < .01$, *** $p < .001$

### Discussion

No national educational system is perfect, with each characterized by unique strengths and identifiable areas of growth. The COVID-19 pandemic served to not only challenge every educational system in the world, but also exacerbated existing weaknesses in these systems. Tremendous responsibility is placed on teachers, leading to many being stretched thin, overworked, and underappreciated. The findings from the 2020 ATP COVID-19 response survey showed that teachers’ personal concerns were among the most important factors in predicting burnout during the COVID-19 pandemic. This was especially pronounced for three personal concerns as might be expected in the midst of a pandemic; teachers reported concern for the health of themselves and their loved ones, with high levels of concern in this area being associated with fears of burnout. Relatedly, teachers also struggled with caring for their loved ones, whether that was childcare responsibilities or more general care of their personal households. Job security weighed heavily on the minds of many teachers, with job loss amidst the COVID-19 pandemic being a reality for millions of U.S. workers. Thus, we see that personal circumstances, rather than work were some of the main predictors of burnout for teachers during the COVID-19 pandemic. This result supports the findings of previous studies emphasizing the increase in safety concerns of teachers [21] and reporting managing parental role as one of the main struggles of teachers during the COVID-19 pandemic [22].

Two work-related variables were also found to be predictive of feelings of burnout amongst U.S. educators. Teachers who graded their students with letters reported an increase in the risk of burnout. Many educators struggled with how to fairly assess and grade student work during such a time of disruption and fear. Having to assign letter grades, versus using other types of grading rubrics, was particularly stressful for teachers. Also, many teachers managed the demands of remote and hybrid learning by recording ahead of time, their lectures and providing instructional videos to their students. While this extra effort by educators is laudable, it nonetheless was associated with feelings of burnout by many of them. Finally, the experience of feeling overwhelmed by information, from a variety of sources, predicted concerns of burnout amongst educators. Many of us remember how rapidly at times the recommendations for how to keep oneself safe and prevent transmission of the virus were changing. Advice (conflicting at times) was coming from many sources, and updates about
case counts and resulting deaths were reported on a daily basis. Educators who found themselves overwhelmed by this barrage of information reported concerns about work-related burnout.

**Recommendations**

While the COVID-19 pandemic was an unprecedented experience across the world, it is unlikely to be the last such pandemic we face. School districts can learn from the experience of living through and educating students during COVID-19 to better prepare for the next disruptive event. Teacher responses to the ATP survey reveal that some school practices are associated with heightened feelings of burnout. Flexibility in the areas of grading schemes and structures as well as in instructional modalities, particularly during times of extreme disruption, may help teachers better meet the needs of their students while avoiding the feelings of emotional and physical exhaustion. Further, teacher responses indicated that information overload predicted the risk of burnout. While school leaders may not be able to control the amount and nature of the information to which teachers are exposed outside of the school walls, they can take a thoughtful approach to how they organize and communicate factual, useful information to their school staff members. A consistent, regular, reliable method for doing so may help teachers to both anticipate and control their exposure to the information they take in and may provide them with heightened confidence in the quality of that information. This could be included in the already existing training required of teachers.

**Strengths and Limitations**

As is true with all studies, the study described here has its strengths and limitations that should be noted. First, this study utilized a sample from the 2020 ATP COVID-19 response survey, allowing us to examine the experiences of a nationally representative sample of teachers during the pandemic. A nationally representative of teachers’ experiences during the COVID-19 pandemic. Such data is important as it ensures that our results are not just reflecting the perspectives of a narrow group of teachers, but rather allows us some confidence in generalizing our findings. At the same time, it should be acknowledged that while such survey data is useful to have, this data was collected precisely during a time of heightened stress and anxiety. Thus, we should be mindful that teacher responses may not only report their feelings and experiences but may also be affected by those feelings and experiences as well. The inclusion of multiple possible predictors of teacher burnout (N=51) was also useful, as during unexpected and unprecedented social and global crisis such as COVID-19 it is difficult to anticipate what specific factors may be contributing to feelings of exhaustion and burnout. One cannot assume that pre-pandemic predictors of burnout will be the same as those predictors of burnout in the midst of a pandemic.

Although the current findings illustrate how multiple psychological (i.e., concerns) and instructional (i.e., teaching and grading) factors of teachers predict teachers’ burnout during the pandemic, this research was not able to explain how demographic factors predict teachers’ burnout. The restricted nature of the dataset from which our sample was drawn resulted in no demographic information being available for the participants in this study. Therefore, future research is needed to expand these findings by including consideration of individual differences in teacher burnout such as diverse characteristics of teachers (e.g., gender, race/ethnicity, teacher employment status, teacher health status, teacher financial status, prep time provided, availability of mentorship, and years of teaching). Additionally, considering that this research focuses on the beginning of the pandemic, longitudinal research will be helpful in examining the relationship between these predictors and the rate and prevalence of burnout in the years following the pandemic.

**Acknowledgments**

The authors have no conflicts of interest to declare that are relevant to the content of this article. The dataset analyzed during the current study is publicly available at apedata.org/. The data reproduced from this research was collected previously and provided as public de-identified data. This study was deemed exempt by the Institutional Review Board of Boston University.

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