Exploratory Analysis of COVID-19 on AMT Part 147 schools related to knowledge-based testing scores for AMG, AMA, & AMP mechanic certification examinations

Christine T. Kelley
System Architect
Lockheed Martin
625 De La Cruz
Weatherford Tx 76085
Kellect1298@gmail.com
KELLE7E6@MY.ERAU.EDU
ORCID ID:0000-0003-2313-7491

Robert E. Gallagher
President
Aircraft Systems Group, Inc.
Odessa, FL 33556 USA
r.gallagher@aircraftsystemsgroup.com,
GALLAGR3@MY.ERAU.EDU
ORCID ID:0000-0002-1476-8833

Abstract

The FAA identifies and mandates under CFR 14, Part 65 Subpart D § 65.75 Knowledge requirements that an applicant for a mechanics certificate must possess. The knowledge-based tests, more commonly referred to as the "written" examinations, covers materials specific to either an airframe certificate (AMA) or a powerplant certificate (AMP) with the general (AMG) component being common to each. The prescribed level of testing for a Part 147 school is specifically outlined under § 147.38a Quality of Instruction and measured by the results of the Knowledge Based Test (KBT) examinations for all students tested against a national standard. During the period of COVID both training and learning challenges have occurred throughout the system of approved institutions. This paper investigates standardized national norm scores at a pre-pandemic level compared to test results during the actual pandemic using data from first quarter 2015 to current. Data gathered from the FAA Form 8080-08 was reviewed, analyzed and stratified by institution type, regions, number of applicants, year and pandemic or non-pandemic. A noticeable drop in average test grades was observed in each of the three testing regimes, AMG, AMA, and AMP. This paper explores if the analyzed variables impact the test scores, and if so, to what degree. This helps advance the field by beginning to address if teaching techniques during the pandemic effected test scores.

Word Count= Abstract 222

Key Words: Aviation Maintenance Technician, AMT, FAA Mechanic, FAA Form 8080-08, Knowledge Requirements, Part 147, Airframe, Powerplant, Testing, Pandemic

Introduction

Aviation maintenance is a highly skilled and heavily regulated environment throughout the world. This degree of heavy regulation ensures the traveling public's safety. According to the International Civil Aviation Organization (ICAO), the roles of the aircraft maintenance engineer (AME) and aviation maintenance technician (AMT) are critical to maintaining the safety of commercial air travel. Not only does the AMT or engineer maintain, repair, inspect and overhaul the aircraft, they also ensure continuous airworthiness of the product. The AMTs are responsible for ensuring airworthiness over the entire life of the aircraft.

As the manufacture of new aircraft models and derivatives continue into the marketplace, the demand for qualified personnel continues to expand worldwide. As explained by van der Heiden, et al. (2015) there is a need for both education and training within a high value-added aerospace industry. The majority of the AMTs within the United States enter the occupation by attending FAA approved FAR Part 147 institutions. According to GAO data, 62% of students use this route to certification. Within that there are a vast array of training institutions including both two- and four-year colleges which offer degrees and management classes both in the public and private sectors. Additionally, some institutes solely offer specific vocational or occupational classes with the goal of making the student complete the coursework and exams. As there is not a minimum educational entry requirement to become certificated, there are some programs offered through public high schools. These programs allow applicants to be eligible for examination upon their graduation from such schools. In a 2002 launch of a new program at Embry Riddle Aeronautical University (ERAU), Pam More has indicated that there is an annual need for 10,000 new certificated AMTs, while the normal product of the FAR part 147 schools is about 6,000 per year. This leaves an annual shortage. Forecasts in 2018 by Mohawk Valley

Community College predicted there to be approximately 135,000 openings for people certified in the field during the next 20 years.

While there was already a shortage forecasted, the onslaught of Covid-19 on the global community had yet to be seen. However, in the late winter of 2020, the pandemic had spread throughout the globe causing a shutdown, requiring an unprecedented storage of the worldwide aircraft fleet. Early in the COVID-19 pandemic the International Air Transport Association (IATA) forecasted the risk of approximately 25 million aviation related jobs on a worldwide basis (Press Release No. 28 dated 7 April 2020). On September 21, 2021, Airlines For America, the US based trade organization, delivered their "Emerging From the Pandemic" report (see chart below) in which the below data was released to the industry showing substantial job losses to the industry in the United States. The data also indicates that while US-based carriers are seeing increases in air travel, they will probably not see the levels climb to the pre-pandemic volumes until 2023.

In the years leading up to the pandemic the industry, experienced record growth with new aircraft being delivered to the market. During this time, the ATEC 2018 Pipeline Report predicted 30% of AMT's were approaching retirement age. The industry also cited hiring initiatives that were falling short according to AviationPros.com, who also forecasted the need for 198,000 new mechanics by 2037. Both Boeing and Airbus had multiple increases in production capacity on a worldwide basis; as well as substantial back orders in their delivery books extending beyond five years into the future. As the pandemic progressed, both manufacturers cut their deliveries and production, however there was still a need to maintain the current fleet, flying or parked. A current forecast from Boeing estimated that there will be a

global demand for 626,000 new technicians in commercial aviation through 2040 (Boeing, 2020).

Table 1. Airline Industry Impacts

The Pandemic Has Taken a Material Toll on U.S. Airline Employment
Voluntary Reductions, Retirements, Job Changes, Employer Shutdowns and Other Factors at Play

Carrier Universe	Scheduled U.S. Passenger Airlines	All U.S. Passenger *and* Cargo Airlines
Measure	FTEs* (000)	Headcount (000)
All-Time High	Jun-2001: 545.9	May-2001: 760.8
Post-2000 Low Point	Apr-2010: 376.7	Apr-2010: 562.3
Pre-COVID Peak	Feb-2020: 458.2	Feb-2020: 753.4
Latest Available Data Point	Jul-2021: 402.6	Jul-2021: 715.3

Source: Bureau of Transportation Statistics based on payroll near the 15th of the month

* Full-time equivalents (FTE) = full-time workers plus 0.5 * part-time workers

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Airlines For America Press Release No. 28 dated 7 April 2020

According to the Code of Federal Regulations 14 (CFR) Part 147, specific curriculum requirements must be met for the issuance of a certificate on the part of the school or training institute. To train a student to become an AMT, the following FAA requirements which are cited in FAR 147, must be met. A minimum of the following contact hours must be included into the program curricula:

General:	400
Airframe:	750
Powerplant:	750
Total:	1,900

These hours are the equivalent of 38 hours a 50 week per year to complete a course. At that time, the student would become eligible to sit for the prescribed series of exams. Prospective students, given the forecasts and industry shutdown, would have begun making decisions as to the viability of such programs and prospective employment opportunities. Additionally, concerns within the education community would have been evaluated for the survivability and viability of such programs. The FAA also dictates the quality of the instruction received under FAR 147.38a by tracking and mandating that success (passing with a minimum of 70%) on the student's first attempt be within defined standards as it relates to the "national passing norm". Failure to comply with the quality standard could require the institution to receive additional federal oversight and program review.

With the industry already under-manned, demand rising, and the demand for global air travel recovering, the researchers wanted to investigate if the quality of education delivered by the FAR Part 147 schools and the success rate of the prospective AMT applicants was impacted by the pandemic.

To examine this question, the researchers analyzed FAA data contained in the FAA Form 8088-8 related to the success of prospective AMT applicants graduating from each of the FAR Part 147 schools. This data is collected on a quarterly basis for each school by the FAA and categorized into each of the three examinations (General, Airframe and Powerplant). The data is further broken down by schools and compared to a national norm rate with a base of 70% passing or success rate. As a normalizing process, data was reviewed beginning in 2015 when the industry was functioning at a normal growth rate giving a five-year window pre-pandemic. This data was collected and compared to the data beginning in the first quarter of 2020 and

analyzed over a five-quarter period. The findings will be described more comprehensively in our paper.

This is critical because schools are rated, inspected, and required to perform to a status as identified by the applicable regulations. Changes in material and curriculum delivery may impact both the success of a school and its viability to continue as a sound business practice. The success of graduates is a measurement of viability.

Literature Review

A common and regulatory thread that ties all the institutions investigated together is that they all must comply with the regulatory requirements to teach and maintain a standard codified in Title 14 of the Code of Federal Regulations. As such, success in the teaching and testing critical material for the issuance of an FAA aviation maintenance technician certification by the federal authorities (the license/certificate) is required. Maintenance certificates are relinquished in only three ways: suspension, surrender or revocation by the issuing authority (the FAA). Most would associate the testing outcomes of individuals examined to produce a correlation to the training programs in which they attended (McGuire & Gubbins, 2010).

The former FAA Administrator (O'Brien, 1990) mentioned that certification education was becoming "teaching to a test". During this time period, the FAA published all of the knowledge-based test (KBT) questions and answers in the public realm. That process has changed over time, and the FAA no longer publishes the KBT testing questions. However, many public companies such as Jeppesen and ASA do publish study guides which parallel the test questions. These are gleamed from previous test takers and no longer from FAA public information.

Walter (2000) concludes that “Implementing training systems that develop knowledge and skills among operational personnel consistent with organizational objectives and operating procedures that are compatible with human capabilities and limitations is fundamental to reducing maintenance error”. This fact draws a direct linkage between both knowledge and action, no longer can the mechanic or technician just be a parts changer. Replacement of parts without sufficient intellectual troubleshooting of a system can produce economic disaster and impact safety margins.

Examining the European system, there is a parallel plan for certification of technicians. In this system, the basic training course consists of knowledge training, knowledge examination, practical training, and a practical assessment, showing relevance to the knowledge as well as the practical component in certification (Dilkilic, 2017). A similar view is expressed by Terry Michmerhuizen, Assistant Professor with Western Michigan University's College of Aviation, where he stated at the EAA’s 2012 Air Venture that AMTs need to learn and embrace non-technical skills such as the four Cs: critical thinking skills; concern for quality and integrity; comprehension of the effects of human factors on their work; and clear ability to communicate. This also points to more areas that an AMT needs to understand as opposed to just replacing parts, the knowledge is a large factor in current needs.

Williams & Rhoades (2005) contend that normal AMTSs exceed the minimum of curricula contact hours by an average of 116 hours. This increased contact hours shows how schools’ endeavor to provide more learning experiences to students to move them to higher levels of success, yet the current analysis shows differently. Currently, according to AW&ST (“Curriculum Crunch” 2021) the FAA is scrutinized for delaying a proposed change to the current rules initiated by the Aircraft Certification, Safety and Accountability Act. This change

was due in March 2021 but is now delayed until November 2021. However, it is unclear if this change will affect the down-sloping trend for grades that is currently seen.

The mechanics' responsibility is to replace parts, troubleshoot systems, isolate faults by following the fault isolation manual (FIM) and restore the system for its intended use (Kinnison & Siddiqui, 2013). While it appears that part removal and replacement is the typical AMT's role, are there more sophisticated functions of maintenance or do is the system producing parts-changers?

Baghdasarin, (2020) states that information literacy is the ability to assess digital (Web-based) data and is a critical skill for those involved in processing airplane health data. Such a statement is viewed as correct and an applicable position because the current state of aircraft maintenance requires such aptitude. Yet Baghdasarin also states Generation Z and Millennial cohorts tend to fall into different learning categories due to their involvement and growth around the internet. How does such a learning style interact and produce understanding as applicants memorize facts like; "How many watts equal one kilowatt?" or "What is the speed of sound on a standard day?" where they must first know what a "standard day" is before they can determine the speed.

The KBT is a comprehensive examination of the student's ability to answer multiple choice questions corresponding to each of the subject based areas of 14CRF Part 147's curriculum. The test questions are objective-based and a student must select the correct response for each of the questions to maintain a minimum of 70%, the passing criteria.

Table 2: Test Details

KBT Test	Total Questions	Elapsed Time	Correct responses
General	60	120 mins.	42
Airframe	100	120 mins.	70
Powerplant	100	120 mins.	70

This test is structured to show the students' mastery of the subject matter and demonstrate their ability to communicate by use of the written word. This shows both the aptitude of the test taker to understand written instructions (i.e., a technical or maintenance manual, the directions to properly service and maintain an aircraft) and their ability to communicate using written language (correct response to the question). This type of test is an additional method employed to assure that the student complies with § 65.71 Eligibility requirements. The requirements are: be able to read, write, speak, and understand the English language, or in the case of an applicant who does not meet this requirement and who is employed outside of the United States by a U.S. air carrier, have his certificate endorsed "Valid only outside the United States". This is also verified when an applicant presents themselves to the local FSDO for authorization. This is not required for those graduating from an FAR Part 147 curriculum AMTs.

Current FAA information shows that Airman Certification Standards (ACS) for General, Airframe and Powerplant examinations are under development with no current proposed release date (FAA-S-ACS-1).

Hu et. al. (2016) find that select preclinical course work may be a strong predictor of standard exam scores. Most have correlated AMT certification with that of medical and nursing

professionals because of the regimented testing involving written, oral and practical exams to a similar paradigm in health care licensing/certification. Swanson & Roberts (2015) state that "The purpose of licensure is to ensure that doctors have the knowledge and skills necessary to practice medicine safely and effectively". In a similar fashion, the FAA's certification procedures to assure that individuals have the knowledge to facilitate safe air travel parallel training for technical fields in medicine, although with different levels of training. Swanson and Roberts further conclude that the important issue for regulators is the need to reassure the public that applicants meet a minimum level of competence, similar to the FAA's goals.

Problem Definition

The problem investigated was to evaluate if the grades for all three series of the FAA knowledge-based maintenance technician examinations were impacted during the COVID-19 pandemic within the United States. The researchers have hypothesized that the pandemic caused the grades to drop for each of the three tests.

The hypothesis considered that there was a shift in educational delivery because educational institutions were required to reduce face-to-face teaching hours. This forced institutions to develop alternative ways to deliver required content to students. The hypothesis predicts that these changes within the educational system would have a statistically significant negative impact on the grades of qualifying exams. With the onset of the pandemic, researchers wondered if various changes to educational content and delivery programs would impact grade levels in AMT education as compared to the historical national norms. As pointed out by Dyen (2017) only two schools in the US had FAA authorization to conduct distance learning by use of either asynchronous or synchronous distance delivery. The changes that occurred were a new method to student and instructor alike with limited or no real planning, beta testing or

understanding delivery requirements did not occur. Some schools just went to online lectures, an instructor speaking and students listening to a video without interactivity, others chose canned programs and still other developed full use of technologies such as canvas and blackboard. These each with their own challenges such as neither student and or instructor was trained either on the development and presentation side or as to the correct way to receive the new technology. Thus, the self-created problem as to if in fact both instructors and students were up to a challenge and applying a technology fit that neither may have been familiar with and hoping on a successful outcome.

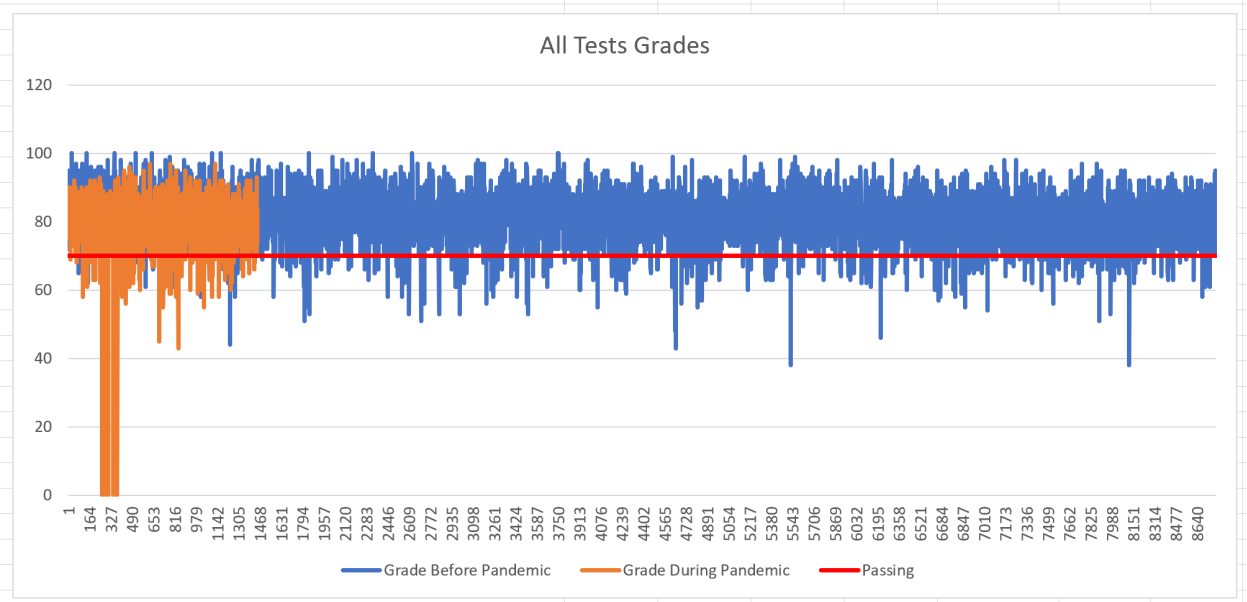
Descriptive Analysis

All Tests (AMA, AMP, AMG)

Schools which report metrics to the FAA do so on a quarterly and yearly basis. For this paper, report FAA Form 8080-08 data was taken from the FAA's website for the quarterly reports for the years 2015 (five years proceeding COVID-19 and the 6 quarters during the pandemic 1Q2020-2Q2021). Within the quarterly reports, there are also columns which show 2 yearly metrics as well (two year averages for smoothing of data), these data were not included in the study. Once the quarterly pdfs were downloaded from the website, they were converted into excel files and all pages merged into one large file. The columns of data in that file were reduced to only those which the researchers wanted to address in this paper: School, Region, City, Number of applicants, Type of test, Number of applicants passed, Average Grade for the Quarter, and the corresponding Year. Reports were gathered from 2015 first quarter to 2021 second quarter. Those records which did not have a grade reported for the quarter were filtered out of the dataset.

Once the data was combined into one dataset with all quarters from 2015 through 2021 showing the desired variables, some descriptive analysis was executed. The first research question to address was, has the pandemic effected the overall grades for the mechanic testing? First, the average grade per institution per quarter for pre-pandemic and during the pandemic to visually investigate if there appeared to be a difference.

Figure 1: All test grades pre-pandemic and during pandemic vs quantity of tests



In the above graph, the average grade vs the quantity of tests taken is shown. This allowed the researchers a visual indication that the grades potentially were lower during the pandemic. To further investigate this, a single ANOVA was run.

Figure: 2: Single ANOVA of all tests and average grades taken during and before the pandemic

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Grade Before Pandemic	8783	715135	81.42263	42.56811
Grade During Pandemic	1449	114330	78.90269	72.04094

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7898.274	1	7898.274	168.9838	2.47991E-38	3.842368
Within Groups	478148.5	10230	46.73983			
Total	486046.7	10231				

*If F is larger than Fcrit then there is a statistical difference between samples

The results of this ANOVA indicated to the researchers that there is a statistically different grade average between the tests which were taken before the pandemic (Q1 2015 through Q1 2020) and after (Q2 2020 through Q2 2021). This result led to investigation of which researched variables contributed to this statistical difference.

Individual Tests

The next step in the analysis was to divide the overall test grades into three categories. These categories are the Aviation Maintenance Technician Professional (AMP), Aviation Maintenance Technician Airframe (AMA), and Aviation Maintenance Technician General (AMG) to evaluate their average test grades. For each test type, a single ANOVA was run to determine if there was a statistical difference between the pre-pandemic grades and those earned during the pandemic.

As was done with the entire data set, a single ANOVA was run to determine if there was a statistical difference between average grade earned before the pandemic vs after. There results determined that there was.

Figure 3: Single ANOVA of AMA tests and average grades taken during and before the pandemic

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre Pandemic	964	79140	82.09544	43.91612
Pandemic	166	13195	79.48795	82.39682

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	962.8307	1	962.8307	19.43348	1.14E-05	3.849716
Within Groups	55886.7	1128	49.54494			
Total	56849.53	1129				

In the same fashion, graphs of the average grade vs quantity of tests were created for AMP and AMG tests. Then a single ANOVA was run for each, with results shown below.

Figure 4: Single ANOVA of AMG tests and average grades taken during and before the pandemic

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre Pandemic	3027	246976	81.59101	46.10829
Pandemic	498	38801	77.91365	109.3104

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5783.022	1	5783.022	105.0992	2.54E-24	3.8441
Within Groups	193851	3523	55.0244			
Total	199634	3524				

Figure 5: Single ANOVA of AMP tests and average grades taken during and before the pandemic

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*	*Delta Avg*
Pre Pandemic	2848	229098	80.441713	39.279355	
Pandemic	467	37016	79.263383	47.610738	1.1783302

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	557.06688	1	557.06688	13.771321	0.0002099	3.8442672
Within Groups	134014.93	3313	40.451231			
Total	134572	3314				

Single ANOVA of all grades, as well as the three different test types shows that there is a statistical difference between the test grades pre-pandemic and during the pandemic. While the difference in average grade is not large, a few points on a hundred-point scale, it is still concerning that the grades dropped at all. It would be especially concerning if this grade drop was indicative of future grades and results continue to drop as the pandemic rages on. To determine this, further investigation was conducted.

Descriptive Analysis

To understand the impact of variables on the average grade, three subsets of data were analyzed. Each test (AMA, AMG, AMP) was evaluated separately. For each test data set, a mixture of variables was evaluated in the study. These variables were: Number of applicants, Region, School Type, Pandemic (Pre/During), and year. For each variable, graphs were created to represent the impact of that variable on the average grade.

Pandemic (Pre/During):

For this variable, if the test was taken before the second quarter of 2020, then it was categorized as “Pre”. If the test was taken during or after second quarter of 2020 then it was categorized as “During”. This allowed the researchers to compare very directly if the grades before and during the pandemic were the same. For each test type, test grades taken during the pandemic were lower than those taken prior to the pandemic. For the AMP test, the grade drop is very slight, however present. The other two tests have a more significant drop in grade as shown in the below graphs.

Figure 6: AMA Pandemic vs pre-pandemic grades

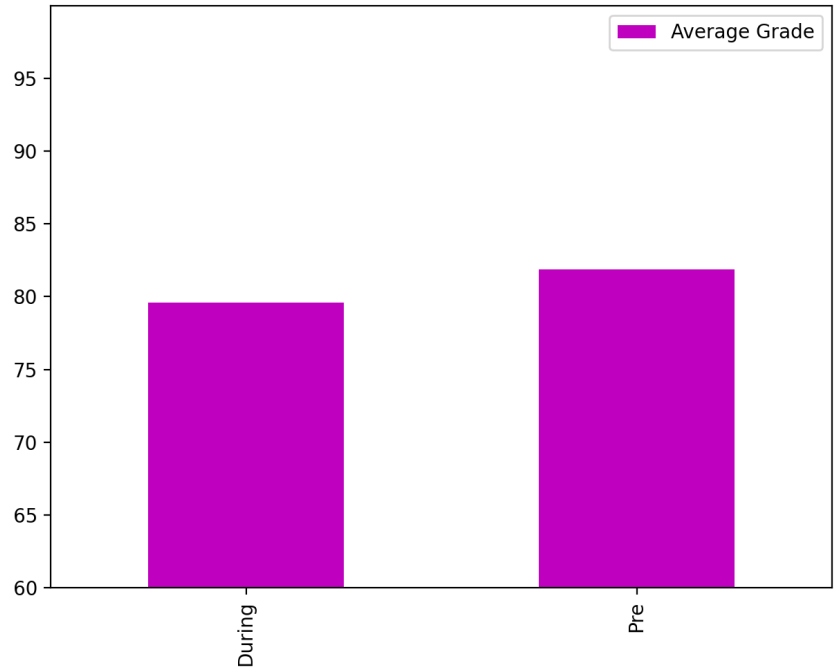


Figure 7: AMG Pandemic vs pre-pandemic grades

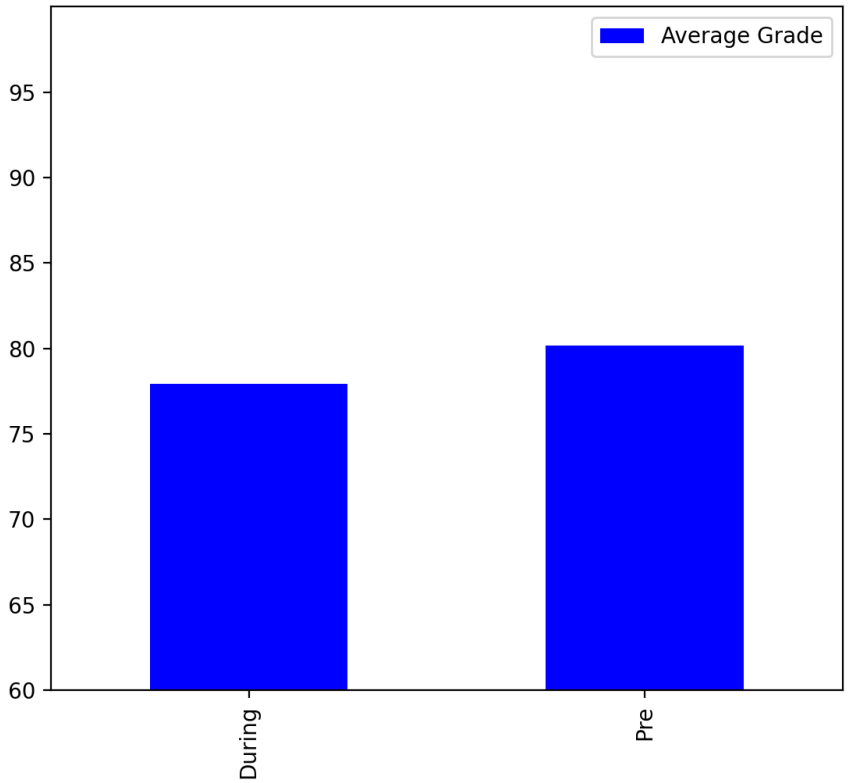
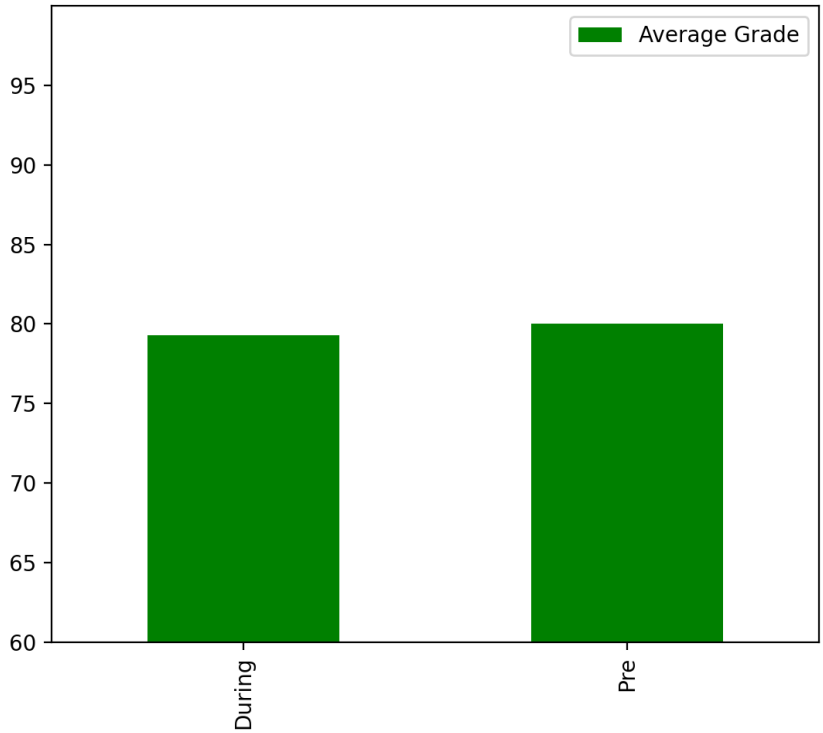


Figure 8: AMP Pandemic vs pre-pandemic grades



The next variable studied was the number of applicants per quarter taking the test at a particular school. The researchers wondered if class size could impact the average test grade. For the AMA and AMP tests, it appears that the greatest number of applicants yielded the highest grades. The AMG test does not appear to have impacts on the average grade based on the number of applicants.

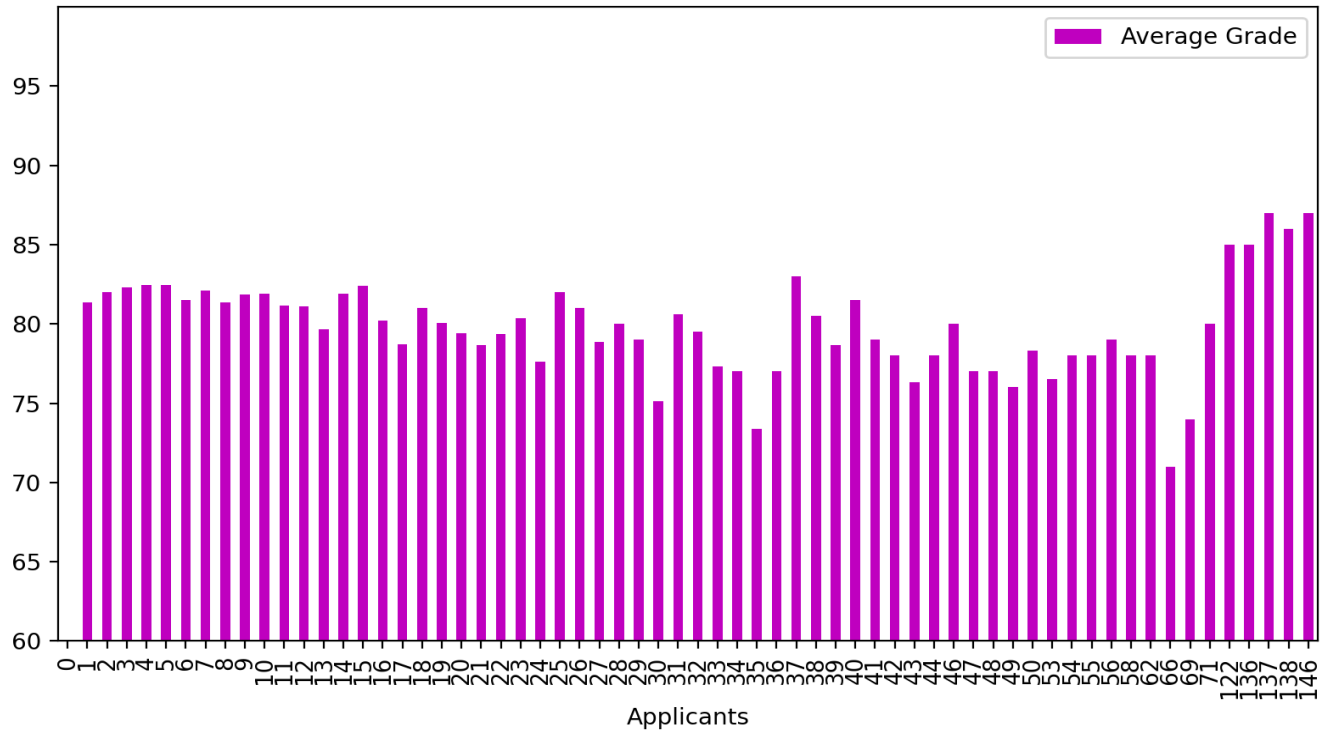


Figure 10: AMG Average grades vs number of applicants per school

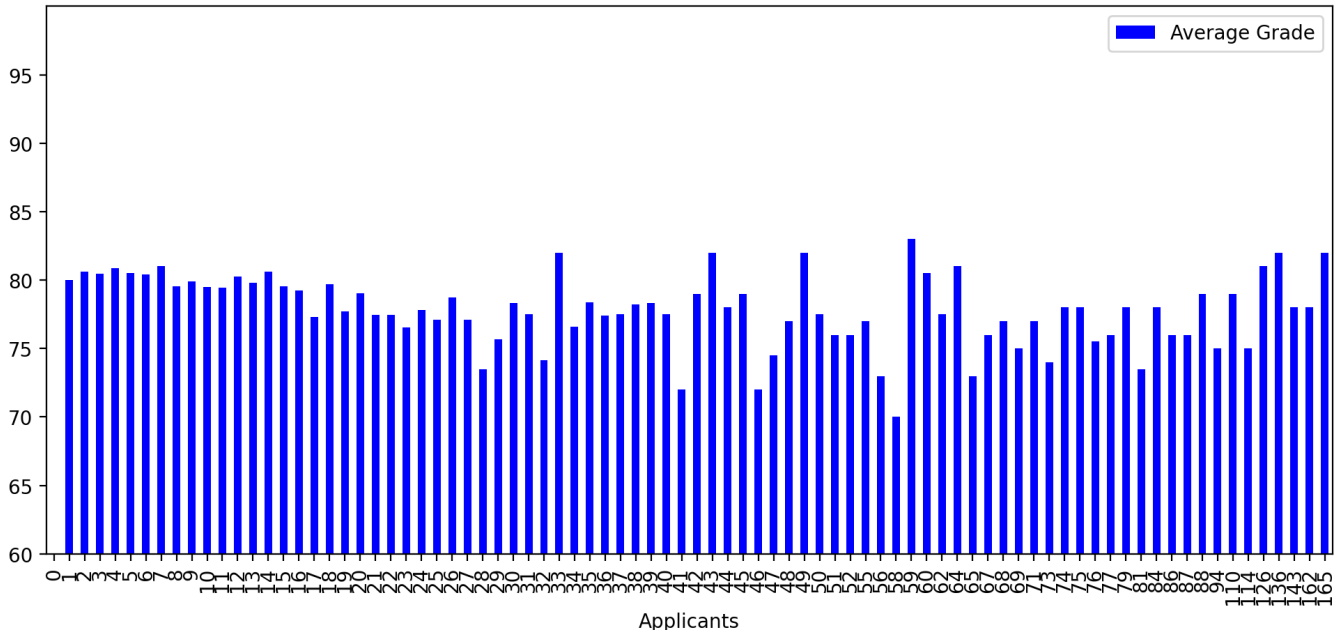
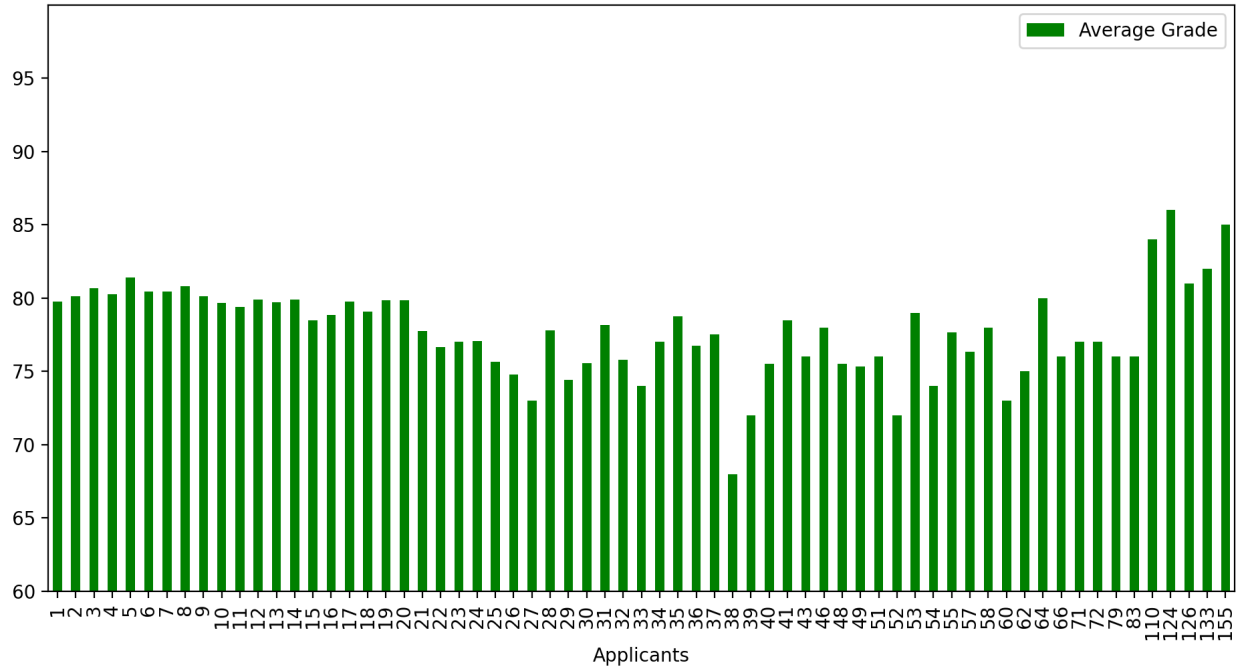
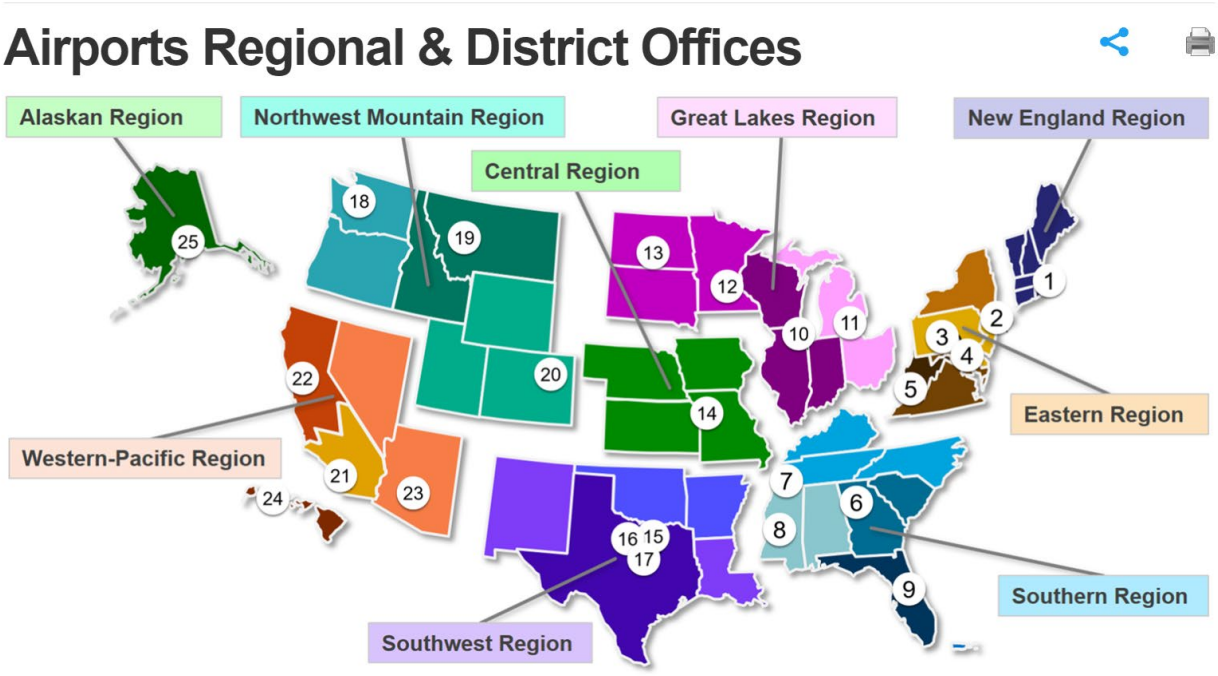


Figure 11: AMP Average grades vs number of applicants



The third variable analyzed is region. The United States is divided into regions according to the FAA. These regions consist of: Alaskan, Central, Eastern, Great Lakes, New England, Northwest Mountain, Southern, Southwest, and Western-Pacific and are shown on the map below.

Figure 12: Regions as defined by the FAA



- **Alaskan** (AK) [25]
- **Central** (IA, KS, MO, NE) [14]
- **Eastern** (DC, DE, MD, NJ, NY, PA, VA, WV) [2]
  - Beckley ADO (WV) [5]
  - Harrisburg ADO (DE, NJ, PA) [3]
  - New York ADO (NY) [2]
  - Washington ADO (DC, MD, VA) [4]
- **Great Lakes** (IL, IN, MI, MN, ND, OH, SD, WI) [10]
  - Chicago ADO (IL, IN, WI) [10]
  - Detroit ADO (MI, OH) [11]
  - Dakota / Minnesota ADO (MN,ND,SD) [12, 13]
- **New England** (CT, ME, MA, NH, RI, VT) [1]
- **Northwest Mountain** (CO, ID, MT, OR, UT, WA, WY) [18]
  - Denver ADO (CO, UT, WY) [20]
  - Helena ADO (ID, MT) [19]
  - Seattle ADO (OR, WA) [18]
- **Southern** (AL, FL, GA, KY, MS, NC, PR, SC, TN, VI) [6]
  - Atlanta ADO (GA, SC, PR, VI) [6]
  - Jackson ADO (AL, MS) [8]
  - Memphis ADO (KY, NC, TN) [7]
  - Orlando ADO (FL) [9]
- **Southwest** (AR, LA, NM, OK, TX) [15]
  - Arkansas/Oklahoma ADO [16]
  - Louisiana/New Mexico ADO [17]
  - Texas ADO [15]
- **Western-Pacific** (AZ, CA, HI, NV, GU, AS, MH) [21]
  - Honolulu ADO (HI, GU, AS, MH) [24]
  - Los Angeles ADO (Southern CA) [21]
  - San Francisco ADO (Northern CA) [22]
  - Phoenix ADO (AZ, NV) [23]
  - California Counties by Airports District Office

Based on the graphs, it appears that the Alaskan, Northwest Mountain and Western-Pacific regions have produced the highest average grades for all tests over the entire testing period. These graphs are shown below.

Figure 13: AMA Average grades vs region

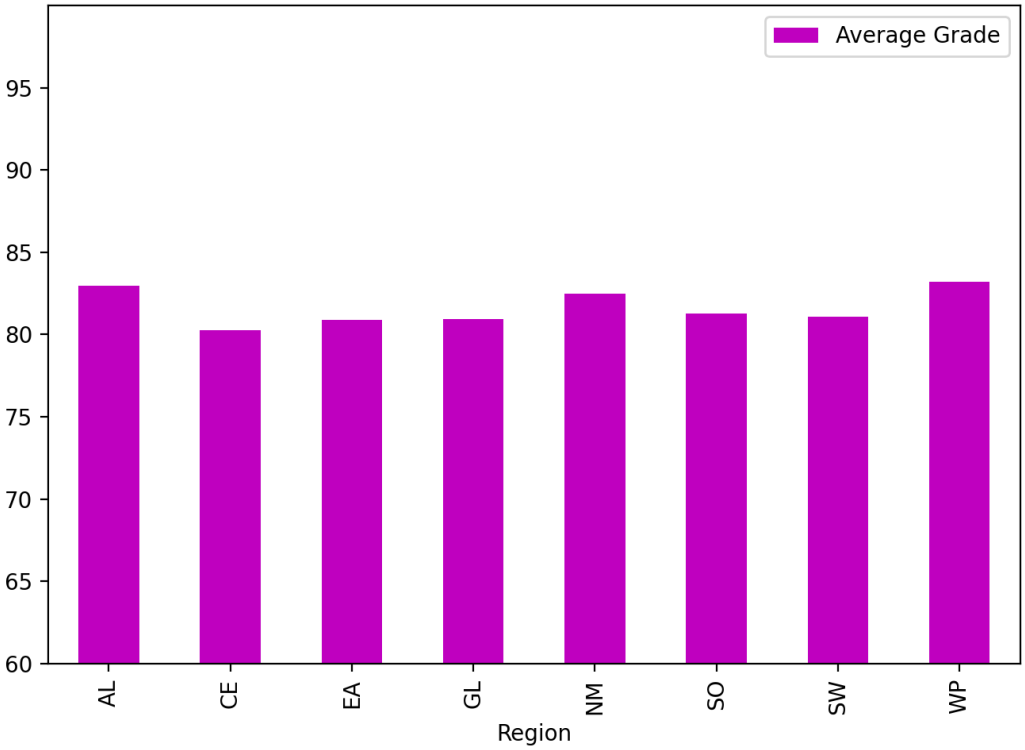


Figure 14: AMG Average grades vs region

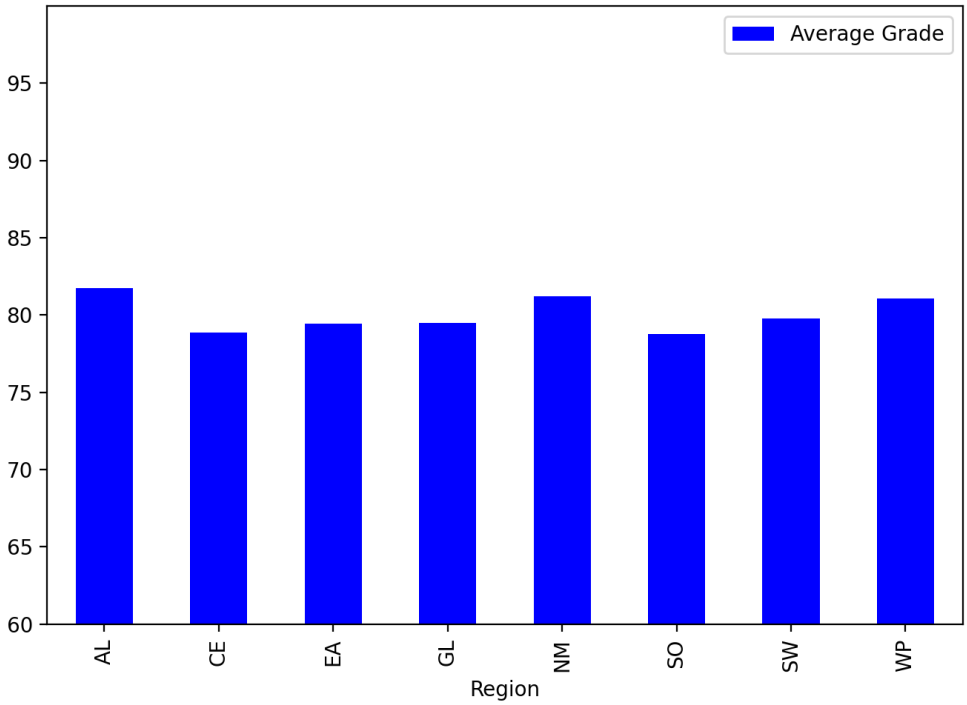
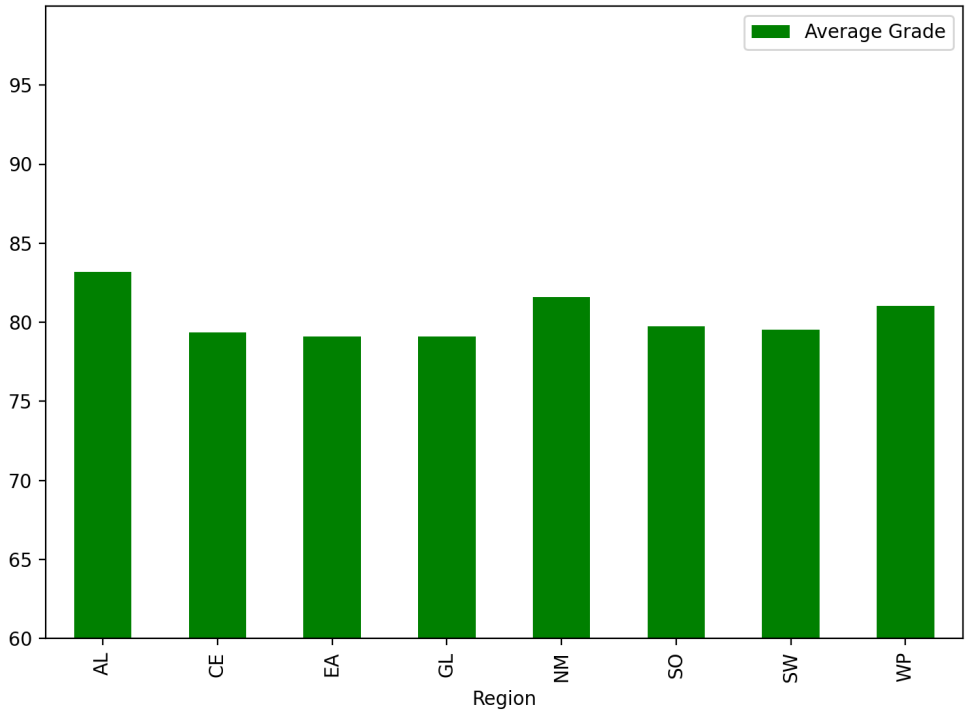


Figure 15: AMP Average grades vs region



The fourth variable assessed is the type of school testing the applicants. The school types were divided into five categories: University, Community College, Technical School, High School, and College. Of these, it appears that the universities had consistently higher average grades than other school types. The graphs for each test type are shown below.

Figure 16: AMG Average grades vs school type

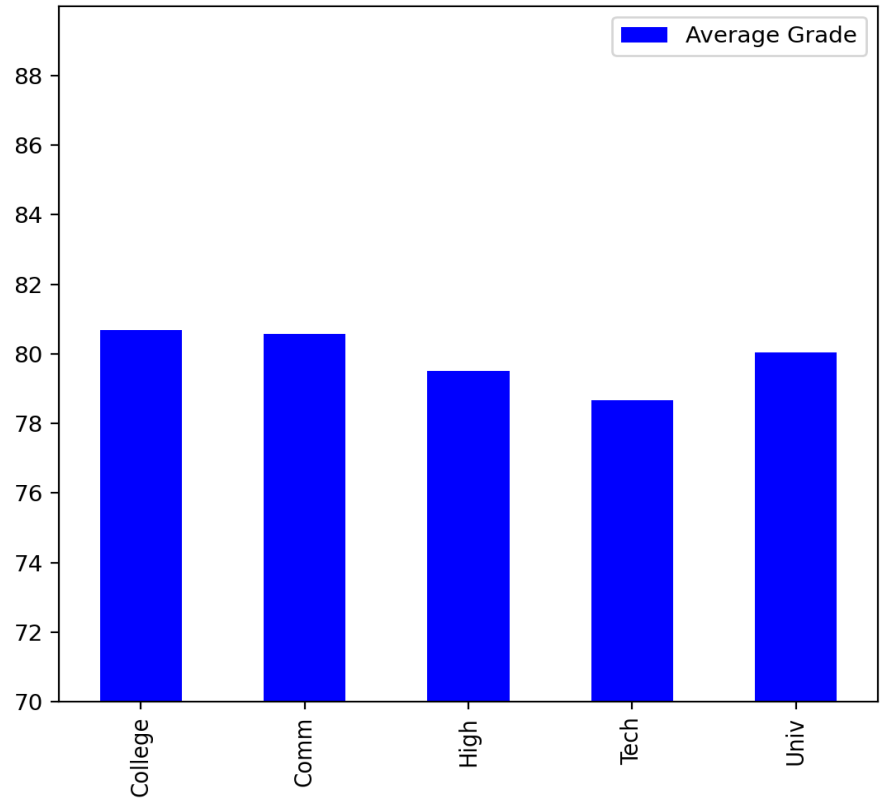


Figure 17: AMA Average grades vs school type

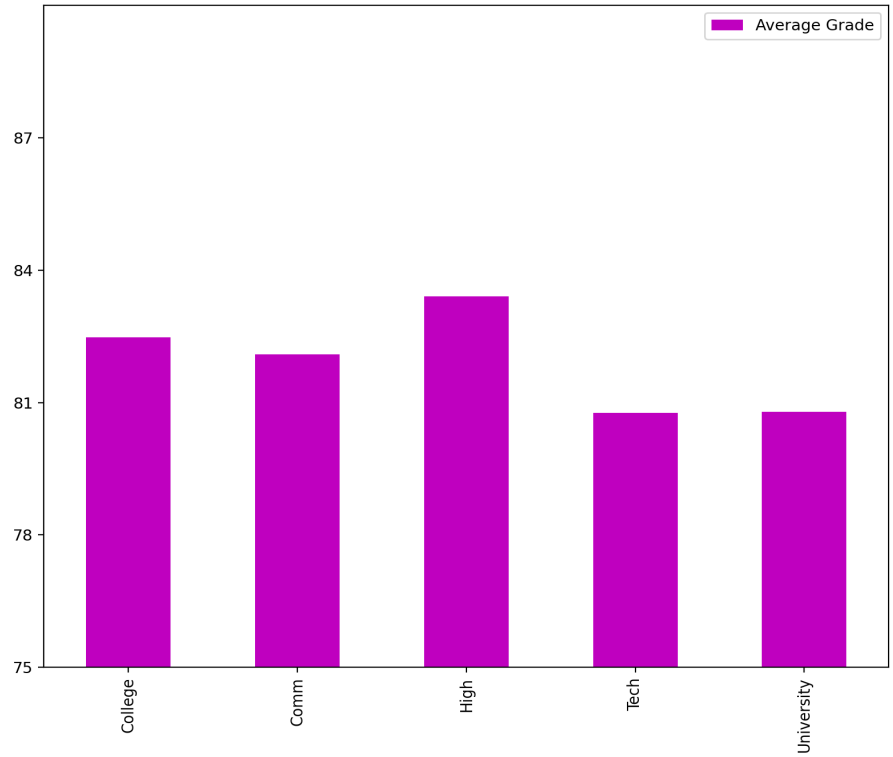
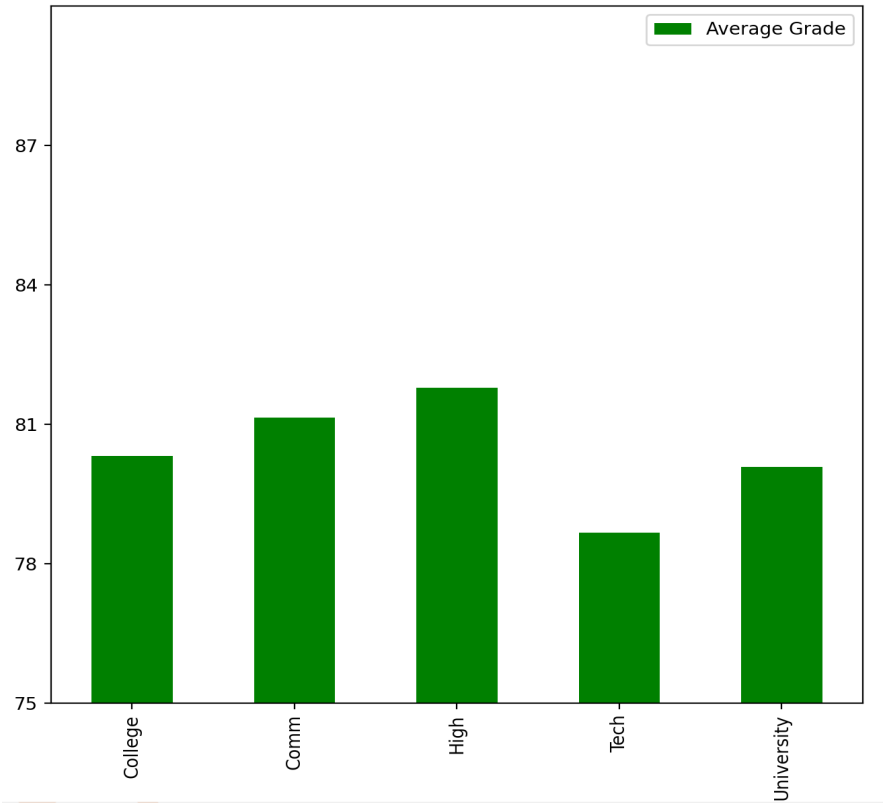


Figure 18: AMP Average grades vs school type

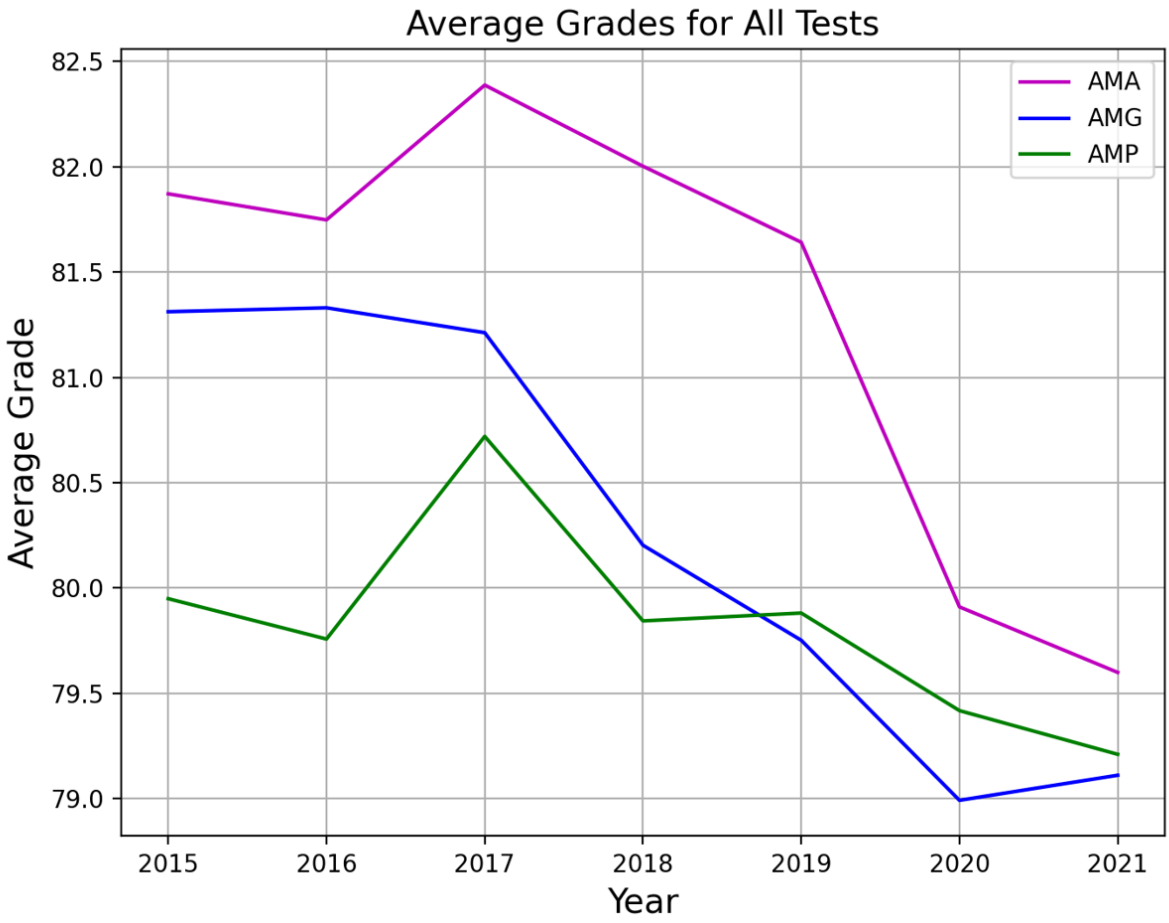


The fifth and final variable analyzed for impact on average test scores is the year in which the test was taken. This graph raised questions for the researchers, as it indicated that the grades in all tests were beginning to trend down before the pandemic, but certainly kept a downward slope since.

Upon completion of the descriptive statistics, a few trends were beginning to emerge. Grades were lower during the pandemic for all tests, although not dramatically. For two of the tests, high number of applicants in the testing class yielded visibly higher test averages. Three of the regions (Alaska, Northwest Mountain, and Western Pacific) have consistently higher grades. All three tests received the highest grades in high school than any other institution type. Lastly, average grades for all tests were beginning to fall before the pandemic began, around 2017. Further investigation and regression models were determined necessary.

The below chart shows a combined composite of all scores, AMG, AMA, and AMP pointing to the fact that the trend lines all went down beginning at the same time at various levels of degrees

Figure 19: All Tests Grades Over Time



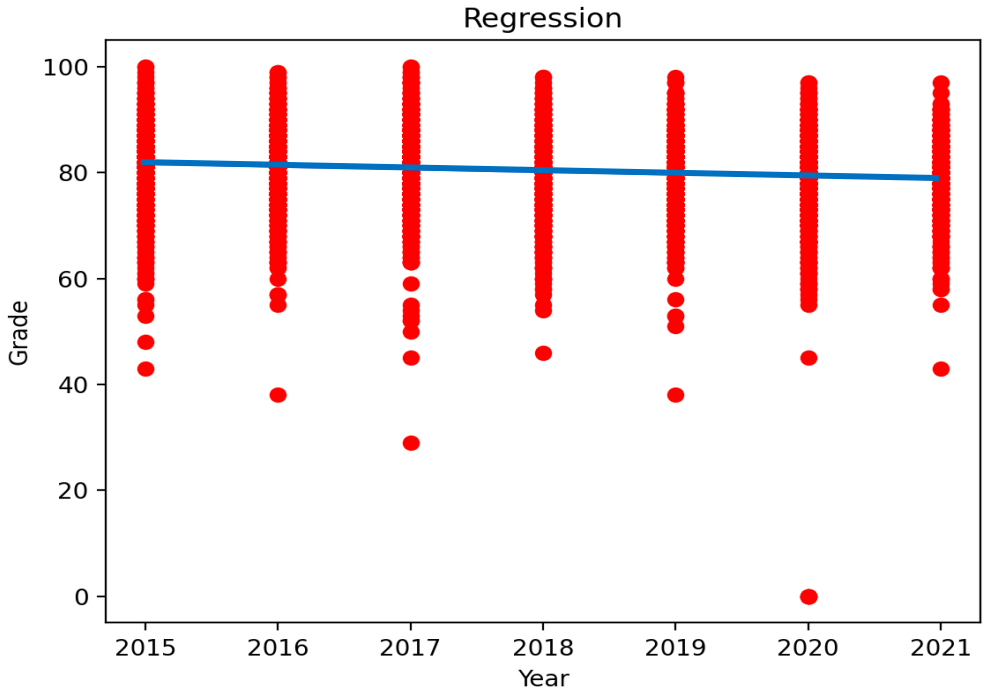
Regression modeling

Once the descriptive statistics were completed, regression modeling was done. Four different types of modeling were done to improve the chances of understanding the situation. First, singular regression was executed in python. The independent variable of average grade was regressed against year, as the researchers were most curious about the grades decreasing over time. The results are shown below.

Figure 20: Single regression of average grade vs year

```
                            OLS Regression Results
==============================================================================
Dep. Variable:          Average Grade   R-squared:                       0.018
Model:                            OLS   Adj. R-squared:                  0.018
Method:                 Least Squares   F-statistic:                     102.9
Date:                Sat, 16 Oct 2021   Prob (F-statistic):           5.59e-24
Time:                        12:46:19   Log-Likelihood:                -18695.
No. Observations:                5609   AIC:                         3.739e+04
Df Residuals:                    5607   BIC:                         3.741e+04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const       1083.0312     98.827     10.959      0.000     889.293    1276.770
Year          -0.4969      0.049    -10.145      0.000      -0.593      -0.401
==============================================================================
Omnibus:                     2200.701   Durbin-Watson:                   2.023
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            33826.881
Skew:                          -1.457   Prob(JB):                         0.00
Kurtosis:                      14.673   Cond. No.                     2.20e+06
==============================================================================
```

Figure 21: Graph of Year vs Grade



Secondly, multiple regression was run to incorporate more of the variables. In this analysis, the dependent variable of average grade was regressed against many independent variables. The results of the regression are shown below.

Figure 22: OLS Regression results with multiple variables

OLS Regression Results

Dep. Variable:	Average Grade	R-squared:	0.060
Model:	OLS	Adj. R-squared:	0.057
Method:	Least Squares	F-statistic:	17.93
Date:	Sun, 31 Oct 2021	Prob (F-statistic):	1.07e-61
Time:	12:28:08	Log-Likelihood:	-18562.
No. Observations:	5609	AIC:	3.717e+04
Df Residuals:	5588	BIC:	3.731e+04
Df Model:	20		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	82.7862	0.825	100.329	0.000	81.169	84.404
AMA	1.7979	0.215	8.355	0.000	1.376	2.220
AMP	0.0455	0.218	0.209	0.834	-0.381	0.472
2016	-0.0803	0.324	-0.248	0.805	-0.716	0.556
2017	0.0186	0.321	0.058	0.954	-0.611	0.648
2018	-0.9054	0.321	-2.817	0.005	-1.536	-0.275
2019	-1.4983	0.317	-4.732	0.000	-2.119	-0.878
2020	-1.6309	0.534	-3.055	0.002	-2.678	-0.584
2021	-1.0599	0.677	-1.565	0.118	-2.388	0.268
Technical	-0.7292	0.272	-2.679	0.007	-1.263	-0.196
High School	2.5317	0.784	3.227	0.001	0.994	4.069
Community School	0.7745	0.306	2.529	0.011	0.174	1.375
College	0.6110	0.316	1.936	0.053	-0.008	1.230
Central	-3.3530	0.866	-3.874	0.000	-5.050	-1.656
Eastern	-2.5650	0.844	-3.039	0.002	-4.220	-0.910
Great Lakes	-2.6164	0.837	-3.124	0.002	-4.258	-0.975
NM	-1.0397	0.871	-1.194	0.233	-2.747	0.667
South	-2.5016	0.845	-2.962	0.003	-4.158	-0.846
Southwest	-1.9728	0.838	-2.354	0.019	-3.616	-0.330
Western Pacific	-1.0324	0.855	-1.207	0.227	-2.709	0.644
Pandemic	-0.9677	0.553	-1.750	0.080	-2.052	0.116

Omnibus:	2912.537	Durbin-Watson:	2.044
Prob(Omnibus):	0.000	Jarque-Bera (JB):	80593.594
Skew:	-1.925	Prob(JB):	0.00
Kurtosis:	21.167	Cond. No.	35.0

From these results, the researchers could see some of the variables which were suspected in the descriptive statistics were statistically significant on the average grade. Of these, it became clear that the AMA grades are higher than the other two tests, grades in the 2018 and on began to drop, universities and technical schools, region and whether it was the pandemic were all significant. However, the R^2 value was low indicating that this model would not be a good predictor of future grades. Further analysis in python was conducted.

The third model run was a ridge analysis. Through the program, the most efficient alpha chosen was .01. When ridge regression was run, the following results were found.

Figure 23: Ridge Regression Results

intercept	79.9502777
AMA	1.174618292
AMP	-0.56536523
AMG	-0.61029575
2015	0.709779943
2016	0.638038828
2017	0.730961656
2018	-0.1842807
2019	-0.77483051
2020	-0.91588818
2021	-0.34940563
University	0.691308456
Technical	-0.13697036
High School	3.072760649
Community School	1.366447343
College	1.177209753
Alaska	2.02849526
Central	-1.20641489
Eastern	-0.42727439
Great Lakes	-0.52739204
NM	1.080782799
South	-0.35362437
Southwest	0.148173658
Western Pacific	1.110719228
Pandemic	-0.95171745
msq_test: 6.6212625202767805	
msq_pred: 6.879530726833391	
r2_test: 0.060536519587132465	
r2_pred: 0.04115014599453359	

From the figure above, a few conclusions can be drawn. The AMA test has higher average scores than the AMG and AMP. Grades start dropping in 2018 and continued during the pandemic. Universities appear to have a higher average grade than any of the other school types.

Western Pacific and Northwest Mountain have higher averages than the other regions, while Alaska has a much higher average than any region. Lastly, the pandemic did have a negative effect on grades, as those taken during the pandemic are lower than those taken before. This analysis continues to have a low R^2 value and would not be good for using in predictions of future grades. However, the variables indicated do appear to have an impact on the grades. Addressing these could help the researchers understand what is happening with the test grades.

Lastly, a fourth regression model was run to calculate the impact of the independent variables. The fourth regression model was lasso and resulted in the below table of calculations. The ideal alpha for this model was .002.

Figure 24: Lasso Regression Results

intercept	80.32107
AMA	1.457975
2015	0.325977
2016	0.248683
2017	0.349425
2019	-0.46995
2020	-0.5291
Technical	-1.03133
High School	0.703316
Community School	0.039991
Alaska	0.625387
Central	-0.44377
NM	0.916281
Western Pacific	1.087526
Pandemic	-1.05191
msq_test: 6.647619038890845	
msq_pred: 6.888261679249922	
r2_test: 0.05304239946217559	
r2_pred: 0.0387148098902369	

Limitations

The FAA Form 8080-08 tracks quarter by quarter assessment of the all the FAA part 147 schools and measures their progress compared to the national norm based upon the specific regulation outlined below:

> **§ 147.38a Quality of instruction.**
>
> Each certificated aviation maintenance technician school shall provide instruction of such quality that, of its graduates of a curriculum for each rating who apply for a mechanic certificate or additional rating within 60 days after they are graduated, the percentage of those passing the applicable FAA written tests on their first attempt during any period of 24 calendar months is at least the percentage figured as follows:
>
> (a) For a school graduating fewer than 51 students during that period - the national passing norm minus the number 20.
>
> (b) For a school graduating at least 51, but fewer than 201, students during that period - the national passing norm minus the number 15.
>
> (c) For a school graduating more than 200 students during that period - the national passing norm minus the number 10.
>
> As used in this section, "national passing norm" is the number representing the percentage of all graduates (of a curriculum for a particular rating) of all certificated aviation maintenance technician schools who apply for a mechanic certificate or additional rating within 60 days after they are graduated and pass the applicable FAA written tests on their first attempt during the period of 24 calendar months described in this section.
>
> [Amdt. 147-2, 35 FR 5534, Apr. 3, 1970, as amended by Amdt. 147-3, 41 FR 47230, Oct. 28, 1976]

The regulation presents its own set of problematic issues due to the duration of the tracking, the size of the cohort within a specific school and it only records the first attempt of an applicant. The second issue is found within the data sets itself as there is a "Two Year Accumulative" measurement which acts as a smoothing parameter and does not identify immediate and specific data issues or issues specific with a cohort.

Training, although having planned and executed for many years under the appropriate FAR's, does not serve individualized instruction. This is evident in classroom settings, thus educators may find themselves teaching to the mean group and not assisting the outside edges of a normal distribution curve of learners. Various institutions were not well versed in multiple platform remote learning delivery systems and had not trained students and staff to acclimate to the use, quality and feedback needed to become successful users of such a product. The authors cannot presently account for any impact this may have had on overall grades. "Federal law for licensing aircraft mechanics license was temporarily relaxed during the coronavirus situation, according to the college, W.P. Marsh, who teaches the Airframe & Powerplant course in the aviation maintenance program at Hinds Community College in Mississippi". As each FSDO overseeing its cadre of schools may have authorized changes to the programs under their specific control there is no central point to access and review each change authorized to each program and therefore cannot be considered in the current analysis, yet we find this an area of future investigation.

Discussion

The below table shows the dated status of 14 CFR Part 147 Appendix B, C, and D. These appendices express the regulatory authority for both what curriculum the AMTS must deliver, and the teaching level required for each subject area. Although neither investigated as part of this study nor part of this research, one could argue if viewed in alignment with Figure 19, the AMG test grade drop appears to coincide with the 2017 revision date of the text. It is possible that this revision contributed to a drop in the grades. However, the drops in the AMG and AMP grades do not follow the same pattern as these were last revised in 1992. One would expect similar changes to have occurred with all three exams to draw such a conclusion.

Table 2. Status of AMG, AMA, and AMP curriculum subject matter (11-06-2021)

General -Appendix B	As amended by Amdt. 147-5, 57 FR 28960, June 29, 1992
Airframe - Appendix C	Docket FAA-2017-0733, Amdt. 147-8, 82 FR 34399, July 25, 2017
Powerplant - Appendix D	As amended by Amdt. 147-5, 57 FR 28961, June 29, 1992

In general, industry practitioners believe that the grades lowered because the FAA changed the test. What would appear as the more correct statement is that the FAA changed the test questions, aligning with former Administrator's thinking (O'Brien, 1990) that teaching was aligning with the test questions. This would support the theory of teaching the test, the questions, and the corresponding answer to students at various institutions. Clearly, if the regulatory side did not change as demonstrated by both the AMG and AMP content since the 1990's, but the FAA was adding to the test question bank there appears a "lag" in the time for the questions to leak out to the public domain. As the FAA stated in 2017, only sample questions were provided to the public and new handbooks released as outlined below.

Table 3. FAA's Airman Testing Standards Branch (AFS-630), publication dates for the AMT Handbooks

AMG	AMG HB (FAA-H-8080-30A): October 2017
AMA	AMA HB (FAA-H-8083-31A): September 2018
AMP	AMP HB (FAA-H-8083-32A): September 2018

These handbooks were released in a more current revision status (date) showing that the regulations for the AMTS did not change (Table 2). It would appear the AMTS were either slow or delayed in revising their curricula to align with new data published, and if that was the case this could be the explanation of the grades going down prior to the pandemic. Curriculum

revisions sometimes lag behind that of instructors and institutions who become complacent with instructional delivery and tend to not revise their presentations, objective and learning outcomes with current data.

Summary and Conclusion

From the exploratory analysis accomplished, the researchers could a concise explanation for the drop in grades during the pandemic. Although small, none the less it is evident and requires further investigation at a more granular level. The other phenomena and more concerning are the grade drop in what is considered “normal times” or pre pandemic, additional investigation is needed. As a result of our investigation, the researchers can conclude that the KBT test results did go downward during the pandemic period. With only this data, it cannot be determined which factor if any is responsible for the trend. It is correct to say that the results prior to the pandemic in the five years proceeding it were already trending down. Additional findings show that certain institutions and regions have consistently higher test grades than others. Future research could investigate what caused the initial downward trend, what was being done at the institutions during the pandemic which helped control the grades from dropping significantly, and which institutions were most successful during this time.

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