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The role of test anxiety in virtual school performance:

Impacts of testing context and implications for equity

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Abstract. Test anxiety is a well-documented factor negatively influencing academic performance, yet its impact in virtual school environments remains underexplored. This quantitative study investigates the relationship between test anxiety and standardized test performance among virtual school students, comparing outcomes across testing contexts—home-based versus facility-based. Quantitative data from 1,788 students across 16 virtual schools reveal higher levels of anxiety, particularly cognitive interference and physiological indicators, in facility-based testing environments. These findings align with prior research on virtual schools, which has consistently reported lower student achievement compared to in-person schools. Results underscore the importance of addressing test anxiety to support equitable educational outcomes in virtual schools.

Keywords. Virtual schools, cyber schools, student achievement, state testing, standardized testing, test anxiety, cognitive interference, worry, physiological indicators, tension.

The relationship between test anxiety and student academic performance has been well-explored extensively for over 50 years, emphasizing the importance of understanding and measuring this phenomenon in novel contexts. One such context is that of students enrolled in fully online schools, known as virtual schools. As previous research has shown, students with a higher proclivity to mental health issues enroll at higher percentages in virtual schools (Maranto et al, 2021), making them potentially more susceptible to the impacts of test anxiety.
A common theme in research on virtual schools has been their lack of student achievement compared with students enrolled in in-person schools (for summaries see Finn et al., 2016; Saultz and Fusarelli, 2017). The reports on virtual charter school performance provided by the National Education Policy Center (NEPC; Molnar et al., 2023) have widely confirmed these poor performance results nationwide. It should be noted that virtual charters' poor academic performance has been carefully documented by the NEPC since 2013 (Miron et al., 2013; Rice et al., 2014; Huerta et al., 2015; Miron and Gulosino, 2016; Molnar et al., 2017, 2019, 2023). This research has been consistent with multiple state sponsored research reports from Michigan (Freidhoff, 2016, 2017, 2018), North Carolina (Department of Public Instruction, 2017), Tennessee (see Potts and Donaldson, 2016), and Kansas (Legislative Division of Post Audit, 2015), other center and think tank based research from Ohio (Ahn, 2016; Ahn and McEachin, 2017; Center for Research on Education Outcomes, 2019), and Georgia (Public Impact and the National Association of Charter School Authorizers, 2015). Additionally, these results have been acknowledged by the pro-charter group, National Alliance for Public Charter Schools (2016) and a pro-charter think tank (Yettick, 2015).

Most efforts expended on understanding virtual schools takes the form of evaluations that estimate the effects of virtual schools on student achievement. However, a smaller but important body of literature raises concerns about the reliability of state test outcomes as indicators for student learning in virtual schools. These concerns relate to the unique population of students served by virtual schools (e.g. students with social or emotional challenges (Scafidi, 2023). For example, Paul and Greene (2022) observe that mental health challenges among virtual school students are predictive of lower performance even after controlling for prior performance. Additional concerns about the validity of virtual school evaluations relate to the unique testing arrangement for virtual school students. Whereas students in brick and mortar schools (i.e. in-person schools) complete state tests in their traditional learning environment, students in virtual schools have historically completed state testing in a non-educational facility (e.g. hotel, conference center, or community center) repurposed for student testing. For example, one study observed a modest negative association between testing outcomes and the occasionally long commutes to testing sites required of virtual school students (Kingsbury et al, 2021). The narrow testing windows (e.g. taking multiple tests in a single day) often required for virtual charter students have also been observed to be negatively associated with testing outcomes, hinting at a possible deleterious effect of testing fatigue (Beck et al, 2019). Kingsbury et al. (2024) analyzed data from COVID-era policies that allowed virtual school students in some states to test from home. The findings indicated that at-home testing was associated with a significant increase in achievement, although causal mechanisms (e.g. reduction in anxiety or longer testing windows) are not identified. Beck (2023) conducted qualitative work on administrators and teachers' perceptions of virtual school students' experiences in taking state standardized tests. This work revealed widespread confirmation from multiple school staff that the high levels of anxiety in the student population were contributing to low observed achievement, calling for more research on

the subject as a potential reason for poor performance on standardized tests for virtual charter students.

Literature Review

Test anxiety and its wide ranging implications for overall student mental health have been characterized as alterations stemming from a student's perceptions of the consequences of or barriers to taking a test (Zeidner, 1998). These changes in students may be behavioral, emotional, or physiological. Test anxiety is a subset of academic anxiety, which is usually elicited by evaluative situations in a learning environment (Cassady, 2010). Students experiencing test anxiety may underperform in an exam due to its disruptive nature (Zeidner, 1998). Five decades of research literature have corroborated a strong negative relationship between test anxiety and academic performance (Sarason & Mandler, 1952; Hembree, 1988). This relationship is consistent for elementary, middle school, and high school, and across academic disciplines (English, Reading, Math, and Science).

Meta-analyses confirm this negative association across various subjects and academic variables, including self-esteem, well-being, self-acceptance, and self-control (Hembree, 1988; von der Embse et al., 2018). Recent research by von der Embse and colleagues (2018) further demonstrates the negative impact of test anxiety on exam performance, grade point average (GPA), and standardized test scores.

Although standardized tests play a central role in assessment of students, teachers and schools in U.S. K-12 education, concerns about reliability are common. In person schools at the K-12 level have already shown significantly higher test anxiety for children taking standardized tests compared with classroom assessments (Segool et al., 2013). To the degree that anxiety among students is not evenly sorted across schools, it is plausible that a potential deleterious impact of anxiety on test performance is also not evenly distributed across schools.

Beyond academic performance, test anxiety is associated with broader mental health outcomes. Steinmayr et al. (2016) reveal a negative relationship between test anxiety and subjective well-being, as well as GPA. Beidel and Turner (1988) link test anxiety to broader anxiety disorders, suggesting that children experiencing test anxiety may exhibit similar behaviors in other evaluative situations, indicating potential general anxiety concerns.

This literature review underscores the enduring negative relationship between test anxiety and academic performance, standardized testing outcomes, and mental health indicators. Understanding and addressing test anxiety are essential for creating a supportive educational environment that promotes student well-being and success. Unfortunately, although the relationship between test anxiety, student academic performance, and broader mental health outcomes has been well-explored for students in in person schools, it has not yet been explored quantitatively in fully online schools. This is important, because previous research has shown that students with a higher proclivity to mental health issues enroll at higher percentages in virtual schools, making them potentially more susceptible to the impacts of test anxiety (Scafidi, 2023; Paul & Greene, 2022). Also, Hurren et al (2006) showed that adaptations and revisions to the methods of testing, as well as changing student comfort with test conditions, reduced test anxiety among students. Thus, this study will explore any potential differences in the relationship between test anxiety for students enrolled in in-person schools and those enrolled in virtual charter schools.

Methods

This study uses a mixed methods approach to answer two related questions:

1. For students in virtual schools, to what extent is test anxiety associated with observed performance on standardized tests?
2. To what extent is testing anxiety for virtual school students attenuated by accommodations that allow students to take tests at home instead of at unfamiliar facilities?

Data

Quantitative data (a survey and academic outcomes) was provided to the researchers by an education management organization that operates a network of virtual schools across the United States, henceforth called Cyber National. Data comes from 16 schools scattered across 7 states (California, Kentucky, Louisiana, Ohio, Virginia, West Virginia, and Wisconsin). Ten of the schools are in California, whereas the other states have one Cyber National School that provided data. The chosen schools reflect a combination of convenience sampling (e.g. principals expressed willingness to participate in the study) and a conscious effort to produce variation in testing conditions. Specifically, California and West Virginia are among the small number of states that have recently passed legislation or introduced regulations that allow students at virtual schools to complete state tests from home. This variation allows us to answer our second research question.

Overall, 14,508 surveys were sent to students, of which 1,788 (12.3%) were completed[1]. While students in grades 3-8 are required to participate in annual state testing, we limited our sample to students in grades 6-8 to alleviate concerns about the ability of students to read and comprehend survey questions. In each participating school, surveys were sent to students within three weeks of the completion of state testing so that students' perceptions toward state testing were informed by recent experiences. All surveys were completed between May 10, 2024 and June 10, 2024. Cyber National shared achievement data for students who completed the survey. Specifically, they shared two years (2022-23 and 2023-24) of data which indicated whether the student was deemed proficient in math or ELA on the state exam, as well as standardized outcomes using the standardization process described by Anderson (2017, p. 57-59).

Survey Instrument

Survey items were extracted from the Multidimensional Test Anxiety Scale (MTAS; Putwain et al., 2020). The MTAS is a recently constructed, multidimensional instrument to measure test anxiety. The test anxiety factors identified are worry, cognitive interference, physiological indicators, and tension. Worry refers to thoughts that are focused on the consequences of the test or assessment (Putwain, Connors, & Symes, 2010). When students engage in this aspect of test anxiety, their attention is on the consequences of the test instead of the test itself (Sarason,1986). In the case of test anxiety, worry instead serves to increase students' stress past their coping abilities (Zeidner, 1998).

Cognitive interference is similar to worry in that it refers to thoughts that draw attention away from the test-taking task. However, unlike worry, these thoughts can be about anything (Zeidner,

[1] Nonrandom survey uptake is not a significant concern because to bias our results there would need to be non-randomness across schools (e.g. more anxious students skipping the survey in remote testing states), an outcome that seems unlikely.

1998). According to Deffenbacher (1978), students who experience test anxiety would spend 60% of their time attending to test relevant tasks and 40% of their time attending to intrusive thoughts that were irrelevant to the test they were taking. Students may find it difficult to dismiss these thoughts and waste valuable time and effort trying to refocus themselves (Zeidner, 1998). Physiological indicators refer to physical manifestations of test anxiety. The most common and obvious physical response associated with test anxiety is changes in arousal (Zeidner, 1998). Students who experience test anxiety may have symptoms like increased heart and breathing rates, trembling in hands, dry mouth, or increased sweating (Galassi et al., 1981). These responses to being in an evaluative situation are derived from the flight or fight response. Students who experience fight or flight during exams are at a disadvantage because students have to sit for hours while experiencing these disruptive physical reactions (Zeidner, 1998).
Tension is sometimes referred to as emotionality in the test anxiety literature. It is seen as the connection between physiological indicators and cognitive processes (Zeidner, 1998). Students with test anxiety who experience the physical changes are more likely to perceive these responses as negative compared to students who do not experience test anxiety, who may perceive them as motivation for increased effort (Zeidner, 1998).

Results

Overall, our sample featured eleven schools in two states where students tested remotely and six schools in six states where students tested at facilities, as seen in Table 1.

Table 1

Sample testing environment

	States	Schools	Sample
Remote testing	CA, WV	11	598
Facilities testing	KY, LA, OH, VA, WI	6	1,019

Results: Research question 1

To assess differences in anxiety across testing environments, we conducted two-sided t-tests to compare differences in means of each of the four constructs. The construct scores are presented to students as a Likert scale with possible responses of 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree). Higher responses indicated higher levels of anxiety.

The t-tests generally supported our hypothesis that anxiety is greater among the facilities testing group, as seen in Table 2.

Table 2

Results of research question 1

	Home	Facilities	Significance
Worry	3.52	3.58	
	(.04)	(.03)	
Cognitive	3.23	3.34	**
Interference	(.04)	(.03)	
Tension	3.39	3.55	***
	(.04)	(.04)	
Physiological	2.43	2.65	***
Indicators	(.05)	(.04)	

*p≤.1, **p≤.05, ***p≤.01

One construct—worry—does not appear to be meaningfully correlated with testing environment. However, the other constructs are correlated with testing environment at the 95% (cognitive interference) or 99% (tension, physiological indicators) confidence level. The physiological indicators construct emerges as the most salient in terms of differences between the populations, with the at-home testing group scoring an average of 2.43 and the facilities testing group scoring an average of 2.65. For context, the construct overall has a standard deviation of 1.17, so the difference in score between the two groups represents 19% of a standard deviation difference.

To address the possibility that the results could reflect differences in the difficulty of the tests themselves (which are different in each state), we performed multivariate regression analysis that controlled for 2022-23 normed test scores in ELA and math, as seen in Table Three. Overall, the results looked similar to the unadjusted comparison, with the magnitude of the at-home testing association increasing slightly when it comes to physiological indicators and cognitive interference but decreasing slightly when it comes to worry and tension.

Table 3

Association between testing condition and anxiety, controlling for previous achievement

	Remote testing	Normed ELA	Normed Math
Worry	-.03	.09	-.28***
	(.08)	(.08)	(.08)
Cognitive	-.15**	.11	-.39***
Interference	(.07)	(.08)	(.08)
Tension	-.14*	.25***	-.36***
	(.08)	(.09)	(.08)
Physiological	-.23***	.25***	-.49***
Indicators	(.08)	(.09)	(.09)

Results: Research question 2

Our second question seeks to understand whether anxiety is negatively associated with test performance. To probe the relationship between the anxiety factors and academic achievement, we first perform univariate regression analyses that assess the degree to which each construct predicts 2023-24 testing outcomes, as seen in Table 4.

The results indicated a consistent, statistically significant link between anxiety and math test performance. For example, an additional point in the cognitive interference scale (i.e. higher levels of interference) is associated with a .1 standard deviation decrease performance on the state test. However, this simple model introduces significant concerns around reverse causality. That is, the relationship between the anxiety measures and performance might be influenced by the likelihood that lower-performing students are more anxious because they anticipate a negative test outcome (Putwain & von der Embse. 2018). To alleviate this concern, we introduced multivariate models that controlled for prior (i.e. 2022-23) testing performance (i.e. columns 2, 4, 6, and 8 in Table Four). Controlling for prior performance significantly shrinks the association between anxiety and contemporary performance. For example, an additional point in the cognitive interference scale was associated with a .1 standard deviation decrease in math performance without controlling for prior performance but .04 standard deviations when controlling for prior performance. Other than worry, the factors remain predictive of contemporary performance at the 95% (tension, physiological indicators) or 99% (cognitive

interference) confidence level. The results indicate that anxiety levels are informed by past performance but that anxiety levels also influence future performance.

Table 4

Predictors of 2023-24 standardized math score

	I	II	III	IV	V	VI	VII	VIII
Worry	-.07*** (.02)	-.02 (.01)		-		-		-
Cognitive Interference	-	-	-.10*** (.02)	-.04*** (.01)		-		-
Tension	-	-		-	-.05*** (.01)	-.03** (.01)		-
Physiological Indicators		-		-		-	-.08*** (.01)	-.02** (.01)
2022-23 std ELA	-	.27*** (.03)	-	.27*** (.03)	-	.27*** (.03)	-	.27*** (.03)
2022-23 std math	-	.60*** (.03)	-	.59*** (.03)	-	.59*** (.03)	-	.59*** (.03)
N	1,738	963	1,738	963	1,738	963	1,738	963

Table 5

Predictors of 2023-24 standardized ELA score

	I	II	III	IV	V	VI	VII	VIII
Worry	-.03** (.01)	.01 (.01)	-	-	-	-	-	-
Cognitive Interference	-	-	.08*** (.01)	-.03** (.01)	-	-	-	-
Tension	-	-	-	-	-.01 (.01)	.01 (.01)	-	-
Physiological Indicators	-	-	-	-	-	-	.04*** (.01)	-.01 (.01)
2022-23 std ELA	-	-	-	-	-	-	-	-
2022-23 std math	-	-	-	-	-	-	-	-
N	1,738	963	1,738	963	1,738	963	1,738	963

Please note that the Roman numerals in Tables 4 and 5 represent the different regression models tested in the analysis. Each column under these Roman numerals indicates a separate model that includes specific predictors of 2023-24 standardized ELA scores. For example, Model I includes “worry” as a predictor. Model II also includes "Worry" but tests additional factors or

changes in the model. Subsequent models (III through VIII) progressively include other variables like "Cognitive Interference," "Tension," or "Physiological Indicators," and control for prior achievement metrics (e.g., 2022-23 ELA and math scores).

Discussion

Research question 1 discussion

Research question 1 asked, “For students in virtual schools, to what extent is test anxiety associated with observed performance on standardized tests?” Results showed a significant difference between the home and site testing groups for the cognitive interference, physiological indicators, and tension factors. There was no significant different for the worry factor. This makes sense as worry refers to thoughts that are focused on the consequences of the test or assessment, which would focus on future consequences of potential poor test performance and not on aspects related to the test site.

In contrast, it makes sense that there is a significant difference in the cognitive interference, physiological indicators, and tension factors, because all of these involve aspects that may be related to the test site. As stated above, cognitive interference is thoughts which draw students away from the testing task (Deffenbacher, 1978). Former qualitative research by Beck (2024) showed that virtual school students have a lot more to consider than a student attending an in-person school, including concerns about getting transportation to the test site and distractions at the test site. Thus, the significant result in our study makes sense simply because of the large number of distracting thoughts regularly experienced by virtual school students. Additionally, cognitive interference has long been postulated as a source of the decrease in student achievement from test anxiety (Lowe et al., 2008; Zeidner, 1998), and research by Putwain et al (2020) has shown that it is directly related.

The results of our study also showed that physiological indicators were significantly related to student achievement. These are physical symptoms of test anxiety, such as increases in heart rate, breathing rate, sweating, etc. (Galassi et al, 1981). This also makes sense as virtual school students often experience state testing at an unfamiliar site using an unfamiliar computer, and surrounded by unfamiliar students (Beck, 2024). Bandura originally proposed physiological indicators as a source of academic efficacy, confirming previous research on its influence on test anxiety (Ware et al, 1990) and anticipating Putwain et al’s (2020) work showing direct relationships between student achievement and physiological indicators.

As seen above, tension is the connection between physiological indicators and cognitive processes (Zeidner, 1998). In our case, tension most likely had a significant relationship with student achievement because virtual school students taking the state standardized test at an in-person location experienced physiological indicators and then identified them as negative, leading them to dwell on the reactions and experience increased cognitive interference.

Research question 2 discussion

Research question 2 asked, “To what extent is testing anxiety for virtual school students attenuated by accommodations that allow students to take tests at home instead of at unfamiliar facilities?” A robust literature links familiarity with testing environment to student anxiety. Therefore, we hypothesized that testing anxiety is more acute in states where virtual school students complete tests in assigned facilities compared to states where students complete tests remotely. Results showed that there was a statistically significant relationship in the test site

groups between test anxiety and math test performance for the cognitive interference, physiological indicators, and tension factors. There was no significant different for the worry factor. Again, this follows common sense as the worry factor involves focused thoughts on the consequences of the test, which would not involve thoughts about the actual test site location. Thus, students at both test site locations had statistically similar achievement on the state standardized test.

The relationship between the cognitive interference factor and test location was statistically significant most likely because of the large number of distractions present at a virtual school testing site compared with an in-person school site. This also relates to recent qualitative research by Beck (submitted) which showed that virtual school students experience a wide range test irrelevant thoughts that do not apply to in-person students, such as those related to getting to the test site (e.g. pressure from parents who have to take off work to drive their student to a testing location, or arranging for a ride to the test site, waking at a different time than virtual school starts, etc.) and those at the test site (having to sit in an unfamiliar chair, at an unfamiliar desk, using an unfamiliar computer, at an unfamiliar hotel or community center where the school cannot rent out the entire facility, so there are the additional distractions of other events and customers that are simultaneously being hosted, etc., (Beck, submitted). Research indicates that individual or combined factors can trigger test-irrelevant thoughts, exacerbating test anxiety and impairing standardized test performance (Donati et al., 2019; Tan et al., 2023; Naveh-Benjamin et al., 1987). This seems to align with the experiences of virtual school students in our study.

The relationship between the physiological indicators and tension factors and test location on the state standardized test was statistically significant most likely because of the unique populations that attend virtual schools. Scafidi (2023) suggests that social and emotional difficulties disproportionately impact students in virtual schools, often serving as a primary reason for their transition from traditional brick-and-mortar schools. For instance, 48% of parents of virtual school students reported that bullying was a significant issue at their child's previous school, compared to 34% of parents in schools of choice more broadly (Morning Consult, 2024). Beck (2023) further highlights concerns about anxiety among virtual school students, noting that testing sites sometimes require buckets due to the severity of students' anxiety-induced emesis.

Similarly, Maranto et al. (2021) found that up to 24% of students in a nationwide virtual school network enrolled specifically due to mental health challenges. Thus, it makes sense that as virtual school students experienced elevated heart and respiratory rates, shaky hands, dry mouth, or excessive perspiration, they connected those physiological reactions with negative thoughts about their exam performance.

Conclusion

Our findings indicate that there is a significant difference in test anxiety between virtual school students who take the test at home versus at a physical test site. Additionally, results showed that there is a significant relationship between three of the four MTAS test anxiety factors of cognitive interference, physiological responses, and tension and student's state standardized test

performance. In other words, the test site does matter for virtual school students, both in terms of the amount of test anxiety and their overall performance on the state test.

Test site is an empirically proven reason that virtual school student have performed poorly on state standardized tests. Results from this study point to the strong possibility that at least some of the reasons for the achievement differences between students who attend virtual and in-person schools lie in the realm of test anxiety. The degree to which test anxiety might explain performance gaps between the virtual and brick and mortar sectors is an area worthy of further investigation, especially given the robust nature of these gaps (for summaries see Finn et al., 2016; Saultz and Fusarelli, 2017; NEPC report - Molnar et al., 2023; state sponsored research reports (Freidhoff, 2016, 2017, 2018; Department of Public Instruction, 2017; Potts and Donaldson, 2016; Legislative Division of Post Audit, 2015) and others (Ahn and McEachin, 2017; Center for Research on Education Outcomes, 2019; Public Impact and the National Association of Charter School Authorizers, 2015; Yettick, 2015).

In light of the observations made in this study, potential reforms include allowing virtual school students to test from home (a decision that has already been legislated or introduced via rule change in a number of states) and virtual school participation in cognitive behavioral interventions such as the "Strategies to Tackle Exam Pressure and Stress" (STEPS) to alleviate testing anxiety (Putwain et al, 2014).

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