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Article

Exploring Correlates of Student Preferences for Virtual or In-Class Learning among Neurodiverse Adolescents Using a Single-Case Design Methodology

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Abstract: The purpose of the current study is to explore several correlates of adolescent students' preferences for at-home virtual or in-class in-person learning in a single case of a school that serves students with learning differences. Correlates of interest were the Big Five personality traits (*Openness to Experience*, *Conscientiousness*, *Extroversion*, *Agreeableness*, *Neuroticism*) and the students' self-reported learning engagement. Participants were recruited from a single independent school for students with neurodiversity and special learning needs, where they had high exposure to computer-/internet-assisted learning. Twenty-seven students responded to questionnaires measuring preferred learning modes, personality traits, and learning engagement. Despite teacher reports that some of these students thrived with virtual learning during the COVID-19 pandemic, 88.5% of this sample preferred in-class learning. The personality traits of Conscientiousness and Openness to Experience were related to a preference for in-class learning. A preference for in-class learning was related, in turn, to learning engagement. Learning engagement was associated with Conscientiousness, Agreeableness, and lower levels of Neuroticism. The strengths and limitations of this study and its implications for further research and practice are discussed.

Keywords: personality traits; virtual learning; in-class learning; student engagement; neurodiversity; independent schools

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1. Introduction

During the early phase of the COVID-19 pandemic (2020–2022), kindergarten through twelfth-grade schools worldwide experienced dramatic and unpredicted disruptions in their modes of instruction. Five different classroom models rapidly evolved: (a) near-exclusive in-class learning, (b) near-exclusive online learning at home, (c) rapid whole class shifts between in-class and at-home learning, (d) hybrid models in which some students were in-class and some were at-home, and (e) newly emerging models in which some students separately chose either predominant in-class or at-home learning [1–5].

Novel experiences in education during this remarkable period of educational stress provided an opportunity to study student learning preferences and their possible correlates. Worldwide, questions arose as to how student experiences with virtual classes versus at-home learning might be related to learner characteristics, educational technology, teacher capabilities, and other variables [6,7]. Some students may have flourished in their virtual

classes during this period. As research consultants to a small independent school for students with special learning needs, the present authors were aware of students in this school who fared well with online learning. In an effort to learn what student characteristics might be associated with important learning preferences, middle and upper school students at this school were given questions assessing their preferences for virtual versus in-class learning and previously developed questionnaires to assess their personality traits and learning engagement.

2. Background

2.1. Personality and Virtual Learning Preferences

No previous investigations of the relationship between student personality traits and virtual versus in-class learning preferences were found. This is not surprising as there was no pre-pandemic impetus for the study of widespread virtual learning. However, prior investigators have studied relationships between the Big Five personality traits and academic achievement, and these were found to be positively correlated [8–11].These findings were deemed relevant to this study in that academic achievement could be indirectly related to learning preferences.

Regarding the personality theory and assessment, psychologists have long engaged in this research in non-clinical populations of adolescents and adults, and these investigators have distilled, through decades of extensive and overlapping work, common, basic, and universal personality traits so that most modern experts now share the perspective that our personalities can be described by varying degrees of five essential traits called the Big Five [12–15]. This Five Factor Model of personality was initially developed based on adults, but numerous researchers have shown that this model extends to adolescents [13,16,17]. Several adolescent measures of the Big Five traits have been developed [18,19]. The first of the Big Five traits is Openness to Experience, which includes creativity and curiosity. Items that examine this trait ask participants to reflect on their levels of inquisitiveness, knowledge, and ability to come up with ideas [19]. Conscientiousness, which consists of organization and achievement focus, is associated with ideas about being organized, creating a plan, and setting goals [19]. Extroversion, or being outgoing and sociable, is queried by asking participants whether they are sociable and have friends [19]. Agreeableness focuses on a desire to get along with others and is examined by asking questions about whether individuals think of others and like to help others [19]. The only negatively valenced trait, Neuroticism, is marked by anxiety and emotional instability. Questions about this trait consider whether participants are easily annoyed or moody [19].

In the application of this work to the field of education, researchers have used various validated and reliable measures of these Big Five personality traits or styles to study their relationships to academic achievement in populations of students in kindergarten through twelfth-grade schools and young adults in higher education. Significant and positive correlations have been found between academic achievement and Conscientiousness and Openness to Experience, but there have been no significant correlations with Extroversion, Agreeableness, or Neuroticism [8–10].

2.2. Learning Engagement and Personality

In a separate research thread from personality theory and assessment, other researchers have had strong interests in assessing student motivation as a pathway to school success [20,21]. This work has led to specific interests in students' learning engagement, defined as the quality of a student's connection or involvement with the school [20,22]. Learning engagement is essentially an outward manifestation of school motivation, and it can be seen through such behaviors as time-on-task and emotional interests in school subjects, people, and/or activities. There have been many different means of measuring learning engagement, as reviewed by [23]. Again, several scholars have reported significant positive correlations between learning engagement and academic achievement in populations of adolescents and young adults [11,24]. However, to the present authors' awareness, there have been no prior investigations of the relationship

between learning engagement and preferences for virtual learning or among K-12 students between learning engagement and the Big Five personality dimensions.

Growing out of these two separate streams of research on (i) interest in and tools for assessing students' Big Five personality traits and (ii) interest in and tools for assessing students' engagement in learning, there have been very recent investigations of how these two constructs (personality and learning engagement) may relate to one another. Specifically, some authors have considered the interrelationship between the Big Five personality traits and student engagement in the classroom, particularly during the unexpected virtual learning environment associated with education during the COVID-19 pandemic. In undergraduate students, Conscientiousness, Extraversion, and Neuroticism have been linked to online engagement [25,26], cyberslacking via engaging in other activities during class [27], and motivation [25]. However, the relationship between the Big Five personality traits and learning engagement has yet to be studied in students below the university level and, certainly, in adolescents with learning differences.

2.3. Learning Engagement and Virtual Learning Preferences

Regarding relationships between students' learning engagement and their preferences for in-class versus virtual learning preferences, the authors are aware of no prior research in any student populations. As a prelude to conducting new research to determine whether students show different levels of learning engagement when learning virtually or in-class, the authors believe it would be valuable to survey students who have recently undergone immersive virtual learning during the COVID-19 pandemic to discover whether these students now prefer virtual or in-class learning and to relate their preferences for learning modes to the levels of their self-reported learning engagement. To the authors' knowledge, this is the first such investigation of this relationship.

3. Current Study

In the current study, we sought to examine learning preferences, learning engagement, and the Big Five personality traits in one school. This particular school focuses entirely on serving students with learning differences, which allowed us to concentrate on how these constructs relate in a neurodivergent sample. In order to examine these research questions within such a small sample, we utilized a single-case design methodology to illuminate the results of necessary decisions to implement models of virtual or in-class learning as the COVID-19 pandemic began in Spring 2020 [28]. Given the importance of examining the relationships among these variables in our unique but small sample of neurodivergent students, we implemented a case study within a survey to understand the real-world case of this school environment during the pandemic [29,30]. The important contextual conditions pertinent to these students at this school during this particular time lend themselves to using the case design method [30].

Therefore, a survey to assess student preferences for virtual and in-class learning was administered in the spring of 2022 in a small sample of students (aged 12–18 years) with special learning needs who were already accustomed, in pre-pandemic periods, to extensive teacher-directed computer-/internet-assisted learning activities. The goal of this study was to determine whether these students' virtual versus in-class learning preferences were related to their Big Five personality traits and/or their self-reported learning engagement. We expected these data to help inform educators of which student characteristics might be associated with learning preferences to assist educational planning for any future virtual learning that might be offered to remote students, traveling student-athletes, or other students who could not be present in classrooms for short or long periods or for various reasons. The following hypotheses were formulated.

3.1. Hypothesis 1

In the absence of prior research relating personality traits to preferences for virtual versus in-class learning, there was no empirical basis for an a priori hypothesis regard-

ing expected relationships between these variables. However, given anecdotal teacher observations suggesting that socially anxious children might achieve better virtually, an explorative hypothesis was adopted, proposing that a student preference for virtual over in-class learning would be related to Neuroticism. Of note, after initiating the study with this hypothesis, the authors encountered seemingly supportive theoretical literature that linked digital nativism (i.e., high levels of comfort and proficiency with internet-based interactions) to social anxiety [31–33].

3.2. Hypothesis 2

While also exploratory, a second hypothesis proposed that high levels of learning engagement would be significantly related to those personality traits that have previously been linked to high academic achievement: Conscientiousness and Openness to New Experiences.

3.3. Hypothesis 3

Similarly, despite an absence of direct investigations of learning engagement and preferences for virtual or in-class learning, previous studies have reported a positive relationship between learning engagement and academic achievement. Assuming that high academic achievement might be linked to a preference for virtual learning, a third highly explorative hypothesis emerged that a preference for innovative virtual learning would be linked to high levels of learning engagement.

4. Methods Section

4.1. School Setting

This study was conducted within a small independent school of approximately 110 students for children with learning differences Chesapeake Bay Academy in Virginia Beach, VA, USA. This school is committed to individualized instruction, and its middleCrnet-based learning technology and thus were well-prepared for remote online learning during the school shut-down periods of the COVID-19 pandemic. The administration and faculty have had a decades-long commitment to educational technology use, including ongoing reliance on a series of increasingly well-integrated learning management systems for presenting educational content, tracking assignments, and communicating between teachers, students, and parents [34]. Students at this school are accustomed to home-based electronic instruction through flipped classrooms, in which they watch teacher-created instructional videos at home and come to class to apply what they have learned. In-class educational technology included the use of interactive VIBE whiteboards, 3D printers, laser cutters, CLASS VR (virtual reality headsets), and 1–1 computer devices for all students. Additionally, during phases of the pandemic, when classes met in the school, the school made use of telepresence robots to engage students who were quarantined at home.

While 90% of surveyed school district leaders in the United States recently reported internet access problems for students during the pandemic, and 40% reported internet access problems even for teachers [35], internet access was never a concern for either students or teachers at this school. While the COVID-19-induced transition from in-class to exclusively virtual classes and online learning created extreme stress in most schools [4], a real-time 2020 survey of parents during the school shut-down period of the pandemic found that most parents perceived a very positive transition to exclusively virtual classes. In a parallel student survey in the same time period, middle and upper school students gave very high satisfaction ratings (M = 8.38 and 9.0, respectively, on a 1 to 10 scale, with 10 being the highest) in response to the question "How satisfied are you overall with the school's digital learning environment?" Thus, this environment seemed well suited for a study on possible student preferences for virtual learning.

This research team sought both external Institutional Review Board approval through the first author's institution and internal approval from the school's own Institutional Review Board to conduct this research. It was important to allow students the option to voluntarily enroll or discontinue the study, even when conducting the study during school time; students

were assured that their participation had no impact on their school standing. All student participants provided assent, and parents/caregivers of all participants provided informed consent. Data were secured through password-protected devices and documents.

4.2. Participants

Forty-six students started the survey, of whom 19 did not complete their questionnaires (with one student discontinuing on the first page), leaving a final sample of 27 students. Anecdotal reports suggested that some prospective participants found the survey too confusing and/or long, and an unknown number may have had reading difficulties that contributed to this high attrition rate (41%). Although we recruited participants from both the Middle and Upper Schools, none of the Middle School students completed the questionnaires, meaning that our remaining participants were all Upper School students. As there were 40 Upper School students enrolled at the time of the study, the small sample for our case design represents 67.5% participation by these high school students.

The participants' average age was 14.11 (SD = 1.97). Most were identified as male (n = 16, 59.3%), while others were identified as female (n = 9, 33.3%) or nonbinary (n = 1, 3.7%). One student indicated that they preferred not to disclose their gender. Students were largely Caucasian (n = 12, 44.4%), with some Hispanic (n = 3, 11.1%), African American (n = 1, 3.7%), Asian (n = 1, 3.7%), and mixed race (n = 1, 3.7%) students. Many students (n = 10, 37.0%) either did not report their ethnicity, wrote that they did not know it, or gave a nonsensical response to this question. Due to the unique nature of this student population, students were also asked whether they had ever been diagnosed with attention deficit hyperactivity disorder (ADHD; n = 16 or 59.3% said yes, n = 6 or 22.2% said no, and n = 5 or 18.5% reported they did not know) or ASD (n = 7 or 25.9% said yes, n = 19 or 70.4% said no, and one student reported they did not know). Of these students, only one reported being diagnosed with both ADHD and ASD. Table 1 shows the self-reported characteristics of student respondents in this study.

Table 1. Demographic characteristics of the students.

Characteristics	**Total % (N = 27)**
Gender	
Male	59.3 (16)
Female	33.3 (9)
Nonbinary	3.7 (1)
Prefer not to say	3.7 (1)
Ethnicity	
White	44.4 (12)
Hispanic	11.1 (3)
Black	3.7 (1)
Asian	3.7 (1)
Mix	3.7 (1)
Missing or Nonsensical Response	37.0 (10)
Diagnoses	
ADHD	
Yes	59.3 (16)
No	22.2 (6)

Table 1. *Cont.*

Characteristics	Total % (*N* = 27)
Don't Know	18.5 (5)
ASD	
Yes	25.9 (7)
No	70.4 (19)
Don't Know	3.7 (1)

Note. ADHD = attention deficit hyperactivity disorder; ASD = autism spectrum disorder; age range = 12–18; mean = 14.11, standard deviation = 1.97.

4.3. Procedures

After parents completed detailed informed consent forms via DocuSign, student participants next provided their own assent, and they were then given access to an online survey consisting of a total of 59 questions that were administered individually via SurveyMonkey without adult assistance within a time block at school. Students were assured their participation was voluntary with no impact on their school standing. This study applied a survey research design with quantitative analyses.

4.4. Measures

4.4.1. Learning Preferences

Participants were asked a series of five questions designed for the current study about their preferences for learning virtually or in person. These included one question where participants rank-ordered their preference for types of learning, ranging from students always in-person in-class to all students always at-home learning virtually. They were also asked two Likert-scale questions (1 = "very untrue for me" to 5 = "very true for me") about whether they would prefer to learn in-person, in-class, or at-home virtually, as well as a question about whether they believed learning in-person was better for all students. Finally, they were asked a forced-choice question: "If I had to choose between learning in-person in-class or learning at-home virtually, I'd choose to" where the response options were "learn in-person in class" or "learn at-home virtually".

4.4.2. Personality

Participants completed the Five Factor Model Adolescent Personality Questionnaire (FFM-APQ) [19], to examine their Big Five personality traits. Participants responded to a series of 25 questions using a 5-point Likert scale ranging from 1 = "strongly disagree" to 5 = "strongly agree". The FFM-APQ consists of five subscales, with each using 5 items to measure one of the following traits: Agreeableness (e.g., "Likes to help others"), extraversion (e.g., "Is very outgoing"), Conscientiousness (e.g., "Sets goals for myself"), Neuroticism (e.g., "Is quite anxious a lot of the time"), and Openness to Experience (e.g., "Is rather curious"). This scale has been shown to have good psychometric properties (Rogers and Glendon, 2017). Cronbach alpha values for the current sample ranged from adequate to excellent for the following subscales: Agreeableness (α = 0.92), Extraversion (α = 0.82), Conscientiousness (α = 0.77), Neuroticism (α = 0.79), and Openness to Experience (α = 0.71).

4.4.3. Learning Engagement

Participants completed the Engagement (E) versus Disaffection with Learning (D) Questionnaire (E vs. D) [22], consisting of 20 items answered on a Likert scale ranging from 1 = "not at all true" to 4 = "very true". The E vs. D consists of four different subscales as follows: Behavioral Engagement (e.g., "In class I work as hard as I can"), Behavioral Disaffection (e.g., "When I am in class, I just act like I am working"), Emotional Engagement (e.g., "When we work on something in class, I feel interested"), and Emotional Disaffection (e.g., "When I am doing work in class, I feel bored"). Cronbach alpha values for the current sample were as follows: total scale (a = 0.85), Behavioral Engagement (a = 0.71), Behavioral Disaffection

(a = 0.50), Emotional Engagement (a = 0.83), and Emotional Disaffection (a = 0.70). The weak consistency in these participants' responses to the Behavioral Disaffection subscale may have been a function of the very high level of self-reported attention-deficit hyperactivity disorder (ADHD) within this sample, perhaps meaning that behavioral distractibility had a different meaning among these children than among those on whom the scale was normed. Regardless of the basis for this weak reliability on the scale in the current sample, a decision was made to disregard this scale for further analyses. All other engagement subscales and the total engagement scale showed high levels of reliability.

4.5. Data Analysis

Primary data descriptors included frequency counts, percentages, means, and standard deviations. Based on the results of the tests of normality of data distributions, we discovered that data were non-normally distributed. Therefore, Spearman correlational analyses were utilized to determine statistically significant relationships between variables of interest to address our hypotheses regarding the following: (a) the relationship between the mode of learning preferences and personality traits on the Five Factor Model personality instrument (FFM-APQ), (b) student responses on the student engagement questionnaire (E vs. D) and the Five Factor Model personality instrument (FFM-APQ) and (c) mode of learning preferences and student responses to the student engagement questionnaire (E vs. D). For all analyses, statistical significance was set at $p < 0.05$. Data were analyzed using the Statistical Package for the Social Sciences (SPSS, version 27.0).

5. Results

5.1. Descriptive Statistics for Student Learning Preferences

On a forced choice question ("If I had to choose. . ."), students were asked to choose between either learning "in person/in class" or "at home/virtual". Across the sample (n = 27), 88.5% (n = 23) chose "in person/in class", 11.1% (n = 3) chose "at home/virtual", and 3.7% (n = 1) did not respond. On 5-point Likert-type ratings of learning preference options, there was a strong preference for learning in-person in-class (M = 4.19, SD = 1.27) and a slight preference against learning at home virtually (M = 2.41, SD = 1.31).

Table 2 presents the results of participant responses to a learning preference question in which students were asked to rank order six possible combinations of in-class and at-home learning modes that might evolve in post-pandemic school offerings. To summarize how participants responded to this question as a group, separate weighted sums were calculated for these options by assigning each participant's choices a number from 1–6 corresponding to the participant's ranking of the option and then summing each student's rank number across all participants to yield a weighted sum for each option. This method produced a rank-ordered popularity of these learning options, as listed from top to bottom in Table 2, with lower weighted sum values indicating the most popular options. Across the group, participants' first and second learning preferences were, "All students are always in person and in class", and "Each student can choose each day whether to learn in person and in-class or at home and virtually". Thus, even without a forced-choice survey format, students clearly preferred learning in-class.

Table 2. Rank-ordered preferences for modes of learning.

							Weighted Sum
Mode of Learning Statement	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	
• All students are always in-person in-class.	15	1	4	2	3	2	64
• All students are always in-person in-class.	8	5	7	3	3	1	72

Table 2. *Cont.*

Mode of Learning Statement	1st	2nd	3rd	4th	5th	6th	Weighted Sum
• Most students are in-person in-class, and only those with health concerns are at-home learning virtually.	2	13	4	4	2	2	78
• All students are always at-home learning virtually.	2	6	2	4	3	10	111
• Most students are at-home learning virtually, and only those with special learning needs are in-person in-class.	0	0	7	10	5	5	116
• Each week all students are in-person in-class for part of the week and at-home learning virtually for part of the week.	0	2	3	4	11	7	126

5.2. Intercorrelations among the Variables

Table 3 presents Spearman correlations between the responses to a single learning preference question asking students to indicate their preferences if forced to choose, for either virtual or in-class learning, and both (i) the Big Five personality traits measured by the FFM-APQ and (ii) the total score and subscale scores of the E v D questionnaire that measured student engagement. The three study hypotheses regarding the expected relationships between these variables were tested by determining whether expected correlations were statistically significant at a $p < 0.05$ test of significance. As noted earlier, no correlations were included for the Behavioral Disaffection scale of the E vs. D questionnaire on student engagement because the Cronbach alpha coefficient for this scale with these participants was low and unreliable ($\alpha = 0.50$).

Table 3. Correlations between the variables.

	1	2	3	4	5	6	7	8	9 #	10	11
1. Prefer to learn in-class											
2. Prefer to learn at-home	−0.45 *										
3. Openness to Experience	0.50 *	−0.18									
4. Conscientiousness	0.55 **	−0.01	0.20								
5. Extraversion	0.15	−0.02	0.38	0.26							
6. Agreeableness	0.07	0.24	0.21	0.49 *	0.49 *						
7. Neuroticism	0.03	0.08	0.25	0.04	−0.16	−0.39					
8. Behavioral Engagement	0.52 **	−0.04	−0.02	0.58 **	0.38	0.49 *	−0.38				
9. Behavioral Disaffection #											
10. Emotional Engagement	0.63 ***	−0.18	0.22	0.65 ***	0.28	0.33	−0.46 *	0.62 **			
11. Emotional Disaffection	0.40 *	−0.02	0.17	0.22	0.10	0.07	−0.33	0.46 *		0.54 **	
12. Total Engagement	0.54 **	−0.06	0.09	0.55 *	0.27	0.26	−0.48 **	0.62 **		0.84 ***	0.80 ***

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; # Behavioral Disaffection correlations were not considered in light of a weak Cronbach alpha value for this subscale.

5.3. Hypothesis 1: Learning Preferences and Personality

Regarding Hypothesis 1, an exploratory prediction that there would be a significant association between a preference for virtual learning and Neuroticism, there was no significant correlation between Neuroticism and a tendency to prefer virtual learning. However, personality traits of Openness to Experience and Conscientiousness were both positively

correlated with students' preferences for in-class learning. None of the other personality traits were related to a preference for in-class learning, and none of the five personality traits were correlated with a preference for virtual learning (all *p*s > 0.05; See Table 3). Therefore, Hypothesis 1 was not supported.

5.4. Hypothesis 2: Leaning Engagement and Personality

Regarding Hypothesis 2, the idea that learning engagement would be related to Conscientiousness and Openness to Experience, Conscientiousness (but not Openness to Experience) was significantly and positively correlated with Behavioral Engagement, Emotional Engagement ($r = 0.54$, $p = 0.007$), and Total Engagement. Conscientiousness was not related to Emotional Disaffection (reverse scored; *p*s > 0.05). Regarding other personality traits, Agreeableness was significantly and positively correlated with Behavioral Engagement and Total Engagement. Neuroticism was negatively correlated with Emotional Engagement and Total Engagement. Extraversion and Openness to Experience were not significantly correlated with any of the student engagement variables (see Table 3). Thus, Hypothesis 2 was partially supported.

5.5. Hypothesis 3: Learning Engagement and Learning Preference

Regarding Hypothesis 3, the idea that learning engagement would be positively related to a preference for virtual learning, no engagement variables were significantly correlated with a preference for virtual learning. However, Behavioral Engagement, Emotional Engagement, lack of Emotional Disaffection), and Total Engagement were all positively correlated with a preference for in-class learning (see Table 3). Hypothesis 3 was not supported.

6. Discussion

This study addressed possible correlates of virtual versus in-class learning preferences using a case design to examine a small group of neurodiverse adolescents in a single independent school for children with special learning needs who had an unusually high pre-pandemic exposure to teacher-directed computer-/internet-assisted learning. The correlates of the learning preferences studied here were the students' personality traits, as measured by a Five Factor Model personality instrument for adolescents (FFM-APQ), and student engagement, as measured by an established self-report student engagement questionnaire (E vs. D). The intent of this research was to identify specific student characteristics that might be related to these learning preferences to identify which students might be best suited for various educational approaches going forward.

While this participant sample's prior exposure to extensive computer-/internet-assisted learning experiences was expected to lead to more preferences within this group for virtual versus in-class learning, 88.5% of these participants preferred to learn in-class/in person. Even when given options to rank in order six iterations of various degrees of virtual and in-class learning, these students' highest-ranking order of preferences was "All students always learning in class". Additionally, there were interesting affirmations in these data for a growing perception among professional educators that interpersonal relationships, social connectivity, and emotional aspects of learning might be difficult to maintain in immersive virtual education [4]. For example, in an effort to identify which, if any, personality traits or learning engagement scores might significantly differentiate student preferences for in-class versus virtual learning, the only significant personality or engagement finding was that Emotional Engagement on the student engagement questionnaire (E vs. D) was significantly related to in-class learning.

Regarding the first hypothesis about the previously unstudied relationship between student preferences for learning modes and their personality traits, despite the authors' initial expectations, supported by some other authors [31–33] that a preference for virtual learning might be associated with higher social anxiety, there was no significant association between these students' virtual learning preference and a personality trait of Neuroticism (or any other personality trait). There were, however, significant correlations between

preferring to learn in-class and both Conscientiousness and Openness to Experience. These same personality traits have previously been associated with academic achievement in general student populations [8,10,11], perhaps suggesting that an *in-class* but not a virtual learning preference may be indirectly linked to student achievement.

This study is the first to report data for adolescent students regarding the relationship between students' personality traits and their learning engagement. Because prior researchers have reported a relationship between both Conscientiousness and Openness to Experience and academic achievement among students in higher education [24] a second hypothesis in this study proposed that a link between learning engagement and academic achievement might result in a significant relationship between the learning engagement personality traits of Conscientiousness and Openness to Experience. In partial support of Hypothesis 2, these adolescent participants with learning differences did express a significant relationship between Conscientiousness (but not Openness to Experience) and Total Engagement, Behavioral Engagement, and Emotional Engagement. There was also a secondary unexpected significant relationship between Agreeableness and both Total Engagement and Behavioral Engagement. The significant relationship between Agreeableness (a social aspect of personality) and learning engagement underlines the importance of the social aspects of learning among adolescents. This is also the first investigation of relationships between students' learning engagement and their preferences for virtual or in-class learning. Hypothesis 3 proposed that high student engagement could be significantly associated with a preference for virtual learning, but this hypothesis was not supported. Rather, in this neurodiverse student sample, students' self-reporting of higher Total Engagement, Behavioral Engagement, and Emotional Engagement were significantly related to preferences for *in-cl*ass learning. The link between in-class learning and learning engagement is particularly interesting, especially since there was a strong association with Emotional Engagement. As discussed earlier, social and Emotional Engagement through in-class learning may make virtual learning less attractive to adolescents, even when they report being satisfied with virtual learning. Anecdotally, when these students were asked for details about what they preferred in-class learning, their most common explanation for this preference was that they wanted to be with friends. While peer relations are known to be of particular importance to adolescents generally, these data raise a question as to whether adolescents with neurodiversity who are finally grouped together in an independent school that is dedicated to similar students might be meeting the needs of social belonging in ways they did not previously experience, perhaps magnifying the importance of in-class learning. According to Maslow's understanding of basic human needs, it makes sense that adolescent students would connect social agreeableness and emotional engagement to a sense of belonging created by an in-class school climate [36].

Attitudinal inquiries about students' preferences for modes of learning are not common in education and certainly not when the targeted students are adolescents with neurodiversity and learning differences. These students with learning differences have often been seen as particularly vulnerable to a virtual mode of instruction; special education departments have typically been the first initiators of high-technology assisted learning tools [37]. Students at the school in the current study had an unusual breadth and intensity of experience with educational technology. Yet, despite high parent and student satisfaction ratings regarding the school's virtual instructional program in the spring of 2020 and faculty reports of some improved efficiencies with at-home virtual learning, these students expressed a strong preference for in-class learning that seemed closely tied to social ties with peers that seem to have facilitated emotional engagement in learning.

6.1. Practical Implications

Practically, these findings are early building blocks for informing educators as to which student characteristics (e.g., personality traits) and learning preferences (e.g., virtual versus in-person learning) are most closely related to academic goals (e.g., student engagement in learning). These data are novel in terms of the variables studied, in a rare student sample,

and for student perceptions of learning immediately following a worldwide naturalistic experiment in immersive virtual education. Educators engaged in new instructional design, particularly for online delivery, may distill from these and other findings that student engagement in educational programs is apt to be highest for those students whose personalities are characterized by high levels of Conscientiousness. Additionally, most students are apt to prefer in-class experiences, perhaps due to their social and emotional needs. It is necessary, moving forward, for virtual learning programs to give particularly intense attention to students' interpersonal relationships and social belonging.

6.2. Limitations and Directions for Further Research

This study's most significant limitation is its small and unique participant sample. Broad generalizations from these data are suspect. Yet, it is important to share these data for their explorative and hypothesis-generating value. These are the first data to depict interrelationships between adolescent students' learning preferences, personality traits, and learning engagement. Still, future investigators are needed to replicate or refute these findings with studies using larger groups of students with varied characteristics. In particular, examining these issues in a sample of neurodiverse undergraduate students could help to situate the current results among the growing literature about the impact of virtual versus in-class learning on university students.

We assume that literacy problems in this group contributed to some unexpected participant attrition. Thus, there may be differences in these variables between neurodiverse students with and without literacy or willingness to complete this study. Important research lessons were learned regarding the need for short, easy-to-understand surveys and gathering oral as well as written data.

Self-reported diagnostic information is limited in its accuracy. In pursuit of trust-building among parents and students who are unaccustomed to research participation, the authors focused on anonymous data gathering and minimizing the need to examine health records. Questions about more subtle or harder-to-identify neurodevelopmental disorders, such as learning disabilities, developmental motor coordination disorder, and Tourette's disorder, were avoided. These students have been clearer and open with one another about their ADHD and ASD diagnoses, and these questions were used in this study to affirm that this sample could be accurately characterized as neurodiverse. Future investigators interested in diagnostic categorizations for other purposes need to use different research methods. Finally, the extent to which personality traits and emotional engagement are malleable is beyond the scope of this article, but this research thread is ripe for further pursuit, perhaps especially in relation to neurodiverse students.

7. Conclusions

This study examined what teaching modes are preferred (and perhaps best suited) for which students under what circumstances. The specific focus of this study was on how individual student personalities and learning engagement might be related to preferences for virtual versus in-class learning in the post-pandemic era. This small, unique data set from neurodiverse students was collected in a school that was unusually well prepared for at-home online learning and where both students and parents had reported high satisfaction with the virtual learning imposed in 2020. Yet even these students strongly preferred in-class to virtual learning, and these preferences were linked to personality traits of Conscientiousness and Openness to Experience. Conscientiousness and Agreeableness were linked to learning engagement, and learning engagement (perhaps particularly emotional engagement) was linked right back to preferences for in-class learning.

Readers should exercise caution in attempts to generalize these data to other populations, but future investigators may be partly guided by this exploratory project. Educators in other small schools may see the value of basing educational decisions on internal data gathered in real-time naturalistic "experiments" like a worldwide pandemic. Independent schools have unique flexibility in their ability to respond quickly to rapid change. They

can play a significant role in the generation of new educational knowledge, especially if data sets can be combined across schools. Pending the replication of these findings with larger and more diverse samples, preliminary impressions from this study for upper school students are that personality characteristics of Conscientiousness and Openness to Experience may be linked to preferences for learning in-class, Conscientiousness and Agreeableness may be most closely associated with learning engagement, and learning engagement may be achieved more easily through in-class than virtual learning unless there is a successful effort to preserve social connectivity in virtual classrooms.

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References

1. Lorenzo, M.F. Zoom in, Zoom out: The Impact of the COVID-19 Pandemi c in the Classroom. Ph.D. Thesis, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, 2020.
2. Christopoulos, A.; Sprangers, P. Integration of Educational Technology During the Covid-19 Pandemic: An Analysis of Teacher and Student Receptions. *Cogent Educ.* **2021**, *8*, 1964690. [CrossRef]
3. Code, J.; Ralph, R.; Forde, K. Pandemic Designs for the Future: Perspectives of Technology Education Teachers During COVID-19. *Inf. Learn. Sci.* **2020**, *121*, 419–431. [CrossRef]
4. Huck, C.; Zhang, J. Effects of the COVID-19 Pandemic on K-12 Education: A Systematic Literature Review. *New Waves-Educ. Res. Dev. J.* **2021**, *24*, 53–84. [CrossRef]
5. Morgan, H. Best Practices for Implementing Remote Learning During a Pandemic. *Clear. House J. Educ. Strateg. Issues Ideas* **2020**, *93*, 135–141. [CrossRef]
6. Gregor, S.; Hutchinson, K.; Harris, D. Online Education: What Have Learned, What Have Our Kids? Produced by American Public Television. The Whole Truth with David Eisenhower. Video Episode, 26:45. 5 May 2022. Available online: https://www.pbs.org/video/online-education-what-have-we-learned-what-have-our-kids-MemJoM/ (accessed on 15 September 2023).
7. Zhou, J.; Zhang, O. A Survey Study on US College Students' Learning Experience in COVID-19. *Educ. Sci.* **2021**, *11*, 248. [CrossRef]
8. Conrad, N.; Marc, W.P. Conscientiousness and Academic Performance: A Mediational Analysis. *Int. J. Scholarsh. Teach. Learn.* **2012**, *6*, 195–214. [CrossRef]
9. Dumfart, B.; Aljoscha, C.N. Conscientiousness is the Most Powerful Noncognitive Predictor of School Achievement in Adolescents. *J. Individ. Differ.* **2016**, *11*, 146. [CrossRef]
10. Hakimi, S.; Hejazi, E.; Lavasani, M.G. The Relationships Between Personality Traits and Students' Academic Achievement. *Procedia-Soc. Behav. Sci.* **2011**, *29*, 836–845. [CrossRef]
11. Kertechian, S.K. Conscientiousness as a Key to Success for Academic Achievement among French University Students Enrolled in Management Studies. *Int. J. Manag. Educ.* **2018**, *16*, 154–165. [CrossRef]
12. Cattell, H.E. The Original Big Five: A Historical Perspective. *Eur. Rev. Appl. Psychol./Rev. Eur. Psychol. Appliquée* **1996**, *46*, 5–14.
13. Digman, J.M. Five Robust Trait Dimensions: Development, Stability, and Utility. *J. Personal.* **1989**, *57*, 195–214. [CrossRef]
14. Judge, T.A.; Higgins, C.A.; Thoresen, C.J.; Barrick, M.R. The Big Five Personality Traits, General Mental Ability, and Career Success across the Life Span. *Pers. Psychol.* **1999**, *52*, 621–652. [CrossRef]
15. O'Connor, B.P. A Quantitative Review of the Comprehensiveness of the Five-Factor Model in Relation to Popular Personality Inventories. *Assessment* **2002**, *9*, 188–203. [CrossRef] [PubMed]
16. Shiner, R.L. How Shall We Speak of Children's Personalities in Middle Childhood? A Preliminary Taxonomy. *Psychol. Bull.* **1998**, *124*, 308. [CrossRef] [PubMed]

17. Bolinskey, P.K.; Arnau, R.C.; Archer, R.P.; Handel, R.W. A Replication of the MMPI-A PSY-5 Scales and Development of Facet Subscales. *Assessment* **2004**, *11*, 40–48. [CrossRef] [PubMed]
18. Lounsbury, J.W.; Tatum, H.; Gibson, L.W.; Park, S.-H.; Sundstrom, E.D.; Hamrick, F.L.; Wilburn, D. The Development of a Big Five Adolescent Personality Inventory. *J. Psychoeduc. Assess.* **2003**, *21*, 111–133. [CrossRef]
19. Rogers, M.E.; Glendon, A.I. Development and Initial Validation of the Five-Factor Model Adolescent Personality Questionnaire (FFM–APQ). *J. Personal. Assess.* **2016**, *100*, 292–304. [CrossRef]
20. Fredricks, J.A. Engagement in School and Out-of-school Contexts: A Multidimensional View of Engagement. *Theory Into Pract.* **2011**, *50*, 327–335. [CrossRef]
21. Wellborn, J.G. *Engaged and Disaffected Action: The Conceptualization and Measurement of Motivation in the Academic Domain*; University of Rochester: New York, NY, USA, 1992.
22. Skinner, E.A.; Kindermann, T.A.; Furrer, C.J. A Motivational Perspective on Engagement and Disaffection: Conceptualization and Assessment of Children's Behavioral and Emotional Participation in Academic Activities in the Classroom. *Educ. Psychol. Meas.* **2009**, *69*, 493–525. [CrossRef]
23. Fredricks, J.A.; Blumenfeld, P.C.; Paris, A.H. School Engagement: Potential of the Concept, State of the Evidence. *Rev. Educ. Res.* **2004**, *74*, 59–109. [CrossRef]
24. Chang, D.F.; Chien, W.C.; Chou, W.C. Meta-analysis Approach to Detect the Effect of Student Engagement on Academic Achievement. *ICIC Express Lett.* **2016**, *10*, 2441–2446.
25. Audet, É.; Levine, S.; Dubois, P.; Koestner, S.; Koestner, R. The Unanticipated Virtual Year: How the Big 5 Personality Traits of Openness to Experience and Conscientiousness Impacted Engagement in Online Classes during the COVID-19 Crisis. *J. Coll. Read. Learn.* **2023**, *53*, 1–18. [CrossRef]
26. Quigley, M.; Bradley, A.; Playfoot, D.; Harrad, R. Personality traits and stress perception as predictors of students' online engagement during the COVID-19 pandemic. *Personal. Individ. Differ.* **2022**, *194*, 111645. [CrossRef]
27. Koay, K.Y.; Poon, W.C. Students' Cyberslacking Behaviour in E-Learning Environments: The Role of the Big Five Personality Traits and Situational Factors. *J. Appl. Res. High. Educ.* **2022**, *15*, 521–536. [CrossRef]
28. Schramm, W. *Notes on Case Studies of Instructional Media Projects*; Working Paper; Institute for Communication Research, Stanford University: Stanford, CA, USA, 1971. Available online: https://files.eric.ed.gov/fulltext/ED092145.pdf (accessed on 5 November 2023).
29. Yin, R.K. *Case Study Research Design and Methods*, 5th ed.; Sage: Thousand Oaks, CA, USA, 2014.
30. Yin, R.K.; Davis, D. Adding New Dimensions to Case Study Evaluations: The Case of Evaluating Comprehensive Reforms. *New Dir. Eval.* **2007**, *2007*, 75–93. [CrossRef]
31. Amichai-Hamburger, Y.; Wainapel, G.; Fox, S. "On the Internet No One Knows I'm an Introvert": Extroversion, Neuroticism, and Internet Interaction. *Cyberpsychology Behav.* **2002**, *5*, 125–128. [CrossRef] [PubMed]
32. Huang, P.-S.; Chung, S.-J.; Liu, C.-H.; Chen, P.-Z. Measuring Cognitive and Social Interactive Attributes of Digital Natives: Development and Validation of a Scale. *Percept. Mot. Ski.* **2023**, *1130*, 732–1761. [CrossRef]
33. Hutchins, N.; Allen, A.; Curran, M.; Lee, K.-D. Social Anxiety and Online Social Interaction. *Aust. Psychol.* **2021**, *56*, 142–153. [CrossRef]
34. Gumpert, M.; Ball, J.D.; Jankowski, J. Technological Innovation in Education: COVID-19 and Beyond. Chesapeake Bay Academy Blog. 2021. Available online: https://www.cba-va.org/blog/technological-innovation-education-covid-19-and-beyond (accessed on 18 September 2023).
35. Herold, B. The Disparities in Remote Learning under Coronavirus (in Charts). Education Week 10 (April). 2020. Available online: https://www.edweek.org/technology/the-disparities-in-remote-learning-under-coronavirus-in-charts/2020/04 (accessed on 22 September 2023).
36. Pichère, P.; Cadiat, A.-C. *Maslow's Hierarchy of Needs*; Lemaitre: Namur, Belgium, 2015.
37. Adebisi, R.O.; Liman, N.A.; Longpoe, P.K. Using Assistive Technology in Teaching Children with Learning Disabilities in the 21st Century. *J. Educ. Pract.* **2015**, *6*, 14–20.