The Association of Personality Characteristics with Learning Strategy Preferences

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Abstract

The purpose of this study was to describe the association between the learning strategy preference of the learners as identified by **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS) and the individual personality traits as defined by the Myers-Briggs Type Indicator (MBTI). The sample was 553 adults in Canada and the United States. Two types of analyses were used to investigate the association between learning strategy preferences and personality traits. First, discriminant analysis explored the interaction of personality traits with the learning strategy preference. Second, analysis of variance measured the association of each personality trait with the learning-strategy-preference groups separately. The findings provided several explicit personality traits associated with each learning-strategy-preference group. These findings support the conclusion that a strong association exists between personality traits and learning-strategy-preference characteristics. Learning strategy preferences and personality traits complement each other. Each clarifies and enriches the other. As a result, teachers have two indicators that can help them personalize the teaching-learning environment for each student. Teachers can use the learning-strategy-group descriptions as guides for organizing each learner's instructional activities and plans and as a cognitive framework for uncovering and monitoring student behaviors and alerting teachers to potential learning difficulties for some students. Students can apply the descriptions of the learning-strategy-preference groups to facilitate self-assessment and metacognition. Theory can be enhanced by considering the two concepts of learning strategy preferences and personality traits coupled and by conducting quantitative and qualitative research to test and expand the generalizability of the learning-strategy-group descriptions. (Permission is granted to use **A**ssessing **T**he **L**earning Strategies of **A**dult**S** and the Personality Identity Estimator in practice and research. Links to printable copies and online completion are appended.)

Keywords: learning strategy, personality type, Assessing The Learning Strategies of AdultS, Myers-Briggs Type Indicator, personality assessment, personality type, Jung

1. Introduction

This study investigated the association between two concepts—learning strategies and personality traits. The development and practical application of each of these concepts have been profoundly influenced by the instruments that identify them. For learning strategies, the principal instrument has been **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS). For personality type, the leading instrument has been the Myers-Briggs Type Indicator (MBTI).

1.1 Learning Strategies

"Learning strategies are the techniques or skills that an individual elects to use in order to accomplish a learning task" (Fellenz & Conti, 1989, p. 7). The idea of learning strategies was conceptualized for the field of Adult Education by Robert A. Fellenz and Gary J. Conti in 1988 at the Kellogg Center for Adult Learning Research at Montana State University. It was further developed as a result of programmatic lines of inquiry by doctoral students in the Adult Education programs at the Center and Oklahoma State University. Learning strategies differ from learning styles in that they are techniques rather than stable traits, and they are selected for a specific task. Such strategies vary by individual and by learning objective (p. 8).

Learning strategies are based on five learning aspects essential to the learning process. These are the constructs

of metacognition, metamotivation, memory, critical thinking, and resource management. Each construct has three components.

- *Metacognition*, knowing about and directing one's own thinking and learning process, involves Planning (analyzing the best way for one's self to proceed with a specific learning task), Monitoring (assessing how one is proceeding through a learning project), and Adjusting (directing and improving one's learning processes).

- *Metamotivation*, an awareness of and control over factors that energize and direct our learning, includes Attention (focusing on the material to be learned), Reward/Enjoyment (anticipating or recognizing the value to one's self of learning specific material and having fun or satisfaction with the learning activity), and Confidence (believing that one can complete the learning task successfully and that the task is personally worth doing).

- *Memory*, the storage, retention, and retrieval of knowledge, is achieved through Organization (structuring or processing information so that material will be better stored, retained, and retrieved), Use of External Aids (using external aids to reinforce memory), and Memory Application (using remembrances, mental images, or other memories to facilitate planning and carrying out learning).

- *Critical Thinking*, the reflective thinking process utilizing higher-order thinking skills in order to improve learning, is facilitated by Testing Assumptions (recognizing and evaluating in relation to a learning situation, especially evaluating the specifics and the generalizability within a situation), Generating Alternatives (imagining and exploring options that are grounded within a given situation), and Conditional Acceptance (accepting of a learning outcome until a better one is discovered).

- *Resource Management*, the process of identification, evaluation, and use of resources relevant to the learning task, entails Identification of Resources (knowing how to locate and use the best source of information), Critical Use of Resources (using appropriate rather than available resources while recognizing their limitations), and Use of Human Resources (integrating others into the social and political processes of learning).

The Self-Knowledge Inventory of Lifelong Learning Strategies (SKILLS) was developed to assess learners' learning strategies in real-life situations. SKILLS had potential uses as an individual learning tool for personal diagnosis to get people thinking about how they learn, as a means for teachers to think about what students are doing, and as a research device to uncover what people do concerning learning. However, research consistently found that learners had patterns in their use of learning strategies, which represented their *learning preferences*.

Collectively, the studies with SKILLS revealed that demographic variables did not identify groups in their learning strategy usage. However, these studies found practices in terms of the pattern of the learning strategies used by the learners. These findings indicated that "placement in a learning strategy group is dependent upon the strategies one chooses to use rather than being predetermined by other factors. Thus, while learners have flexibility in the learning strategies that they can select for a specific task, the research indicates that when learning strategies are defined by the five concepts in SKILLS, there are clear patterns in the learning strategies … use[d] when initiating a learning activity" (Conti, 2009, p. 889).

Therefore, **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS) was developed to identify the pattern of learning strategy usage of learners. The 3,070 cases from the SKILLS studies in which the data were in similar form were analyzed with the multivariate procedures of cluster analysis and discriminant analysis. Cluster analysis examined how these learning strategy variables affected each person. Thus, cluster analysis allowed the focus to shift from the items in the instrument to the people taking the instrument. "Therefore, a cluster analysis of the aggregate data set of 3,070 was conducted to uncover the hypothetical constructs in the data and to define the learning strategy groupings actually in the data. The results of this analysis [of the 3,070 cases from SKILLS studies] revealed three distinct clusters" (Conti, 2009, p. 891).

Because of their similarity to groups in the previous SKILLS studies, these three distinct clusters were named Navigators, Problem Solvers, and Engagers. The distribution among the three groups of the 3,070 respondents from the SKILLS studies was relatively equal: Navigators—1,121 (36.5%), Problem Solvers—973 (31.7%), and Engagers—976 (31.8%) (Conti, 2009, p. 891). Discriminant analysis was used to determine the differences among the three groups. This analysis revealed that the significant process that separated the groups related to how each group sought to accomplish the learning task. The Navigators and Problem Solvers initiate a learning task from the cognitive domain by looking externally from themselves at the utilization of resources that will help them accomplish the learning. Conversely, Engagers start from the affective domain and involve themselves

in the reflective process of determining internally that they will enjoy the learning task enough to finish it (p. 891).

When defining learning strategies as the conceptual areas of metacognition, metamotivation, memory, critical thinking, and resource management, three distinct learning-strategy-practices exist. Preference is a multivariate concept. It was discovered with the multivariate procedures and has the distinguishing characteristic of multivariate analysis—the simultaneous interaction of numerous variables. The multivariate procedures of cluster analysis and discriminant analysis made the invisibleness hidden in the individuality of each of the 15 constructs in the learning strategies variables visible in the collective preference. These groups are as follows:

- *Navigators* are focused learners who chart a course for learning and follow it (Conti, 2009, p. 893). They initiate a learning activity by identifying useful resources for the task and immediately prioritizing them. Navigators want order and structure and are logical and objective. Consequently, they rely extensively on planning their learning. They enjoy structure, utilize schedules, appreciate deadlines, and want defined learning objectives and expectations in learning situations. They expect and appreciate prompt feedback. Navigators tend to dislike group work unless an expert leads the group because they feel that they can often do the work more efficiently by themselves. Because Navigators constantly strive for perfection, everything in their learning environment relates to achieving efficiency and effectiveness.

- *Problem Solvers* rely on critical thinking skills (Conti, 2009, p. 894). They initiate a learning activity by looking externally at available resources and immediately generate alternatives based on them. Consequently, most of their learning activities relate to generating alternatives. With so many options available to them, learning is an adventure for Problem Solvers that they prefer to do in their own way without a rigid structure. Problem Solvers are comfortable dealing with abstract ideas and, as a result, often think in terms of symbols. Problem Solvers are very descriptive and detailed in their answers and consistently use many examples to explain an idea. As a result, they are storytellers who rely on stories about their experiences because these provide concrete examples for learning.

- *Engagers* are passionate learners who love to learn, learn with feeling, and learn best when actively engaged in a meaningful manner with the learning task (Conti, 2009, p. 894). The essential thing for Engagers in the learning process is building relationships with others. Feelings are the key for the Engagers. They show this by using emotional words to express their "love for learning" and that "Learning is FUN!" With this passion, Engagers fully immerse themselves in the learning once they have decided to engage in it. Engagers are excellent networkers who love group work. They enjoy the learning process and delight in new accomplishments. Engagers are not interested in coming up with new or abstract ways of doing things. Instead, their focus is more on the learning process and the relationships built during this process than on the academic outcomes of the learning.

Research related to ATLAS falls into four categories: (1) research that focused on the instrument to better describe the groups in ATLAS (e.g., Ghost Bear, 2001; Ghost Bear & Conti, 2002), (2) research that tested the instrument with groups (e.g., Shaw, Conti, & Shaw, 2013), (3) research that used ATLAS as an auxiliary tool (e.g., Varmecky, 2012), and (4) research with an experimental format (e.g., Munday, 2002; Conti, 2009, p. 893). Other topics include curriculum development (McNeil, 2011, 2012, 2018, 2023) and application of ATLAS with professionals (Solomon, 2023).

1.2 Personality Types

Personality is "the enduring configuration of characteristics and behavior that comprises an individual's unique adjustment to life, including major traits, interests, drives, values, self-concept, abilities, and emotional patterns" (APA, 2023a, para. 1). The concept of personality implies that there are relatively stable predispositions in each person that is displayed through their behavior (Lloyd, 2022, p. 819). Various theories explain the structure and development of personality, but all agree that it is dynamic and helps determine behavior (APA, 2023a, para. 1). These theories can be divided into two rival paradigms: Trait and Type (Lloyd, 2022). Each of these has several instruments for identifying and measuring personality. However, the two foremost models are the Five-factor Trait-based model and the Myers-Briggs Type Indicator (MBTI^{TM}) approach (p. 817). Although there is much congruence between the personality characteristics identified by each method, they differ in how they define personality. The Five-Factor model of personality, the Trait model, hypothesizes five independent components of personality, each labeled a Trait. Individuals are assessed for the strength of each Trait. These assessments are combined to provide a summary of the person's personality. The Myers-Briggs approach, the Type model, theorizes equivalent pairs of personality components. Each person is considered to have a preference for one or

other component of each pair, and a person's personality is expressed as a combination of these pairs.

Generally, both models are, to a large extent, identifying essentially the same human characteristics; both use questionnaires to evaluate an individual's personality characteristics; and their commonalities indicate that they are on the right track in seeking to identify significant components of human personality (Lloyd, 2022, p. 820). They indicate that personality traits are behavioral indicators that can be observed and identified. Accordingly, a personality trait is "a relatively stable, consistent, and enduring internal characteristic that is inferred from a pattern of behaviors, attitudes, feelings, and habits in the individual. The study of personality traits can be useful in summarizing, predicting, and explaining an individual's conduct" (APA, 2023b, para. 1).

Personality types were initially conceptualized by Carl G. Jung (1921/1971). Isabel Briggs Myers and her mother, Katherine Briggs, adapted and expanded Jung's personality type dimensions to develop the Myers-Briggs Type Indicator (MBTI) to apply these psychological types to people's lives (Myers & McCaulley, 1985, p. 1). Consistent with the Type theory approach, the MBTI seeks to identify a person's preference/predisposition on four independent preference areas or scales: Energy Source and Direction, Perceiving Information, Making Decisions and Judgments, and Preferred Life Style. Within each scale are contrasting behavioral dispositions from which to choose. This results in a total of 16 different combinations, which are designated with four-letter codes such as ESFJ or ISFJ. Each of these 16 codes designates a specific personality type. The preferences for each of the four scales are as follows:

- Energy Source and Direction
    - Extraversion (E)—Source and direction of energy expression are mainly in the external world with a preference to direct energy to the outer world of action, people, and objects.
    - Introversion (I)—Source of energy is primarily in their inner world with a preference to focus energy on the inner world of ideas, concepts, and mental images.
- Perceiving Information
    - Sensing (S)—Preference for mainly believing factual, concrete, and tangible information received directly from the external world by the sense organs.
    - Intuition (N)—Preference for obtaining information from the internal or imaginative world in which the world is seen indirectly as a series of patterns, abstractions, trends, and future possibilities.
- Making Decisions and Judgments
    - Thinking (T)—Preference for making a decision mainly through logic, resulting in forming logical, analytical, sequential, quantitative, and objective assessments.
    - Feeling (F)—Preference for making decisions based more on a subjectively-held sense of values, on a view toward the probable human consequences of the outcome, and on emotions based on feeling what one should do. Decisions are based mainly on feelings and emotions.
- Preferred Life Style
    - Judging (J)—Preference for organizing all of one's life events and generally sticking to plans that have been made.
    - Perceiving (P)—Preference for improvising and exploring alternative options. (Conti, 2023, p. 2)

The MBTI is one of the most widely used instruments in the world for identifying personality differences (Randall, Isaacson, & Ciro, 2017, p. 2). The MBTI has been translated into more than 30 languages, and more than 2 million people in the United States take it yearly (Weiler, Keller, & Olex, 2012, p. 234). It has been (1) used worldwide in diverse places; (2) used with various age groups at different education levels from childhood through adult; (3) used to link personality types with a variety of topics such as (alphabetical) emotional intelligence, job training, reading comprehension, teacher development, team development, and visual impairment; (4) used to link personality types with a variety of topics such as (alphabetical) emotional intelligence, job training, reading comprehension, teacher development, team development, and visual impairment; and (5) used with diverse audiences such as (alphabetical) business, coaches, college faculty, new college students, nurses, and online students (Conti & McNeil, 2011, p. 4).

Recent research confirms that MBTI's popularity continues. Studies published within the past year not only repeat the previous pattern of diversity in the application of the MBTI but also expand its use to new and developing areas of social interaction. These emerging areas (alphabetically) include:

- artificial intelligence and social media (Hernandez, Muratet, Pierotti, & Carron, 2022; López-Santillán, González, Montes-y-Gómez, & López-Monroy, 2023; Radisavljević, Rzepka, & Araki, 2023; Sánchez-Fernández, Baca Ruiz, & Pegalajar Jiménez, 2023)

- brain research (Bhardwaj, Tomar, Sakalle, Bhardwaj, Asthana, & Vidyarthi, 2023; Venurkar, Srivastava, Shukla, Acharya, Saha, & Deshpande, 2022)
- gaming (Bocci, Ferrari, & Sarini, 2023; Hernandez, Muratet, Pierotti, & Carron, 2022).
- language processing (López-Santillán, González, Montes-y-Gómez, & López-Monroy, 2023; Ryan, Katarina, & Suhartono, 2023) and
- predictive modeling (Bhardwaj, Tomar, Sakalle, Bhardwaj, Asthana, & Vidyarthi, 2023; Cristescu, Ciupercă, & Cîrnu, 2022; Naseri & Momtazi, 2023; Pavan Kumar & Gavrilova, 2022; Sánchez-Fernández, Baca Ruiz, & Pegalajar Jiménez, 2023; Wang, Ye, Lv, Gong, Lu, & Wang, 2023).

Other topics include:

- economics and finance (Francis & Village, 2022; Ventre, Salvador, Martino, & Maturo, 2023; Woo & Sohn, 2022)
- leadership (Turner & Elson, 2022; Zárate-Torres & Correa, 2023; Zhang, Yang, Lusha, Leung, & Lau, 2022) and
- medical and pharmacy (Akhtar, Ashfaq, Khalid, & Baig, 2023; Flowers et al., 2023; Kodweis, Jasmin, Hall, & Havrda, 2023; Paul, 2023; Venurkar, Srivastava, Shukla, Acharya, Saha, & Deshpande, 2022).

The worldwide application of the MBTI includes research in Brazil (Frantz, Olivo, Sales, & Silva, 2022), Central India (Venurkar, Srivastava, Shukla, Acharya, Saha, & Deshpande, 2022), Germany (Ventre, Salvador, Martino, & Maturo, 2023), Indonesia (Pavan Kumar & Gavrilova, 2022), Pakistan (Akhtar, Ashfaq, Khalid, & Baig, 2023), Slovenia (Kubale, Lobnikar, & Dvojmoč, 2022), Spain (Gadalla, Nikoletseas, de A. Amazonas, & Rolim, 2023), and Switzerland (Zhang, Yang, Lusha, Leung, & Lau, 2022). Language is not a barrier for the MBTI with studies conducted in Arabic (Mokhaiber Dandash & Asadpour, 2023), Korean (Jeon, Jung, & Shin, 2023), and Spanish (López-Santillán, González, Montes-y-Gómez, & López-Monroy, 2023). The MBTI is also being used in some novel ways. For example, it is being used in validating a new scale (Francis & Village, 2022) and in developing a screening tool for high school students for surgeons of the future (Walsh, Sui, Higgins, Moon, Lee, & Antonoff, 2023). This breadth and scope of diversity demonstrates that personality traits have a solid theoretical and research base with robust contemporaneous application.

2. Method

2.1 Instruments

The purpose of this study was to describe the association between the learning strategy preference of the learners and the individual personality characteristics. Learning strategy preference was identified with **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS), and personality type was measured with the continuous scores on the Myers-Briggs Type Indicator (MBTI). ATLAS is a valid and reliable instrument for quickly identifying learning strategy preferences (Conti, 2009, p. 895). It consists of five items and identifies three learning preference groups: Navigators, Problem Solvers, and Engagers. Construct validity was established using cluster analysis and discriminant analysis with 3,070 SKILLS cases. "Content validity for ATLAS was established by using discriminant analysis to determine the exact pattern of learning strategies used by each group when it was compared to the other groups" (p. 892). Criterion-related validity was assessed by comparing it to SKILLS and by testimony by respondents of ATLAS's accuracy of the group placement (p. 893). Reliability was established by the test-retest method with a 2-week interval. "The coefficient of stability for these two testing was .88 ($p < .001$) with 110 (90.9%) responding the same on both testings" (p. 893).

Personality traits were measured with the MBTI. The MBTI contains four separate indices concerning what people attend to in a given situation and how they draw conclusions about their perceptions (Myers & McCaulley, 1985, p. 2). The form used in this study consisted of 94 "forced-choice items representing behavioral preferences and preferred self-descriptive adjectives related to the psychological type theory. Raw scores are tabulated to indicate preferences for each indicator's four scales. These results produce both continuous and categorical scores to indicate preferences for the 4 scales of the 16 potential personality types" (Conti, 2023, p. 3). Several studies have concluded that the MBTI has reasonable construct validity, is reliable over time, and distinguishes the individual personality types in the four dichotomous dimensions (Capraro & Capraro, 2002; Randall et al., 2017).

2.2 Sample

This study continues our line of inquiry concerning the development and use of **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS). As part of our overall line of inquiry, the sample for this study was previously reported (Conti & McNeil, 2011). It was reported that data were collected from 553 volunteers in Alberta,

Canada, and in the states of Montana, Nebraska, New Mexico, Oklahoma, and Texas. This group comprised Adult Basic Education teachers, public school teachers, professionals who teach adults in various agencies, adult students returning to a nontraditional college credit program, firefighters, students in continuing education classes, community college students, and college students (p. 4).

In addition, it was reported that respondents provided information concerning their age, gender, ethnicity, and educational level and then completed both the ATLAS and the 94-item version of the MBTI. The sample comprised 321 females (58.2%) and 231 males (41.8%). The average age of the group was 30.8, ranging from 18 to 90. The ethnic make-up of the group was as follows: White—83.9%, Native American—6%, African American—4.9%, Hispanic—4.2%, and Other—1%. The educational level of the respondents varied as follows: Less than a high school diploma—.7%, high school diploma—37%, vocational or educational certificate—11.5%, associates degree—24%, bachelor's degree—13.9%, and graduate degree—13.8%. The respondents were distributed across the three learning-strategy-preference groups as follows: Navigators—199 (36%), Problem Solvers—142 (25.7%), and Engagers—212 (38.3%) (Conti & McNeil, 2011, p. 4).

2.3 Research Questions

Specifically, this current study continues our line of inquiry with ATLAS regarding learners' learning strategy preferences and personality traits. Our initial study measured the relationship between learning strategy preferences and personality traits. The purpose of that causal-comparative study was to measure the relationship between learning strategy preferences and indicators of personality type (Conti & McNeil, 2011, p. 4). Learning strategy preference was identified with **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS), and personality type was measured with the continuous scores on the Myers-Briggs Type Indicator (MBTI). No significant relationship was found between the global personality types as defined by the MBTI and the learning-strategy-preference groups of ATLAS (p. 6). Despite this lack of a significant relationship with the labeled personality types, several indicators showed an individual relationship to the learning-strategy-preference groups. This finding indicates that "those in the various learning-strategy-preference groups have differing degrees of support for the various personality type indices which is not related to the comprehensive personality types theorized by the MBTI" (p. 6).

This present study is a descriptive study that continues this line of inquiry by describing the individual personality characteristics associated with each learning strategy preference. Instead of exploring the effects between the categories defined by each of the two instruments in the study, the purpose of this study was to describe the association between the learning strategy preference of the learners and the individual personality characteristics as defined by the 94 items in the MBTI. Consequently, the research questions directing the research were:

1) What personality traits interact with each learning-strategy-preference group?

2) What personality traits can be identified from each personality type item for association with each learning-strategy-preference group?

The two research questions differ in their focus. The first research question explored the interaction of personality traits with the learning-strategy-preference groups by simultaneously examining all 94 personality traits. However, the second research question measured the association of each personality trait with the learning-strategy-preference groups separately.

Discriminant analysis was used to answer the first research question. Participants were grouped according to their learning strategy preference on ATLAS, and the 94 items from the MBTI were used as the discriminating variables. Analysis of variance and its descriptive statistics were used to answer the second research question. Analysis of variance is an inferential statistical procedure for comparing groups in terms of the mean scores. An analysis of variance was calculated for each of the 94 MBTI items, with the participants grouped according to their learning strategy preference on ATLAS. For the statistical analyses, a significance level of .05 was selected. The Scheffé test, which is viewed as the most conservative and desirable comparison method after data analysis (Sheskin, 2007, pp. 895–896), was used for post hoc comparisons to identify precisely how the learning strategy preference differed after a significant *F* ratio was obtained.

3. Results: Interaction of Learning Strategy Preferences and Personality Traits

The first research question investigated the differences in personality traits for the 94 MBTI items for each ATLAS learning-strategy-preference group. Discriminant analysis was used for this analysis because it examines the interaction of the variables in the analysis (Conti, 1993, pp. 90–91). Discriminant analysis is a robust multivariate statistical procedure that simultaneously examines the differences between groups on several

variables (Klecka, 1980, p. 5). In this process, discriminant analysis identifies the relationship between membership in the group and the predictor variables in the analysis (Kachigan, 1991, p. 216). As a multivariate statistical procedure, it examines the interaction of the predictor variables in discriminating between the groups. Thus, in this study, discriminant analysis has the ability to simultaneously identify personality type traits from the MBTI associated with the learning-strategy-preference groups of ATLAS (Conti, 1993, p. 90).

For the first research question, discriminant analysis is used to help determine which personality type traits are the most potent discriminators among the learning-strategy-preference groups (Klecka, 1980, p. 9). To conduct the discriminant analysis, the 553 participants were grouped according to their ATLAS learning strategy preference, and the 94 items from the MBTI were used as the discriminating variables. These discriminating or predictor variables were used to determine their accuracy in correctly classifying the participants into their correct learning-strategy-preference group (Conti, 1993, pp. 91–92; Kachigan, 1991, pp. 218–219; Klecka, 1980, pp. 8–14).

The accuracy of the discriminant analysis in placing the 553 participants in their correct learning-strategy-preference group based on the personality traits identified in the analysis was shown in the classification table (Conti, 1993, p. 91). The analysis was 54.6% accurate in placing the participants in their correct learning-strategy-preference group (see Table 1). This accuracy should be judged in relationship to the likelihood of placement by chance in the learning-strategy-preference groups. Because there are three learning-strategy-preference groups, there is a 33.3% likelihood of being placed in any of the three groups randomly. Therefore, the usefulness of the discriminant analysis in providing information about how the MBTI personality traits discriminate between the ATLAS learning-strategy-preference groups should be judged by how much improvement there is over the 33.3% level. Accordingly, the personality traits identified in the analysis provide a 21.3% improvement over chance in correctly identifying the participant's learning strategy preference.

Table 1. Accuracy of discriminant analysis in classifying group membership

Group	Predicted Group Membership			Total
	Navigator	Problem Solver	Engager	
Number in Each Group				
Navigator	137	28	33	198
Problem Solver	34	86	22	142
Engager	58	75	78	211
Percent of Placement				
Navigator	69.2	14.1	16.7	100
Problem Solver	23.9	60.6	15.5	100
Engager	27.5	35.5	37.0	100

Although the discriminant function that predicted the placement of the participants in the learning-strategy-preference groups was a 21.3% improvement over chance, this placement was uneven. Table 1 shows that the predicted placement was most accurate for Navigators (69.2%) and slightly less accurate for Problem Solvers (60.6%). However, the predicted placement for the Engagers (37%) was nearly equal to placement by chance.

The structure matrix from the analysis was used to name the process that distinguished the three learning-strategy-preference groups from each other. The items with the highest correlation in the structure matrix are the strongest in describing the distinguishing process. Five personality traits had correlations at .4 or above. These were items 16 (.63), 8 (.56), 68 (.48), 52 (.47), and 4 (.40). Collectively, these items indicated a personality trait with a preference for planning and scheduling. The Navigators had a firm preference for planning and scheduling, with 72.4% supporting this personality trait. The other learning-strategy-preference groups were ambivalent, with only 44.4% of the Problem Solvers and 48.8% of the Engagers supporting a preference for planning and scheduling.

Thus, the discriminant analysis revealed two distinct groups related to personality traits. The Navigators were different from the Problem Solvers and the Engagers. Because discriminant analysis results are often easier to interpret when the division is into two groups (Conti, 1993, p. 92), a second discriminant analysis was conducted with the Problem Solvers and Engagers combined into a single group.

The analysis was 69.4% accurate in placing the participants in their correct learning-strategy-preference group and was a 19.4% improvement over the 50% chance placement rate for the two groups. The results of the

structure matrix were similar to the previous analysis with the same personality traits and with nearly similar correlations: Items 16 (.57), 8 (.55), 68 (.48), 52 (.47), and 4 (.40). While the Navigators had a strong preference with 72.4% supporting the personality trait of planning and scheduling, the combined group of Problem Solvers and Engagers remained ambivalent with 56% support.

Because the Problem Solvers and Engagers formed a group distinct from the Navigators, a separate discriminant analysis was conducted to investigate the personality traits that distinguished them from each other. The analysis was 64.9% accurate in predicting the placement of the Problem Solvers and Engagers in their correct groups. This was a 14.9% improvement over the 50% chance placement rate for the two groups. The structure matrix revealed only three personality traits with a correlation at or above .29: Items 42 (.68), 80 (.33), and 16 (.29). These items indicate a personality trait of impulsiveness with spontaneous and unplanned actions. Problem Solvers (62%) support spontaneity and unplanned actions more strongly than Engagers (45%).

Although the research question called for examining the personality traits individually, discriminant analyses were also calculated for each of the four personality type dimensions of the MBTI to investigate if any relationships existed between learning strategy preferences and the personality traits when bundled into the dimensions. Each analysis used the ATLAS learning-strategy-preference groups and only the items from the specific personality type dimension for the discriminating variables. Each of the analyses classified only a low number of participants correctly. All were slightly above the 33.3% chance placement level: Extraversion-Introversion (40.3%), Sensing-Intuition (48.6%), Thinking-Feeling (44.5%), and Judging-Perception (46.3%). No further analysis was pursued because of these failures to predict placement meaningfully above chance placement.

4. Association of Learning Strategy Preferences and Personality Traits

ATLAS identifies three learning-strategy-preference groups, and the MBTI contains 94 items. The second research question asked if these three learning-strategy-preference groups differed significantly from each other on each of the 94 items in the MBTI. One-way analysis of variance with each of the 94 MBTI items and the ATLAS groups was used to answer this question. Because the analyses involved three learning-strategy-preference groups, the Scheffé test pinpointed the exact differences after finding a significant F ratio. A separate one-way analysis of variance was calculated for each MBTI item, with the participants grouped by the three ATLAS learning-strategy-preference groups. The results showed significant differences among all groups for 53 items (see Table 2). Although a significant F ratio existed, the Scheffé test revealed that the differences were too minute for eight of the items to be meaningful: Items 10, 11, 14, 19, 22, 27, 43, and 74. However, the results from the other 45 Scheffé tests identified meaningful groupings that further described the personality characteristics of each of the three learning-strategy-preference groups.

Table 2. Item number and F value for analysis of variance between learning strategy preference and MBTI items

1. $F = 4.5$	2. $F = 6.4$	4. $F = 16.2$	6. $F = 8.9$	7. $F = 3.7$	8. $F = 19.7$	10. $F = 3.3$	11. $F = 3.5$	12. $F = 5.5$
14. $F = 3.0$	16. $F = 25.1$	18. $F = 4.5$	19. $F = 3.3$	20. $F = 12.4$	22. $F = 3.8$	26. $F = 6.6$	27. $F = 3.2$	28. $F = 13.5$
32. $F = 7.9$	33. $F = 3.9$	35. $F = 4.7$	36. $F = 6.5$	40. $F = 8.5$	42. $F = 13.5$	43. $F = 3.9$	46. $F = 8.0$	48. $F = 6.4$
50. $F = 3.8$	52. $F = 14.5$	54. $F = 5.3$	56. $F = 6.0$	58. $F = 9.4$	59. $F = 8.5$	60. $F = 8.1$	62. $F = 5.2$	63. $F = 5.1$
64. $F = 8.9$	66. $F = 3.6$	68. $F = 15.7$	70. $F = 6.9$	72. $F = 11.2$	74. $F = 3.3$	76. $F = 7.9$	78. $F = 7.0$	80. $F = 7.1$
82. $F = 4.8$	84. $F = 4.5$	85. $F = 6.8$	87. $F = 5.7$	90. $F = 13.1$	91. $F = 5.4$	93. $F = 5.5$	94. $F = 8.4$	

Note. All items had a $df = 2/550$ and $p < .05$.

4.1 Navigators

Navigators are the most distinct group of the three learning-strategy-preference groups. Navigators differed from the Problem Solvers and Engagers, who were similar in these traits, on 23 personality type items. These items were Items 2, 4, 8, 16, 20, 28, 32, 36, 40, 46, 52, 56, 58, 60, 62, 63, 64, 68, 70, 72, 78, 85, and 90. A Scheffé test was calculated for each of these significant F ratio outcomes. These results indicate that the Navigators differ from the Problem Solvers and Engagers in three distinctive areas of personality traits. Navigators have a solid preference for Concreteness, Order, and Planning.

Navigators like things concrete. They prefer the literal over the abstract and facts rather than ideas. They are sensible, systematic, firm-minded, and matter-of-fact. Navigators are very comfortable when they understand the underpinning of things. Courses dealing with facts are more appealing than courses involving theory. Their desire for concreteness reinforces their fondness for order.

Daily routines and schedules fortify Navigator's partiality for order. Navigators find daily routines restful and a comfortable way to get things done. Indeed, they find doing things at the last minute uneasy and hard on their nerves. Routine can be enhanced with schedules. Navigators find following a schedule extremely appealing. They have a strong preference for arranging things well in advance. This preference for scheduling includes formal events and informal activities, such as what they will do on a weekend. Making and having lists facilitates both scheduling and planning.

Planning is the dominant personality trait for Navigators that provides a foundation for Concreteness and Order. Planning applies to all life aspects, from simple daily planning to formal projects. Navigators depend on starting tasks early to finish with time to spare. When Navigators know in advance that they have something to do, they find it enjoyable to be able to organize and plan accordingly. They like to organize things carefully before they start and to take the time to list and order separately the things to be done. This allows them to break the tasks into parts and see the entire structure.

Navigators have three dominant personality traits that they do not share with Problem Solvers or Engagers. These can be summarized as planning, scheduling, and embracing a daily routine. Making lists facilitates these personality traits.

Navigators differ from Problem Solvers in several ways. Navigators have a strong desire for stability. They are most successful when following carefully worked-out plans. They enjoy certainty and prefer permanency over change. They easily adapt to the routine and build on the accepted way of doing things. They have a robust preference for dealing with the known compared to the unknown. Socially, they tend to be quiet and reserved.

Navigators are more concrete and cognitive than Engagers. They prefer thinking over emotion and get along best with realistic people with both feet on the ground. Navigators are decisive and consider it a high accolade to be considered a consistently reasonable person.

4.2 Problem Solvers

The Problem Solvers did not differ from the Engagers on any specific personality traits but differed from the Navigators on 12 items. For their most distinctive difference from both other groups (Item 42), 76.1% of the Problem Solvers favored analyzing a problem and attacking it rather than just supporting the existing ways of doing it. The Problem Solvers shared comparable personality traits with the Engagers on all other items. However, the Problem Solvers differed from the Navigators on Items 1, 12, 26, 33, 48, 50, 54, 66, 82, 87, 93, and 94. These items revealed a strong desire for flexibility and acceptance of change. They readily deal with the unexpected and are comfortable with abstract and theoretical ideas. They get more excited and enthusiastic about things than the average person. Problem Solvers enjoy being creative and inventing their own way of doing things. They embrace change and are not afraid to venture into the unknown. Socially, they tend to interact easily with others.

4.3 Engagers

The Engagers did not have any traits that differed from both Problem Solvers and Navigators, but they differed from the Navigators on nine items: Items 6, 7, 18, 35, 59, 76, 80, 84, and 91. These items exposed the strong emotional personality traits of the Engagers. They thrive on feelings and devotion. They enjoy casual and leisurely activities and being around imaginative people. Engagers prefer friends who constantly develop new ideas and appreciate impulsive activities. Engagers consider it very commendable to be called a person of genuine feeling.

5. Discussion

5.1 Implications for Practice

The findings from the two research questions indicate that various personality characteristics can be associated with each ATLAS group. The findings from the first research question described global differences among the groups. One discriminant analysis found that the Navigators had a firm preference for planning and scheduling, while the Problem Solvers and Engagers were ambivalent about planning and scheduling. A second discriminant analysis found that Problem Solvers supported spontaneity and unplanned actions more strongly than Engagers.

The findings from the second research question provided several explicit personality traits associated with each learning-strategy-preference group. A summary of these profiles is as follows:

- *Navigators*: Navigators have the three dominant personality traits of planning, scheduling, and embracing a daily routine. They like things concrete. Navigators are systematic and prefer the factual over the abstract. Their desire for concreteness reinforces their fondness for order. Daily routines and

schedules support their desire for order. Navigators find following a schedule extremely appealing. Planning is a dominant personality trait for Navigators and applies to all life aspects. They like to organize things carefully before they start. Making and having lists facilitates breaking tasks into parts and seeing their entire structure. Navigators strongly desire stability and are most successful when following carefully worked-out plans. They strongly prefer to deal with the known compared to the unknown. Navigators prefer thinking over emotion and prize being considered a consistently reasonable person.

- *Problem Solvers*: The dominant personality trait of Problem Solvers is their free spirit. Problem Solvers favor analyzing and attacking problems rather than merely accepting the conventional ways of doing them. They embrace change and are not afraid to venture into the unknown. Problem Solvers have a strong desire for flexibility and readily accept change. They eagerly deal with the unexpected and are comfortable with abstract and theoretical ideas. They get very excited and enthusiastic about things. Problem Solvers relish being creative and inventing their own way of doing things.

- *Engagers*: Engagers operate out of the affective domain. They thrive on feelings and devotion. They enjoy casual, leisurely, and natural activities. Engagers appreciate being around imaginative people who constantly develop new ideas. Engagers cherish being considered a person of genuine feeling.

These personality traits reinforce the learning-strategy-preference characteristics. They enhance the learning-strategy-preference characteristics by providing further details concerning the characteristics and insights related to the origin of the learning strategy characteristic. For example,

- The Navigator's foremost personality traits of planning, scheduling, and succeeding when following carefully worked-out plans support and complement their approach to learning. "Navigators have a demand for order and structure, are logic oriented, are objective, and are perfectionists. In learning situations, they like structure and are highly organized, want schedules and deadlines, desire clear learning objectives and expectations, and like summaries and recaps at the end and advanced organizers at the beginning of the learning activity" (Conti, 2009, p. 893).

- The free spirit, spontaneity, and openness to change personality traits of Problem Solvers support their learning characteristics: "Problem Solvers rely on critical thinking skills … most of their learning activities relate to generating alternatives. Because they are open minded to so many learning possibilities, they often have difficulty making decisions …. Problem Solvers procrastinate because it allows thinking to continue. Problems Solvers view trial-and-error as a process for generating more alternatives. Because they are curious, inventive, and intuitive, learning is an adventure for Problem Solvers and is one that they prefer to do in their own way without rigidity or didactic orders …. Problem Solvers are the most comfortable [learning strategy group] dealing with abstract ideas" (Conti, 2009, p. 894).

- The emotional personality traits of thriving on feelings and devotion are consistent with Engagers being "passionate learners who love to learn, learn with feeling, and learn best when they are actively engaged in a meaningful manner with the learning task …. Engagers initiate a learning activity from the affective domain …. For Engagers, everything in the learning process relates to building relationships with others. Feelings are the key for the Engagers, and this is reflected in the use of emotional words and terms with feeling such as love and fun …. Engagers are excellent networkers who love group work" (Conti, 2009, p. 894).

Thus, the personality traits and learning-strategy-preference characteristics supplement each other. Each provides clarity and further enhancement to the other. Such complement raises the causality dilemma, which develops first in the learner. Do the personality traits stimulate the development of a specific learning strategy preference? Or, does a person's preferred strategy for learning foster the development of certain personality traits? Fortunately, teachers do not have to puzzle over this paradox. Why not? The significant thing for teachers is that this research provides evidence that they are associated with and reinforce each other. Consequently, teachers have two indicators that can help personalize the teaching-learning environment for each student.

How do these two indicators work? Personality traits are behavioral indicators that the teacher can observe. These traits are relatively stable, consistent, and enduring internal characteristics that are implied from an individual's behavior and that can be useful in predicting and explaining a person's conduct (APA, 2023b, para. 1). Because this conduct is associated with learning strategy preferences, teachers can use these traits as informed clues concerning the student's learning pattern. Accordingly, teachers can focus their teaching strategies on addressing these indicators. The feedback gathered from implementing these informed teaching

strategies can be used to further refine each student's learning program. Such actions can allow teachers to act as true professionals. "True professionals know not only what they are to do, but are also aware of the principles and reasons for acting" (Elias & Merriam, 1980, p. 9).

Learning strategies are the skills that a student chooses to use for a specific learning task (Fellenz & Conti, 1989, pp. 7–8). Teachers can observe the physical exhibitions of the student's learning process but not the mental portions, such as metacognition. Consequently, the teacher's incomplete knowledge based solely on the external manifestations can hamper the implementation of an efficient learning plan for the student. However, this limited knowledge can be expanded when supplemented with supporting personality trait information and observations. The interaction of these two sources of information can be synergistic in aiding the teacher in designing and implementing effective teaching strategies for each student.

When dealing with the interaction of the learning strategy preferences and personality traits, teachers need to be careful not to conflate the two. It is very easy to merge the two during the dynamics of the teaching-learning transaction. Nevertheless, it is critically important to remember that each is a separate construct. Personality traits are persistent characteristics connected to behavior and attitudes that distinguish a person from others. However, learning strategies deal directly with learning and the learning process. For the teacher, this is comparable to the grammatical relationship between a verb and an adverb. Learning is the action and, therefore, the verb. Learning is the goal; it is the thing of interest. The personality traits are the indicators of this learning action and, therefore, are the adverbs. Like adverbs, personality traits modify, strengthen, and clarify the actions of the learning strategies. Together, they provide transparency to the learner's behavior and thought process. This combination can facilitate increased efficiency in addressing the individual needs of each learner.

5.2 Application by Teachers

The association between learning strategy preferences and personality traits may be used in several practical ways. This association produced detailed descriptions for ATLAS's three learning-strategy-preference groups. These descriptions can be applied in practice by teachers in several ways.

Teachers can use the learning-strategy-group descriptions as guides for organizing each learner's instructional activities and plans. The learning-strategy-group descriptions can provide examples to assist teachers in interpreting and understanding the pattern of the learner's behavior. The learning-strategy-group descriptions explain the relationship among numerous behaviors and reveal the learning approach associated with this behavioral pattern. This awareness of the association between personality characteristics and learning can empower teachers to analyze individual student behaviors at a higher level and, importantly, link them to the student's learning process. The insights from this focused analysis can provide critical information for designing targeted and relevant instruction for the student.

The learning-strategy-group descriptions can provide teachers with a cognitive framework for uncovering and monitoring student behaviors. Teachers regularly observe a steady flow of different student behaviors. The challenge for teachers is deciphering the relationship among these behaviors and discerning their patterns. The learning-strategy-group descriptions provide a mental model for assigning meaning related to the learning process for these behaviors and understanding their pattern. This framework can be applied over several stages. It can initially be used to clarify and understand the pattern of the behaviors. Once the teacher has formed an opinion concerning the observed pattern, the learning-strategy-group descriptions can serve as standards for monitoring the accuracy of this teacher assessment. Continuous monitoring can provide the teacher with additional information to confirm the preliminary appraisal or adjust the assessment. The strength of consistently practicing this process is that it provides a dynamic process for the student to receive personalized instruction.

The framework of the learning-strategy-group descriptions can also alert teachers to potential learning difficulties for some students. The learning-strategy-preference groups are the learners' favored approaches to learning in specific situations. Just because a learning strategy is favored for a precise learning task does not guarantee that it will be the most effective approach for that task. For example, learning for globalization is enhanced with a Problem Solver approach (Libertus, 2003). Nevertheless, Navigators may not be inclined to apply such a plan, and Engagers may not feel the value of this method. Consequently, two of the three learning-strategy-preference groups may be destined for an unpleasant or failed learning experience. Teachers alerted to situations like this can avoid them. Knowing that learning about globalization is enhanced by the Problem Solver skills of generating alternatives, teachers can teach these groups prerequisite skills such as brainstorming as an introduction to the instructional unit on globalization. The knowledge from applying and monitoring the framework can inform the teacher which students need this preliminary instruction. The educationally exciting aspect of this is that because of teacher actions such as this, all of the students will possess

the skills for successfully learning in this situation.

Educators can also use the information from the framework of the learning-strategy-group descriptions for organizing learning teams. Teamwork is essential in all aspects of education and industry, yet many educators fail to consider the strengths and challenges of the individuals involved when forming instructional teams (Shen, Prior, White, & Karamanoglu, 2007, p. 54). Clearly, it would be helpful to know the student's personality and approach to learning when forming teams (p. 55). Forming teams based on this information is better than using an alternative random selection method (p. 63). For example, a large church of approximately 1,500 in Tulsa, Oklahoma, used ATLAS as a guide when restructuring itself into a learning congregation in which adults learn how to learn together (Harris, 2003). The individual learning strategies of the church leaders and congregation members are essential in this learning context. "By incorporating learning strategy preferences, leaders can speculate on the outcome of a task based on the nature of the task when the individual with the right learning strategy preferences is selected for the task. Navigators will bring order, Problem Solvers will bring new notions, and Engagers will nurture the relationships needed to get the tasks accomplished" (p. 209). This approach is similar to Collins' (2001) analogy to "first get the right people on the bus, the wrong people off the bus, and the right people in the right seats—and then they figured out where to drive it" (p. 13). Efforts such as this can be even more impactful when augmented with information from the framework that relates the learning strategy preference with personality traits.

The teacher implementing Personalized Instruction can facilitate the application of the learning-strategy-group descriptions. Personalizing Instruction is the learner-centered teaching style that recognizes and utilizes the uniqueness of each student's strengths (Yoshida, Conti, Yamauchi, & Kawanishi, 2023). Personalizing Instruction is dynamic. It actively involves learners in identifying their own problems and builds on their prior experiences. It begins with recognizing the individuality of each student and the student's strengths. This process energizes the learner to take an active, dynamic role in their personalized learning. Personalizing Instruction subtlety lets students know they are respected as individuals (Larkin-Hein & Budny, 2000, p. 13). Importantly, Personalizing Instruction recognizes that learning is an internal process that is not always visible (Kittredge, 1998, pp. 21-22).

5.3 Improving Student Metacognition

Students can apply the descriptions of the learning-strategy-preference groups to facilitate self-assessment and metacognition. Metacognition, one of the conceptual areas of ATLAS, is the study of how learners monitor and direct their learning. Metacognition is knowing about and directing one's own thinking and learning process. Flavell (1976) introduced the concept into cognitive psychology and emphasized self-regulatory tactics to ensure success in the learning endeavor. "Metacognition is a dialogue between the learner and his/her thought processes that result in monitoring and regulation of learning. It is thus an ability to plan strategies for producing what information is needed, to be conscious of one's own steps and strategies during the act of problem-solving and to reflect on and evaluate the productivity of one's own thinking" (Shetty, 2014, pp. 2-3).

Therefore, metacognition is the awareness of one's own thinking patterns that helps a learner become self-directed and self-regulated (Shetty, 2014, p. 1). This awareness allows students to engage in their learning consciously, reflect on their learning process, gain insights from their direct learning experiences, enhance their analytical and critical thinking, assume greater responsibility for their learning, and prepare for lifelong learning. Here, the task of teachers, counselors, and other educators is to recognize and foster the metacognitive capabilities of all learners because metacognition is a critical ingredient to successful learning (p. 8). The descriptions from the learning-strategy-preference groups can be a valuable tool for objectively making students aware of their interpersonal and intrapersonal preferences. This knowledge can then assist students in developing, regulating, and monitoring their learning patterns related to their potential success and satisfaction with various settings and environments.

Consequently, the learning-strategy-preference descriptions can be a tool for immediate use for increasing a student's metacognition. These descriptions can assist in "getting feedback from learners on what is going on in their minds. How do they perceive the learning situation? What, in fact, are they learning, and how well? How aware are they of themselves as learners? Do they monitor their own thinking process? Are they able to tell us or show us what kinds of teaching have an impact on their learning?" (Cross, 1990, p. 10).

In this metacognition process, the students can become aware of their tactic and strategy knowledge, will be able to monitor their cognition, and will be able to organize this knowledge. Thus, they will be aware of their thinking procedures and be able to change and organize their thinking. This metacognition requires awareness and high-level thinking/critical thinking and is essentially thinking about thinking. This metacognitive approach to

reflection is healthy for the individual and productive for meaningful learning (Ozturk, 2021, p. 55). The learning-strategy-preference-group descriptions can facilitate this metacognitive process for students.

With the information and the metacognition gained from using descriptions for the learning-strategy-preference groups, teachers will be better able to help students with self-understanding and with making thoughtful individual choices. Coupled with the student's increased self-awareness gained through the metacognitive process of reflecting on their personality characteristics indicated by the learning-strategy-preference group, teachers can effectively use the knowledge of the association between learning strategy preferences and personality traits to help students make daily choices and to develop more comprehensive learning plans for students.

5.4 Enhancing Theory and Research

The development of the learning-strategy-group descriptions has the potential to extend theory and practical research related to learning strategies and personality styles. The findings link specific personality traits with learning strategy preferences. This is not a cause-and-effect relationship, but it does reveal precisely the association between the two. This knowledge can transform how teachers view and interpret student behavior, leading them to infer how that behavior may impact learning. Consequently, the two separate concepts of personality styles and learning strategies are no longer isolated. Future research and applications with these two concepts should consider them coupled. Such a reframing can add new dimensions to each concept and their interaction.

Teachers have two means to identify their students' learning strategy preferences and personality styles. One way is by observation, and the other is with instruments. The goal of this process is for teachers to be aware of the student's characteristics so they can constantly observe, monitor, and adjust them. The use of instruments can aid this overall process. Each of the concepts of learning strategy preference can be identified with easy-to-use instruments: ATLAS for learning strategy preference and the Personality Identity Estimator for personality type (Conti, 2023).

The challenge with these instruments is their reading level. Future research could address this language limitation in several ways. For example, researchers could modify these instruments with age-appropriate language for various educational levels. They could also observe students at various levels and develop checklists of observable behaviors compatible with the current framework of learning-strategy-group descriptions. Also, researchers could do qualitative research to observe and interview students and teachers at various educational levels to develop fuller descriptions for learners at each of these grade/age levels. However, the present and future instruments are just tools. The actual efficiency of applying the association of learning strategy preferences and personality traits is for the teacher to be aware of the overall characteristics of each ATLAS group in order to constantly observe, monitor for, and adjust to the indicators in the framework.

6. Conclusion

This study continued our line of inquiry with ATLAS regarding learners' learning strategy preferences and personality traits. The purpose of this study was to describe the association between the learning strategy preference of the learners as identified by ATLAS and the individual personality characteristics as defined by the 94 items in the MBTI. Two types of analyses were used to investigate this association. First, discriminant analysis explored the interaction of personality traits with the learning-strategy-preference groups by simultaneously examining all 94 personality traits. Second, analysis of variance measured the association of each personality trait with the learning-strategy-preference groups separately.

The findings from these analyses indicate that various personality characteristics can be associated with each ATLAS group. The findings from the discriminant analyses described global differences among the groups. The findings from the analyses of variance provided several explicit personality traits associated with each learning-strategy-preference group. These findings support the primary conclusion from this study that there is a strong association between personality traits and learning-strategy-preference characteristics. They complement each other. Each clarifies and enriches the other. As a result, teachers have two indicators that can help them personalize the teaching-learning environment for each student. This combination has practical implications for application by teachers and students and can expand the theory and research related to learning strategy preferences and personality traits.

7. Limitations

Learning is a complex activity and takes place in a wide variety of formal and informal situations. The sample for this study was comprised of adults in diverse settings. The study was delimited to one

learning-strategy-preference instrument and one personality type instrument. Therefore, the findings are limited to adult learners. However, learning is enough of a general human activity that the findings can be applied in various situations to assess their applicability. Future studies in diverse settings with assorted populations may enhance and expand these findings and have implications for their generalizability. Supplementary studies may also use other instruments to measure each of the constructs of learning strategy preference and personality traits. Such studies could also provide extra insights into the findings of this study.

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Authors' contributions

Dr. Conti was responsible for the conceptualization, methodology, formal analysis, writing-original draft preparation, and writing-reviewing and editing preparation for the creation of the published work. Dr. McNeil assisted in the conceptualization, data collection for the line of inquiry, methodology, and writing-review and editing preparation.

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No additional data are available.

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Appendix

Online and Printable Copies of Assessing The Learning Strategies of AdultS (ATLAS) and the Personality Identity Estimator (PIE)

Paper and online-completion versions of **A**ssessing **T**he **L**earning Strategies of **A**dult**S** (ATLAS) and the Personality Identity Estimator (PIE) are available at the following website addresses. **Permission is granted to use Assessing The Learning Strategies of AdultS (ATLAS) and the Personality Identity Estimator (PIE) in practice and research.** Therefore, you may print ATLAS and PIE or use the self-scoring online versions at no charge. Additional research tools for use with ATLAS and PIE are available at:

http://conti-creations.com or

http://www.conti-creations.com/conti.htm

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***A*ssessing *T*he *L*earning Strategies of *A*dult*S* (ATLAS)**

http://www.conti-creations.com/atlas.htm

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Personality Identity Estimator (PIE)

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