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Development of a user-friendly instrument for identifying the learning strategy preferences of adults☆

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ABSTRACT

Learning strategies offer a means of addressing individual differences. A programmatic line of inquiry at two universities in the United States has led to an extensive body of research related to learning strategies and to the development of two instruments. This study reports on the development of one of these instruments that can be used to quickly identify learning strategy preferences. Although this instrument, Assessing The Learning Strategies of AdultS (ATLAS), appears very simple and is easy to use, a series of multivariate statistical procedures were used to develop and validate it. These procedures are reported here in detail so that practitioners can be aware of its strong research base and use it with confidence. ATLAS can be used either for self-assessment or by an instructor in order to quickly identify how an individual learner approaches a learning task.

1. Learning strategies

One of the distinguishing characteristics of adult learning is that it is learner directed. Since the emergence of adult education as a professional field of study in the 1920s, andragogy and self-directed learning have been two of its foundational theories of adult learning (Merriam, 2001, p. 3). Andragogy was conceptualized by Knowles (1970) as "the art and science of helping adults learn" (p. 38) and was based on a set of assumptions that transformed the "learning-teaching transaction" (p. 49) from being teacher centred to being learner centred. With such an approach, the educator's role is to involve learners in as many aspects of their learning as possible and to create a climate supportive of their learning (Houle, 1996, p. 30). Likewise, the concept of self-directed learning as set forth by leaders such as Knowles (1975) and Tough (1971) has the goal of "the development of the learner's capacity to be self-directed" (Merriam, 2001, p. 9). Because of these twin "pillars" (p. 3, 11) which clearly place the learner at the centre of the learning–teaching transaction, instructional models for teaching adults "focus on what instructors can do in the formal classroom setting to foster self-direction and control of learning" (p. 9). Such a focus requires a consideration of the individual differences among learners.

Knowles originally proposed andragogy as a set of assumptions for how adults learn differently from children. However, he moved over time to a position that the difference was due more to the focus of the learning than to the age of the learner, and he came to view learning on a continuum ranging from teacher directed to student directed (Merriam, 2001, p. 6). While either approach may be appropriate depending on the situation, the overall goal of the teaching–learning transaction is to move the learner toward greater self-direction regardless of age. This broad goal necessities attention to individual differences.

"Individual differences have always been identifiable and have long interested educators" (Smith, 1993, p. 24). The large body of research around individual preferences and dispositions "leaves little doubt that there is a sound basis for taking seriously what has come to be called learning style" (p. 24). Learning style is "the individual's characteristic ways of processing information, feeling,

☆ This research is the result of a line of inquiry on learning strategies in the United States at Montana State University and Oklahoma State University and involves the dissertation research of many doctoral graduates. Abstracts for these dissertations can be retrieved from *Dissertation Abstracts;* copies of the dissertations may be secured through interlibrary loan with these universities; and copies may be purchased from UMI Dissertation Services (www.umi.com), which is located in Ann Arbor Michigan. ATLAS can be accessed online at http://www.conti-creations.com/atlas.htm.

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and behaving in learning situations" (p. 24). While for adults learning style "represents a viable component of the whole learning how to learn concept" (p. 24), much of the general research related to learning styles has centred around Kolb's (1984) conceptualization of learning styles in his Experiential Learning Model. Kolb described four learning styles based upon how people perceive information to gain new insights through either abstract thinking or concrete experiences and how people process this information to internalize it either through observing and reflecting on it or by working with the new information to test it. Learning styles identified in this fashion can "serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1982, p. 44).

While a knowledge of learning styles can help instructors better understand learners and "have important implications for program planning, teaching, and learning" (Smith, 1993, p. 24), they are not something that an instructor can teach to a learner because they are inherent within the learner. This has led educators to examine the concept of learning strategies. "Learning strategies are the techniques or skills that an individual elects to use in order to accomplish a learning task. They differ from learning style in that they are techniques rather than stable traits and they are selected for a specific task" (Fellenz & Conti, 1989, pp. 7–8). The interest in learning strategies grew out of the work of learning specialists such as McKeachie (1988) and Weinstein (1987) in their attempts to teach study skills to students in higher education, and it was fostered by developments in cognitive psychology that provided "a better theoretical understanding of the reasons these study strategies work" (p. 3). In the field of adult education, learning strategies have been linked with real-life learning rather than with study skills.

One of the assumptions of andragogy is that adults are problem centred and desire to immediately apply their learning in real-life situations (Knowles, 1970, p. 48). Sternberg (1990) points out that there are many differences between learning for everyday problems and learning for academic or test-taking situations. These are as follows:

- First, adults must recognize problems in the real-world rather than have problems identified for them by someone such as a teacher.
- Second, problems have to be not only recognized but also defined because the way they are defined will determine how they are solved.
- Third, while problems in academic situations are usually well-structured, real-world problems seldom are.
- Fourth, real-world problems are highly contextualized while school problems are decontextualized.
- Fifth, school problems have one right answer while very few real-life problems have a single right answer.
- Sixth, relevant information is given for school problems while in real-life it is often difficult to discover where to get information or even to know what information is relevant.
- Seventh, solving real problems often requires the examination of arguments from the opposing side while most school problems teach people to confirm what they already believe.
- Eighth, while one usually gets clear feedback in school on problems faced, there is seldom clear feedback on real-life problems – until it is too late.
- Ninth, while academic environments encourage individual solutions to problems, adult problem solving is usually arrived at through group decision processes.

Thus, the assessment of adult learning strategies requires that learning episodes be characteristic of real-world problems rather than artificial academic situations.

Consequently, "the Center for Adult Learning Research at Montana State University undertook a long-range research and development project related to adult learning strategies" (Fellenz & Conti, 1989, p. 8). An instrument was developed to measure adult learning strategies in real-life learning situations. This instrument was named the Self-Knowledge Inventory of Lifelong Learning Strategies (SKILLS). Although SKILLS was somewhat time consuming to take and difficult to score, it was used in several studies, and the results of these studies provided insights into how people use learning strategies. The instrument that was developed for this study, Assessing The Learning Strategies of AdultS (ATLAS), was based on this research with SKILLS. Therefore, an understanding of SKILLS is necessary in order to understand the background of ATLAS.

SKILLS consists of a series of 12 scenarios from general categories of real-world situations which are vocational, domestic, interpersonal, religious, medical, recreational, cultural, or political in nature (Shirk, 1990, p. 44). The items in SKILLS necessitate various types and levels of learning, and they assess how likely an individual is to use specific strategies for dealing with the learning problem. Each scenario contains 15 items. There are three items for each of the five constructs of metacognition, memory, metamotivation, resource management, and critical thinking. The scenarios are divided into two sets and can be completed in less than 20 min. Respondents complete four of the six scenarios in a set.

Metacognition is knowing about and directing one's own thinking and learning process. The concept was introduced into cognitive psychology in the 1970s (Flavell, 1976) and emphasizes self-regulatory tactics used to ensure success in the learning endeavour (Brown, 1982). The three Metacognition strategies in SKILLS are Planning, Monitoring, and Adjusting. Planning strategies include eliciting purpose from self and the situation, organizing, and identifying the steps essential to the learning process (Yussen, 1985). Monitoring keeps learners on the track as they learn. It reminds them of purpose, of resources, of previous experience, and of their strengths and weaknesses. Adjusting strategies help learners evaluate and regulate their learning activities. They include revision of learning plans and change of learning strategies in light of new knowledge or greater insight into the learning task or one's own learning abilities.

Metamotivation is an awareness and control over factors that energize and direct one's learning. The three Metamotivation strategies in SKILLS are Attention, Reward/Enjoyment, and Confidence. These are related to a model offered by Keller (1987). Attention is the focussing of learning abilities on the material to be learned. Reward/Enjoyment is anticipating or recognizing the personal value of learning specific material and having fun or satisfaction with the learning activity. Confidence is believing that one can complete the learning task successfully and that the task is personally worth doing.

Memory involves the mental processes used to store, retain, and retrieve knowledge (Paul & Fellenz, 1993). The three Memory strategies in SKILLS are Organization, Use of External Aids, and Memory Application. Organization is structuring or processing information so that material will be better stored, retained, and retrieved. The Use of External Aids involves using external aids to reinforce memory. Memory Application is using remembrances, mental images, or other memories to facilitate planning and carrying out learning.

Critical thinking is a reflective thinking process utilizing higher order thinking skills in order to improve learning. *In Developing Critical Thinkers*, Brookfield (1987) applied critical thinking to real-life situations and pointed out that it is composed of (a) identifying and challenging assumptions, (b) challenging the importance of

concepts, (c) imagining and exploring alternatives, and (d) reflective skepticism. The three Critical Thinking strategies in SKILLS are a slight modification of Brookfield's components: Testing Assumptions, Generating Alternatives, and Conditional Acceptance. Testing Assumptions is recognizing and evaluating the specifics and the generalizability within a learning situation. Generating Alternatives entails imagining and exploring options that are grounded within a given situation. Conditional Acceptance is accepting a learning outcome until a better one is discovered.

Resource management is the process of the identification, evaluation, and use of resources relevant to the learning task (Fellenz, 1993). The three Resource Management strategies in SKILLS are Identification of Resources, Critical Use of Resources, and Use of Human Resources. Identification of Resources involves knowing how to locate and use the best source of information. Critical Use of Resources is using appropriate rather than available resources while recognizing their limitations. Use of Human Resources involves integrating others into the social and political processes of learning.

2. Development of user-friendly instrument

After its development in 1991, numerous studies with diverse populations were conducted using SKILLS. Collectively, these studies found that gender, age, and race are not useful in discriminating among different groups in their learning strategy usage. However, the same studies consistently found that distinct groups of learners exist when they are identified by the pattern of the learning strategies which the learners use, and this suggested the need for further study. Together these two types of findings indicate that patterns of learning strategy use cut across variables such as gender and age which are typically used to group people in educational studies. Instead, the distinct groups which are inherent among people are independent of demographic labelling. Anyone can be in any group. 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 which people have a propensity to use when *initiating* a learning activity.

Therefore, a project was undertaken to develop an instrument for identifying the pattern of learning strategy usage of learners and to establish the validity for this instrument. The goal was to produce an instrument which was easy to administer, which could be completed rapidly, and which could be used immediately by both facilitators and learners. The instrument which was created was named Assessing The Learning Strategies of AdultS (ATLAS), and the remainder of this paper describes the numerous steps that were undertaken to establish its validity and reliability.

ATLAS consists of five items that are organized in a flow-chart design (see Fig. 1). Each item begins with a sentence stem that leads to two options. The first item addresses the task of undertaking a new personal learning activity. Each option leads the respondent either to instructions to proceed to another item or to information about the respondent's correct group placement. Once the group placement is identified, the respondent is directed to a page with the descriptions of the various learning strategy preference groups. By responding to two or three items, a respondent's learning strategy preference can be identified. Depending upon a person's reading level, ATLAS can be completed in approximately 1–3 min. Although ATLAS appears to be a very simple instrument, its contents are based on powerful multivariate statistical procedures.

The items for ATLAS can be organized in a variety of formats for administering the instrument. The format for the original and most widely used form of ATLAS is a $8.5' \times 5.5'$ bound booklet with each item on a separate page and with each option for an item having a box which directs the respondent to the next appropriate action. The descriptions of the learning strategy preference groups are attached as the final page of the booklet. Each page of this self-contained booklet is printed on a different coloured card stock, and after selecting an option for an item, the participant is instructed to go to the appropriately coloured page. Comments from field use with this coloured booklet overwhelmingly indicate that the participants find this format very nonthreatening and appealing. For research and workshop purposes, it has also been used in various one-page formats and in computerized form (see http://www.conti-creations.com/atlas.htm). The items in ATLAS were subjected to tests for validity and reliability.

3. Construct validity

Validity is concerned with what a test actually measures (Wiersma & Jurs, 2005, p. 362). While there are several types of validity, a joint committee of three national associations concerned with learning and research wrote in 1966 that the three most important types recognized in educational research are construct, content, and criterion-related validity (Kerlinger, 1973, p. 457). While each of these types of validity focuses on different aspects of an instrument, it has come to be recognized that validity is a unitary concept (Gay & Airasian, 2000, p. 162; Wiersma & Jurs, 2005, p. 327), that "there are different types of evidence of validity" (Wiersma & Jurs, 2005, p. 327), and that "there are multiple ways to establish the various forms of test validity" (Gay & Airasian, 2000, p. 169).

Construct validity assesses the underlying theory of the test. It is the extent to which the test can be shown to measure hypothetical constructs which explain some aspect of human behaviour (Gay & Airasian, 2000, pp. 162–163; Wiersma & Jurs, 2005, pp. 328–329). It is the element that allows for the assigning of meaning to the test and for defining what the test is really measuring (Gay & Airasian, 2000, p. 167). The process of determining construct validity "usually involves gathering a number of pieces of evidence to demonstrate validity" (p. 168), and this evidence can be both logical and empirical analyses (Wiersma & Jurs, 2005, p. 329). The process of establishing construct validity for ATLAS used both logical and empirical analyses. First, the items that were used for constructing ATLAS were from SKILLS. Since the construct validity of these items had already been established (Conti & Fellenz, 1991), their validity did not have to be re-established and was inferred to ATLAS. Second, the results of the numerous research studies using SKILLS were synthesized and consolidated. Third, cluster analysis was used to identify the naturally-occurring groups inherent in the data.

Much of the learning strategy research using SKILLS was coordinated at the Center for Adult Learning Research at Montana State University. Fifteen doctoral dissertations were completed using the instrument in Montana, and another (Uhland, 1995) used the conceptual basis from SKILLS for data gathering. SKILLS was also used in a nationwide study using American Express financial planners (Conti, Kolody, & Schneider, 1997). These studies involved diverse populations in various states and Canada in the areas of two-year college students (Hays, 1995; Kolody, 1997; Kolody & Conti, 1996; Strakal, 1995), the business community (Courtnage, 1998; Gehring, 1997), tribal communities (Bighorn, 1997; Hill, 1992), nursing (Lockwood, 1997), the military (Korinek, 1997; Yabui, 1993), public school administration (McKenna, 1991), students concurrently enrolled in high school and college (Ungricht, 1997), college students (Gallagher, 1998), older adults (Quarles, 1998), and volunteer leadership (Moretti, 1994).

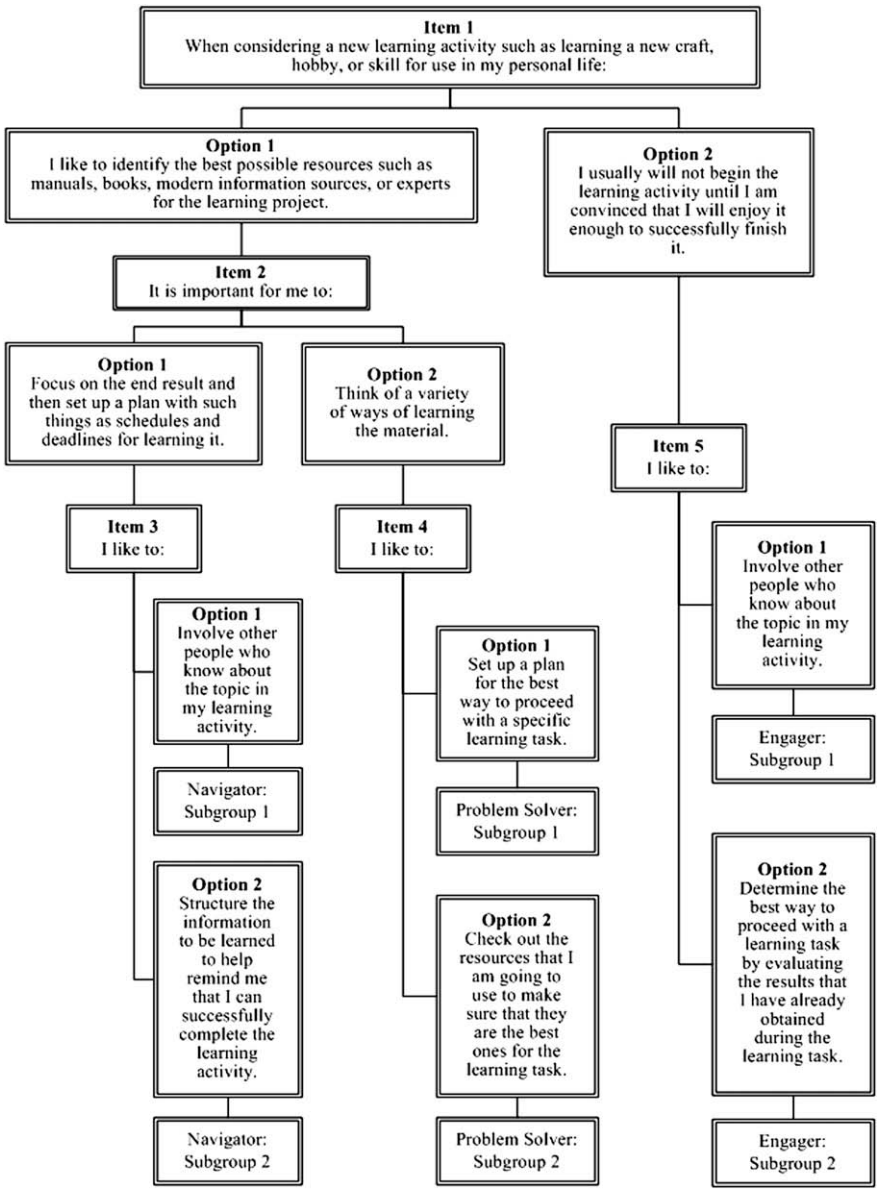

Fig. 1. Flow-chart of items in ATLAS.

Collectively, these studies produced a data set of 3070 cases in which the data were in similar form.

Studies coordinated through the Center for Adult Learning Research utilized a similar research design which was recommended by the staff at the Centre. This design consisted of describing the learning strategy profile of the participants, conducting discriminant analysis to determine if the respondents differed in learning strategy usage in any way on selected demographic variables, and conducting cluster analysis to uncover inherent learning strategy groupings within the sample. Several of the studies involved interviews and focus groups with the various cluster groupings to elicit qualitative data to better describe the groups.

Cluster analysis is a multivariate statistical procedure that seeks to identify homogeneous groups or clusters (Aldenderfer & Blashfield, 1984, Chap. 1; Norusis, 1988, p. B-71). It seeks to partition a group into relatively homogeneous subsets based on similarities (Kachigan, 1991, p. 261). Because it is a multivariate technique, cluster analysis examines the person as a whole; that is, all variables are kept together for the individual and analysed in relationship to each other (Conti, 1996, p. 68). One common method of forming clusters in this statistical procedure is hierarchical grouping in which clusters are formed by grouping cases into bigger and bigger clusters until all cases are members of a single cluster (Norusis, 1988, p. B-73). In this process, the computer calculates the proximities between the individual cases, combines the two nearest clusters to form a new cluster, recomputes the proximities between existing clusters and the new cluster, and then repeats the combining and recomputing steps until all cases have been combined into one cluster (SPSS, 1988, p. 405). The goal of this process is to identify clusters that have small within-cluster variation while also having large between-cluster variation (Kachigan, 1991, p. 262); that is, it creates clusters with members who are very much like each other while at the same time who differ as much as possible from those in the other clusters.

While "it is important to recognize the fundamental simplicity of these methods" (Aldenderfer & Blashfield, 1984, p. 14), it is also

crucial to realize that the clusters are being formed by the interaction of the individual's responses on all of the variables. Variables do not operate in isolation. All of those that are significant in forming the groups are considered in concert with the others. Thus, unlike univariate procedures which look at one variable at a time in isolation from the individual, cluster analysis is concerned with how these variables interact within a person. Since learning is a human enterprise and since the concepts related to learning are very complex, cluster analysis allows the focus to shift from the items in the instrument to the people taking the instrument. In the studies related to learning strategies, the 60 responses (15 learning strategy items × 4 scenarios) to the items in SKILLS were used as the variables for the cluster analysis.

Several studies using SKILLS explored for naturally-occurring groups of learners using cluster analysis. Although many of the characteristics of the groups were similar, the various studies using very different populations found differing numbers of clusters among the samples: Five clusters – Gehring, Hays, Kolody, Strakal, and Ungrich; four clusters – Bighorn, Courtnage, Korinek, and Lockwood; and three clusters – the study by Conti, Kolody, and Schneider. Therefore, a cluster analysis of the aggregate data set of 3070 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 revealed three distinct clusters.

"The key to using cluster analysis is knowing when these groups are 'real' and not merely imposed on the data by the method" (Aldenderfer & Blashfield, 1984, p. 16). Although the use of multivariate analysis of variance or discriminant analysis as a means of performing significance tests on the clusters is inappropriate statistically because of the invariably high significance results (pp. 64–65), discriminant analysis is a useful tool for exploring if a clear process exists which separates the groups (Conti, 1996, p. 71). Discriminant analysis is a statistical technique which allows the investigation of the differences between two or more groups in relationship to several variables simultaneously (Klecka, 1980, p. 7). As with any multivariate technique, the emphasis is upon analysing the variables together rather than singly. With this process, the researcher seeks to discriminate "between the groups on the basis of some set of characteristics, how well do they discriminate, and which characteristics are the most powerful discriminators" (p. 9). To do this, the researcher divides those in the data set into distinct groups and uses a set of discriminating variables to study the differences between the groups. The discriminant analysis produces a discriminant function; this is a formula which contains the variables and their coefficients and which can be used to place people in the groups (pp. 22–25). It also produces a number that expresses the percentage of people who are correctly placed in their proper group by the discriminant function (pp. 49–51); for example, a classification number of 90% indicates that the formula correctly placed 9 out of 10 people in the analysis in their correct group. Thus, while cluster analysis starts with an undifferentiated group and attempts to partition it into meaningful subgroups, discriminant analysis begins with "*a priori* well-defined groups in an attempt to identify the variables which distinguish the groups" (Kachigan, 1991, p. 262).

In order to explore the data, three separate discriminant analyses were conducted on the data set of 3070. They were for the 5-cluster, 4-cluster, and 3-cluster solutions produced by using the Quick Cluster program of SPSS. For each analysis, the groups were those produced by the cluster analysis, and the discriminating variables were the 60 items from SKILLS. Although there were many similarities in the output for the three analyses, the discriminant functions produced by each differed greatly in their ability to correctly place learners in their correct group. The correct placement percentage for each solution was as follows: five clusters – 62.5%, four clusters – 73.9%, and three clusters – 96.1%. Because ATLAS is concerned with correct placement in the groups formed by SKILLS, because it is very accurate, and because it is much more accurate than the other two solutions, the 3-cluster solution was selected to serve as the conceptual basis for ATLAS.

Thus, the construct validity for ATLAS was established by using the items from the established SKILLS, by the logical analysis of reviewing the literature of studies actually using SKILLS in field-based research, and by consolidating the similar data from many of these studies. This was then followed by statistical analyses using cluster analysis and discriminant analysis. This resulted in the identification of three groups with similar patterns of learning strategy usage. Because of their similarity to groups in the various studies which were reviewed, these groups were named Navigators, Problem Solvers, and Engagers. The distribution of the respondents among the three groups was relatively equal: Navigators – 1121 (36.5%), Problem Solvers – 973 (31.7%), and Engagers–976 (31.8%).

4. Content validity

Content validity refers to the sampling adequacy of the content of the instrument (Wiersma & Jurs, 2005, p. 328). To establish content validity, it is necessary to "clearly identify and examine for completeness the bounds or the content area to be tested before constructing or selecting a test or measuring instrument" (Gay & Airasian, 2000, p. 163). For ATLAS, content validity is concerned with the degree to which the items are representative of learning strategy characteristics of the three groups identified in the SKILLS' research. Therefore, a series of discriminant analyses were conducted to simultaneously examine all 60 items in SKILLS to determine the differences between each group. Discriminant analysis was used because this statistical procedure produces a structure matrix that shows the correlation between the individual discriminating variables and the overall discriminant function (Klecka, 1980, p. 31). The structure matrix contains the coefficients which show the similarity between each individual variable and the total discriminate function, which is the equation that expresses the statistical relationship of the significant variables in the analysis and which is used for placing people in groups. The variables with the highest coefficients have the strongest relationship to the discriminant function. These coefficients are used to name the discriminant function because they show how closely the variable and the overall discriminant function are related. Interpreting the structure matrix results in naming the process that distinguishes the groups from each other (p. 31). "By using the various clusters as the groups and by using the variables from the cluster analysis as the set of discriminating variables, an analysis can be generated which produces a structure matrix which describes the *process* that separates the various clusters into distinct groups" (Conti, 1996, p. 71). Thus, several separate discriminant analyses were conducted, and the findings from the structure matrix for each of these discriminant analyses were used to determine the wording of the items in ATLAS.

The structure matrix of the discriminant analysis for the three groups of Navigators, Problem Solvers, and Engagers revealed that the major process that separated the groups related to how each groups sought to accomplish the learning task. The Navigators and Problem Solvers initiate a learning task by looking externally from themselves at the utilization of resources that will help them accomplish the learning. Engagers, on the other hand, involve themselves in the reflective process of determining internally that they will enjoy the learning task enough to finish it. The learning strategies associated with the Navigators and Problem Solvers are Identification of Resources and Critical Use of Resources. Those

used more extensively by the Engagers are Confidence and Reward/Enjoyment. This process was 96.1% accurate in discriminating between the Navigators and Problem Solvers as one group and the Engagers as another group. Therefore, the first item on ATLAS requires the respondent to choose between these concepts related to how they initiate a learning task.

Since the Navigators and Problem Solvers are grouped together on the first item, a second item is used to separate them. Because the responses are structured in a flow-chart format, the Engagers neither see nor respond to this item. The structure matrix analysis of the discriminant analysis using only the 2094 in these two groups revealed that the process that separated the Navigators from the Problem Solvers involved the way they focussed on the learning task. Navigators are much more concerned than Problem Solvers with identifying exactly what needs to be learned and on designing a plan for the learning. In contrast, Problem Solvers are more concerned with identifying a variety of solutions for the learning task. The learning strategies associated with the Navigators are Attention and Planning while the Problem Solvers utilize Generating Alternatives. This process was 98.3% accurate in discriminating between the Navigators and Problem Solvers.

Since the analysis of the data set of 3070 for ATLAS produced only three clusters while most of the previous research had found either four or five clusters, additional cluster and discriminant analyses were performed to investigate the structure of each of the three preference groups. This process revealed that each of the three learning strategy preference groups contains two subgroups. The discriminant analysis with the 1121 Navigators was 80.2% accurate in identifying the members of the two subgroups; one group (45.1%) has a strong preference for the Use of Human Resources while the other group (54.9%) is more concerned with the Organization of material into meaningful patterns. The discriminant analysis with the 973 in the Problem Solver group was 79.3% accurate in identifying the members of the two subgroups; one group (52.3%) has a stronger preference for Planning while the other group (47.7%) relies more on Critical Use of Resources. The discriminant analysis with the 976 in the Engager group was 82.2% accurate in identifying the members of the two subgroups; one group (53.2%) has a stronger preference for the Use of Human Resources while the other group (46.8%) relies more on Planning and Conditional Acceptance. Thus, two subgroups with each having about half of the overall group were found within each of the three learning strategy groups. Therefore, items, which were based on the structure matrix from the discriminant analysis, were written for each group to provide participants with additional insights about their tendencies within their overall learning strategy group preference. The accuracy rates for placing participants in their correct group are lower for the subgroups than are the accuracy rates for the overall group placement indicating that the subgroup information is not as stable as that of the overall group placement.

Thus, 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. Since the three groups were originally identified by a multivariate process, the items were arranged so that respondents follow a track of questions. Qualitative data collected during field-testing to determine the best wording for items revealed that respondents might find options for distinguishing between other groups appealing to them if they saw them. Therefore, the items are arranged in a flow-chart format so that once a choice is made the respondents do not have access to the items that do not apply to them because they have already identified themselves as belonging in another track. While ATLAS has only a few items, each item is based on the powerful multivariate procedure of discriminant analysis. Instead of using an approach which involves summing multiple attempts to identify a characteristic, ATLAS used discriminant analysis to precisely describe the content for each item.

5. Criterion-related validity

Criterion-related validity compares an instrument's scores with an external relevant criterion variable (Huck, 2004, p. 90). While establishing criterion-related validity for most instruments is usually the direct procedure of comparing the new instrument to an established concurrent measure such as instrument or behaviour (Wiersma & Jurs, 2005, p. 328), it is a more difficult procedure with an instrument created in the model used for ATLAS. This is because this approach uses a multivariate process to create a new instrument from items that are scored in a univariate format on the original instrument. Multivariate statistical analysis is concerned with the simultaneous investigation of several variables (Kachigan, 1991, p. 1). Thus, the process of establishing criterion-related validity in essence involves trying to compare a whole that results from a synergistic analysis to its parts. This is difficult because the total is greater than sum of its parts. Therefore, the following three separate things were done to assess the criterion-related validity of ATLAS.

- First, the group placement on ATLAS was compared to the scores on SKILLS for the various SKILLS items from the structure matrices that were used to construct the items in ATLAS; this provided a comparison between the responses of the ATLAS preference groups and the specific items from SKILLS that were used to identify them.
- Second, respondents completed four SKILLS scenarios that were modified to have two items with responses that reflected the learning strategies from the discriminant analysis results that were used for forming the preference groups for ATLAS.
- Third, the participants were asked to self-report on the accuracy of the ATLAS placement for them after they had read a description of the ATLAS groups; this provided a check between the response on ATLAS and the real-world of the respondent.

Both the SKILLS and the ATLAS were completed by 40 professionals who work with adult learners in various settings. Participants responded to both instruments. Responses on the SKILLS were scored and compared to the preference group placement on ATLAS. For 80% of the participants, their scores on SKILLS in the six learning strategy areas that were most influential in the discriminant analyses for forming the ATLAS groups were consistent with their ATLAS preference group selection. These six learning strategy areas were Attention, Confidence, Critical Use of Resources, Generating Alternatives, Identification of Resources, Planning, and Reward/Enjoyment.

A second criterion-related validity check was conducted to compare ATLAS to SKILLS. Four of the twelve scenarios, which make up SKILLS, were modified for this analysis. These were the ones dealing with writing a letter to the editor, learning about local history, putting a bike together, and recruiting leaders. For each of these scenarios, the ranking of the 15 learning strategies was replaced by two questions. Each question had a stem with a choice of one of two options. These options were based on the discriminant analysis results that had been used to form the items in ATLAS. The first question corresponded with the first item in ATLAS. It required respondents to select between a response that either was an Identification of Resources or Critical Use of Resources learning strategy or was a Confidence or Reward/Enjoyment learning strategy. The Navigators and Problem Solvers were expected to

select the Resource Management option while the Engagers were expected to select the Metamotivation option. The second question for each scenario had an option for the learning strategies either of Generating Alternatives or of Planning or Attention. The Navigators were expected to select the Planning or Attention learning strategy, and the Problem Solvers were expected to select Generating Alternatives; this item did not apply to Engagers. Responses were gathered from a variety of professionals and from students in a university business program and students in a community college business program. The 154 participants' selections for the various items were 75.7% as expected for their learning strategy preference group.

ATLAS has been used in numerous studies since its development. One of the major uses of ATLAS is to stimulate the users' metacognitive process of thinking about how they go about learning. In order to foster this process and to check on the validity of ATLAS, users have been asked to provide feedback on how accurate they feel the description of their ATLAS preference group is in describing them. Consistently, approximately 90% of the respondents feel that they have been placed in the proper group (see Table 1). Overall, 92.1% of the 2938 participants in these studies agreed that the group in which ATLAS placed them was an accurate description of them.

Thus, because of the multivariate procedures that were used for creating ATLAS, criterion-related validity was assessed in three different ways. Because of the consistency between scores on SKILLS for the learning strategies used to create ATLAS and ATLAS group placement, because of the expected responses based on ATLAS groupings on approximately three-fourths of the items in modified SKILLS scenarios, and because of the extremely high testimony by respondents of the accuracy of the group placement by ATLAS, it was judged that ATLAS has criterion-related validity.

6. Reliability

"Reliability is the degree to which a test consistently measures whatever it is measuring" (Gay & Airasian, 2000, p. 169). The reliability of ATLAS was established by the test–retest method which addresses "the degree to which scores on the same test are consistent over time" (p. 171). ATLAS was administered to a group of 121 adult education practitioners with a 2-week interval. The group, which was 71.4% female and 28.6% male, had an average age of 43.1 years. Its racial make up was as follows: White – 73.1%, African American – 12.6%, Native American – 4.2%, Hispanic – 2.5%, and Other – 7.6%. The coefficient of stability for these two testing was .88 ($p < .001$) with 110 (90.9%) responding the same on both testings.

Table 1
Self-reported accuracy rate for ATLAS with various populations.

Population	Accuracy	Study
617 adult and high school students in vocational programs	94%	Ausburn and Brown (2005)
412 students at teacher training school in The Gambia	92%	Pinkins (2001)
404 students at a special 3-year technical school in Oklahoma	88.9%	Massey (2001)
380 users of eBay	90.6%	Ghostbear (2001)
324 senior users of SeniorNet	91.2%	Girdner (2003)
272 telephone sales representatives at Dollar car rental	91.4%	Goodwin (2001)
252 certified athletic trainers across the United States	94.8%	Hughes (2002)
210 adults over 65	95.2%	Chesbro, Conti, and Williams (2005)
67 graduate students in an nontraditional business administration program at a private college in Oklahoma	88.9%	Turman, 2001

7. Description of ATLAS groups

Since its development, ATLAS has been used extensively in a programmatic line of inquiry by doctoral students in the Adult Education program at Oklahoma State University. This dissertation research falls into four categories: (a) research that focussed on the instrument to better describe the groups in ATLAS (e.g., Ghostbear, 2001; James, 2000; Willyard, 2000), (b) research that tested the instrument with groups (e.g., Hulderman, 2003; Nichols-Sharpe, 2004; Shaw, 2004; Taylor, 2004), (c) research that used ATLAS as an auxiliary tool (e.g., Libertus, 2003; Lively, 2001; Massey, 2003; Varmecky, 2003; Varmecky, 2008), and (d) research with an experimental format (D.R. Munday, 2002; W.S. Munday, 2002). Collectively, these 36 dissertations have provided an enhanced description of the three ATLAS groups that were uncovered with multivariate procedures, and they have discovered the relationship of learning strategies with some key demographic variables.

One's learning strategy preference as identified by ATLAS has not been found to be associated with any demographic variables such as gender or race (Ausburn, 2004; Conti et al., 1997, p. 71; Ghostbear, 2001; Hinds, 2001; Lively, 2001; Willyard, 2000), and the distribution and characteristics of the groups are the same for international students as they are for students from North America (Armstrong, 2001; Pinkins, 2001; Shumaker, 2001). These learning strategy preferences are developed by the time a learner reaches adolescence (Shaw, 2004). Moreover, a knowledge of one's learning strategy preference by the learner and the teacher can lead to improved academic gain in the classroom (D.R. Munday, 2002; W.S. Munday, 2002).

The numerous interviews from the studies have suggested a potentially helpful symbolic analogy for each group. The Navigators are microscopic as they narrow, focus, and zoom in on the learning task. Problem Solvers, on the other hand, are telescopic as they zoom out to include as large a field as possible in their learning. Engagers are stethoscopic with their feelings from the heart and concern for relationships.

The following sections describe each of the three learning strategy preference groups identified by ATLAS. First, the general characteristics of each group are provided. Second, these are linked to behaviours that relate to the teaching–learning transaction.

7.1. Navigators

Navigators are focussed learners who chart a course for learning and follow it. These learners initiate a learning activity by looking externally at the utilization of resources that will help them accomplish the learning task and by immediately beginning to narrow and focus these resources. They rely heavily on planning their learning, and their motto is "Plan the work; work the plan" (Ghostbear, 2001; Ghost Bear, 2008; Ghost Bear & Conti, 2002; Willyard, 2000). They are constantly striving for improvement, and consequently everything in the learning environment relates to achieving efficiency and effectiveness.

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. They use many organizational tools such as coloured markers, staples, and binders. They

expect and appreciate prompt feedback and will often clarify the details of a learning task several times. Navigators are results oriented and seek logical connections. For them, emotions are not a consideration in learning, and liking the teacher and subject are not important. Consequently, they tend not to like group work unless it is led by an expert (Ware, 2005) because they hate slackers and feel that they can often do the work more efficiently by themselves. Navigators put much internal pressure on themselves by seeking perfection, are hyper-critical of errors they make, and often need a period of time to deal effectively with criticisms of their work.

7.2. Problem Solvers

Problem Solvers rely on critical thinking skills. Like Navigators, Problem Solvers initiate a learning activity by looking externally at available resources; however, instead of narrowing the options available, they immediately begin to generate alternatives based on these resources. Problem Solvers are storytellers who elaborate extensively on stories about their experiences (Ghostbear, 2001) because these provide concrete examples for learning. Because they are constantly seeking alternatives, 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. Consequently, they do not do well on multiple-choice tests because these limit divergent thinking, and Problem Solvers procrastinate because it allows thinking to continue. Once they are interrupted in the learning process, they have difficulty in starting it again.

While Navigators see it as a failure, 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. Of the three learning strategy preference groups, the Problem Solvers are the most comfortable dealing with abstract ideas, and they often think in terms of symbols. Problem Solvers are very confident of their own abilities and will often ask questions in class just to help others understand better even if they do not want to know the answer. Problem Solvers are very descriptive and detailed in their answers and insist on using many examples to explain an idea. As a result, they are storytellers who enjoy the process of telling the story more than worrying about its completion; although they may seem sometimes to get lost in the details, they will eventually "boomerang" back to the main point of their story (Geerdes, 2003). The motto for Problems Solvers is "Ask them what time it is, and they will build you a clock" (Ghostbear, 2001, p. 376).

7.3. Engagers

Engagers are 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; "the key to learning is engagement – a relationship between the learner, the task or subject matter, the environment, and the teacher" (Kidd, 1973, p. 266). While the Navigators and Problems Solvers use the cognitive process of identifying resources to start a learning task, Engagers initiate a learning activity from the affective domain; that is, before they will begin a learning task, they involve themselves in the reflective process of determining internally that they will enjoy the learning task enough that it is worth doing. The motto for learning for Engagers is that "It is FUN!!" (Ghostbear, 2001, p. 378).

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. Learning has an aura of excitement for Engagers, and they fully immerse themselves in the learning once they engage in it. They seek and find joy in the learning process and delight in new accomplishments. However, they can get bored quickly. To avoid this, the instructor needs to have them actively engaged in the learning and must remember that Engagers are as interested in the process of learning and the relationships that are built during this process as they are in the academic outcomes of the learning. Unlike Problem Solvers, Engagers are not interested in developing new or abstract ways of doing things; instead, they will often take the path of least resistance to get to a final result or they will utilize shortcuts created by others because these things allow more time and energy for concentrating on the dynamics of the learning process. Engagers are excellent networkers who love group work. They tend to develop an emotional affinity with the teacher and have a hard time separating themselves from their work; a positive relationship with the instructor can be a catalysis for engagement for them (Shaw, 2004). Because the central feature of learning for Engagers is building relationships, they rely heavily on human resources.

8. Relevance to practice

Learning strategies offer a means for addressing individual differences in the learning process. When defining learning strategies as the conceptual areas of metacognition, metamotivation, memory, critical thinking, and resource management, research has uncovered three distinct groups of learning strategy preferences. Learners can use the knowledge of these groups to understand and improve their learning by becoming aware of how they initiate a learning task. Teachers can use this knowledge to design and implement effective instruction by either tailoring it to address individual differences or by teaching the learner new learning strategies to apply in a specific situation. The key to using learning strategy preferences is being able to identify them in a quick and nonthreatening way. ATLAS provides a tool for identifying one's pattern of learning strategy preferences. ATLAS has been constructed with powerful multivariate statistics and extensively tested by means of a programmatic line of inquiry. Consequently, the results from ATLAS can be used with confidence both for the metacognition of the learner and for instrumented learning.

Instrumented learning involves using instruments to provide information for participants so that it can be used for various types of self-improvement (Blake & Mouton, 1972). This information is provided in a context and in relationship to a particular model so that the participant can use it to focus learning. With ATLAS, the goal is to get a quick and accurate group placement of the learners' preferences for initiating a learning task so that targeted learning can begin.

A key element of instrumented learning is metacognition. "Metacognition is popularly conceived of as thinking about the process of thinking" (Fellenz & Conti, 1989, p. 9). "Simply put, learning instruments provide adult learners with metacognitive references for reflecting upon their experiences. Thus, the instrumented learning process is analogous to the learning process of reflective practice" (Hulderman, 2003, p. 86). In this reflective process, ATLAS provides a tool to help learners identify, clarify, and explain their actions in learning situations. Through the metacognitive process, it enables them to depersonalize this learning process. This in turn makes adjustments easier in learning situations.

These adjustments may vary in different countries, and they need to be culturally appropriate. The following is an example of how this might be applied in the United States. If in a team learning situation a Navigator, who wants to move the group toward closure,

becomes frustrated with a Problem Solver, who is generating alternatives, the Navigator's concerns can be expressed in the language of the description of the learning strategy groups. If both team members are aware of the characteristics and of their groupings, a simple statement such as "There you go being a Problem Solver again" can provide the vehicle for discussing the issue. In a similar fashion, if the Problem Solver truly feels that more exploration is need, a statement such as the following could keep the focus on the content rather than on personalities: "I realize that as a Navigator you desire more efficiency here, but as a Problem Solver, I think we need to generate more alternatives before deciding." However, if the Problem Solver is not committed to the need for many more new ideas, a statement such as the following could move the group forward: "Okay, I defer to the Navigator."

The concept of recognizing and addressing individual differences presents a challenge for instructors. If each individual is unique, how does an instructor begin to gather enough information to know how to begin to help an individual initiate a learning activity? The research with ATLAS suggests one approach to this problem. Although the concept of learning strategies is concerned with how learners approach a specific task, this research shows that learners tend to have a pattern for how they initiate a learning activity. These patterns are clear, easily identifiable, meaningfully different from each other, and impact the nature of the learning. A knowledge of these characteristics can provide the instructor with a model for approaching each learner. Since there are only three preference groups in this model, the differences are broad enough for easy recognition and for teacher action to address each learning strategy preference. When it is feasible, ATLAS can be used to formally identify each learner's preferred approach to learning. However, when it is not possible to administer the instrument, the knowledge of the characteristics of the three groups can be used to monitor the learners' words and actions to access their individual differences.

When addressing individual differences through the use of learning strategy preferences, it is important to realize that this is not restricted to a formal classroom and that it is not always necessary to reinforce the learner's preference. The teaching–learning process takes place in many settings. These include such diverse situations as a financial planner working with clients, nurses working with outpatients, human resources personnel conducting training sessions in an organization, and librarians helping patrons. Many times in these diverse settings, a learner's preferred learning strategy may be an effective approach for the learning situation. When it is, recognition of this preference can provide the instructor with insights in how to initially begin to work with the learner. However, when the learner's preference is not in the opinion of the teacher the most effective approach for a learning task, the learner's preferred approach may not be the best way to go about learning a certain task. For example, Libertus (2003) found that a disproportionally large number of those involved in issues related to globalization are Problem Solvers. The preferences of the Problem Solvers for generating alternatives, for having conditional acceptance, and for thinking in abstract terms are conducive to developing a global awareness. Since Navigators and Engagers do not have a natural tendency to learn in this manner, addressing individual differences would involve the instructor in teaching these two groups some learning techniques such as brain storming at the beginning of a unit on global awareness.

Although much of the research done to describe the ATLAS groups was conducted in the United States, initial work with ATLAS suggests that the three learning strategy preferences identified by it are not bound just to the United States. The database of 3070 that was used to uncover the three groups was made up of North Americans; 1143 respondents were adults attending 2-year colleges in Alberta, Canada (Kolody, 1997). Two studies with ATLAS involved non-American populations. Both the study conducted in The Gambia (Pinkins, 2001) and with international students at Oklahoma State University (Armstrong, 2001) found the distribution of the three preferences groups to be essentially the same as for the original database of 3070. These findings suggest that ATLAS may be identifying general characteristics of learning rather than focussing on culturally specific traits. While culture must always be considered in any teaching–learning transaction, the characteristics of the learning strategy preference groups of Navigators, Problem Solvers, and Engagers have the potential to serve as a general tool for instructors in a multitude of cultures to better understand and address the individual differences of their students.

Thus, this typology of three learning strategy preferences can be useful for identifying groups of learners in the instructional setting. It can help learners become aware of how they initiate a learning task and can help instructors plan learning activities to address individual differences. "Group differences are the cornerstone of much of the social research done today" (Keller, 2006, p. 23). Identifying these differences can be beneficial "when they are used to focus understanding, discussion, and reflective thought about the learner; however, they can be detrimental if they are used to avoid critical thinking about the learners" (Conti & Kolody, 2004, p. 187). ATLAS with the group descriptions that accompany it is a valid and reliable instrument for quickly identifying these groups. However, it is only a tool. Its value resides in the reflective way that individual learners and instructors use it.

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