INVESTIGATING LEARNING STYLES PREFRENCES OF MATHEMATICS EDUCATION STUDENTS AT FACULITY OF EDUCATION IN SANA'A UNIVESITY

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ABSTRACT

Students' characteristic strengths and preferences in the ways they take in and process mathematics information. A hundred and seventy-four mathematics education students randomly selected from the Faculty of Education, Sana'a University were surveyed by using the Index of Learning Styles Questionnaire. The findings reveal that, 67.2%were classified as active learners, 88.5%were sensing learners, 70.7% were visual and 81.0% were sequential.

An implication of these observations is that to improve the thinking and problem-solving skills of mathematics education students (high school preserves mathematics teachers). Faculty of Education should attempt to improve the quality of their teaching, which in turn requires understanding the learning needs of today's mathematics education students and designing instruction to meet those needs.

INTRODUCTION

Teaching Mathematics has been changed tremendously over the past two decades. Curricula, teaching methods, and teaching materials have been developed to meet the changing needs of the math population. On other hand, research on learning styles has provided teachers with a different view of learning and demonstrated how to apply it to classroom teaching. Moreover, an awareness of individual differences in learning has made mathematics educators and program designers more sensitive to their roles in teaching and learning and has permitted them to match teaching and learning styles so as to develop students' potentials in mathematics learning.

The idea that people learn differently is venerable and probably had its origin with the ancient Greeks (Wratcher, Morrison, Riley & Scheirton, 1997). For many years, educators have noticed that some students prefer certain methods of learning more than others, these dispositions referred to as "learning styles". The ways in which an individual characteristically acquires, retains, and retrieves information are collectively termed the individual's learning style.

Students have different learning styles-characteristic strengths and preferences in the ways they take in and process information. Some students tend to focus on facts, data, and algorithms; others are more comfortable with theories and mathematical models. Some respond strongly to visual forms of information, like pictures, diagrams, and schematics; others get more from verbal forms-written and spoken explanations. Some prefer to learn actively and interactively; others function more introspectively and individually. At the same time, teaching methods also vary. Some teachers lecture, others demonstrate or lead students to self-discovery; some of them focus on principles and others on applications, some emphasize memory and others understanding.

Mathematics students need to know mathematics; however, the problem is with the compatibility of student's characteristic approach to learning and the instructors' characteristic approach to teaching. In a class where such a mismatch occurs, the students tend to be bored and inattentive, do poorly on tests, get discouraged about the course, and may conclude that they are not good at the subjects of the course and give it up (Felder & Silverman 1988; Godleski, 1984; Oxford et al. 1991; Smith & Renzulli 1984).

Kumaravadivelu (1991) states that: "... the narrower the gap between teacher intention and learner interpretation, the greater is the chances of achieving desired learning outcomes". P. 98. In addition, there are many indications (e.g. Van Lier, 1996; Breen, 1998) that bridging the gap between teachers' and learners' perceptions plays an important role in enabling students to maximize their classroom experience and their learning respectively.

STATEMENT OF THE PROBLEM

Practical and theoretical considerations motivated the research. From the practical perspective, a common complaint among faculty mathematics instructors is that students are often quite verbal, asking such profound questions as; how long should the course be? Is all the content in the course going to be on the test? How can there possibly be more than one solution to that problem? And, why do we have to take this math class?

Faculty complaints about students are varied but I can say that "most of mathematics students can memorize and plug numbers into formulas but they don't know how to think!" And yet, we have in our mathematics education department one or more faculty members who manage to get many of those same students to perform at remarkably high levels, displaying first-rate problem-solving and critical and creative thinking skills. Skill deficiencies observed in mathematics students must therefore also be attributable in part to what instructors are doing or failing to do.

The problem is that no two students are alike. They have different backgrounds, strengths and weaknesses, interests, ambitions, senses of responsibility, levels of motivation, and approaches to studying. Teaching methods also vary. Some instructors mainly lecture, while others spend more time on demonstrations or activities; some focus on principles and others on applications; some emphasize memory and others understanding.

How much a given student learns in a class is governed partially by his native ability, prior preparation and student's view knowledge and derives meaning but also by the compatibility of the student's attributes as a learner and the instructor's teaching style. For example, in Yemen, most undergraduate students see knowledge as something to be transmitted by the teacher rather than discovered by the learners. They, therefore, find it normal to engage in modes of learning which are teacher-centered and in which they receive knowledge rather than interpret it. Most Yemeni students likewise name "Teacher copy caters" as their most frequent activity in collage mathematics classes. Perhaps the most popular Yemeni learning styles originated from the traditional teacher-centered, book-centered, and Focus on algorithmic problem solving and an emphasis on rote memory method. As faculty, many of us prospered under the traditional lecture system, where the focus was on coverage of material through teaching by telling. This approach may work for us but it may not work for the majority of today's students. Students are changing dramatically, and we need to respond to those changes. What happens, for example, when the learning is not on the same "wavelength" as the teacher - when the connections simply aren't there? If we believe that what we are teaching has real value, then we can benefit from understanding the effect of how we are presenting it and to whom.

This is not to say that instructors should determine their students' individual learning attributes and teach each student exclusively in the manner best suited to those attributes. It is not possible to discover everything that affects what a student learns in a class, and even if instructors could, they would not be able to figure out the optimum teaching style for that student-the task would be far too complex. Moreover, even if a teacher knew the optimum teaching styles for all students in a class, it would be impossible to implement them simultaneously in a class of more than two students. Further faculty should be more aware of the importance of understanding diverse learning styles and designing course work to reach the broadest possible spectrum of styles meeting the needs of their own students. In order to provide a framework in which we can understand the advantages of using strategies for teaching mathematics, this research primary purpose is to determine the learning styles that are particularly favored by Yemeni undergraduate mathematics education students.

From the theoretical perspective, much recent research has been devoted to teaching methods. Most studies have focused on the effects of teaching methods on students' performance. Styles of learning receiving little attention. In this research we need to examine mathematics education students' characteristic strengths and preferences in the ways they take in and process mathematics information.

RESEARCH QUESTION

Which learning styles are particularly favored by mathematics education students?

PURPSES OF RESEARCH

The purposes of this research are to answer the following questions:

1. What type of information does the mathematics education student preferentially perceive: *sensory* sights, sounds, physical sensations, or *intuitive* memories, ideas, and insights?
2. Through which modality is sensory information most effectively perceived: visual pictures, diagrams, graphs, demonstrations, or verbal sounds, written and spoken words and formulas?
3. How does the mathematics education student prefer to process information: actively through engagement in physical activity or discussion, or reflectively through introspection?

4. How the mathematics education student does progresses toward understanding: sequentially in a logical progression of small incremental steps, or globally in large jumps, holistically?

SIGNIFICANCE OF THE RESEARCH

This research would benefit many parties directly in the teaching and learning of mathematics and also the whole education system in general. Identifying student learning styles helps educators understand how people perceive and process information in different ways.

The research will provide guidance to instructors on the diversity of learning styles within their classes and to help them design instruction that addresses the learning needs of all of their students.

An implication of this research is to improve the thinking and problem-solving skills of preserves teachers, mathematics and mathematics education instructors should attempt to improve the quality of their teaching, which in turn requires understanding of the learning needs of today's mathematics students and designing instruction to meet those needs.

The findings of this research would contribute to the field of teaching of mathematics in particular and to other field of science in general.

LIMITATION OF RESEARCH

The research is limited and has focused on the learning styles classified by Index of Learning Styles Questionnaire and learners of the mathematics education department in Faculty of Education, Sana'a University.

DEFINITION OF TERMS

For this research, the Researcher defines the following terms:

LEARNING STYLE

The literature is filled with variations definitions for learning style. For example, Merriam and Caffarella (1991) present Smith's definition of learning style, which is popular in adult education, as the "individual's characteristic way of processing information, feeling, and behaving in learning situations" (p. 176).

On the other hand, Swanson (1995) quotes Reichmann's reference to learning styles as "a particular set of behaviors and attitudes related to the learning context", and he also presents Keefe's definition of learning styles as "the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p. 2)

In addition, from the more complex variations on this theme James and Gardner (1995), for example, define learning style as the "complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store, and recall what they are attempting to learn" (p. 20).

From these definitions it appears that they tend to reflect the perspectives of the different learning styles inventories. However, the researcher defines Learning Style in this research as the way that each individual begins to concentrate on, process, internalize, and remember new and academic information.

BACKGROUND

Theoretical foundations have been built in order to try to categorize the incredibly wide range of ways people, often unconsciously, absorb pieces of information and build knowledge through them. Some students are comfortable with theories and abstractions; others feel much more at home with facts and observable phenomena; some prefer active learning and others lean toward introspection; some prefer visual presentation of information and others prefer verbal explanations. One learning style is neither preferable nor inferior to another, but is simply different, with different characteristic strengths and weaknesses. There is no such thing as a good or bad learning style; just many different styles are based upon the various theorists' descriptions. According to Williams (1983) and Reiff (1992) brain theory research indicates that the two hemispheres of the brain process information differently. Each hemisphere contributes its special functions to cognitive activities. On the one hand, the left hemisphere has the verbal, sequential, and analytical abilities. The right one, on the other, has the global, holistic, and visual-spatial functions.

Williams in (1983) indicated that learners who are right-hemisphere tend to be intuitive, imaginative, and impulsive; they prefer to start with a broad idea and then pursue supporting information. They learn best by seeing and doing in an informal, busy, and somewhat unstructured environment. They prefer group discussions, simulations, panels, and other activity-based learning. Conversely, learners who are left-hemisphere tend to be analytical, rational, and objective; they prefer putting together many facts to arrive at a general understanding. They prefer traditional lectures, demonstrations, and assigned readings.

David Kolb, known as a precursor of the research in this specific area, created in 1983 his theory which shows that learning process is break down into two main processes: cognition process (how learners take information in) which is either concrete experience (being involved in a new experience) or abstract conceptualization (creating theories to explain observations) and conceptualization process (how learners internalize information) which is either active experimentation (using theories to solve problems) or reflective observation.

Kolb selected two dimensions, the degree to which people preferred to be active or reflective when they learn or solve problems, and the degree to which they pay more attention to the direct concrete experience or the explainable abstract aspects of the situation. Active people tend to focus on a single alternative and begin action, while the more reflective like to keep open multiple possibilities. Those with a tendency toward abstract conceptualization like to focus on the explainable and definable aspects of situations and things, while those more interested in concrete experience are more interested in specific things and sensory aspects.

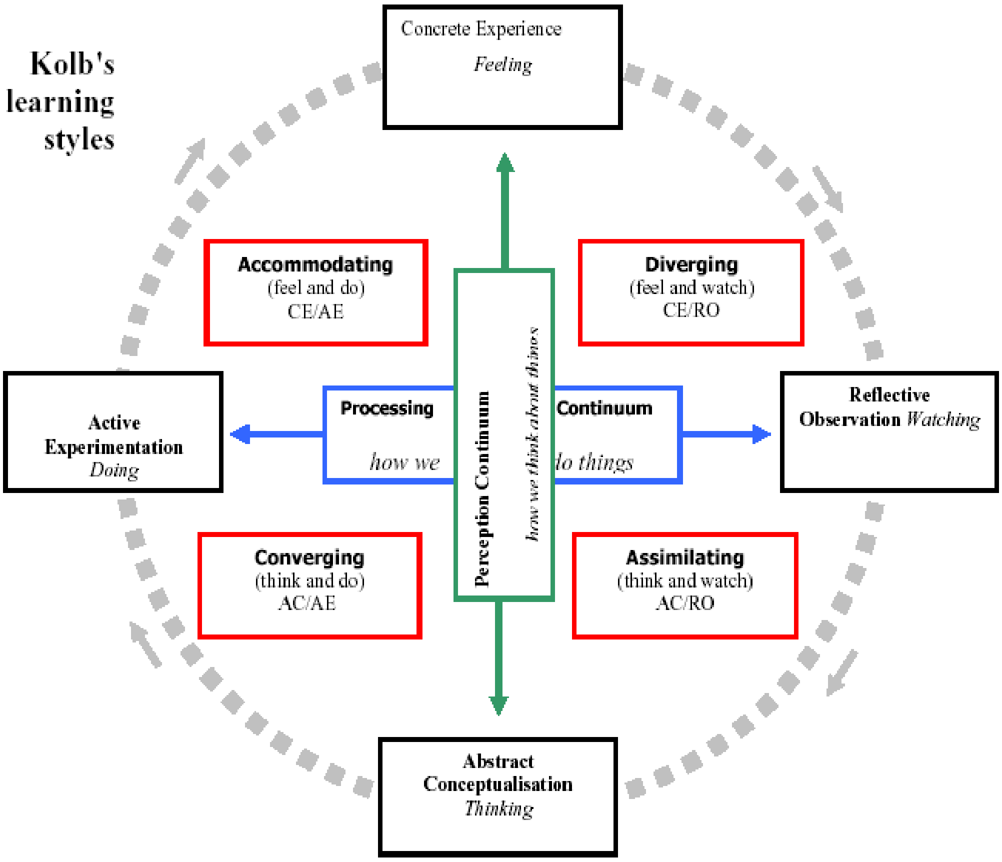
When developing the instrument, Kolb discovered that people who did best in the standard tests of divergent thinking, like brainstorming uses for a brick, tend to be more reflective and pay more attention to the direct concrete experience aspects. So he labeled people in this quadrant as “divergers”. These folks tend to prefer to be artists, therapists, and human resource professionals.

People in the opposite quadrant, who tend to be more active, and focus more on the explainable abstract aspects of a situation, seem to do extremely well on tests in which they must converge on a single answer, such as multiple choice tests or IQ tests. So he labeled these people “convergers”. These folks tend to prefer engineering and planning professions.

Kolb found that those who prefer the reflective abstract way of learning like to take in lots of different and conflicting information and find ways to integrate them. So he labeled them “assimilators”. These people tend to become scientists and PhD college faculty.

Finally, he looked at the active people who also focus on direct concrete realities and found that they are constantly making those adjustments to the plans which are necessary to accomplish their goals, and labeled them as “accommodators”. These people make great project managers, production supervisors, and salespeople. Klob point out that the most effective learning involves all quadrants, a process of reflecting on experience, developing new theories, making plans, and acting upon those plans. Then, reflecting on that experience and continuing in what he called the “learning cycle”.

Figure 1 shows a Picture organizing Klob's learning styles.



David kolb, adaptation and design Alan Chapman 2005-06, based on Kolb's learning styles 1984 at www.businessballs.com

On the other hand, Felder's work (Felder, 1988; Felder & Soloman, 1993) proposes a variation to Kolb's position, establishing relationships among styles and the ways information is dealt with. He has identified four dimensions related to learning styles along with the poles of each dimension Perception (sensing, intuition); Information Input (visual, verbal); Information Processing (active, reflective); Information Understanding (sequential, global). The four learning style dimensions from work of Felder et al. are:

Sensing and Intuitive Perception

People are constantly bombarded with information, both through their senses and their subconscious minds. The volume of this information is much greater than they can consciously attend to; they therefore select a minute fraction of it to admit to their "working memory" and the rest is effectively lost. In making this selection, sensing learners (sensors) favor information that comes in through their senses and intuitive learners (intuitors) favor information that arises internally through memory, reflection, and imagination. (These categories derive from Carl Jung's theory of psychological types.

Sensors tend to be practical; intuitors tend to be imaginative. Sensors like facts and observations; intuitors prefer concepts and interpretations. Sensors like to solve problems using well-established procedures, don't mind detailed work, and don't like unexpected twists or complications; intuitors like variety in their work, don't mind complexity, and get bored with too much detail and repetition.

Visual and Verbal Input.

Visual learners get more information from visual images (pictures, diagrams, graphs, schematics, demonstrations) than from verbal material (written and spoken words and mathematical formulas), and vice versa for verbal learners.

Most of the information presented in almost every mathematics course is overwhelmingly verbal-written words and formulas in texts and on the chalkboard, spoken words in lectures, with only an occasional diagram, chart, or demonstration breaking the pattern. Mathematics information is simply said and not shown to the visual learners. This means there is a little chance that they will retain it.

Active and Reflective Processing

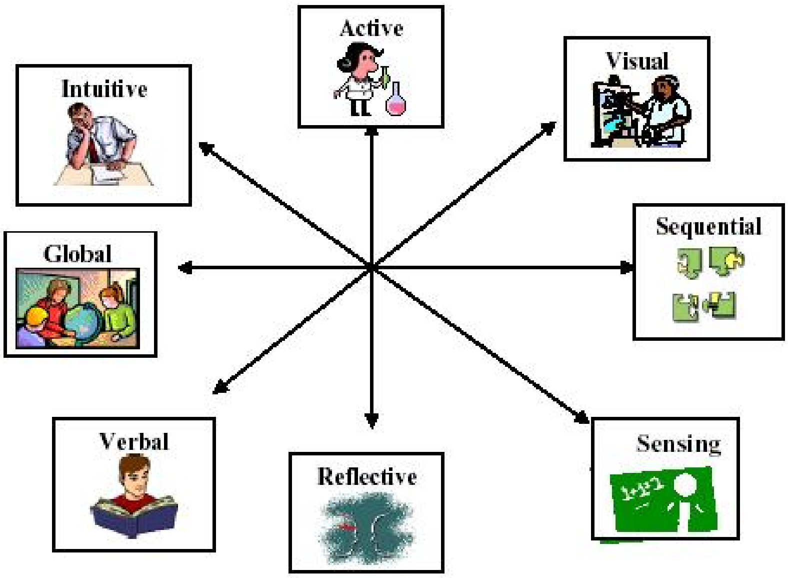
Active learners tend to learn while doing something active-trying things out, bouncing ideas off others; reflective learners do much more of their processing introspectively, thinking things through before trying them out. Active learners work well in groups; reflective learners prefer to work alone or in pairs.

Sequential and Global Understanding

Sequential learners absorb information and acquire understanding of material in small connected chunks; global learners take in information in seemingly unconnected fragments and achieve understanding in large holistic leaps. Sequential learners can solve problems with incomplete understanding of the material and their solutions are generally orderly and easy to follow, but they may lack a grasp of the big picture-the broad context of a body of knowledge and its interrelationships with other subjects and disciplines. Global learners work in a more all-or-nothing fashion and may appear slow and do poorly on homework and tests until they grasp the total picture, but once they have it they can often see connections to other subjects that escape sequential learners.

Before global learners can master the details of a subject, they need to understand how the material being presented is related to their prior knowledge and experience; yet only exceptional teachers routinely provide such broad perspectives on their subjects. In consequence, many global learners who have the potential to become outstanding creative researchers fall by the wayside because their mental processes do not allow them to keep up with the sequential pace of their science courses. The researcher designs and organizes the learning styles according to Felder's classification with the following picture.

Figure 2: The learning styles according to Felder's classification



Felder along with Solomon (1996) outlined their four dimensions of learning that was mainly based on the work of Kolb and Myers-Briggs. He went on to develop an index of learning styles that determines, based on responses to 44 questions, the learner's preferences in the four dimensions mentioned above. Felder is careful to note that everyone uses both poles of any particular dimension, but that learners tend to favor one pole over the other. He found that the learning styles of engineering faculty and undergraduate students (based on self-assessments) are similar with regard to the Information Reception Dimension (with both groups reporting a preference for "visual" learning), and the Information Sequencing Dimension (with both groups reporting a preference for "sequential" learning). These two groups differ on the Perception Dimension (with more students than faculty reporting being sensing learners) and on the Information Processing Dimension (with more students than faculty reporting being active learners).

Howard Gardner's multiple intelligences (1983, 1993, 1999) complement these categories, by agreeing that teaching-learning processes should focus on the particular "intelligences" of each person. His definition for intelligence is 'a bio-psychological potential to process information that may be activated in a cultural scenario to solve problems or to create products that are valued in a culture" (1999, p. 47). His most current research indicates that there are eight distinct forms of intelligence: linguistic, logical-mathematical, spatial, kinesthetic, musical, interpersonal, intrapersonal, and the naturalist. Gardner suggests that different intelligences may be independent abilities-a person can be low in one domain area but high in another. All of us possess the intelligences but in varying degrees of strength and skill. The eight intelligence categories proposed by Gardener are as follows:

Linguistic intelligence refers to people's capability of learning best through language–including speaking, writing, reading, and listening. It involves sensitivity to spoken and written language, the ability to learn languages, and the capacity to use language to accomplish certain goals. This intelligence includes the ability to effectively use language to express oneself rhetorically or poetically; and language as a means to remember information. They are able to verbally or in writing explain, convince, and express themselves.

Logical-mathematical intelligence is related to people who learn better through numbers, reasoning, and problem solving. It consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. In Howard Gardner's words, it entails the ability to detect patterns, reason deductively and think logically.

Musical-rhythmic intelligence involves skill in the performance, composition, and appreciation of musical patterns. Learning processes are performed through sounds–including listening and making sounds such as songs, rhythms, patterns, and other types of auditory expression.

Bodily-kinesthetic intelligence entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements. Under this style are people who learn best through physical activity such as dance, hands-on tasks, constructing models, and any kind of movement. They are able to manipulate and control objects, as well as express their ideas through movement.

Visual-Spatial intelligence refers to the ability to learn visually, organize thinking spatially.

Interpersonal intelligence is concerned with the capacity to understand the intentions, motivations and desires of other people.

Learning is usually achieved through cooperative work or social activities.

Intrapersonal intelligence entails the capacity to understand oneself, to appreciate one's feelings, fears and motivations. This style depicts concentrated, mindful students, encouraging metacognitive practices such as getting in touch with their own feelings and self motivation.

STDUIES RELATED

Data have been collected in a number of studies from undergraduate students' samples for the Index of Learning Styles. For exampling, study of the 129 undergraduate engineering students at Iowa State, 63% were classified as active learners, 67% were sensing learners, 85% were visual and 58% were sequential.

Another study of 83 undergraduate engineering students at Michigan Tech, 56% were classified as active learners, 63% were sensing learners, 74% were visual and 53% were sequential.

A study of 21 British students showed that 85%were classified as active learners, 86% were sensing learners, 52% were visual and 76% were sequential.

Another study of 42 Elec. Engr. International students at Ryerson University found that 52% were classified as active learners, 62% were sensing learners, 76% were visual and 52% were sequential learners.

Also, a study of 214 Science students at Universities in Belo Horizonte (Brazil) indicated that 65% were classified as active learners, 81% were sensing learners, 79% were visual and 67% were sequential learners, whereas 52% of 235 students of Humanities were classified as active learners, 62% were sensing learners, 39% were visual and 62% were sequential learners.

Kim Barron and Paul C. Lynch (2007) presented study was done by Tom Litzinger, Sang Ha Lee, & John Wise in Penn State University and Rich Felder in North Carolina State University. 1000 students contacted in each College of Education, Engineering, and The Liberal Arts. The number of students who completed the Index of Learning Styles Instrument on-line is 534. Their desterputions were 113 Education, 235 engineering, and 186The Liberal Arts.

METHOD OF THE RESEARCH

This research took place at Faculty of Education, in Sana'a University for the first term of 2005/2006. The population for the research was all the students in mathematics teacher program for high schools. A random sample consists of 174 students was selected from the population. The massive majority of participants were females (96%).

INSTRUMENT

For this research, the Index of Learning Styles (ILS) was selected to categorize student's learning styles. The Index of Learning Styles (ILS) was formulated by Richard M. Felder and Linda K. Silverman. It consists of 44, 2 point type items. These items represent 4 dimensions of learning styles: active/reflective, sensing/intuitive, visual/verbal, and sequential/global. Each learning style dimension is associated with 11 forced-choice items, with each option (a or b) corresponding to one or the other category of the dimension (e.g. sensing or intuitive).

RELIABILITY AND VALIDITY OF INSTRUMENT (ILS)

As of 1991, the first version of the instrument (which had 28 items) was administered to several hundred students and the data were subjected to factor analysis. Items that did not load heavily on one and only one item were replaced with new items to obtain the current 44-item version of the instrument. Factor analyses for current version revealed that these 4 dimensions are valid and the coefficient of this scale is 0.89 for the first administration.

Test-retest reliability measurements have been carried out by Livesay et al. The Correlation Coefficients are 0.73 for active/reflective dimension, 0.78 for sensing/intuitive dimension, 0.68 for visual/verbal dimension, and 0.60 for sequential/global dimension. All the Correlation Coefficients sign at p = 0.05. The Cronbach's coefficient alpha, are 0.56 for active/reflective dimension, 0.72 for sensing/intuitive dimension, 0.60 for visual/verbal dimension, 0.54 for sequential/global dimension. (Livesay et al., 2000)

Tuckman (1999) suggests that an alpha of 0.75 or greater is acceptable for instruments that measure achievement and 0.5 or greater is acceptable for attitude assessments 0.5 as the criterion of acceptability for the ILS. Zwanenberg et al. (2000) indicated that all values of Cronbach's coefficient alpha determined in four different studies exceed the criterion value of 0.5. Zywno (2003) and Livesay et al. (2002) concluded that their reliability and validity data justified a claim that the ILS is a suitable instrument for assessing learning styles. Hence, ILS has satisfactory reliability and validity.

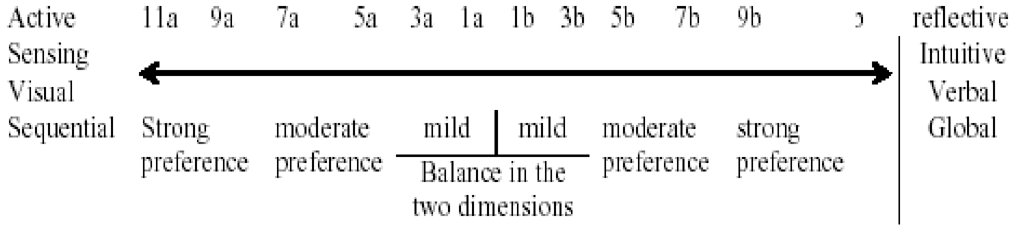
The choice to use the ILS instrument over others available was an important one. The ILS is the most comprehensive and well researched. It is also, an on-line instrument used at no cost for non-commercial purposes by individuals who wish to determine their own learning style profile and by educators who wish to use it for teaching, advising, or research. It gets over 100,000 hits per year and has been translated into Spanish, Portuguese, Italian, German, and several other languages.

INSTRUMENT TRANSLATION PROCESS

Content and face validity of the ILS (in Arabic language) were established by a panel of three faculty members. The Arabic version of the ILS was pilot-tested for reliability with 38 students out of the sample. Cronbach's alpha for the four dimensions is as follows: 0.53 active/reflective, 0.63 sensing/intuitive, 0.56 visual/verbal, and 0.51 sequential/global. All of the alpha values exceed the value 0.5 which is acceptable as Tuckman's suggestion.

SCORES

For statistical analysis, the researcher used a scoring method that counts 'a' responses, so that score on a dimension would be an integer ranging from 0 to 11. Using the sensing/intuitive dimension as an example, 0 or 1 'a' responses would represent a strong preference for intuitive learning, 2 or 3 a moderate preference for intuitive, 4 or 5 a mild preference for intuitive, 6 or 7 a mild preference for sensing learning 8 or 9 a moderate sensing, and 10 or 11 a strong preference for sensing. The figure below explains the scoring method was used for statistical analysis.



If a person score on the scale is 1-3, he is fairly well balanced on the two dimensions of that scale. If his score on scale is 5-7, he has a moderate preference for one dimension of the scale and will learn easily in a teaching environment which favors that dimension. And if his score on the scale is 9-11, he has a very strong preference for one dimension of the scale and he may have real difficulty learning in an environment which does not support that preference.

RESULTS OF THE ANALYSES

Data were analyzed using the Statistical Package for Social Science, SPSS Version 14.0, Analyses of data included frequencies, and percentage as well.

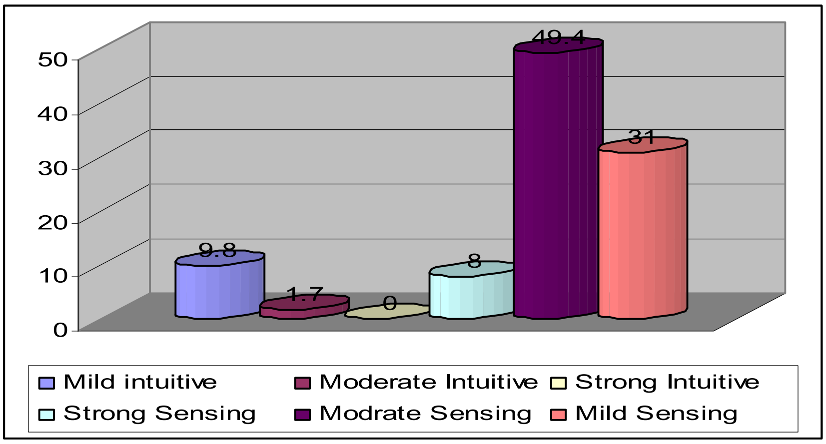
To answer the question of what type of information does the mathematics education student preferentially perceive? Measuring tools for Intuitive and Sensing perception appear in Table 1:

Table 1: The distribution of student satisfaction with the Sensing/Intuitive Perception

Sensing/Intuitive Perception		Frequency	Percent	Cumulative Percent	Frequency	Percent
Intuitive	Mild intuitive	17	9.8	9.8	20	11.5
	Moderate Intuitive	3	1.7	11.5		
	Strong Intuitive	0	0.0	11.5		
Sensing	Strong Sensing	14	8.0	19.5	154	88.5
	Moderate Sensing	86	49.4	69.0		
	Mild Sensing	54	31.0	100.0		
	Total	174	100.0			

Perception of information of the participants as seen in table (1) is 9.8% for the mathematics education students participated in the research are classified as Mild intuitive, and 1.7% for moderate intuitive, 8.0% of the participants who are classified as Strong Sensing, 49.4% as moderate Sensing, and 31.0% as mild Sensing. It shows that 88.5 of mathematics education students participated in the research are classified as sensing information perception, and by implication 11.5% were classified as intuitive perception. The disterpution of the participation percentages are shown in figure 3.

Figure 3 The distribution of student satisfaction with the Sensing/Intuitive Perception



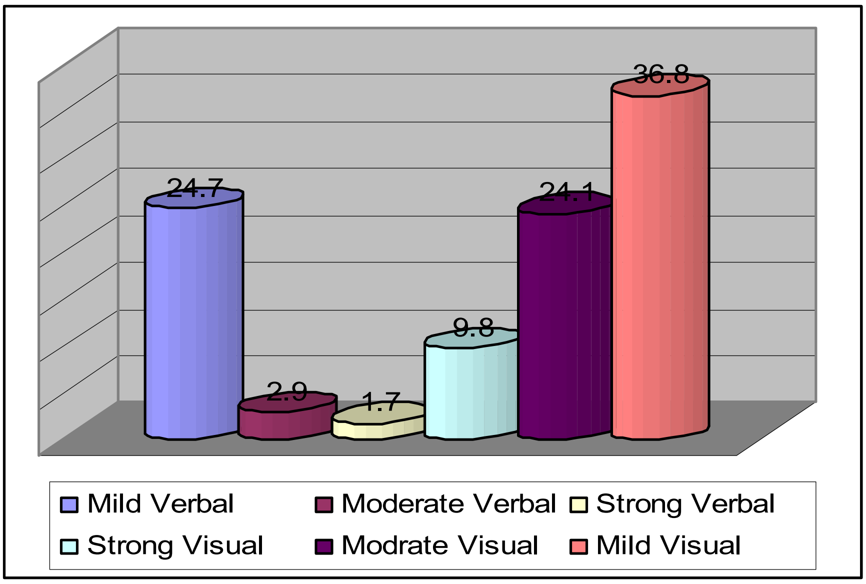
2- Through which modality is sensory information most effectively perceived: *visual*-pictures, diagrams, graphs, demonstrations, or *verbal*-sounds, written and spoken words and formulas? The analysis results are showed in table 2 below.

Table 2: The distribution of student satisfaction with the Visual and Verbal Input

Visual and Verbal Input.		Frequency	Percent	Cumulative Percent	Frequency	Percent
Verbal	Mild Verbal	43	24.7	24.7	51	29.3
	Moderate Verbal	5	2.9	27.6		
	Strong Verbal	3	1.7	29.3		
Visual	Strong Visual	17	9.8	39.1	123	70.7
	Modrate Visual	42	24.1	63.2		
	Mild Visual	64	36.8	100.0		
	Total	174	100.0			

As seen in table 2, 24.7% of the mathematics education students participated in the research are classified as mild verbal, 2.9% moderate verbal, and 1.7% as strong verbal, whereas, 9.8% of the participants are classified as Strong visual, 24.1% moderate visual and 36.8 % as mild visual. It shows that 29.3 of mathematics education students participated in the research are classified as verbal information perception, and by implication 70.7 % are classified as visual information perception. The distribution of the participation percentages are shown in figure 4.

Figure 4 the distribution of student satisfaction with the Visual and Verbal Input.



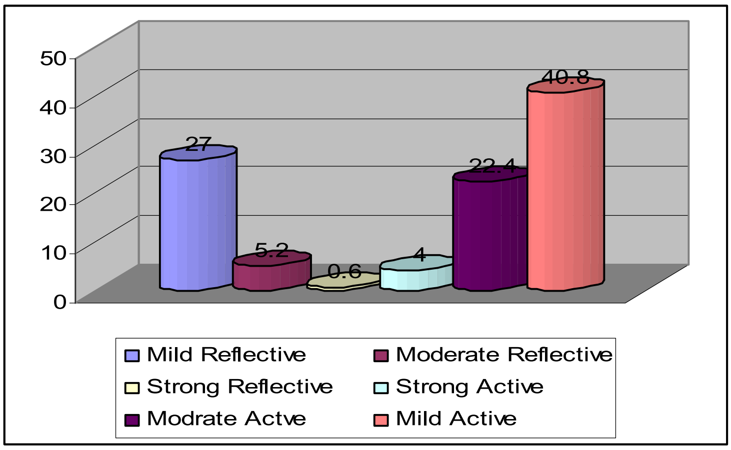
3- How does the mathematics education student prefer to process information: actively-through engagement in physical activity or discussion, or reflectively-through introspection? Measuring tools for active and reflective processing appear in Table 3.

Table 3: The distribution of student satisfaction with the Active/ Reflective Processing

Active/ Reflective Processing		Frequency	Percent	Cumulative Percent	Frequency	Percent
Reflective	Mild Reflective	47	27.0	27.0	57	32.8
	Moderate Reflective	9	5.2	32.2		
	Strong Reflective	1	.6	32.8		
Active	Strong Active	7	4.0	36.8	117	67.2
	Moderate Active	39	22.4	59.2		
	Mild Active	71	40.8	100.0		
	Total	174	100.0			

Table 3 shows that 27.0% of the sample are classified as mild reflective, 5.2% moderate reflective and 0.6% are classified as strong reflective, whereas, 4.0% of the participants are classified as strong active, 22.4% moderate active and 40.8 % as mild active. Hence, 32.8% of the 174 students are classified as reflective learners, and by implication 67.2% are classified as active learners. The percentages distribution is shown in figure 5.

Figure 5 The distribution of student satisfaction with the Active/ Reflective Processing.



4- How does the mathematics education student progress toward understanding: sequentially-in a logical progression of small incremental steps, or globally-in large jumps, holistically? Measuring tools for active and reflective processing appear in Table 4.

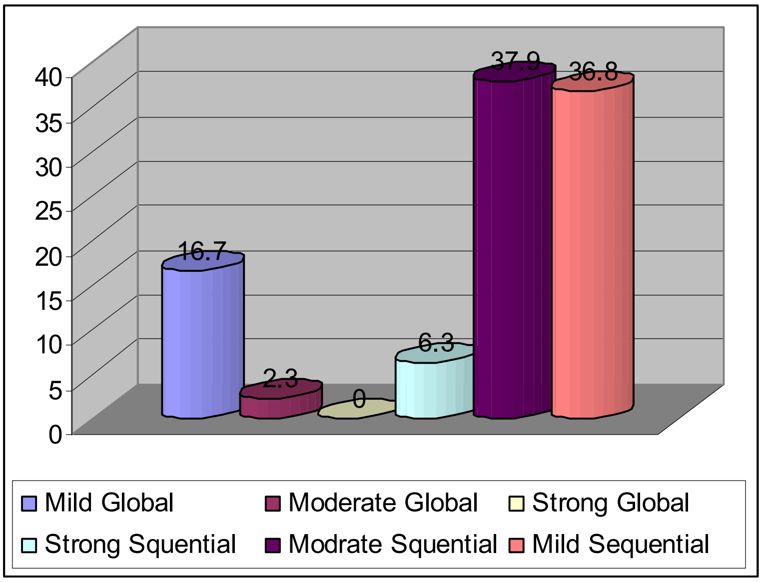
Table 3: the distribution of student satisfaction with the Sequential and Global Understanding

Sequential and Global Understanding		Frequency	Percent	Cumulative Percent	Frequency	Percent
Global	Mild Global	29	16.7	16.7	33	19.0
	Moderate Global	4	2.3	19.0		
	Strong Global	0	0.0	19.0		

Sequential and Global Understanding		Frequency	Percent	Cumulative Percent	Frequency	Percent
Sequential	Strong Sequential	11	6.3	25.3	141	81.0
	Moderate Sequential	66	37.9	63.2		
	Mild Sequential	64	36.8	100.0		
	Total	174	100.0			

Table 4 shows that 16.7% of the sample is classified as mild global, 2.3% moderate global and 0.0% is classified as strong global, whereas, 6.3% of the participants are classified as strong Sequential, 37.9% moderate Sequential and 36.8 % as mild Sequential. Hence, 19.0% of the 174 students are classified as global learners, and by implication 81.0% were classified as Sequential learners. The percentages distribution is shown in figure6.

Figure 6 The distribution of student satisfaction with the Sequential and Global Understanding.



Conclusions and Recommendations

This section will be dealt with in the following paragraphs. They indicate that the educational needs of students with strong preferences for certain poles of the dimensions are not met by traditional approaches to mathematics education instruction. Table 5 summarizes the learning styles of the 174 undergraduate mathematics education students who completed the ILS in Sana'a University.

Table 5: summarizes the learning styles of the sample completed the ILS in Sana'a University.

Processing			Perception			Input			Understanding		
Active	n	117	Sensing	n	154	Visual:	n	123	Sequential	n	141
	%	67.2		%	88.5		%	70.7		%	81.0
Learn by trying things out, and working with others. learn best by doing something physical with the information			Concrete and practical, oriented toward facts and procedures. Prefer data and facts.			Prefer visual representations – pictures, diagrams, flow charts.			Linear and orderly, learn in small incremental steps. Easily make linear connections between individual steps.		
Reflective	n	57	Intuitive	n	20	Verbal	n	51	Global	n	33
	%	32.8		%	11.5		%	29.3		%	19.0
Learn by thinking things through, generally working alone. Do the processing in their heads.			Conceptual and innovative, oriented toward theories and meanings. Prefer theories & interpretations of factual information			Prefer written and spoken explanations.			Holistic and system wide thinkers, learn in large leaps. Must get "big picture" before individual pieces fall into place.		

From table 5 above, 67.2% are classified as active learners (and by implication 37% are classified as reflective learners). Hence, 117 of the sample tend to learn while doing mathematics activities, bounce ideas off others and 57 of the sample think ideas through before trying them out.

Unfortunately, most undergraduate courses are lecture classes which mean that they do very little for either group: the active learners never get to do anything and the reflective learners never have time to reflect. Instead, both groups are kept busy trying to keep up with a constant barrage of verbiage, or else they are lulled into inattention by their enforced passivity.

It appears in table (5), that 88.5% are sensing learners (so that 11.5% are intuitive learners). This means that 154 out of the 174 students like to solve problems using well-established procedures, don't mind detailed work, and they don't like unexpected twists or complications; while, only 20 students out of the 174 like variety in their work, don't mind complexity, and get bored with too much detail and repetition.

In undergraduate mathematics education studies, most mathematics courses (particularly Abstract Algebra and Topology) the focus is on abstract concepts, theories, and formulas, putting 88.5% of the students at a distinct disadvantage. Moreover, 154 out of the174 students are less comfortable with symbols; since words and algebraic variables the stuff of examinations are symbolic, hence most of the students must translate them into concrete mental images in order to understand them. This process can be a lengthy one, and many of the students who know the material typically run out of time on tests. The net result is that most of the students tend to get lower grades in lecture courses.

Table 5 also, indicates that 70.7% of the participated learners get more information from visual images (pictures, diagrams, graphs, schematics, demonstrations) than from verbal material (written and spoken words and mathematical formulas), and only 29% of the students prefer to get their information from written and spoken explanations.

Most of the information presented in almost every mathematics course is overwhelmingly verbal-written words and formulas in texts and on the chalkboard, spoken words in lectures, with only an occasional diagram, chart, or demonstration breaking the pattern. Mathematics information is simply said and not shown to visual learners. This means that there is a little chance for 123 out of 174 students to retain it.

Table 5 above show that 81.0% of the participants tend to gain understanding in linear steps, with each step coming logically from the previous one. They follow logical stepwise paths in finding solutions. However, 19.0% of the participants tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it."

Most college mathematics courses are taught in a sequential manner. Thus, most of the participants know a lot about specific aspects of a subject, yet they may have troubles relating them to different aspects of the same subject or to different subjects.

Current research suggests that mathematics education students are generally active, sensing, visual, sequential learners; as opposed to reflective, intuitive, verbal, global learners. Roughly translated, most college students receive instruction by the traditional lecture method, while their learning styles are incompatible with that delivery mode. In short, there's a disconnect between teaching style and learning style. It's like teaching the blind with pictures and teaching the deaf with the spoken word.

These problems could be minimized and the quality of mathematics education significantly enhanced if instructors modified their teaching styles to accommodate the learning styles of all the students in their classes. Major transformations in teaching style are not necessary to achieve the desired balance. Of the eight defined learning style categories, four (intuitive, verbal, reflective, and sequential) are adequately covered by the traditional lecture-based teaching approach, and there is considerable overlap in teaching methods that address the style dimensions short-changed by the traditional method (sensing, visual, active, and global). The systematic use of a small number of additional teaching methods in a class may therefore be sufficient to meet the needs of all of the students.

THEORETICAL IMPLICATIONS

- More research is needed to investigate the learning styles among all majors in faculty of education.
- More research is needed to investigate the relationship between learning styles and academic achievement among all majors in faculty of education.

PRACTICAL IMPLICATIONS

- Instructors of higher education should move toward changing existing methods to accommodate students' learning styles.
- University should encourage instructors to assess their students' learning styles.

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استقصاء أساليب التعلم المفضلة لدى طلبة تربويات الرياضيات بكلية التربية صنعاء

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الملخص :

يهدف هذا البحث التحقيق من معرفة أساليب التعلم التي تتسم بالقوية والأفضلية لدى طلبة تربويات الرياضيات في طريقة إدخال ومعالجة المعلومات الرياضية. ولتحقيق هدف البحث طبق استبيان مؤشرات أساليب التعلم على عينة قوامها **174** فرداً تم اختيارهم عشوائيا من طلبة تربويات الرياضيات بكلية التربية، جامعة صنعاء. وأسفرت النتائج أن **67.2** ٪ من أفراد العينة صنفوا ضمن أسلوب التعلم النشط، و **88.5** ٪ ضمن أسلوب التعلم الحسي، و**70.7**٪ ضمن أسلوب التعلم البصري، و **81.0** ٪ ضمن أسلوب التعلم التتابعي.

ويترتب على هذه الملاحظات: تحسين التفكير ومهارات حل المسائل الرياضية لدى طلبة تربويات الرياضيات (معلمي رياضيات التعليم الثانوي قبل الخدمة)، كما ينبغي على كلية التربية محاولة تحسين نوعية تدريسهم، وهذا بدوره يتطلب فهم الاحتياجات التعليمية لطالب تعليم الرياضيات اليوم واستخدام طرائق التدريس اللازمة لتلبية هذه الاحتياجات.