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AN ASSESSMENT OF DERMATOGLYPHIC PATTERNS AND PREFERED LEARNING STYLE: A CASE STUDY OF COMPUTER SCIENCE STUDENTS

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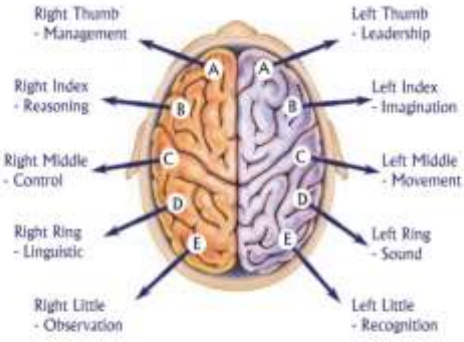
Abstract:
Background: Dermatoglyphics is the study of fingerprint patterns found on soles and palms of humans. It gives a deep correlation between fingerprints and human cognition. This field of tudy has gained huge importance among researchers of forensic science, genetics, biology, anthropology, psychologists, and behavior/cognitive science. The present study was conducted on a sample of Computer Science students to find the relationship of index fingerprint pattern and Felder Silverman Learning Style dimensions. **Methodology:** The Felder Silverman Questionnaire and index fingerprint pattern of the 141 students from the Department of Computer Science of Mohan Lal Sukhadia University,Udaipur,India were considered for data and analysis. **Results:** The results show more than 60% of students exhibiting Ulnar fingerprint patterns and the Whorl fingerprint is the other dominant fingerprint found among the students. Fingerprint patterns were mapped with the learning style dimensions as per the Felder Silverman model and an association between fingerprint patterns and learning style was established through data analysis and summarization. **Conclusion**: The Ulnar loops are found to be most prominent in this Computer Science students group establishing the fact that the Ulnar loop fingerprint pattern indicates scientific aptitude among individuals.

Introduction :

Dermatoglyphics is a study of dermal ridges on palms and fingerprints, soles and toes (Herschel, 1880; Galton, 1892). One of their important functions is to help us process and understand personality and cognitive style. This type of knowledge can be helpful in career choice, manpower selection, and human behavior (Dholiya & Dholiya, 2017; Raizada, Johri, Ramnath, Chowdhary, & Garg, 2013; Yarovenko, Vasily, 2013; Babu DB, 2015). The application of Dermatoglyphics has found wide research in medical science and forensic science (Girish, Sharada, Priya, & Babu, 2013; Miller JR, 1966; Dhankar, 2015; BS, 2006; Jameela, 2007; Tikare, Rajesh, Prasad, Thippeswamy, & Javali, 2010; Yarovenko, 2013) . There are three main fingerprint classification groupings which include: Whorls, Loops, and Arches (Singh & Majumdar, 2015) . People with Loop patterns are identified with dynamic, analytical, and non-administrative responsibilities. These individuals are mainly prone to be easygoing and better at communication skills. Loop openings that don't open towards the thumb are Radial loops, and the ones that do are Ulnar loops. Persons with Radial loop patterns have reverse thinking and like to question whereas Ulnar Loop patterns are imitators and observant (Hurray, 2017; Singh & Majumdar, 2015; Kamboj, 2008) . Arch patterns are most easy to recognize as forms of plain curve and waveform patterns. Persons with Arch pattern are introverts, hard workers, and follow steps to pursue any task. (Navit, et al., 2015). Whorls form a concentric or aggregate circle on the whole finger which are signified by denser ridge counts between delta and core. The persons with whorl pattern reflect the high intensity of character and intellect with higher levels of comprehension and human activity. They maintain an equal balance between serious and lighthearted perspectives (Namouchi, 2011; Bibangco P & Mary Gift D, 2020; Bo, Ping, & Lan, 2008; Kucken & Newell, 2005).

There is a direct correlation of brain lobes with fingers as studied by some researchers illustrating linkage between left brain and right brain with a right hand and left hand respectively (Singh & Majumdar, 2015). According to Academy of Mulltiple Intelligence (Brainbow) the right hand index finger is linked with frontal lobe of the brain which is responsible for logical processing and thinking capabilities(Figure-1). This has been applied in several DMIT(Dermatoglyphics Multiple Intelligence Test) based studies conducted world wide (Bo, Ping, & Lan, 2008).



(a)

(b) ARCH WHORL RADIAL ULNAR

Figure 1: (a)Brain lobe functioning and finger(Courtesy DMIT Lab) (Academy of Multiple Intelligence (Brainbow)) (b) Fingerprint pattern –Arch, Whorl, Radial loop, and Ulnar loop

The right-hand thumb reveals management ability, the Index finger shows logical reasoning ability, the Middle finger shows the ability to control movement, the Ring finger explores language ability, and the Little finger highlights observation, reading, and comprehension ability. Left-hand thumb shows creativity, interpersonal and leadership skills, Index finger for artistic approach, Middle finger identifies the ability to control movement, Ring finger identifies the ability to process and appreciate art and the little finger reveals abstract patterns & visual sense. (Kumar, Kumari, & Babu, 2014; Singh & Majumdar, 2015; Navit, et al., 2015). Some scientists and researchers have studied fingerprints for intelligence (IQ) mapping, medical diagnosis, personality trait, and personal behavioral identification (Babu DB, 2015; Dhankar, 2015; Zhang, Hao; Huang, Tao; Liu, Sanya; Yin, Hao; Li, Jia; Yang, Huali; Xia, Yu, 2020). Each fingerprint is related to certain learning patterns like Cognitive, Affective, Critical, Enthusiastic, Reflective capabilities which have been concluded by multiple researchers (Kumar, Kumari, & Babu, 2014; Namouchi, 2011) . The critical finding of Kumari *et al*., illustrates loop patterns prefer critical and effective learning, while students with whorl patterns prefer cognitive learning. Mostafa Najafi in 2009 conducted a study in Iran and identified a loop pattern on any finger that associates better academic performances of students and better IQ. Nayak *et.al*, in 2017 studied that students with ulnar loop also preferred problem-based learning and students with radial loop preferred self-directed learning methods. (Najafi, 2009). With the review of different related work there comes a relationship of fingerprint and learning styles (Parvez & Blank, 2007; Jurgensen AP, 1993; Nayak, Velan, Shern, Zoung, Jeyarajan, & Aithal, 2017).

Learning styles are a very important part of the personality which relates to the ability of individuals with their understanding (Chang, Kao, Chu, & Chiu, 2009). There are different learning style models studied by the researchers(Felder Silverman,David Kolb, Myer Briggs, Honey P Mumford ,Rita Dunn)to identify psychological learning behavior which is derived from Jung's theory and further expanded in the way they perceive, take input, process and organize. They have their standard tools to identify the learning styles (Felder R. M., 1988; Herrmann, 1988; Kolb, 1999; Fleming, 1995; Kolb, Alice Y, 2013). Among all the models Felder Silverman model covers all aspects of learning potential i.e. the way the data can be perceived, processed, received, and understood which directly correlates with human behavior (Felder & Spurlin, 2005; Graf, Sabine, Silvia, Tommaso, & Kinshuk, 2007; Karagiannis, Ioannis, & Maya, 2018; Nafea, François, & Ying, 2019; Zhang, Hao; Huang, Tao; Liu, Sanya; Yin, Hao; Li, Jia; Yang, Huali; Xia, Yu, 2020). Table 1 below illustrates the Felder Silverman Dimension in detail with characteristics and learning patterns.

The ILS Questionnaire tool of Felder Silverman consists of 44 questions with 11 questions from each four dimensions-perception, input, processing, and understanding. Each question has two options- a or b for answering, which defines the specific learning style of that dimension.

Table 1 Felder Silverman Dimensions in context of learning style, learning input and learning pattern (Felder R. M., 1988; Felder & Spurlin, 2005)

Dimensions	**Learning Style**	**Characteristics**	**Learning Input**	**Learning pattern**
Perception	**Sensing**	Sensing learners prefer to take concrete and practical information.	Prefer Facts and Data	Comfortable with realistic and practical applications.
	Intuitive	Intuitive learners prefer indirect perception, speculation, and imagination.	Prefer theories, new concepts, innovation, and complex problem	Comfortable with ideas.
Input	**Visual**	Visual learners prefer to learn by remembering what they see.	Prefer Pictures Diagrams, Flow chart	Comfortable with pictorial representation
	Verbal	Verbal learners prefer to learn by remembering what they hear.	Prefer Verbal explanation and written words	Comfortable with a lot of written content.
Processing	**Active**	Active learners prefer to learn by Experimentation and by doing something with the information	Prefer Discussion, questioning, arguing, and brainstorming	Comfortable in groups and handling things.
	Reflective	Reflective learners prefer to learn by thinking about that information and understand before processing.	Prefer explanation, interpretation, drawing analogous and formulating models	Comfortable by themselves and alone while working.
Understanding	**Sequential**	Sequential learners prefer to organize information in a linear and ordered form.	Prefer material presented in a steady progressive way	Can work with material when they understand it partially and have strong convergent thinking

	Global	Global learners prefer more holistically and in a random manner without seeing the connection. (disorganized way)	Prefer direct complex and difficult material	May find it difficult to work with the material that they understand partially, better in divergent thinking

The right-hand index finger is related with logical reasoning ability, perception, and conceptual understanding which are important factors in terms of cognitive abilities that are helpful in this study. The study proposed in this paper is based on the appearance of dominant patterns on Right-hand index fingerprints of Computer Science students and their relation with Felder Silverman learning styles dimension.

Objective of the Study :

1. To study fingerprint patterns in Computer Science students.
2. Relating dermatoglyphics with Felder Silverman Learning Styles of individuals as measured using ILS.
3. Relating Academic Achievement with Fingerprint Pattern of Computer Science students.

Methodology

The sample size of the study

In this study, a total of 141 graduate and post-graduate Computer Science students were involved. All the participants were aged between 19 and 23 years and among them, 92 were males and 49 were females. Initially, they were asked to fill the ILS questionnaire, and then the right-hand index fingerprints were collected from each of them.

Data collection

In the present study, ILS questionnaire was used to assess the learning style of the students. Apart from that, student's demographic data was also included in the study along with marks obtained by the students during the academic year. After filling the questionnaire, the right index finger impressions from the students were taken using a stamp pad. The students were asked to place their right index finger on the stamp pad and then asked to place it on the paper; roll their index finger from one side to another to get a complete impression of the index finger. While obtaining accurate index finger impressions, proper care was taken to ensure that the impression work is done without any overlap. The responses given by the students to the questions were then analyzed. The entire fingerprints recorded were studied with the help of a magnifying lens to find out the patterns.

Data interpretation

All the data were collected and segregated as per the result of the ILS questionnaire. The fingerprints patterns were classified and grouped into four basic patterns: arch, whorl, radial loop, and ulnar loop(Figure 2). The concluded patterns were then mapped with learning styles and academic performance of the students(Table 2). Results obtained were expressed in percentage and appropriate graphs were used to present the results.

Result

The results produced by analyzing the data from the spreadsheet are discussed in this section. The fingerprints obtained from the students were grouped into four dermatoglyphic patterns: Whorl, Arch, Radial loop, and Ulnar loop. The most common fingerprint pattern found among the students was the ulnar pattern (n =63 %), followed by the whorl pattern(n = 23%), arch (n = 9%), and radial loop(n= 5%).(Figure-2)

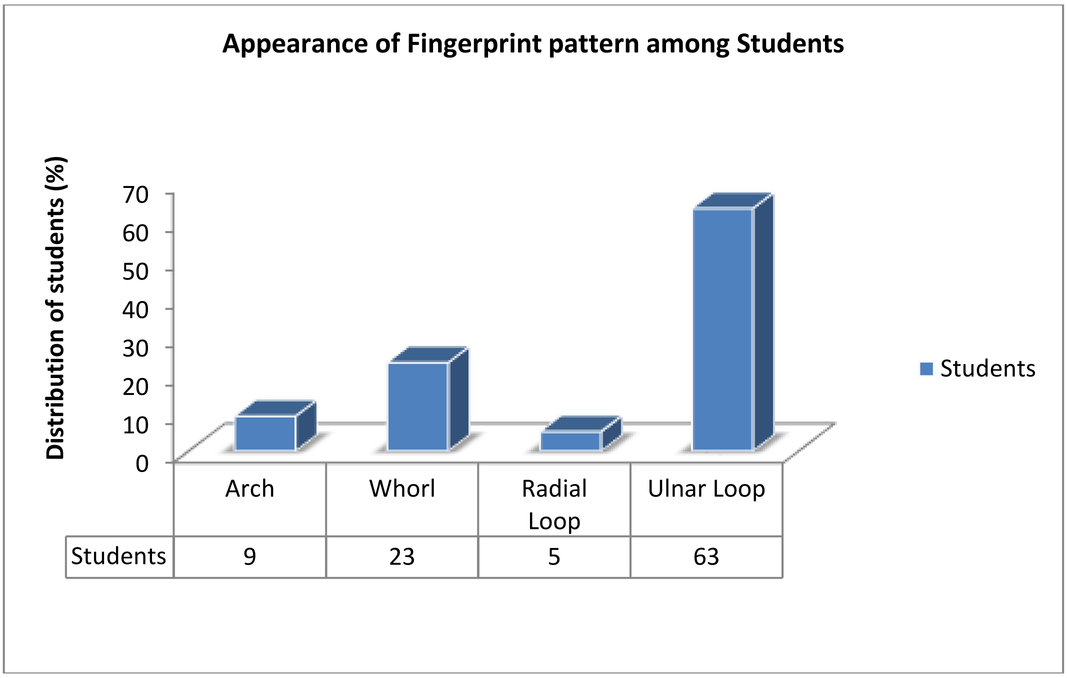


Figure 2: Fingerprint pattern present among students

Table 2 Association of Fingerprint pattern with Felder & Silverman's Learning style Dimension

Fingerprint pattern	Perception		Input		Processing		Understanding	
	Sensing	Intuitive	Visual	Verbal	Active	Reflective	Sequential	Global
Ulnar	57	32	82	7	49	40	47	42
Whorl	11	21	24	8	14	18	17	15
Arch	12	1	11	2	4	9	6	7
Radial	2	5	5	1	4	3	4	3
Grand Total	82	59	122	18	71	70	74	67

As per the given data in Table 2, it was observed that across all four types of Fingerprint Patterns, no clear distribution was found for the 'Understanding' dimension of Felder & Silversman's Learning Style Model(see Figure 3). Student's fingerprint patterns were equally distributed across Global and Sequential Learning Styles. Across all fingerprint patterns students with 'Ulnar loop' Fingerprint Patterns demonstrated following learning styles across the remaining three dimensions of Perception, Input and Processing as per Felder & Silversman's Learning Style Model.

Perception : Sensing

Input : Visual

Processing : Active

Similarly, Students with 'Whorl' Fingerprint Patterns showed following dominated learning styles-

Perception : Intuitive

Input : Visual

Processing : Reflective

Students with 'Arch' Fingerprint Patterns exhibited following dominated learning styles-

Perception : Intuitive

Input : Visual

Processing : Active

And, finally, Students with 'Radial' Fingerprint Patterns on their Right Hand Index Finger were found to be having the following learning styles as per Felder & Silversman's Learning Style Model.

Perception : Sensing

Input : Visual

Processing : Reflective

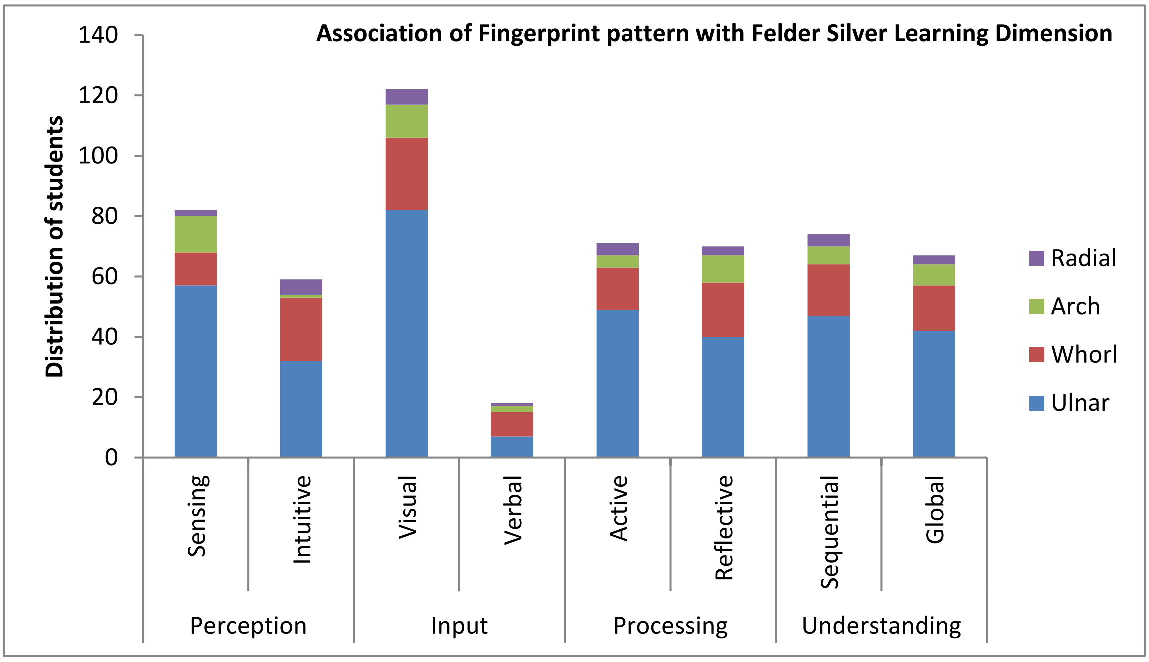


Figure 3: Distribution of students fingerprint pattern and learning dimension

Figure 4 shows the relationship between fingerprint patterns and academic performance of students. The students were grouped under 3 groups namely low, average and high scoring students based on their academic scores. These were then plotted across the four groups of fingerprint patterns. The graph revealed that students with Ulnar loop and Whorl pattern exhibit higher academic scores in comparison to other types of the fingerprint pattern.

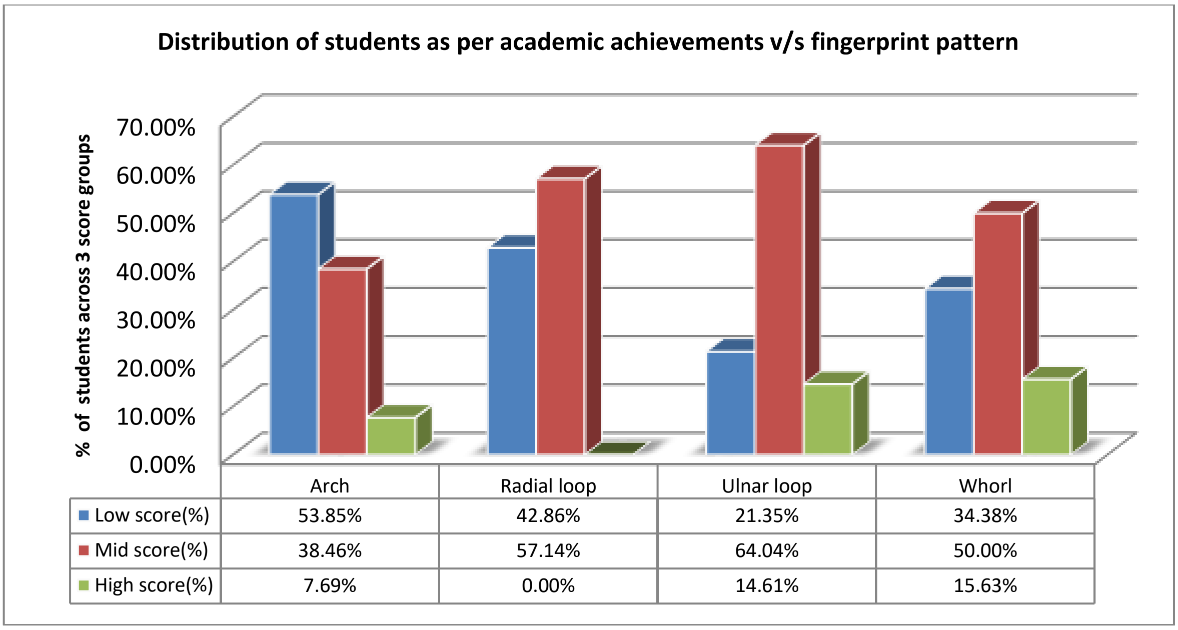


Figure 4 Distribution graph of students as per Academic achievement and Fingerprint pattern

Table 3 shows the summary of dominant learning style identified across four types of fingerprint patterns. This finding also paves way for selection of appropriate teaching pedagogy that matches the learning styles of individuals. This shows that students with

- **Arch pattern** exhibits Sensing, Visual and Reflective learning dimension which means they require more interpretation and visual /pictorial support with practical application-based learning.
- **Radial loop** pattern exhibits the Intuitive, Visual, and Reflective learning dimension which means that students require complex learning, pictorial/visual support. These individuals should be allowed to think and reflect in isolation.
- **Ulnar loop** pattern exhibits Intuitive and Visual learning style dominantly.In case of processing learning dimension ,these students exhibited both active and reflective styles. Hence,they are more flexible as far as understanding dimension is concerned and a mixed approach will be more suited for these learners.
- **Whorl pattern** exhibits Intuitive, Visual and Active learning styles which means that students prefer practical application and group study with visual /pictorial input in a progressive way.

Table 3 Mapping of Learning Style with Dimensions

Learning Dimension/ Pattern	Sensing/Intuitive	Visual/Verbal	Active/Reflective	Sequential/Global
Arch	Sensing	Visual	Reflective	Not Conclusive
Radial loop	Intuitive	Visual	Reflective	Not Conclusive
Ulnar loop	Sensing	Visual	Not Conclusive	Not Conclusive
Whorl	Intuitive	Visual	Active	Not Conclusive

Discussion

Analysis of the fingerprint patterns from this study showed that the ulnar loop pattern was the most commonly occurring pattern followed by whorl, radial loop, and arch in the group of Computer Science Students. However, some other researchers have also shown that loop (Ulnar/Radial)pattern and whorl are the most common fingerprint pattern present in Science Students (Kumar, Kumari, &

Babu, 2014; Adenowo & Dare, 2016) as shown in Table 4 which compares the frequency of patterns present on the specific finger in different group of students .

Table 4 Comparitive analysis of research studies in terms of fingerprint pattern

Pattern	**Computer Science Students(Right Index Finger)(**Present Study) **(%)**	**Medical Students (Right Index)(%)** (Kumar, Kumari, & Babu, 2014)	**Group of students with IQ(%) Right Index Finger (II digit finger right)** (Najafi, 2009)
Arch	9.2	10.5	14
Radial loop	4.6	5.6	19
Ulnar loop	63.12	34.7	53
Whorl	22.69	49.2	58

Kumari *et.al* in 2014 identified maximum whorl pattern among medical science students in the right index finger whereas the present study reveal the maximum appearance of ulnar pattern among computer science students in the right index finger. Adenowo and Dareb in 2016 showed fingerprint patterns of medical students have high percentage distributions of ulnar loops with high academic records and low percentage distributions of arch patterns among the weak categories of students. The present study also produced high percentage distributions of ulnar loops with an average and high academic record, however whorl loops were most found in students with a high academic record. The academic performance of a student is a result of the student's learning ability and the present study reveals that students with whorl pattern prefer active learning style. This observation can be used to design the pedagogical style adapted for the students.

Conclusions

This study reveal that students with ulnar loop scored better academically and they prefer sensing learning and visual methodologies compared to students with other fingerprint patterns. From the data, Global /Sequential learning styles could not be conclusively depicted. This study establishes association of fingerprint patterns with the learning style of an individual.The high occurrence of Ulnar Pattern is shown by Computer Science students in correlation to mid and high academic score of around 78.65% which is significant.The least occurring pattern among Computer Science students is Arch and percentage of students having above average academic scores is around 46.15%. Previous studies also reveal occurrence of Ulnar and Worl pattern significantly.among Computer Science and Medical Students.

So,this study clearly concludes that students or learners having Ulnar Loop patterns will have a strong inclination towards Programming skills, Analytical Skill, Data analysis with logical approach . This work is confined to Computer Science students and specifically right hand fingerprint is considered so other aspects cannot be concluded which can be further extended in future work. It can pave way to formulate appropriate pedagogy for students with specific learning styles,derived from their fingerprint patterns.

Future Work :

Further work can be done by including fingerprints of all the fingers and co-relating with the learning dimensions. Also, the sample for the study can be taken from different age groups of learners, different geographical locations, different domains, etc. to enhance the accuracy of the work.

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Works Cited

Academy of Multiple Intelligence (Brainbow), I. [. (n.d.). *The 37 types of fingerprints.* Retrieved June 2021, from Brainbow: www.brainbow.in

Adenowo, T., & Dare, B. (2016). Digital and Palmer Dermatoglyphic: A Bio-Indicator for Intelligence Quotient. *Journal of Basic and Applied Research , 2* (3), 313-319.

Babu DB, A. S. (2015). Dermatoglyphics in dentistry:A review . *Int J Contemp Dent Med Rev , 54*, 1-3.

Bibangco P, E. J., & Mary Gift D, D. (2020). Inception-V3 Architecture in Dermatoglyphics-Based Temperament Classification. *Philippine Social Science Journal , 3* (2), 173-174.

Bo, J., Ping, T. H., & Lan, X. M. (2008). Fingerprint singular point detection algorithm by Poincaré index. *Weas Transaction on Systems , 7* (12), 1453-1462.

BS, N. (2006). *Forensic Science in Crime Investigation.* Hyderabad: Lowhouse.

Chang, Y. C., Kao, W. Y., Chu, C. P., & Chiu, C. H. (2009). A learning style classification mechanism for e-learning. *Computers and Education , 53* (2), 273-285.

Dhankar, C. (2015). Exploring the Role of Dermatoglyphics in Learning- A Case Study. *International Journal of Social Sciences and Management , 2* (3), 301-303.

Dholiya, K., & Dholiya, A. (2017). Dermatoglyphic Multiple Intelligence Analysis. *International Journal of Memory and Intelligence , 1* (1), 24-26.

Felder, R. M. (1988). Learning and Teaching styles in Engineering Education. *Engr. Education , 78* (7), 674-681.

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the index of learning styles. *International journal of engineering education* , 103-112.

Fleming, N. D. (1995). I'm different; not dumb. Modes of presentation (VARK) in the tertiary classroom. *Annual Conference of the Higher Education and Research Development Society of Australasia (HERDSA). 18*, pp. 308-313. Australasia : Research and Development in Higher Education, .

Galton, F. (1892). *Fingerprints.* NewYork: McMillan & Co., London and New York.

Girish, H., Sharada, P., Priya, N., & Babu, N. C. (2013). Dermatoglyphics in Dentistry: An Insight. *World Journal of Dentistry , 4* (2), 144-147.

Graf, Sabine, S. R., T. L., & Kinshuk. (2007). In-depth analysis of the Felder-Silverman learning style dimensions. *Journal of Research on Technology in Education* , 79-93.

Herrmann, N. (1988). *The Creative Brain.* Lake Lure, NC.: Brain Books.

Herschel, W. (1880). Skin furrows of the hand. *Nature , 23*, 76.

Honey, P. (2006). *KOLB'S LEARNING STYLES.*

Hurray, A. (2017). Understanding Changing Trends to Study Human Behaviour through Quantitative and Qualitative Assesment through Dermatoglyphics. *International journal of Social Science and Humanitiy , 7* (9), 9.

Jameela, T. P. (2007). Dermatoglyphic patterns evident in disability groups. Mahatma Gandhi University.

Jurgensen AP, K. D. (1993). Fingerprint Verification for Use in Identity Verification System. (pp. 257- 80). Aalborg University.

Kamboj, M. (2008). Dermatoglyphics. *British dental journal , 204* (2), 51-51.

Karagiannis, Ioannis, & M. S. (2018). An adaptive mechanism for Moodle based on automatic detection of learning styles. *Education and Information Technologies , 23* (3), 1331-1357.

Kolb, Alice Y. (2013). *The Kolb learning style Inventory 4.0 A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications.* Philadelphia, PA: Hay Group.

Kolb, D. A. (1999). *Learning style inventory.* Boston: MA: McBer and Company.

Kucken, M., & Newell, A. C. (2005). Fingerprint formation. *Journal of Theoretical Biology , 235* (1), 71-83.

Kumar, S. V., Kumari, K. L., & Babu, P. V. (2014). Dermatoglyphics and Its Relation to Intelligence Levels of Young Students. *IOSR Journal of Dental and Medical Sciences , 13*, 01-03.

Miller JR, G. J. (1966). Dermatoglyphics in pediatric practice. *J Pediatr , 69*, 302-12.

Nafea, S. M., F. S., & Y. H. (2019). On Recommendation of Learning Objects Using Felder-Silverman Learning Style Model. *IEEE Access , 7*, 163034-163048.

Najafi, M. (2009). Association Between Finger Patterns of Digit II and Intelligence Quotient Level in Adolescents. *Iranian Journal of Pediatrics , 19* (3), 277-284.

Namouchi, I. (2011). Anthropologicalsignificance of dermatoglyphic trait variation:An intra-Tunisian population analysis. *Int J Mod Anthrop , 4*, 12-27.

Navit, S., Chadha, D., Khan, S. A., Singh, R. K., Johri, N., Navit, P., et al. (2015). The Mystery of Handprints: Assesment and Correlation of Dermatoglyphics with Early Childhood Caries A Case-ControlStudy. JCDR. *Journal of clinical and diagnostic research: JCDR , 9* (10), ZC44.

Nayak, S. B., Velan, J., Shern, N. L., Zoung, L. F., Jeyarajan, A., & Aithal, A. P. (2017). Correlation between dermatoglyphic pattern of right thumb; learning methodologies; and academic performance of medical students. *Journal of Datta Meghe Institute of Medical Sciences University , 12* (3), 177-180.

Parvez, S. M., & Blank, G. D. (2007). A pedagogical framework to integrate learning style into intelligent tutoring systems. *Journal of Computing Sciences in Colleges , 22* (3), 183-189.

Raizada, A., Johri, V., Ramnath, T., Chowdhary, D., & Garg, R. (2013). A cross-sectional study on the palmar dermatoglyphics in relation to carcinoma breast patients. *Journal of clinical and diagnostic research: JCDR , 7* (4), 609.

Singh, M., & Majumdar, O. (2015). Dermatoglyphics: blueprint of human cognition on fingerprints. *Comput Sci Electron J , 6* (2), 124-146.

The 37 types of fingerprints- courtesy by Academy of Multiple Intelligence (Brainbow), India. [Online]. (n.d.). Retrieved from www.brainbow.in

Tikare, S., Rajesh, G., Prasad, K. V., Thippeswamy, V., & Javali, S. B. (2010). Dermatoglyphics - A marker for malocclusion. *International Dental Journal , 60* (4), 300-304.

Yarovenko, V. (2013). Forensic dermatoglyphics. *Legal studies , 4* , 351 - 372.

Yarovenko, Vasily. (2013). Dermatoglyphic personality traits in the context of crime determination. *All-Russian criminological journal , 1*, 36-40.

Zhang, Hao; Huang, Tao; Liu, Sanya; Yin, Hao; Li, Jia; Yang, Huali; Xia, Yu. (2020). A learning style classification approach based on deep belief network for large-scale online education. *Journal of Cloud Computing , 9* (1), 1-17.