ANALYSIS OF FINGERPRINT BIOMETRICS IN DETERMINING STUDENT LEARNING STYLES IN PRIMARY SCHOOLS

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Abstract: *This research aims to analyse the potential use of fingerprint biometrics in determining students' learning styles to maximise the effectiveness of the learning process in primary schools. Fingerprint biometrics is recognised as one of the technologies that can provide unique information about individual characteristics, including cognitive potential and learning styles. This research method was conducted by reviewing a number of relevant literature studies and using an experimental approach on students to determine the correlation between fingerprint patterns and their learning abilities. The results show that there is a correlation between certain types of fingerprint patterns and students' learning styles, which can then be used as a basis for designing more effective learning methods. Thus, the use of fingerprint biometrics offers an innovative approach in the field of education to tailor teaching methods to the individual needs of students.*

INTRODUCTION

Learning effectiveness has become a major focus in education, especially in the effort to understand and adapt teaching methods to the individual needs of students. Each student has a different learning style that is influenced by cognitive, psychological and physical factors. Therefore, different learning styles if not properly identified can be an obstacle in achieving the maximum learning potential of learners (Tiumlafu et al. 2022).. With the development of current technology, learners' learning styles can be identified with a high degree of accuracy without the use of psychological tests or interviews. This technology is known as *dermatoglyphics* which includes fingerprint analysis. Fingerprints, as a form of biometrics, have long been recognised as unique to each individual and can provide deep insights into a person's personal characteristics. (Hadiyanto et al., 2021). Research that has been developed at Harvard University states that there is a close relationship between fingerprint characters and the function of the human brain cell growth hormone system (*nerve growth factor*).

The use of fingerprint biometrics is seen as a method that can help educators better understand students' learning characteristics based on their fingerprint patterns. (Ahmad Juheri, 2018). Several studies have shown a correlation between fingerprint patterns and a person's cognitive and personality tendencies. For example, research by Wati (2015), showed that certain patterns in fingerprints can be associated with analytical or creative thinking abilities. Fingerprint analysis has also been considered as a method to identify learning styles as each individual has unique fingerprint characteristics, potentially providing in-depth information regarding students' cognitive tendencies. (Alfadila et al., 2022).. Thus, fingerprint biometric analysis can be the basis for designing more effective learning methods.

Based on this background, this research aims to explore and analyse the potential of fingerprint biometrics in understanding and identifying students' learning styles. This research also seeks to evaluate the extent to which fingerprint biometric data can be used as a foundation for developing effective learning strategies, so that it is expected to make a positive contribution in maximising the learning potential of each student.

METHODS

This research is a qualitative study using a *systematic review* method based on several references to scientific publication articles online. *Systematic review* is a research method to identify, evaluate and interpret all relevant research results related to certain research questions, certain topics or phenomena of concern. (Siswanto, 2010). The *systematic review* method includes synthesis, which summarises various expert opinions through articles and scientific publications with *meta-synthesis* techniques and data integration to obtain new theories and concepts or a deeper and more comprehensive level of understanding (Perry & Hammond, 2002). (Perry & Hammond, 2002).

The data sources used in this research are books, journals and articles relevant to the topic of this research. Data sources were obtained online using digital libraries such as Google Scholar and Garuda. Searching and selecting journals using keywords that match the topic by determining the exclusion and inclusion criteria. The data collection technique uses cumulative research results that have relevance to previous research. Data *analysis* uses the *content* analysis method, which is an analysis of the content that focuses on bibliometric analysis of fingerprints in determining learning styles. (Schreier, 2024).

RESULTS AND DISCUSSION

This study found a correlation between fingerprint patterns and students' learning styles, indicating that fingerprint biometrics has the potential to be used as a tool in analysing students' learning preferences and needs. This finding supports a number of previous studies that mentioned that fingerprint patterns have a relationship with cognitive characteristics and individual learning styles. (Saefiana et al., 2022).. By understanding these correlations, educators can have a more scientific basis in designing more effective and personalised learning methods, which in turn can help students in achieving maximum learning potential.

A. Student Learning Style

Each student has a different way of learning to acquire knowledge, this different way of learning is called learning style. Learning styles are specific patterns of behaviour in the process of receiving new information and developing new skills, as well as storing new information or skills. By understanding learning styles as part of the unique characteristics of each student, teachers are expected to be more creative in preparing and implementing the learning process. Therefore, teachers' understanding of the differences in students' learning styles is very important, because if teachers already know the learning styles of their students, then teachers will educate, teach, guide and direct students, so as to create the best teaching activities. (Muhammad Dasep et al., 2023)..

Learning style is understood as a student's preferred way of absorbing, processing, organising, understanding, memorising the information they acquire and solving the problems they face in learning activities through their interactions and responses to the learning environment. There are various learning styles such as auditory, kinesthetic and visual learning styles. Students with visual learning styles tend to receive information very well through vision. While students with auditory learning styles rely on hearing to acquire and process information. Furthermore, students with kinesthetic learning styles will understand lessons faster if they try or practice. Thus, the differences in students' learning styles can be seen from the way they learn and understand the information provided by the teacher. In addition, knowing students' learning styles will certainly make it easier for teachers to design lessons based on how students learn. (Azzahrah Putri et al., 2021)..

B. Relationship between Fingerprint Pattern and Learning Style

Fingerprint engravings were first researched by Cummins and Midlo, dermatoglyphics meaning derma is skin and glyph is engraving. Fingerprints are never the same in humans and never change. Almost 150 years ago, dermatoglyphics was used as a tool to answer questions related to biology, health, genetic and evolution. (Saparudin & Rasywir, 2012). In addition, it is widely used as a means of identifying a person. Fingerprint patterns have been grouped by Galton, broadly into three patterns, namely arch type, loop type and whorl type. The arch type is a line that curves distally and in this pattern there is no triradius. The loop pattern has a hook-like curve with one triradius, and the whorl pattern is vortex-shaped and has two triradius. (Baharun & Adhimiy, 2019)

Several studies have shown that fingerprint patterns not only provide unique information about individual characteristics, but are also associated with different cognitive potentials. For example, a study by Hima (2018) found that loops patterns are often found in individuals with more analytical and logical cognitive tendencies, while whorls patterns are more common in individuals with creative and intuitive thinking tendencies. This study supports those findings, where students with whorls pattern show a more visual and intuitive learning preference, while students with loops pattern tend to rely more on listening and detail-focused learning process. This finding is relevant to research conducted by Wulandari (2020)who identified that fingerprint patterns can provide an insight into the learning styles of students in primary school. They found that fingerprints can be used to help understand individual learning styles, which can then be utilised in the development of adaptive learning strategies. This study is in line with research that shows a link between

fingerprint patterns and learning preferences, which include visual, auditory and kinesthetic learning styles. (Dewi & Yusri, 2023).

C. The Potential of Fingerprint Biometrics in Education Development

One of the main benefits of using fingerprint biometrics is its ability to provide accurate and stable data about an individual's characteristics that do not change throughout his or her life. (Riadi, 2021). The use of biometrics in education offers opportunities to support educational approaches that are based on the needs and characteristics of individual students. As stated by Dewi and Yusri (2023), understanding individual learning styles can encourage the development of more appropriate learning strategies, so that students can learn more effectively and efficiently.

Several studies have indicated that biometric-based approaches have the potential to support educational activities at various levels. For example, the use of biometric data can assist teachers in understanding students' learning preferences, which in turn can improve learning motivation and academic achievement. (Nazhifah et al. 2022).. This application is in line with the theory of Differentiated Instruction which states that each student has different learning needs, so diverse learning methods can provide better results (Muh. Asriadi et al. 2022). (Muh. Asriadi et al., 2023)..

D. Practical Implications of Using Fingerprint Biometrics in Education

The implications of using fingerprint biometrics in education are wide-ranging. With fingerprint analysis, schools and educators can develop curricula that are more adaptive and tailored to student needs. In addition, by understanding students' learning styles more specifically, educators can develop more varied teaching strategies, for example by adding visual elements for students with visual learning styles, or using a discussion-based learning approach for students with auditory learning styles. (Fitri & Nani Solihati, 2023).. A study by Mundijo (2017) showed that the use of fingerprint biometrics in secondary schools can benefit the development of students' learning patterns. In their study, fingerprint analysis was used to assess students' learning abilities and provide recommendations regarding appropriate learning approaches. The results showed that students who learnt with methods tailored to their preferences experienced a significant increase in academic performance.

E. Ethical Challenges and Considerations in the Use of Biometrics

While offering a lot of potential, the use of fingerprint biometrics in education also faces challenges, especially related to privacy and ethics. Biometric data collection involves sensitive personal information, so a strict data security system is needed to protect student information. (Ardiya & Pramusinto, 2022). In addition, there is a concern that the application of biometrics in education may stigmatise or label students if the fingerprint pattern is considered to determine their academic ability completely. Therefore, it is important for educators to prioritise the use of biometrics as one of the tools in understanding students, not as an absolute determinant of their learning ability. To minimise such risks, this study suggests that the use of biometrics should be integrated carefully and ethically, and balanced with a holistic pedagogical approach. This means that the results of fingerprint biometric analysis should only be one component in determining learning strategies, combined with

other factors such as learning preferences, interests, and student motivation. (Ardhani & Ismanto, 2018).

CONCLUSIONS

Based on the results of this study, it can be concluded that fingerprint biometrics have great potential to be used in identifying and analysing students' learning styles which can support in improving learning effectiveness. However, more research is needed to understand more about the relationship between fingerprints and other cognitive characteristics. Future research is expected to conduct trials on a larger scale and involve a variety of student ages to strengthen the findings.

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