# UNIVERSITI TEKNOLOGI MARA

# EXPLORING BLIND USERS MAP LEARNING EXPERIENCE FOR OUTDOOR WAYFINDING USING AN AUDIO-TACTILE MAP

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# ABSTRACT

The lack of studies focusing on blind users' experiences interacting with audio-tactile maps for learning wayfinding is a concern. There is an urgent need to understand their potential when using an audio-tactile map. This research aims to investigate blind users' experiences in learning wayfinding using an audio-tactile map that was developed based on the attributes they required. It specifically studies 44 totally blind users due to the challenge of complete loss of vision. This research is based on a qualitative research approach, where data from interview questionnaires and user studies with blind users was gathered. There were six phases involved to achieve the research objectives, which initially started with planning and reviewing literature, feature and function identification to include on a prototype, prototype development, evaluating user experience using the prototype, analyzing and interpreting data to yield important map learning elements and blind user map learning criteria, before finally verifying the elements with expert users, which leads to a refined BUML-UX model and a design model for a non-visual interface. The collected data focused on the spatial information that is salient to their wayfinding, presented in tactile symbols and ambient sounds based on their perception, as well as learning maps from different perspectives. The data was analyzed using thematic analysis to evaluate and determine map learning elements from users' perceptions of non-instrumental and instrumental qualities and users' emotional reactions that influence their map learning experience. The instrumental qualities (speech, ambient sounds, tactile symbols for presenting spatial information, and static or rotatable learning techniques to understand orientation) and non-instrumental qualities (satisfaction and vitality) lead to a positive experience for blind users. Their emotional reactions towards how the information is presented for them to use are crucial for researchers, designers, and software developers to take note of. This research contributes to theoretical, empirical, and practical contributions. It is hoped that the outcomes of this research can enhance audio-tactile maps or other comparable technology for blind users' learning wayfinding through improved technology.

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# CHAPTER 1
# INTRODUCTION

## 1.1 Research Background

Navigating in a real-world setting is one of the difficulties enduring blind people (Golledge, 1999; Wang et al., 2023) due to the lack of information about what is around them. Since vision is unable to be relied on, other modalities such as hearing, touch, proprioceptive or vestibular, are used by blind people to perceive information about the surrounding environment (Voss, 2016). The information perceived from the different channel(s) are converged and overlaps for spatial processing in several different areas of the brain (Millar, 1994). The organization of the information in blind people's brains will form an internal representation of the travelled environment which is also known as cognitive maps (Millar, 1994).

A considerable amount of literature has investigated how the cognitive maps of people without vision in wayfinding can be supported (Bleau et al., 2023; Giudice, 2018; Giudice et al., 2020; Kaplan & Pyayt, 2024; Koustriava et al., 2016; Papadopoulos et al., 2017; Papadopoulos, Barouti, et al., 2018; Papadopoulos, Koustriava, et al., 2018; Schinazi et al., 2016; Telesinska, 2023). Millar (1994) pointed out there are three types of information that are important for blind people to get around; 1) advance information about what is around (Kitchin & Blades, 2002; Papadopoulos & Karanikolas, 2009; Papadopoulos, Barouti, & Koustriava, 2016), 2) information from permanent sources (Kitchin & Blades, 2002; Papadopoulos & Karanikolas, 2009; Papadopoulos, Barouti, & Koustriava, 2016) and 3) information on the relation between different frames of reference (Giudice, 2018; Millar, 1994; Schinazi et al., 2016). The first two types of information have been greatly discovered by the studies on the use of tactile maps by blind users during the preparation phase. However, the third type of information that is related to understanding spatial cognition is still underexplored in the related studies with map use at the preparation phase (Edwards et al., 2015). Spatial cognition refers to the ability of an individual to use knowledge about spatial relationships and environments, e.g. locating points in space, and determining the orientation of objects (Kaufman & Cameron-Bradley, 2015). This relates to the use of a frame of reference by the person in coding the information of the position or direction