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# TECHNICAL REPORT

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**Peppy Pole: An Anthropomorphic and Interactive Hiking Companion**

by

Sahar Mahavli

Shanny Lu

Ursa Maity

**CPEN 541 Human Interface Technologies**

## **Acknowledgement**

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## **Abstract**

In this paper, we present the Peppy Pole, an anthropomorphic and interactive hiking pole prototype that merges life-like features with the innate functionality of a hiking pole to create rich and interactive experiences for hikers. Compared to regular or other forms of smart hiking poles, the Peppy Pole leverages the 'poleness' of a hiking pole in its character. Our prototype is made up of a smartphone collecting sensor data, sending the data to an Arduino Uno that actuates the expressions of the Pole with motors. Our findings in a two-steps user study evaluating the indoor function of the Pole partially supported the fact that the Peppy Pole's life-like features can motivate hikers to go on hikes more frequently by displaying its "own" wish to be taken out on hikes. We also found while evaluating the outdoor functions of the Peppy Pole that it helped hikers hike more distances compared to a regular pole.

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# Introduction

Today, trekking and hiking is one of most popular outdoor and recreation activities. Many technologies such as GPS devices, satellite phones, personal locator beams, and smartphones are examples of technologies influencing the experience of hiking and other outdoor recreations (Blackwell (2015)). It can be observed that while there are many technologies created and proposed to enhance the hiking experience in terms of navigation, safety, and comfort, there are no signs of using technological devices and interfaces for improving the social and emotional aspects of these outdoor activities.

Research on anthropomorphic interfaces and designing products with lifelike traits suggests that these technologies can influence the emotional connection between the user and the product (Burnebeit et al. (2009)). However, the potential for using these interfaces in outdoor activities and the effect of the mentioned emotional attachment on the hiking experience has not yet been explored.

To engage hikers in personal experiences stimulated by the physical, emotional and behavioral traits of the hiking pole, we propose to design an anthropomorphic hiking pole that communicates its feelings to the hiker and responds to the hiker's actions. This form of interaction can create and enhance the emotional attachment between the hiker and the hiking pole. We will explore whether this attachment can subsequently encourage and motivate the hiker to hike more frequently and for longer periods and distances.

## 1.1 Organization of the Report

This report is structured as follows:

- ✓ Chapter 1 provides a brief introduction and describes an outline of the project.

- ✓ Chapter 2 discusses the concept of Anthropomorphic Objects and the motivation to use it in a hiking pole,
- ✓ Chapter 3 discusses the methods used for designing the Peppy Pole prototype and the design of our user study.
- ✓ Chapter 4 contains the compilation of the results obtained from our user study.
- ✓ Chapter 5 highlights the limitations of the prototype and user study as well as the future scope of this work,

# **Background**

## **2.1 Introduction to Anthropomorphic Objects**

Humans have a natural need for social connections which forms one of the strong motivation factors for the tendency to choose anthropomorphic gadgets (Epley et al. (2008)). Brown (2010) proposed that numerous anthropomorphic techniques have been increasingly applied nowadays, especially by marketing brands. Beyond that, Mourey et al. (2017) mentioned that the fast development of the Internet of Things has created items that appear to be “alive” through intuitiveness, interaction, responsiveness, and even personality. The fact that individuals are engaged with anthropomorphic products consists with the belongings theory saying that people own a fundamental demand to belong and form social attachments with live being.

The manner in which anthropomorphic tendencies actualize differs based on different personal preferences. Previous research indicates that people who suffer chronic loneliness are more likely to assign human like traits to devices like an alarm clock, air purifier, battery charger, etcBartz et al. (2016). A study including 210 Australian participants, on effects of anthropomorphic tendency on destination attitude and travel intentions indicated that people with high levels of anthropomorphic tendency prefer to humanized destination, travel intentions and view a personified traveling advertisementLetheren et al. (2017).

## **2.2 Lifelike Characteristics in Anthropomorphic Objects**

Adding lifelike characteristics to different products can influence the relationship between the user and the product. A study by Burnebeit et al. (2009) introduced a product prototype called the Impatient Toaster which presented lifelike traits to encourage people to use it more often. They showed that these traits help create an emotional bond between the user and the product.

Such an emotional attachment with everyday objects may be investigated further in all aspects of people's lives ranging from indoor activities to outdoor recreation such as hiking or trekking.

Row and Nam (2016) conducted a study on lifelike characteristics in interfaces. They found out that for the interfaces to feel more alive to the users, they must have certain features. Some important examples of these features are lively movement in the interface, behaving like an independent agent and acting autonomously without need for operation, and having an appearance resembling a living organism. Features like these are included in the design of an anthropomorphic interface to make it feel more alive to the user.

## 2.3 Motivation to Design Anthropomorphic Hiking Poles

Even though there are many patents owned and papers published on multi-purpose smart hiking poles/canes, there is no evidence of research on the effects of augmented anthropomorphic features on hiking poles or walking sticks.

Hanlin (2020) invented a smart ski pole with integrated speaker that includes a display, a speaker, buttons and a controller all within the pole grip. With a different set of features, Alghazi (2015) has invented a multi-functional smart mobility aid device that includes sensors to collect biometric information and perform activity tracking. Several versions of smart white canes for the visually impaired has also been designed and proposed by A. et al. (2019), Hung et al. (2018) and Yohannan and Shyam (2020). These canes use ultrasonic or infrared sensors for recognizing obstacles and inform the user with haptic and/or audio feedback. Although these hiking poles are functional and have smart features, not much focus is directed on addressing how to create an emotional bonding with the hiking pole/cane and how that bonding will affect the user experience.

Anthropomorphism does not necessarily mean assigning superficial characteristics such as a human-like face or body, but rather to create objects with more significant human characteristics like the ability to think and feel emotions (Waytz et al. (2014)). In the light of this definition, we observed there has not been much focus in existing literature on an anthropomorphic hiking pole for establishing emotional connection with the hiker that might improve the social and motivational aspects of the hiking experience. It is expected that this shall be a more intimate experience for the hiker than just a smart assistant on a smartphone, i.e., and in the design, the primary focus is on the pole's physically-*"poleness"*.

# Methods

The Peppy Pole prototype has been designed with the features mentioned in Section 3.1 and the design process is described in Section 3.2. The user study was designed considering time constraints and limited availability of participants due to the current pandemic situation.

## 3.1 Prototype Features

To design lifelike features in the prototype, we try to observe and imagine how a living hiking pole would feel in different situations. Focus has been given on features that give a sense of aliveness. The movement of the hiking pole's wrist straps is used to express the feelings of the pole because lively movement is considered to be a very effective anthropomorphic feature (Row and Nam (2016)). The following are the sets of augmented features of the prototype referred to as the "Peppy Pole" in the upcoming sections.

### 3.1.1 Outdoor Features

- In the beginning of the hike, the Peppy Pole shows it is excited by a particular movement.
- During the hike, after a certain period of walking, the Peppy pole gets tired and lets the hiker know of its current fatigue by a combination of spinning and tugging movements.
- The Peppy Pole keeps expressing its tiredness until the user takes a break from hiking and let it rest for some time.
- After being well rested, the Peppy Pole will express its excitement again. This feature is allowing the hiker to acknowledge the feelings of the Peppy Pole as an independent entity and at the same time helps the user have regular breaks during their hike.

- The hiker can also let the Peppy Pole know when he/she gets tired by holding the pole loosely at an angle tilted towards the ground. This gesture was chosen because it corresponds well with the feeling of fatigue. The Peppy Pole will respond to the hikers' feeling to create a sense of support and encouragement.

Our goal in designing these sets of features is to see if these living traits in a hiking pole or walking stick can help the hiker be more motivated to finish their hike and hike for longer periods of time.

### 3.1.2 Indoor Features

- The Peppy Pole's general satisfaction grows with the number of steps it takes in a hike.
- The Peppy Pole's satisfaction decreases by the hours it sits idle at home, not walking.
- Based on how many steps the user has walked with it, the Peppy Pole will be "content" for a number of days and after that it will start to show signs of boredom and restlessness until the user takes it on another hike and walks with it some more.

These features were introduced to investigate how the expression of boredom or request to be taken out on another hike affect the users' motivation to hike more often and their hiking habits in general.

## 3.2 Prototype Design Process

Our prototype of the Peppy pole consists of 3 main parts : Arduino Uno, motors, and smartphone attached to a single hiking pole as shown in Figure 3.1.

### 3.2.1 Motors

- Two 3-6V DC motors are used for displaying the features discussed in the previous section. The motors are supposed to move the two parts in the hiking pole's wrist band, marked part (a) and (b) in Figure 3.1.
- Different speeds and moving patterns for different situations by trial and error.

- When the pole is excited and happy to start the hike, Motor A spins at high speed about rpm. For ease of viewing, a green ribbon is attached to Motor A and fixed on the top of the prototype. There is a 20s and 10s delay in the spinning. We set the Motor Pin of the Arduino to analog value of 0. In an ideal version, this motion shall be displayed by attaching Motor A to Part (a).
- When the pole is tired and wants to stop for rest, Motor A spins slowly it and the Motor B tugs on the Part (b) of the wrist band. The tugging was achieved by tying one end of a thin string to Motor B which spins and the other end to Part (b) of the wrist strap. There is a 3 and 5s delay in the spinning. We set the Motor Pin of the Arduino to analog value of 40.
- When the user tells the pole that he/she is tired, only the tugging motion is activated. Motor A does not spin.

### 3.2.2 Smartphone

- We are using the sensor data from the smartphone to cue the actions of the Peppy Pole in different situations. This approach was chosen for ease of building the control for our prototype. Also, current smartphone models usually have sensitive sensors.
- Pedometer sensor of the smartphone model is used to count steps and Orientation sensor is used to detect any titling action.
- We developed two android applications for the two sets of features (outdoors and indoors) explained in the previous section.
- An Android application called the PeppyOutdoors is developed for the features mentioned in Section 3.1.1. It uses the pedometer data from the smartphone sensor to count the number of steps the pole is walking to determine when it should get tired. When the hiker want to express their tiredness to the pole they should hold the pole loosely and tilted towards the ground. The Application uses the orientation sensor on the smartphone to sense when the user is tilting the pole more than the set threshold.
- Another Android application called PeppyIndoors is developed for the features mentioned in Section 3.1.2. It keeps track of the number of steps the user takes and then sets a timer

based on that count eventually giving a signal to the user via the Peppy Pole's movement that it is time to be taken out for a hike.

### 3.2.3 Arduino Uno

We use a serial connection using USB-C to USB cable to connect the smartphone to the Arduino Uno. The Arduino receives the signals from the smartphone through the serial connection and is programmed to control the movements of the Motor A and B.

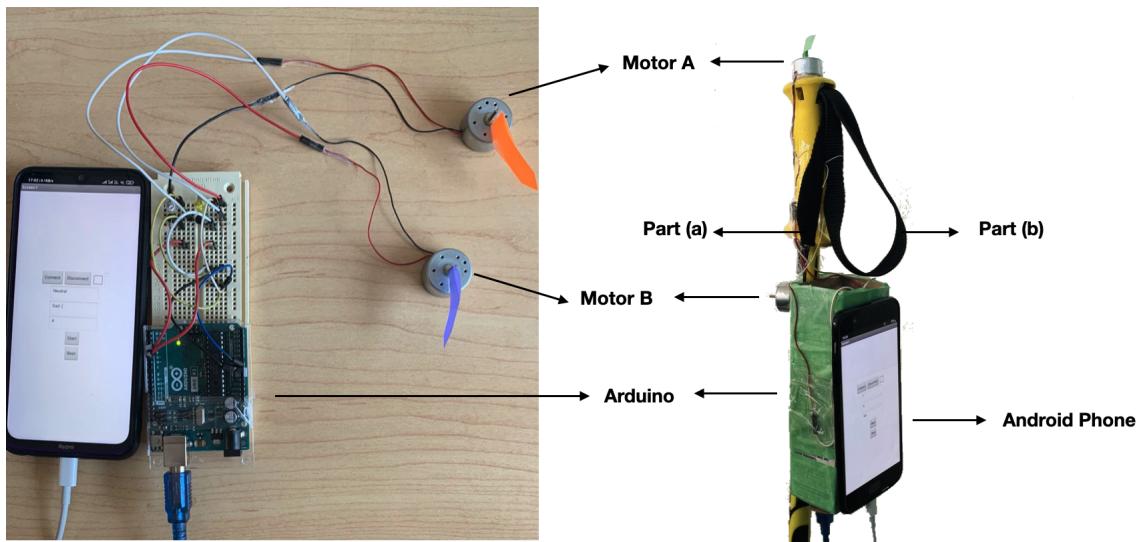


Figure 3.1: Peppy Pole Design Prototype

## 3.3 List of Components

The list of components used for the prototype along with the resources used are given below. We use the connections as shown in Figure 3.2 to connect the two motors to the Arduino Uno. An zoomed in view of our connection is attached in Figure 3.3.

1. EXP-300 Experimentor Solderless Breadboard
2. Arduino Uno Rev3
3. Transistor P2N222A (2 units)
4. Jumper Wires- F/F, M/F 28AWG
5. Cable

6. USB (F) to USB-C (M) cable
7. 3-6V DC Motor
8. Red and Green LEDs (1 each)
9. 10 ohm and 100 ohm Resistors (1 each)
10. Smartphone One Plus 5: in-built sensors used.
11. PeppyOutdoor and PeppyIndoor developed using the MIT App Inventor

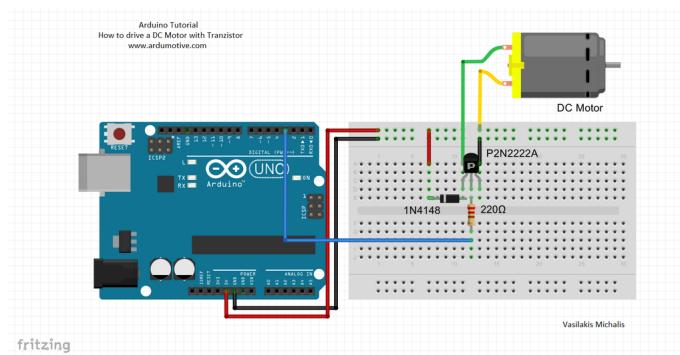


Figure 3.2: The connection shown here is from a tutorial in [www.instructables.com](http://www.instructables.com)

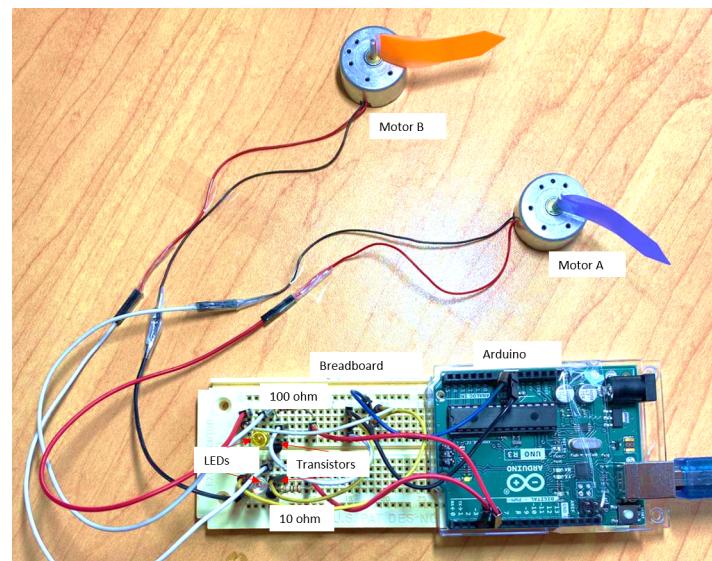


Figure 3.3: The components used are labelled in the image

## 3.4 User Study Design

In order to test the indoors and outdoors features of the Pole we designed two experiments. Before conducting the actual user study, we initially performed a pilot study with 2 participants (1 female and 1 male). Some questionnaire questions and prototype design were improved based on their feedback.

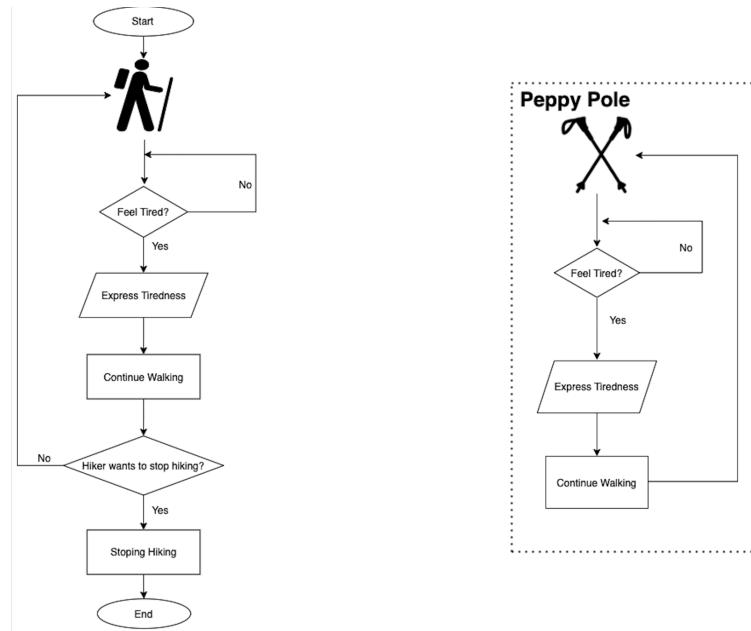


Figure 3.4: Flow Chart showing Hiker with Peppy Pole during Outdoor activities

### 3.4.1 COVID 19 Safety Measures

Having the safety and well-being of the participants in the user study was our most important goal. In order to comply with the COVID-19 safety measures in our experiments, we conducted the outdoors experiment in an open and outdoors setting. We sanitized the prototype after each user performed the tasks and maintained social distancing during the experiments. In the indoors experiments, we handed the sanitized prototype to the users along with instructions and they chose to do the study either at their homes or at study rooms while wearing face masks. We then conducted the interviews online.

### 3.4.2 Phase A: Outdoors Experiment

- In order to simulate the real conditions of a hiking trip and make the participants feel tired while addressing time limitation issues, we conducted our outdoors experiment at the entrance of Wreck Beach in Vancouver, British Columbia which leads to a set of 490 outdoors stairs.
- After introducing the features of the Peppy Pole, the participants were asked to climb 100 stairs up and down once with the Peppy Pole and once with the a regular hiking pole. This is to make sure the user becomes familiar with walking with a hiking pole and the augmented features of the Peppy Pole.
- The participants were asked to climb the stairs again with the Peppy Pole and the regular hiking pole, but this time they were asked to climb as many stairs as they felt like.
- The stair count, the time, and the number of times the Peppy Pole took a rest were recorded for each round and analyzed later.
- The participants were then interviewed and asked to fill a questionnaire. The participants were asked to get sufficient rest and refresh between each round of climbing stairs.
- To reduce the confound effect caused by the order of whether using Peppy Pole or regular pole first, half of the participants were randomly assigned to climb with Peppy Pole first and the other half climbed with the regular hiking pole first. The proposed outdoor activities interaction between hikers and Peppy Pole is shown in the Figure 3.4. Figure 3.5 illustrates the interaction between hiker and Peppy Pole while they get tired as shown in Figure 3.4. Hiker will express tiredness by holding the hiking pole over 45 degree, and Peppy will express its tiredness by tugging wrist bands and spinning motor.

### 3.4.3 Phase B: Indoors Experiment

- In the indoors experiment the users spent 1.5 hours with the Peppy Pole at their homes or at study rooms. After they were explained how the Pole works, they were asked to walk with the pole around the room for 20-30 steps and go back to what they planned to do, such as studying, cooking, reading, playing video games, etc.

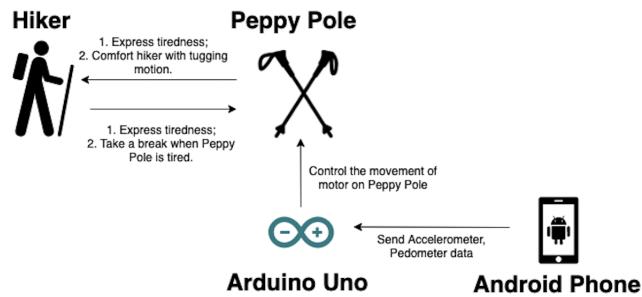


Figure 3.5: Peppy Pole Mechanism and Interaction with Hiker in Outdoor Activities.

- After a certain period of time depending on the number of steps they walk, when the pole gets bored and expresses its boredom the participant has to walk with it some more.
- Participants usually will repeat the process to get familiar with this function. This is done to avoid the use of a novelty design by the participant influencing the experimental results.
- After 1.5 hours with the pole, the participants were asked to fill a questionnaire and interviewed by the authors.

### 3.4.4 Hypothesis

We defined two hypotheses to perform data analysis in our user study.

#### Hypothesis 1

$H_0$ : There won't be a difference in the distance covered by the user when using the Peppy Pole with "poleness" life-like features compared to the regular hiking pole.

$H_1$ : There will be a difference in the distance covered by the user when using the Peppy Pole compared to the regular hiking pole.

# **Results and Discussion**

## **4.1 Participants Data**

We recruited two separate sets of Participants for the two phases of our user study. For Phase A: outdoor experiment, six participants (3 male and 3 female) aged between 23-27 were recruited. Most (five) of them identify themselves as physically fit, while one doesn't. Three hike once a month, one hikes once every 2-3 months, while two users have never hiked before. Also, three of them have experience in using hiking pole before.

For Phase B: indoor experiment, five participants (3 female and 2 male) with the age between 23-27 were recruited. All of the participants were UBC students.

Three participants were common in Phase A and B experiments. Before beginning the experiments, participants gave written consent for the investigators to use the questionnaire response and audio recording of the interview. The details of the Participants in both Phases are given in Table 4.1 and Table 4.2.

*Note: All participants were requested to follow the Covid-19 protocol. The Peppy Pole prototype and the regular pole was sanitized regularly with rubbing alcohol between each change of hands.*

## **4.2 Phase A: Outdoors Experiment**

### **4.2.1 Quantitative Analysis**

The participants are given the freedom to walk as long as they want. Thus, in order to compare among different users to analyze whether they prefer to cover longer distance with Peppy Pole, we first set the number of steps with regular pole for all users to the fixed value, 100 steps, and

Participant Code	Age	Sex	Used Hiking Pole before	Hiking Frequency
A	25	Female	No	Never
B	24	Male	Yes	Once a month
C	24	Female	No	Never
D	27	Female	No	Once a month
E	23	Male	Yes	Once every 2-3 months
F	24	Male	Yes	Once a month

Table 4.1: Participant Details for Phase A

Participant Code	Age	Sex
D	27	Female
E	23	Male
F	24	Male
G	24	Female
H	23	Female

Table 4.2: Participant Details for Phase B

then scaled the number of steps with Peppy Pole correspondingly by following the formula:

$$\text{Number of Steps}_{(scaled)} = 100 \times \frac{\text{Steps with Peppy Pole}}{\text{Steps with Regular Pole}}$$

Using R, a repeated measures ANOVA test on the dependent variable: number of steps, was conducted to investigate the data and validate them against our hypothesis. Specifically, we analyze whether these additional anthropomorphic features on Peppy Pole compared to regular pole motivated participants to walk longer. As shown in the Figure 4.1 below, based on the analysis result:  $F_{(1,10)} = 5.764$ ,  $p = 0.0373 < 0.05$ , we can reject the hypothesis  $H_0$  that there will not be a difference between the number of steps the users choose to climb when using the Peppy Pole with "poleness" life-like features compared to the regular hiking pole. Based on collected comparative data, as shown in Figure 4.2, most users were willing to walk longer with the Peppy Pole, while two users hiked the same distance. Therefore we can also conclude that users would prefer to cover longer distance with the lifelike features embedded in Peppy Pole

compared with regular hiking pole.

```
Df Sum Sq Mean Sq F value Pr(>F)
Regular.or.Peppy..0.or.1. 1 600.9 600.9 5.764 0.0373 *
Residuals                 10 1042.6 104.3
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 4.1: ANOVA Test Results for Hypothesis 1

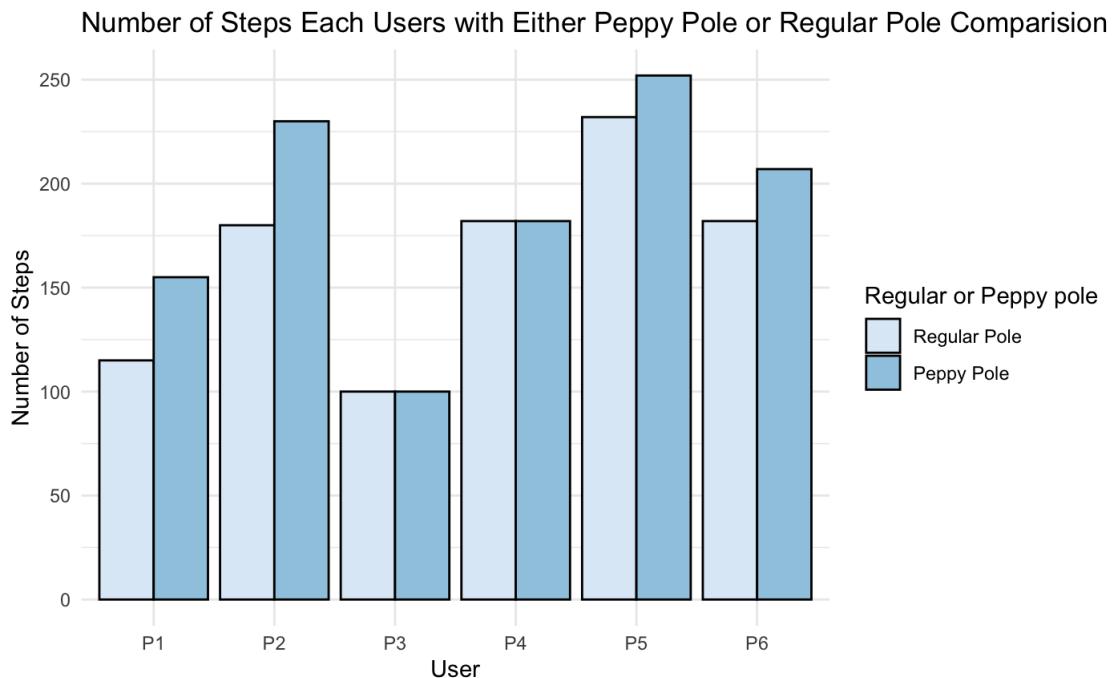


Figure 4.2: Comparison of the number of steps each user Walked with either Peppy Pole or regular Pole

After completing the outdoors experiment, the participants were asked to fill a questionnaire designed with the five-point Likert scale. Their responses to some of the key questions of the questionnaire are shown in the Figure 4.3 based on their responses in the questionnaire, the participants gave an average response of 4 to the statement: the sound and movements of the Peppy Pole made it seems alive. Except one user (disagree) the other 5 either strongly agreed or agreed to the statement: Compared to a regular pole, the Peppy Pole makes the user more motivated to finish the hike. This statement got an average of 4 from all 6 users.

It can be observed that the users were not enthusiastic about the feature of hiking pole responding to their tiredness and gave a score of 3.34 to the statement: the Peppy Pole's response

to my tiredness provided comfort for me. Based on the results, the overall enjoyability of the hike increases when using the Peppy Pole. The participants scored the statement: compared to when using a regular hiking pole, I enjoyed my hike more with the Peppy Pole, as 4.34 which is a very good score relatively. Overall, the users agreed with a mean of 3.83 that they prefer to use the Peppy Pole instead of a regular pole in the future hikes.

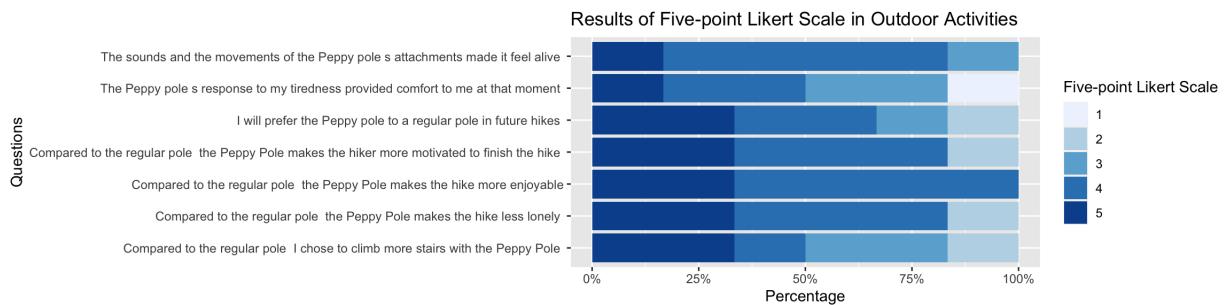


Figure 4.3: Results of Five-point Likert Scale Analysis in Outdoor Activities in Questionnaire. Here the scale values are defined as follows: Strongly disagree-1, Disagree-2, Neutral-3, Agree-4, Strongly agree-5

## 4.2.2 Qualitative Analysis

Semi-structured interviews were conducted with each participant in both experiments during the user study. You can see the main findings of this analysis in terms of different features of the Peppy Pole grouped in the following subsections.

### 4.2.2.1 Augmented Features

Four out of six participants found the way the Peppy Pole expressed its feeling interesting and commented on the Pole's movements. Overall they found the way the pole moved and tugged the wrist bands 'cute' and 'likable'. It seemed like most of the participants preferred the tugging motion. Given below are some direct accounts of the participants regarding the prototype's movement.

1. Participant D: "The spinning gives the pole a character. The tugging felt like a child really intimate and likeable." A: "Partially. But better if we add some more sounds. the tugging feature is great."
2. Participant C: "Yes, it felt very alive. I liked the tugging feature."

### 3. Participant F: " I like the tugging motion and think it was cute."

Four participants commented on how they liked the fact that the Pole got tired after some time and they needed to give it some rest before continuing the hike. They felt like it affects the quality of their hike positively and felt like it was helpful in letting them know they should also take a break.

Participant F stated that "It is very good that it makes the hiker have rest in equal intervals because it is very important in hiking. The Pole should take slope and conditions of the trail into consideration when computing when to get tired to match the hiker's condition better." It seems like the participants were mostly interested in how the Pole's regular breaks will affect their rest management during hikes and they made suggestions to improve this feature in ways that benefit the hiker's experience. They also made general suggestion about improving the resting feature such as suggesting to drink water or snacks.

Participant A suggested that the pole "should evolve with their hiking experience and match its stamina to the stamina of the hiker as they become more fit."

One feature that seemed to be not interesting in the users' point of view was the hiker's ability to communicate her/his tiredness to the pole. Two of the participants mentioned this features as a negative point.

Participant F said, "I personally didn't like telling the pole I am tired and felt like it was useless". While the other participants did not mention it explicitly, they did not seem to be very interested in that feature of the Peppy Pole as well. According to one of the participants it is easy to forget to use this feature because it has to be initiated by the hiker.

#### **4.2.2.2 Motivations and Loneliness**

Three participants commented on how the Peppy Pole was effective in their motivation to finish the hike.

1. Participant A, mentioned that the fact that "the pole got excited to start walking after each break" made them motivated.
2. Participant E, said that the pole was motivating them to hike more distance because "...the cue actually pushed me to go a little bit further every single time."
3. Participant F, felt that while the Peppy Pole affected the motivation "to hike with better quality". Also, It "did not affect their motivation to finish the hike directly."

The Peppy Pole can also be effective in reducing the hiker's loneliness during hikes. Three participants mentioned how the life-like features of the Peppy Pole made them feel like they were not alone during the hike as seen in the excerpts from their answers below.

1. Participant B: "This depends if I am hiking alone... In solo hike this is helpful .Especially, in trails that have less traffic."
2. Participant A: "...It felt like I had a friend with me..."
3. Participant D: "It makes the hike feel less lonely...As if the pole has a personality."

#### 4.2.2.3 Limitations

Users provided some constructive feedback and suggestions about the Peppy Pole. Two participants commented that the current Peppy Pole prototype is too massive, and they preferred the design of the pole to be ideally slim. Participant D said, "It was heavy. It got tired too frequently." Participant A also mentioned that the tugging feeling received from the pole was not strong and obvious enough sometimes. Participant E pointed out that Peppy Pole requested for rest too frequently, consequently he got enough rest and could not get a chance to interact with the pole while he felt tired.

### 4.3 Phase B: Indoors Experiment

#### 4.3.1 Quantitative Analysis

- In the indoors experiment the 5 participants were asked to fill a questionnaire after spending 1.5 hours with the Peppy Pole. The answers for the questionnaire were in the 5 point Likert scale format and can be viewed in Figure 4.4.
- Based on the responses collected from those participants the following can be deduced. With a mean response of 4 the majority of the participants agreed that the sounds and movements of the Peppy Pole made it feel alive.
- Except one person the other 4 either agreed or strongly agreed that the Peppy Pole's request to be taken out makes it more likely for them to go on a hike sooner and gave an average of 3.8.

- With an average of 3.8 the participants agreed that they prefer the Peppy Pole to the regular hiking pole in future hikes.

Due to the time limit, it was relatively tough to explore how frequently the users would go for a hike with either Peppy Pole or regular pole, through a comparative user study. Therefore, we couldn't directly answer the second indoor-related research question by phrasing a hypothesis. However, since we intentionally recruited users in indoor experiments with previous experience in using hiking pole, their positive feedback would be relatively meaningful to partially support the research question about whether the Peppy Pole can motivate the hiker to go on hikes more often, by displaying its "own" wish to be taken out on hikes. An extension of our current study design with more participants for a longer duration may be effective in fully answering this question.

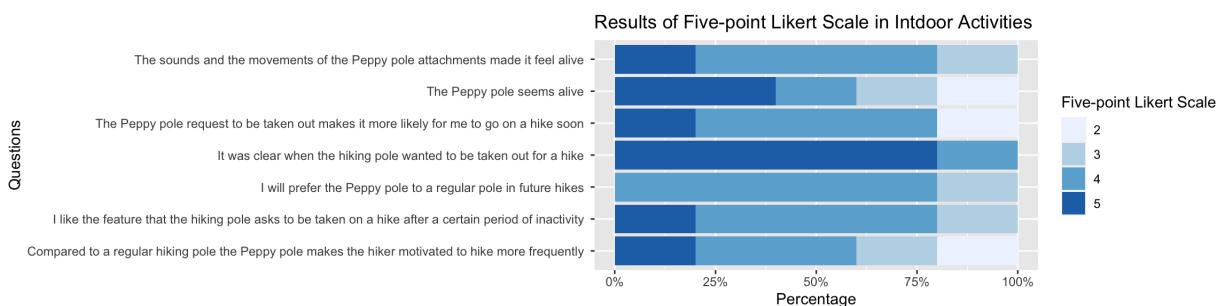


Figure 4.4: Results of Five-point Likert Scale analysis in Indoor Activities in Questionnaire

### 4.3.2 Qualitative Analysis

- Two out of five participants in the indoors experiment also suggested that the pole felt like it was alive and they believed that this sense of aliveness improves the motivational aspect of the Peppy Pole in this experiment setting. One participant expressed how he thinks that the sounds and movements the pole makes is a great addition to the way it reminds the person to go on more hikes. Another participant also said that "It's definitely different from getting a notification from your cellphone!".
- Participant G said "it is effective as motivation because it felt alive"
- Two out of five participants (F and H) mentioned concerns about how this feature of the hiking pole may not be effective in long-term. They feel like after some time the feature might get repetitive and boring and the user will decided to ignore the signals.

- The participants made recommendations on how the Pole can be smarter regarding when it gets bored. Two of them mentioned that if the pole gets bored in inconvenient times, it will not only be ineffective but also become irritating to the user. So it is better if it expresses its boredom on weekends or at times when the owner is more likely to be free.

# Conclusions

## 5.1 Prototype Limitations

We intended to use different parts of the pole as the means for its expression. The motors were originally designed to move the two parts of the wrist strap but in the current prototype one of the motors is spinning an attached strap instead of the pole's strap. This can be fixed in later versions to create a more consistent artifact.

Because of limited access to different electronic components, actions and movements of the motors did not vary as well as it should and the pole's expressions were limited by this factor. The need for using the smartphone's sensors also added to the bulkiness of the prototype and created a negative impression for some of the users in the study.

## 5.2 Experimental Limitations

Due to the time limit, our experimental design for indoor activities was condensed into a less than two hours study, which are supposed to be tested in a longer time period, such as one week. Even though in the questionnaire and semi-structured interview, we asked participants to imagine if they conducted the user study in a longer period and answered the corresponding questions, some factors would still have a potential impact on user study results. In the future, the experiment will be conducted for a longer period to investigate the motivation caused by Peppy pole's "poleness" life-like indoors features more accurately.

Regarding the outdoor experiment, some participants misunderstood our initial purpose of asking them to walk as long as they want, and intentionally walked the same distance with both Peppy Pole and regular hiking pole for consistency. Also, the rest platforms alongside the stairs at the selected experimental position: Wreck Beach, is a big confound variable for some

participants since they preferred to stop at those platform instead of a middle point of the stairs, about which we were notified while conducting the semi-structured interview.

Also, to collaborate with more participants' schedule in a short time period, we pick climbing Wreck Beach stairs as our experimental activities instead of going for a real hike. The same issues with indoor user study about the condensed hiking time occurred here as well - participants were asked to imagine they were hiking in a longer and real hiking trip. This would influence the collected data results, especially those users who didn't ever have an experience on hiking before.

Because of the Covid-19 Pandemic, the number of people allowed to gather together is extremely restricted. Recruiting more participants with diverse background to conduct the user study would make the result more persuadable and accurate.

### 5.3 Future Work

The possible improvement of the Peppy Pole is leveraging its "poleness" features instead of extra augmented features to accomplish our original "poleness" objectives and some aspects including portability and smartness.

The effectiveness of the artifact is definitely an important factor in the evaluation of the anthropomorphic features in a hiking pole. In future designs, without the mentioned limitations in the prototype, a more consistent artifact can be designed to better express the Pole's feelings and allow for better communication between the hiker and the pole. Exploring these new methods of communication and evaluating their effectiveness is a future direction in designing anthropomorphic interfaces in hiking poles.

Based on the feedback collected in the study, it is observed that while the life-like features made the Pole interesting to the users, they are mostly interested in those features that directly improve their hiking experience in terms of better performance. Therefore, we suggest more exploration in creating and features that benefit the hikers by being customized and taught based on the users' habits and tendencies.

Our user study design can be extended by recruiting more participants and more time in both the Phases A and B. Especially in Phase B, we can ask users to try out the regular pole and Peppy Pole as well and then analyze which one shall they prefer for motivation for hiking more. Getting more of this data, can help us frame a hypothesis regarding our second research

question as well. Similarly, Phase A can include more extensive hiking trails and a longer study to gather more data that shall provide a strong support to our first hypothesis.

## 5.4 Conclusion

We built an anthropomorphic and interactive hiking pole prototype called Peppy Pole, with life-like features that were built on existing features of a hiking pole. With the indoor and outdoor anthropomorphic features, we aimed to explore the potential implications in motivating hikers to go for a hike more frequently and help them walk longer distance during their trekking trips.

In addition to the normal functionality of a hiking pole, the Peppy pole gained two core functionalities in both indoor activities and outdoor activities by making some mechanical movements, sounds and tugging feelings. Through conducting the user study, the result supported the *H1* in Hypothesis 1: User will prefer to climb different distance when using the Peppy Pole with life-like features compared to the regular hiking pole. Especially, based on collected data, we could summarize that users would prefer to walk longer with our proposed Peppy Pole compared with the regular hiking pole.

Therefore, we could concluded using ANOVA test on our study findings that the Peppy Pole's outdoor features can help the hiker to cover more distance. Our findings from experienced hiking pole users also partially showed that the indoor feature can effectively motivate hikers to go on hikes by displaying its "own" wish to be taken out on hikes.

# **Useful Information**

## **A.1 Questionnaire**

### **A.1.1 Phase A**

How do you personally think about the following statements based on your experience with Peppy Pole (strongly disagree, disagree, neutral, agree, strongly agree)?

1. The Peppy pole seems alive (Acts like a live creature).
2. The Peppy pole communicates with me.
3. I could see when the Peppy pole was excited.
4. I could see when the Peppy pole was tired.
5. The Peppy pole could sense when I was tired.
6. The Peppy pole responded to my tiredness.
7. The Peppy pole's response to my tiredness provided comfort to me at that moment.
8. The sounds and the movements of the Peppy pole's attachments made it feel alive.
9. Compared to the regular pole, I chose to climb more stairs with the Peppy Pole.
10. Compared to the regular pole, I feel that I hiked quicker in the same routine with the Peppy pole.
11. Compared to a regular hiking pole, the Peppy pole:
  - (a) Makes the hike less lonely.

- (b) Makes the hike more enjoyable.
  - (c) Makes the hiker more motivated to finish the hike.
  - (d) Makes the hiker motivated to hike more frequently.
12. I will prefer the Peppy pole to a regular pole in future hikes.

### A.1.2 Phase B

How do you personally think about the following statements based on your experience with Peppy Pole (strongly disagree, disagree, neutral, agree, strongly agree)?

1. The Peppy pole seems alive (Acts like a live creature).
2. It was clear when the hiking pole wanted to be taken out for a hike.
3. The sounds and the movements of the Peppy pole's wrist strap made it feel alive.
4. I like the feature that the hiking pole asks to be taken on a hike after a certain period of inactivity.
5. The Peppy pole's request to be taken out makes it more likely for me to go on a hike soon.
6. Compared to a regular hiking pole the Peppy pole makes the hiker motivated to hike more frequently.
7. I will prefer the Peppy pole to a regular pole in future hikes.

### A.1.3 Post-experiment Interview

1. What do you think the positive points of the Peppy pole are?
2. What do you think the negative points of the Peppy pole are?
3. Imagine you're doing a longer hike when you get tired, do you think that having these features of the pole help you finish the hike?
4. What do you think about the effect of the Peppy pole in motivation to finish the hike?
5. Did the pole feel alive to you?

6. Will it be boring after some time and will you eventually ignore it?
7. Do you have any feedback/comments to improve the Peppy pole?

## A.2 Links to resources

- Google Forms were used to collect the participant data and the answers to our questionnaire. The form links are given below:
  1. Form link for Phase A
  2. Form link for Phase B
- The Code used for programming the Arduino and the MIT App Inventor is given in [here](#).
- Link to data collected [here](#).
- Link to the record of consent forms by users is [here](#).
- Copy of the Ethics Protocol Form duly signed by the Student Investigators can be found [here](#).
- Certificates of the TCPS 2: Core completion for the student investigators can be found [here](#).
- A Demo of how the Peppy Pole Prototype works can be found [here](#).

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