

EXPLORING THE BASIC ART AND DESIGN LANGUAGE THROUGH 3D PRINTED TACTILE FLASHCARDS: A PILOT STUDY

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Abstract: This article presents a pilot study conducted in a lab to investigate the design activity and to test the prototype of the 3D printed tactile flashcards on the primary language of arts through the elements of arts and the principles of design. Five volunteers have participated in the design activity. They have been questioned and tested on the prototype to see the suitability of the design activity before bringing it with the blind and visually impaired. For this study, structured interviews and direct observation of each design activity of the 3D-printed tactile flashcards have been recorded to be analyzed. The three-phase has emerged from the activity. The first phase is to establish early knowledge of the touch senses. The second phase is the intervention of the tactile flashcards and reflecting upon those visual images. The data gathered shows the consistency in valuing and identifying each image from their touch sense based on their interaction with the 3D-printed tactile flashcards. The study's results will support the 3D-printed tactile flashcards as an effective qualitative tool that could be fully utilized in the future evaluation of the blind and visually impaired group of people.

Keywords: Blind Person, Art; Haptic, Tactile

Introduction

When discussing visual art, the unsighted group audience has always been neglected; they could never enjoy visual art like the sighted audience. Through this design activity, a prototype of a 3D tactile flashcard has been produced to understand how the blind and visually impaired group (BVI) of people can enjoy art. This is to observe and stimulate the respondent toward the understanding of aesthetics in art through their sense of touch (Mohamad, Vermol, & Anwar, 2022).

A prototype of a 3D printed tactile flashcard (3D PTF) using the 3D printed technology has been created using the primary language of art and design, with the understanding of the elements of arts and the principles of design. This assistive technology that has been created for the blind and visually impaired group (BVI) is actually expected to grow and flourish at a swift pace, and this will give result in the lives of individuals in means that were not possible in those days (Bhowmick & Hazarika, 2017). Furthermore, to do so, design and technology are involved in creating such work to assist and aid them through the process of valuing and experiencing art.

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In this research paper, we will present the pilot study that took place in a verbal protocol lab with five volunteers the pilot study will be using a 3D prototype printed tactile flashcards to be tested for the purpose of the BVIG) to value and experience art through the primary language of art and design. A prototype is a tool that uses the elements of art and the principles of design with the most straightforward and basic understanding of visual art. The touch senses will be the key essential factor in bringing the results of experiencing these ideas; hence, haptic art is vital in experiencing this activity. And the essential element of the haptic exploration of this activity is that it involves active hand movement to give enough sensory information a person should receive, and it does not come from a non-resistant contact but from the action of investigating the environment (Jones, 2018).

Visual art may apply to the sighted audience, but how could this visual art be implied to the blind and visually impaired group when visual is the least they can use through their sense? Hence, visual art can only be applied to the sighted audience. Then what do we call art for the BVIG?

Research Motivation

This pilot study that took place aims to understand the BVIG of how aesthetics in the art could be applicable and understood to the BVIG through the 3D PTF as a tool to measure the BVIG art experience through the basic language of art and design with the basic's elements of art and the principle of design. The 3D tactile flashcards have been created using the idea of a touch sensor that uses the tactile relief from the flashcards that could explore within the respondent's touch senses. Tactile graphics has always been used for blind and visually impaired people made, using raised lines and texture to transfer the meaning of drawings by touch. These tactile systems seem to be one of the best tools for their graphical image understanding. (Schiff & Foulke, 1982).

Hence, the interaction between the mediator and the audience is a process of stimulating reflection on the experience. That experience then will lead to assessing whether the effect or power is thriving. This art interaction from both the audience experience and the technological approach will be crucial in evaluating both from an audience and artist perspective. This evaluation plays quite a role in the exploration and suggestion of creating art that involves an audience from all sorts of life (Candy, 2014).

The Design Activity Set-Up

The pilot study has led the researcher in deciding the three cameras that are needed and used during the actual design activity that will take place in the Malaysia Association for the Blind (MAB). The three main cameras will be placed around the respondent. The primary camera will be at the front to capture the vital part: facial expression and hand and body movements while exploring and enjoying the 3D PTF. The other two cameras will be set in two corners facing the side in front of the respondent to capture each hand movement while the design activity takes place. All these will be evidence and data to the researcher, so that this could be put together to observe and analyze each response to the 3D PTF. The sound recording will also be placed during the design activity to ensure that the interview, question and answer, is recorded to collect data and information. Moreover, these will all be recorded for putting and analysing of all information for this research.

A table and a working space are needed for the respondents to work and explore with the mediator also known as the 3D printed tactile flashcards to respond and use the touch senses. The 3D PTF is given from mediator A and mediator B and at times to mediator C. This is for the respondent to compare and explore the tool that is given to them.

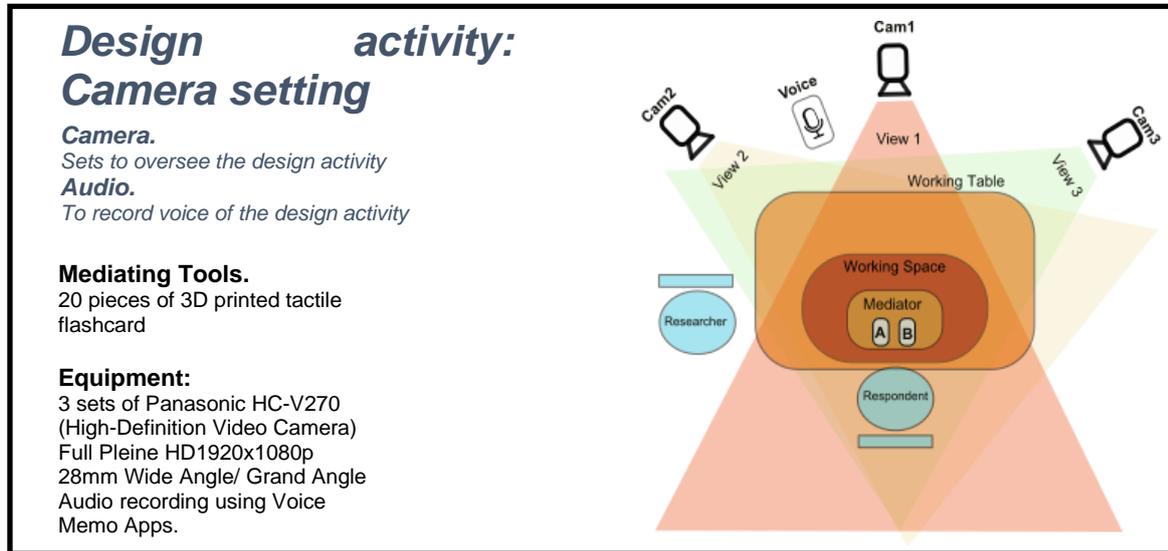


Figure 1: Camera and audio settings for the design activity.

Design Study

The design study activity plan has been constructed in figure 2. Respond to define the awareness of the BVIG of how they can enjoy artwork involved through this design activity. The research process that talks about some ways to gather information through interactive behaviour, and this is through the observation, analysing and learning from all the audience experiences as it is happening in real life.

The best way to gather information on such interactive behaviour is to observe, analyse and learn from various audience experiences as they occur in real life. (Edmonds, Bilda & Muller, 2009). Hence, the researcher had constructed methods of how they can experience it through the basic language of art with the elements of arts and the principles of design. Through this design activity, the researcher will first question of the ‘how’ art can be assisted for the main target audience of the BVIG before deciding a mediator as an art tool. Then next factor will be the ‘what’ would the respondent feel through their touch experience, haptic imagery senses is to observe and see whether the respondent can assume what the image might be. This is to understand whether the respondent can relate to the images through their experience of their surroundings. The final part would lead to the ‘how’ question. How would the respondent reflect upon those images that they have touched? Through the respondents’ action, activity and movement will lead the researcher to understand the blind and visually impaired audience with their touch sense by observing, listening and questioning what they are thinking and why they are thinking in that manner.

The idea of practice in art also involves the discipline from within art and design. An idea such as making, and methods has always come together in the process. The researcher gathered all the

information through experience and literature review. Through this idea, the researcher created a tool as a mediator to represent the art idea. Through this process, interrogation and interpretation in the production will reflect upon the art tool (Earnshaw, Liggett, Cunningham, Thompson, Excell, & Heald, 2015).

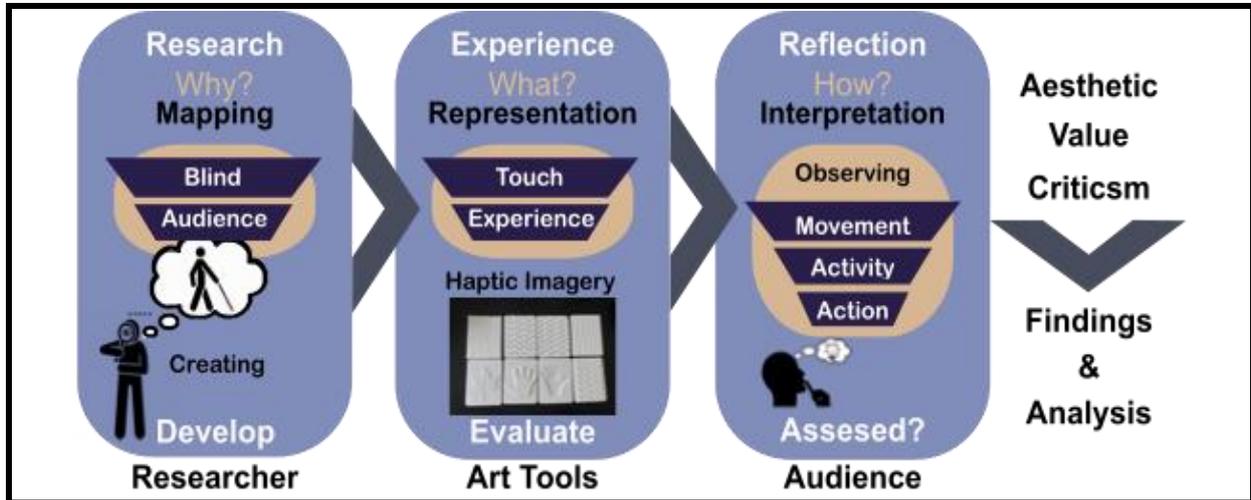


Figure 2: Design Protocol Analysis Framework through Research, Experience and Reflection of the Blind and Visually impaired Audience design study.

Research

The first stage in identifying the why is the need to close the gap between the blind and visually impaired audience and the sighted audience in enjoying the artwork, making the researcher dwell on the possibilities of tools in terms of art and design that are needed in closing this gap. Practicing art could only be qualified as research if the intention is expanded into our knowledge and understanding by conducting authentic research in and through art objects and creative processes (Borgdorff, 2006). Using a mediator from technology is needed and has been created and developed to map out the possibilities through the research process and literature review. Influenced by things around them will lead the respondent to perceive and assume what the image could be and the sensation through their touch senses.

Experience

Once the 3D PTF prototype has been created as a tool, it will lead the researcher to the possibilities that would influence the respondent. The device will then be a mediator for respondents to stimulate their thoughts, mind and experience as these will allow the respondents' views to draw their emotions and imagination. Furthermore, all data information that has been gathered is to be analysed by the researcher. The challenge for the researcher is to extract the idea of understanding, feelings, imagination and the enjoyment of the touch experience from the tactile flashcards. This is to measure the tools as an indicator, which can be used to probe further and dwell on the similarities and differences between the respondent. (Candy,2014). With the primary language and understanding of art through the elements of art and design principles. To see and observe the potential possibilities of how this group can enjoy art in the simplest manner.

Reflection

Reflecting on the response by the respondent, videotaping and audio taping demonstrated by the BVIG of the audience will lead the researcher to analyse the importance of the tools and how this could be a potential deciding factor in the art for the BVIG. Information and feedback such as sharp edges, how much rise is needed on the flashcards, and whether it will be enjoyable and fun will indicate the researcher's reflection. These observational protocols will gather information (Creswell, 2003), and reflective notes and thoughts such as speculations, feelings, problems, ideas, impressions and biases (Bogdan & Biklen, 1997) will be part of the reflective notes (Creswell, 2003).

3D Printed Tactile Flashcard Prototype as a Tool

A system using a simple design using computer software and converting it to a 3D printed technology tactile was created as a simple, fun and easy art tool to interact and value artwork with the BVIG. The primary language of art and design has always been taught in the school of art through the elements of art and the principles of design (Witte, Larmann, & Shields, 2012). Through these art fundamentals, a person probably could enjoy art more and, at the same time, also produce an artwork that could be worthwhile to the artist (Careau, 2008). This 3D printed tactile flashcard is a tool as a means of art as communication between the sighted and the unsighted group audience. Examples the cubic form is 35mm rises from the base of the flashcard.

For the blind and visually impaired group, the natural and actual object in life is more prominent than the abstract ones' (Papadaki & Tzvetkova-Arsova, 2013); hence, few images that have been portrayed on the flashcards are the everyday things we could find around us, due to this the prototype would help them relate their understanding through the flashcards presented to them.



Figure 3: The 3D-printed tactile flashcard that has been created with the basic language of art through the elements of art and the principles of design.

Experiment / Design Activity Plan

The pilot study conducted in the Formgiving Design Lab has led the research into 3 phases. Five art educators have been invited to participate in this design activity. Each respondent was blindfolded and

was made sure they could not see. The reason being is to have the idea how the blind and visually impaired group of people would be perceiving through this activity. And at the same time, the respondent was asked to use their other senses apart from their visual senses. Hence, this is to test how their visual mind works using the touch sense.

They were all informed of the intent of the research and that their participation was voluntary. The objective of this design activity is for them to be able to identify each image, pattern, shape, texture and form from the 3D PTF that has been presented to them. This is an idea of using art tool as a communication and to let them become familiar with and reflect upon each 3D PTF so that they can relate their understanding and experience through their touch senses. In other words, this study is to identify what influence each respondent has on the 3D PTF that has been presented.

This design activity aims to recognize problems and difficulties occurring during the process and could affect the validity and standard of the results. (Blessing & Chakrabati, 2009). This is for the researcher to oversee how everything planned out could collect data information. Questionnaires and interviews from this design activity play a role in gathering all feedback and responding to the 3D PTF. Open-ended questions towards the respondent were used in the interview for interaction and discussion. The reason for listening carefully to what they have to say will lead them to construct meaning for the design activity. The researcher intends to make sense of and interpret the meaning behind the 3D PTF design activity (Creswell, 2003).

Apart from that, this is to compare whether the blind and a visually impaired group of people can enjoy art with the simple art language together with the sighted audience, to the best of both worlds. In addition, the respondent is encouraged to express personal feelings, minds and thoughts of each 3D PTF that was being presented in relation to the tactile flashcards. The Verbal Protocol Analysis (VPA) design activity was conducted in the verbal protocol lab to discover the BVIG human behaviour. This method is essential in gathering information where the respondent was asked to ‘talk aloud’ or ‘think aloud’ (Green, 1998).

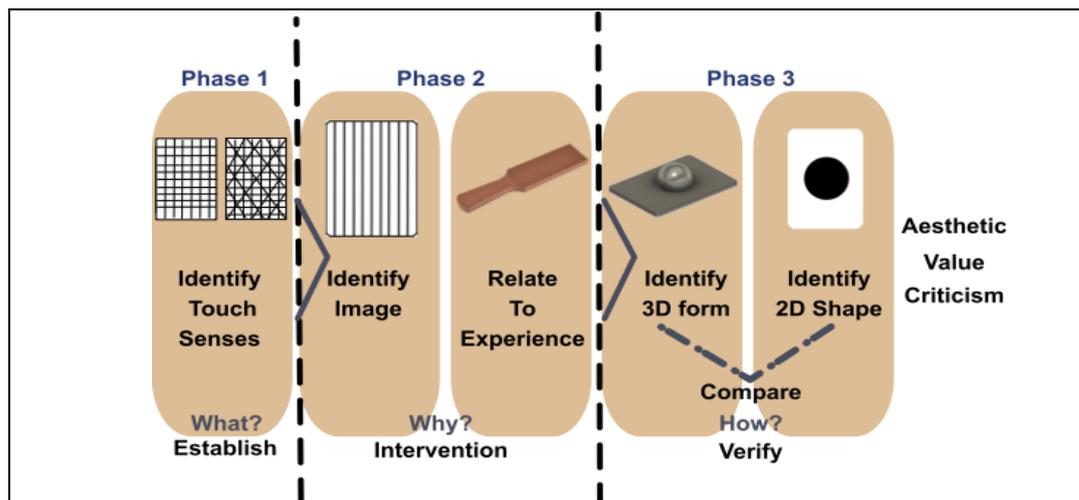


Figure 4: The design activity framework in data collection using the 3D PTF.

- ***Phase 1 – Establish***

The first phase of the activity is to identify a straightforward task of comparing two of the 3D PTFs to test their sensitivity through their touch senses to two different textures of the flashcards (Jones, 2018). The reason being is because the understanding of the blindness may also direct them to the tactile sensitivity of their touch (Grant, Thiagarajah, & Sathian, 2000). The surface of each flashcard is slightly different, one is smoother compared to the other one, but at the same time, the texture is almost like one another. This activity aims to verify that the respondent can differentiate and is aware that the surface is different from one flashcard to another. This establishes their early knowledge of their touch senses (Heller & Ballesteros, 2006). At this point, the respondent does not need to put any relation of what the image is, what it might be, or what they would think of it. Once this has been established, the respondent is able to go through the second phase of the design activity.

- ***Phase 2 – Intervention***

The next stage of the activity was to ask the respondent whether each respondent was able to identify images, patterns or shapes of the given flashcard. The first flashcard that was presented would be the line flashcards. There are three different types of lines the first would be straight lines, the second would be curvy lines, and the third is jagged lines. Because the lines were then repeated a few times on the flashcards, it also shows patterns and rhythm on the flashcards. Once that has been identified, flashcards shaped like triangles, squares and circles are given. These simple shapes are usually easy to understand. These simple basic shapes are then asked. This is to make the respondent aware of what shape it might be. The flashcards of texture are then given. Three different textures on a flashcard are given, one is with leaves texture, one is with rocks texture and another with tire texture. These three different textures are then given to the respondent. The researcher looks at how the respondent could relate their understanding and experience through all the 3D PTF they touched and their relationship with their surroundings. And how the respondents were able to identify each image that has given to them respondent. Through this process, the researcher is looking at and watching the vulnerability of their touch senses.

- ***Phase 3 – Verify***

The final phase of the design activity is for the respondent to touch the 3D form based on the flashcard. The 3D form flashcard is based on the three simplest forms: a cubic form, a spherical form and a cylinder form attached with the flashcards. All three forms rise more than the rest of the flashcard, allowing the respondent to explore and interact with more space and images or objects of the flashcards. This is also an opportunity for the respondent the have more imagination and creativity that they could relate to. The respondent experience will allow them to reflect upon other images on their map to connect back to the flashcard that is given.

And based on this activity, the researcher will take the chance to ask the respondent to compare the circle shape flashcard and the sphere form flashcard, then to compare which flashcard they can enjoy more and which is more fun to touch and play. This is to observe and collect data from respondents to be the critical point of the findings. All these data will then be collected and analyzed.



Figure 5: Design activity, overviewing three phases of activities strategically plan to establish touch responses of selected respondent mediated from the printed flashcards.

Findings and Discussions

Based on the pilot study, the three-phase has emerged from the data collected. The first phase of the activity is for the respondent to establish their knowledge in respond to their touch senses. The second phase led the respondent to has an assumption of what the image was. Basic shapes, lines and space flashcards were presented to the respondent for the respondent to assume what it is. At this phase, most respondents can answer the exact image given to what their touch senses are. The second part of the second phase that has emerged from the study will be the experience; the relation of what the image is from life experience helps the respondent to relate to each image of what it could represent from the respondent's life experience. Moreover, the third phase of the study will reflect on what everything is all about and what is prominent understanding gathered by comparing the respondents' experiences.

The first phase of the design activity leads all the respondent to be able to differentiate between two different texture that is like one another. The second phase of the design activity gives the impression that the respondent can know what each tactile represents and how it can relate to their surroundings and experience in understanding what the image might be. Two out of five respondents stated that the straight line reminded them of wallpaper. The third phase allowed the respondent to reflect upon their experience and compare what is best to hold and touch towards the tactile sense of touch. Three of five respondents mentioned that the sphere they touched reminded them of a doorknob. This shows the consistency of the visual mind of the respondent.

When touching the 3D PTF, she imagined that these flashcards are with colors even though they appear not to have color as such, but the sensation of touching led the respondent to be able to imagine such. One of the respondents mentioned that the cubic form has a very sharp edge to the flashcard, making it feel dangerous on the edges. However, one respondent enjoys the idea of the texture flashcard compared to the rest of the flashcards because the feeling when touching it is exciting. The first respondent enjoys touching; when asked why he replied that the sensitivity tends to be more due to not being able to see with the eyes. When holding and touching combined would make the respondent more aware and conscious. Some respondents tend to enjoy the texture flashcards compared to the rest of the tactile flashcards because texture gives the ability to various feelings.

Table 1: Five respondents have answered questions through the design activity on the 3D-printed tactile flashcards as a tool for this research.

Phase 1	R1	R2	R3	R4	R5
1. What can you feel?	1. Able to feel due to different textures.	1. One is rough, and one is smoother.	1. One is rough, and the other is smooth.	1. Rough and smooth	1. Rough and smooth
Phase 2	R1	R2	R3	R4	R5
1. What can you feel? <i>(Lines; straight, jagged & curvy)</i>	1. I can feel the curvy line like a wave. 2. The zig-zag line feels like shoe soles. 3. And the straight line reminds me of wallpaper.	1. I can feel the texture is undeniable.	2. The texture is noticeable and has very wavy lines. E.g., Cake mold 3. The zig zag line. E.g., wall bricks. 4. The edges help in identifying the Jagged lines. 5. Wavy lines flashcard is the best to touch. 6. Wavy lines can feel curvy. 7. There is a space that can feel the pattern of the flashcard.	1. There is a wavy texture, like a wave. 2. I can feel the movement and repetition. 3. It can feel straight line like a wallpaper. 4. Zig zag texture like a hand saw.	1. I feel the texture, like a cake mold or a washboard for clothes. 2. I can feel the wavy surface. 3. It has a jagged line texture.
2. What are you able to feel? <i>(Shape; triangle, square & circle)</i>	1. Triangle shape 2. Square shape.	1. I can feel triangle, square and circle shapes.	1. Able to identify the shapes based on the edges of it.	2. Square shape. 3. Circle shape. 4. Triangle shape.	1. Square shape. 2. Circle shape. 3. Triangle shape.
3. What can you feel by touching that? <i>(Space; negative, positive space)</i>	1. It is not symmetrical. 2. The shape is like a flower in a long vase. 3. The other one is a shape of a hand. 4. Finally, realize both shapes are the same, but one with positive space and the other one is negative space.	1. Able to feel the shape, one is outward, and the other is inward.	1. Can feel like the same image but one is with positive space the other with negative space. 2. One emerges, and the other one is sinking.	1. It feels like the shape of fingers. 2. Both have the same shape, but one feels the form emerge from the base the other feels a sinking image.	1. Able to feel one space arises, and the other one is a deeper area.

4. What can you feel from touching the flashcard? (<i>Texture; tire, leave & rocks</i>)	1. I can feel the texture. 2. The texture of rocks is enjoyable to touch because there is a space of relaxation. 3. The tire texture is packed, with no breathing space. 4. The texture feels like a tree.	1. Space is small, but you can feel it arises. 2. One has more space than the other flashcard. 3. The leaf's texture feels like a flower that has a flower stem. 4. The rocks texture flashcard has the feeling of a tar road.	1. Wow! Exciting feeling. 2. The texture feels more complicated than the previous one. 3. Tire flashcard texture would be suitable for stamping. 4. The tire texture has space in between but not the rocks texture flashcard.	1. The texture is much rougher. 2. I can feel a leaf's shape because of the repetition line.	1. The texture of geometric. E.g., Lego 2. Organic texture.
Phase 3	R1	R2	R3	R4	R5
1. What can you feel based on the flashcard? (<i>Form; cubic, sphere & half cylinder</i>)	1. Half sphere. E.g., doorknob. 2. The half sphere is much more interesting to touch and hold. 3. Even though both started from the square, the cubic has more space to touch. 4. Half cylinder. E.g., Like half-pipe or half bottle.	1. Feel the relief. E.g., Half cylinder 2. I can feel half sphere. 3. The relief form has more excitement when touching. 4. Between the shape of a square and the form of a cubic, the 2D feels safer because of the edges.	1. More like a 3D effect. E.g., ball 2. Form of a cylinder. 3. Form of a cubic, e.g., box. 4. The most fun is the sphere form to hold.	1. Form of a sphere. E.g., doorknob 2. I prefer the 3D form flashcard compared to the 2D shape flashcard.	1. It feels like a doorknob. 2. The 3D form is better for touching and feeling than the 2D shape relief flashcard.

Conclusions

In conclusion, this design activity study results will be a new journey of taking the blind and visually impaired art audience to understand and appreciate art aesthetics. The objective of questioning the respondent on the 3D PTF is to validate the prototype with the experts to see whether the prototype could be understood with the fundamentals of art and design through the elements of art and the principles of design. Then the prototype will be a mediator for the blind and visually impaired to experience the basics of art before we even touch on making art for the blind.

Furthermore, through these design activities, we can know what influences the audience based on the flashcards. Studying these possibilities will not only allow them to imagine and explore from the prototype as part of a mediator between the basic art and design language but also allow the audience of the blind and visually impaired group to experience and value art. This tool could also close the gap between the sighted and unsighted audience to enjoy and explore art in the simplest and most fun way.

This study also establishes the validity of the 3D PTF as a tool and improves questions, format, and scales (Creswell, 2003). The researcher also noticed that the time was longer than expected, which is one of the issues that the researcher must deal with when doing the actual experiment. Sometimes, when the respondent needs to give further explanation or more description as expected from the activity, this also shows that time, space and the surroundings of the activity play quite a role in gathering enough information.

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Declaration of Interest Statement

The authors declare that they have no conflict of interests.

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