The Art of Drawing and Painting with the Original Through Touch-Screen Monitor by The Congenital Totally Blind[*]

การวาดภาพระบายสีตามภาพศิลปะต้นแบบผ่านจอภาพแบบสัมผัสโดยคนตาบอดสนิทตั้งแต่กำเนิด

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บทคัดย่อ

   งานวิจัยนี้เป็นการสร้างวิธีการและอุปกรณ์เครื่องมือโดยใช้เทคโนโลยีจอภาพแบบสัมผัส และพัฒนาโปรแกรมคอมพิวเตอร์เฉพาะในงานวิจัยนี้โดยแปลงข้อมูลค่าของสีสันไปเป็นระดับเสียงโน้ตดนตรี เพื่อใช้ในการรับรู้สีสันและรูปร่างของภาพศิลปะ และการวาดภาพระบายสีตามภาพศิลปะต้นแบบที่ได้สัมผัสไป เพื่อให้ศิลปะเป็นการสื่อสารเพื่อคนทุกคน

   งานวิจัยนี้เป็นงานวิจัยเชิงคุณภาพ เป็นประเภทการวิจัยแบบกรณีศึกษา และการวิจัยประยุกต์ โดยใช้วิธีการและเครื่องมือในการเก็บข้อมูล ได้แก่ การจดบันทึก, การสัมภาษณ์, การสังเกตการณ์, การบันทึกเสียงสนทนา, การถ่ายภาพ, การถ่ายวีดิโอ และแบบทดสอบในการวาดภาพกับอาสาสมัครซึ่งเป็นคนตาบอดสนิทตั้งแต่กำเนิดที่มีการศึกษาระดับชั้นมัธยมปลายขึ้นไป การวิจัยนี้อยู่ในขั้นเริ่มต้นจึงกำหนดใช้แถบสีในระดับผู้เริ่มต้นจำนวน 12 เฉดสี ซึ่งมีสีที่จำเป็นเพียงพอและเหมาะสมต่อการใช้งานในเบื้องต้น

   การวิจัยนี้ได้ทำการทดลองให้อาสาสมัครซึ่งเป็นคนตาบอดตั้งแต่กำเนิดสัมผัสภาพศิลปะต้นแบบโดยใช้จอภาพแบบสัมผัส และให้จดจำเสียงที่ปรากฏในตำแหน่งและมิติต่างๆ ของภาพ จากนั้นจึงให้อาสาสมัครวาดภาพระบายสีตามภาพศิลปะต้นแบบ ผลการวิจัยพบว่า สามารถใช้ระดับเสียงโน้ตดนตรีแทนสีสันได้ ซึ่งเป็นการใช้ระบบรับรู้ทางการได้ยินแทนการมองเห็น อาสาสมัครสามารถรับรู้สีสันและรูปร่างของภาพศิลปะโดยประมาณได้ และสามารถวาดภาพระบายสีได้ใกล้เคียงภาพศิลปะต้นแบบ อีกทั้งอาสาสมัครยังเกิดความพึงพอใจที่ได้ร่วมกิจกรรมทางด้านศิลปะของงานวิจัยนี้ เครื่องมือที่ได้พัฒนาในงานวิจัยนี้สามารถนำไปใช้กับคนตาบอดกรณีอื่นได้ด้วย และสามารถนำไปใช้เป็นเครื่องมือช่วยในการเรียนวิชาศิลปศึกษาสำหรับนักเรียนตาบอดได้

คำสำคัญ : สี, เสียง, การรับรู้, วาดภาพ, ระบายสี, ศิลปะ, คนตาบอด, คอมพิวเตอร์

Abstract

The purpose of this research was to establish the method and device utilizing the touchscreen technology and computer software specially developed for this research. Color values are converted to sound pitch of musical notes in order to perceive colors and shapes of painting arts, drawings and the ability to paint through touching the original painting art. Therefore, everyone can appreciate art.

This study is a qualitative research applying case studied and applied research method. The methodology and tools for data collection are note-taking, interviewing, observation, conversation recording, photography, videotaping and painting test. The samples of the study are the high school students who are congenital totally blind. Since this research is still at the beginning phase, color palettes defined for the beginners were only 12 shades which are enough and appropriate for basic application.

The research methodology began with the subject touched the original painting art utilizing touch-screen monitor and remembered the sound pitch that appeared in positions and dimensions of the picture spatial. After that, the subject drew and painted animating the original painting art. The result of the research found that sound pitch of musical notes can be used to represent colors, which hearing is used instead of vision. The samples are able to perceive the approximate colors and shapes of painting art and able to draw and paint similar to the original. Moreover, they enjoy and satisfy with the activity of this research. In addition, the device developed from this research can be used for any other kinds of the blinds and can be applied in Art Education for the blind students.

Key Word (s): color, color, sound, perception, draw, paint, Art, blind, computer

1. Introduction

Art is an expression which is deeply moved or affected emotion for empirical through media such as sound, line, color, texture, form and others. (Royal Institute of Thailand, 2003: 1,101) Form creates a person who is an artist to communicate with the spectators. Art can be perceived by the five senses such as seeing color by eyes, hearing with ears, taste with the tongue, smell from the nose, and touching the physical environment. The perception of art such as painting, sculpture and animation are mostly perceived from a vision which is the first sense to recognize and interpret to affect the

physical body and mind of the spectators that this effect may be identical or different knowledge, understanding and experience. Looking and seeing are the first step that is very crucial for the perception of art. However, there is one who cannot appreciate the artwork by looking or seeing, that is the blind. Art is totally unable to communicate with this group of people.

There were an exhibitions and ativities, which are "Art for all", were the opportunities for the blind people to express and perceive in art for example, the blinds touched sculptures, the blinds touched and feeled the bas-relief figures which are made specially, the blinds were drawing and painting, and so on. However, they were able to perceive shapes and forms of the sculptures and bas-releft figures, but they were not able to perceive colors of figures. Then If the blinds touched and feeled the original figure directly, they perceived some textures only but they were not able to perceive some colors. And also, the original figures were broken and peel. Even the acitivities which the blind drew and painted, they did not know what colors and shapes are they paint ? There are neccessery assistants for help to tell and hand to some pigments for them, which the blinds are able to do by themselves. However, the art acitivities for all made the blinds to satisfactions and experiences. Thus, this research studied and made the device and software for these solutions.

This purpose of the research is not for the blind to have the ability to see the colors but for them to have the perception of figures to various colors and shapes. When they perceived, this device will help the blinds to express with drawing and painting follow to the original art figure that they touched. To show the efficiency of device and software, along with to show the understanding and skill of the blinds which they are able to represent with the original art figure utilizing the technique that color values to sound pitches translation, which is used the hearing to represent the vision. That is the computer-aided design in art.

The theory is converting color code to sound pitch of musical notes by comparing the HLS color model with the helix of musical notes (Shepard, 1965, quoted in Deutsch, 1982: 353). This research is focused as color perception of visual art painting of famous of the world and color expression of drawing and painting with the original. The blinds are able to draw and paint colors from the sound pitch of musical notes.

The blinds and sighted people should have equal rights to perceive and express, including the knowledge, information and experience, for life in social. Color perception is important for the blinds in perceiving and learning. Art is indicated as growth, civilization, taste, cognition and intelligence. Color is one of the elements of arts that is important. This research is able to make the experience of the blinds for a better opportunity to touch and perceive the color of the original of famous painting art and to express with drawing and painting to represent from the original and to satisfy with making artworks through the device and software.

2. Aim of the research

1) To develop computer software such as the touching, drawing and painting program which will convert color to sound pitch through the device, Touch-screen technology, and the congenital totally blind is able to paint with original picture to correct the representation.

2) To present and exhibit the artworks, the painting with the original, from the congenital totally blind to the spectators.

3. Hypothesis of the research

1) The device in this research is able to help the totally blind to perceive color of painting art which the totally blind use the fingertip to touch and perceive the positions from the sound pitch and move with drag on the Touch-screen monitor then be able to explain, analyze, critic and comment about the painting art with touching.

2) The congenital totally blind is able to perceive and remember the color utilizing sound pitch to impress and satisfy in painting art.

3) When the totally blinds were able to remember the sound pitch that is to represent the color, they were able to draw and paint with the original of painting art and to communicate and show the artworks to the spectators.

4. Scope of the research

1) The subject of population in this research is the congenital totally blinds or before 5 years old (Lowenfeld, 1981: 67) and they are at a secondary school in grade 10 or higher and ever studying in a basic art education.

2) The variables in the study are:

- Independent variables are the devices such as the computer, touchscreen monitor, keyboard and software which are specially developed. And the intelligence and experience of the subject.

- Dependent variables are the artworks from drawing and painting the color perception and satisfaction of the blinds.

- The control variables are the training program for using the device and software and test method.

3) This research does not aim for the blind to see the color but to perceive the variety and differences of color in the positions on painting art, through perceiving in hearing the sound pitch of musical notes to represent the color, and the blind is express the art by drawing and painting with the devices.

4) This research is developing a prototype and test with the subjects, and trained them to remember the codes of sound pitch to limited color in order to define the quantity of color that necessary and suitable for 12 shades of color.

5. Research outcome

1) To get the new technique and promote utilizing the device and computer software to communicate and perceive the color of painting art and to express with drawing and painting with the original of painting art as the representative for the congenital totally blinds.

2) Artworks collection of color painting from the congenital totally blind, which are able to the analysis, critique, to study in art education and integrated in other subjects.

3) To bridge the gap in perceiving the visual paining art for all human beings and to create the genuine universal design.

6. Methodology of the research

This study is a qualitative research. To study and develop the devices to help the color perception of painting art and expression with drawing and painting. Trained the subjects to use the device for better understanding and skills, and to gain the knowledge in art and design education for the blinds who are toward the evolution in

various fields, skills, creativities and imaginations that are able to integrate to other fields. The results of the research are the artworks, which are drawing and painting from the expression. The following are the methodologies of the research:
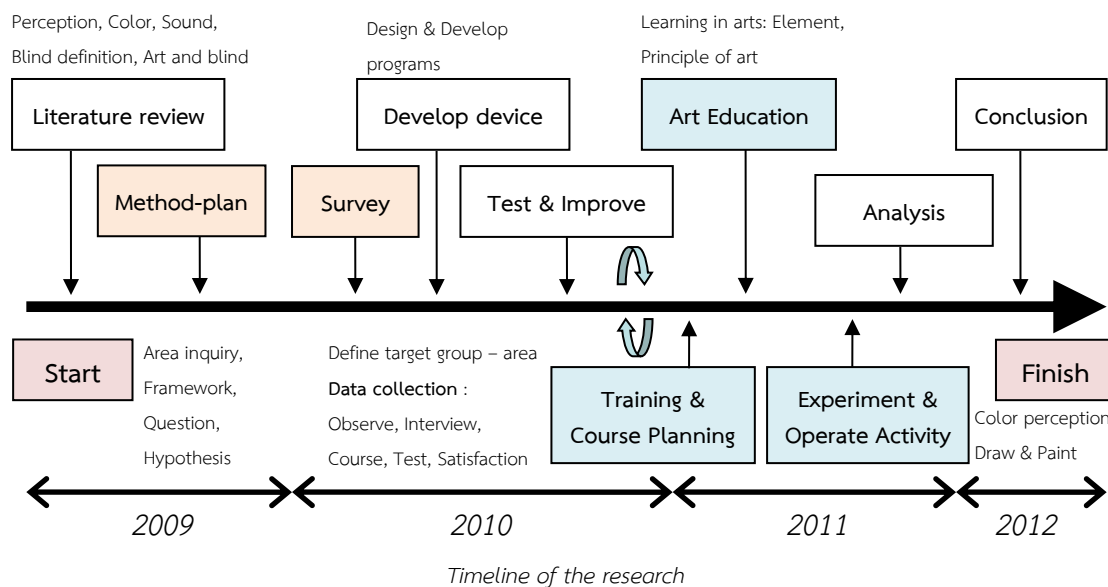

Timeline of the research

Figure 1: A diagram of the methodology of the research

1) Criteria for area selection of the research: This research is designed and developed the device to help the congenital totally blinds who have the color perception and composition of painting art. Therefore, the participants who test this device and tools are the congenital totally blinds. The researcher selected research area in Thailand because it is convenient for travelling and fieldwork. The researcher received assistance from Khon Kaen School for The Blind of The Christian foundation for the blind in Thailand under The Royal Patronage of H.M. The King for the research site. This research is a behavior and understanding studied of a person who is blind and do not relate to culture or tradition. Therefore, the methodology and analysis of the result are able to use with other samples who are foreigners or living in the other countries.

2) Fieldworks are separated into 2 sections; the first is the experimental fieldwork to study the participants or samples for data collection with demo software, to interview and observe for the device and software improvement (Pre-Test) and the last fieldwork is to use the device and final software to test with the method to participants or samples, for the analysis and critique of the result (Post-Test).

3) Observation and Interview. The researcher was prepared some questions for proceeding to rapidly, concisely and the participant is not bored. The interviewing will be formally and Informally, which is going to process with the activities. The Tools, which are for data collection, are such as fieldwork preparing, camera, video and sound recorder. To bring some data that is recorded is to analysis for the next.

4) Design and developed software. From data is received, it will be made to design and developed the device, which are computer software and touch-screen monitor. The specification of computer is a standard. It is easily purchased in the market place and there are a stereo sound processing and input devices are a keyboard, which is able to use with personal computer and laptop and touch-screen monitor, which is extensively in present. To developed software separated 2 parts such as a development of program processing and design interface. The software are touching program for testing and perception training and painting software for expression of drawing and painting.

5) Training program preparing is to making the method for using the software and device in this research. Due to the face that the blind never used then it is a new device and must be training and learning to skill before. The training program used the principle of orientation and mobility (O&M), which is the important subject for the blind, is be make to conception of training program development in the next.

6) Experiment and improvement of device and methodology. The researcher will be testing with the participants who are the congenital totally blinds. In during to device and software testing in this research, the researcher must be observed, inquired and noted the advantages and disadvantages which are some data to improve the software to appropriable with the participants or users and to developed better.

After the analysis of the result, then toward the conclusion, discussion and suggestion of the research.

7. Design and development of device and software

From the literature reviews and related studies about the theory of color and the theory of music, the researcher analyzed and synthesized to the principle of design and developed the software to convert color codes to sound pitches that refer to the

principle of universal music for making the device to use in this research, which is explained as follows:

1) The device is selected for design and development software

The researcher selected the Touch-screen monitor as the device for interactive with the users to fingertip position point to the drawing and painting then appear to sound. The computer is used to process and interpret color to sound pitch of musical notes.

The computer devices are selected to support the Touch-screen monitor which is to input data with a touch or point to the screen and display, and the keyboard to input data.

The Microsoft Visual Basic 6.0 software, which is the software for application making in this research, is installed and run on the operating system of Microsoft Windows 7, they are supported to work with Touch-screen monitor.

2) Analysis method of the software processing

The analysis method of the software processing is explained the concept to develop software and represented to calculate the main software working. The basic data of computer technique using in the research are splited into 2 parts as follows:

- Data of the sound standard are used and called, "MIDI (Musical Instrument Digital Interface.)" It is the standard of instrumental digital, it was the synthesis of sound on the computer, it was defined as the musical notes and controlling value of instruments.

- Data of Input and output software are developed into 2 parts which are the part of processing sound from color of the picture and the part of drawing and painting.

3) Methods of comparing the color to sound pitch of musical notes

From the literature reviews that referring to the HLS of 3 dimensions model to start from the plane of X and Y-axis which are the circle of hue sorting together and refer to the helix of the sound model (Shepard, 1965, quoted in Deutsch, 1982: 353) and to start from the plane of X and Y-axis also. When they were compared as follow:
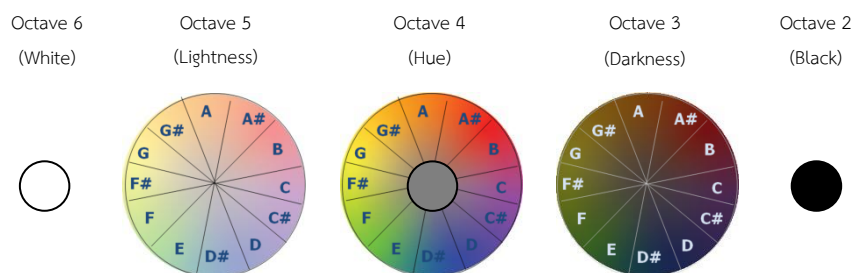
Figure 2: Separation of color range and sound pitch with the HLS model

For the theory of universal music, which is the principle of communicating the sound and music procedures, rules and according to plans, is separated the sound system to 4 scale which are diatonic, pentatonic, chromatic and mode scale (Samrej Kommong, 2009: 22-25). The chromatic scale has the 12 musical notes such as C C# D D# E F F# G G# A A# B and they are to step on the sound pitch in the half of tone and complete to an octave. The plane of the circle is split to 12 ranges of musical notes and exactly to 12 ranges of color.

When the Z-axis of the HLS model color which is the value of color from grey up to white and down to black. Comparing with the Z-axis of the helix of sound model which is the octave of middle sound pitch. The developed software was selected to the second of octave only. Therefore, to define the fourth of the octave is the middle, To increased the higher octave that is the sixth of octave and total to 77 sound pitch and color.

The developed software in this research is for prototype and primary testing with the participants or samples, then reduce color for easy and quick to remember. To select 6 colors from hue such as purple, blue, green, yellow, orange and red, which are able to use and explain about the mixing of color wheel in secondary color, and to selected the more necessary 3 colors such as azure which is light green-blue, pink which is light red and brown which is dark orange for using in painting for perfection, and to select white, grey and black, total 12 color.
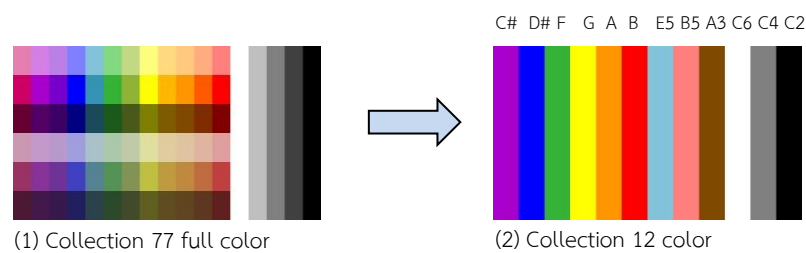
C# D# F G A B E5 B5 A3 C6 C4 C2

(1) Collection 77 full color   (2) Collection 12 color

Figure 3: The palette of 77 color and reduce to selected 12 necessary color

4) Design interface for user

The designing and developing process is separated into 2 programs which are touching software,drawing and painting software. The device consists of Touch-screen monitor, keyboard and computer.

Due to the fact that the participant or sample is blind, the design interface is straight forwarded, simple to use and to display in full screen.

For touching software, when the user points the fingertip to the Touch-screen, which is stay to open the art picture, the area of color will give the sound pitch of a musical note such as blue is D# note, black is C note in the second octave. The figure shown was reduced some details and color to 12 colors.

Figure 4: The fingertip is pointing and touching on a touchscreen monitor with The Starry

Night, by Vincent van Gogh, was reduced the details and color

For the drawing and painting software, users must select colors from the palette by dragging a fingertip to hear the sound with the position of fingertip pointing together for the example, red is B note, green is F note and so on. After that, press the space bar key to change or close the palette and appear in painting space, the color selected from the palette was able to paint on the area. Then press enter key to touching mode for checking the color and shape that painted by oneself, and press enter key again for back to continue drawing.

(1) Select Red color

Press space bar

(2) Drawing Red color line

(3) Select Green color

Press space bar

(4) Drawing Green color line

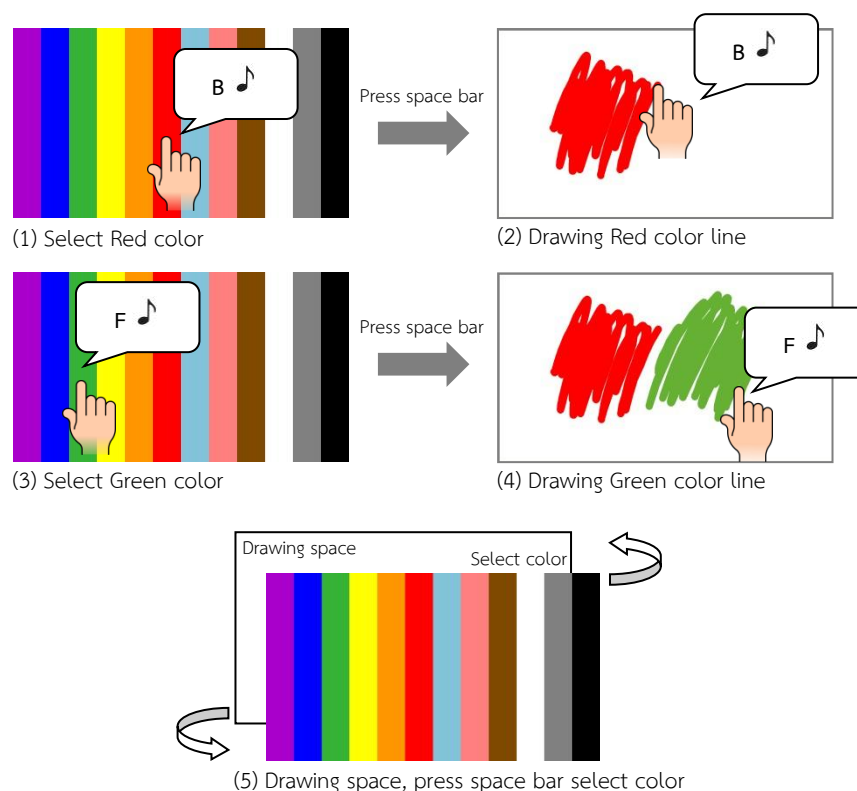(5) Drawing space, press space bar select color

Figure 5: Using to drawing and painting software

8. Analysis of the result

This research entered the field work to test with the participants and data collection with the tools that prepared. It was a final fieldwork and data collection. They were able to be flexible according to the situations. Using the test methods to draw and paint with the original art figure such as "The Starry Night" of Vincent van Gogh and "Horse in a Landscape" of Franz Marc, which were reduced some details and color. The participants touched the figure with touching software first, when they perceived and remembered colors and positions of the figure then they draw by drawing and painting software to animate the original. The atmosphere and analysis of the result are as follows:

Figure 6: The participant, who is blind, is touching the colors and shapes perception of The Starry Night, the original painting.

Figure 7: The chronology of the participant, who is blind, drawing and painting with The Starry Night, the original painting.

Critical Step	Critical Description
Information	Type : Digital Painting, Title : My "The Starry Night" Artist : The congenital totally blind, Resolution : 1,366 x 768 pixels Touch-screen size : 42 inch
Description	To paint it full space. The black is a long row under and about 1/4 of picture. There is a shape that is a tree to turn away to the left which is occurring from the measurement of a trace or rift on the monitor frame. To draw the moon as circle, to draw some details and delicately. There is the measurement and remember some positions of drawing already use it such as own body and rift on the frame that is screwed and advertise signboard.
Analysis	To compose the elements truly. She is able to remember and express and pass on animating the original art figure correctly. To show the prominent and subordinate parts.

Critical Step	Critical Description
Interpretation	This is a drawing and painting animating the original art figure by the representation that is truly and correctly, to draw complete details and colors. The artist is able to communicate and excellently represent and similar to the original.
Judgement	The artist is able to pass on some details completely and clearly that is to show the abilities and skills. It is the artwork that is excellent and impressive when knowing that the artist is the congenital totally blind.

Table 1: To show the analysis and critique the artwork of the participant, The Starry Night.

Analysis: To selected the color that is main part of figure before. Showing the skill of touching and checking own figure that show delicately, there is the skill of solving by using parts of the body to measure and remember the colors and positions that has already drawn. Showing estimation and interpretation of own figure. To remember position and proportion of own drawing utilize the part of the body and trace or rift on the frame of the monitor and satisfaction for painting in this activity.

Figure 8: The participant, who blind, is touching for colors and shapes perception of the Horse in a Landscape, the original painting.

Figure 9: The chronology of the participant, who is blind, is drawing and painting with the Horse in a Landscape, the original painting.

Critical Step	Critical Description
Information	Type : Digital Painting, Title : My "Horse in a Landscape" Artist : The congenital totally blind, Resolution : 1,366 x 768 pixels Touch-screen size : 21.5 inch
Description	Painting with yellow to the full space. Painting with color to animate the original correctly, whole as red, blue and green.
Analysis	To compose to animate the original correctly. She is able to remember and express to animate the original correctly. To know about pictorial and to paint background characteristic.
Interpretation	This is a drawing and painting animating the original art figure by the representation that is truly and correctly, to draw complete details and colors. The artist is able to communicate and excellently represent and similar to the original.
Judgement	The artist is able to pass on some details completely and clearly that is to show the abilities and skills. It is the artwork that is excellent and impressive when knowing that the artist is the congenital totally blind.

Table 2: To show the analysis and critique the Horse in a Landscape, the artwork of the participant.

Analysis: To selected the main color of picture before paint it. To know the touching and checking own figure. To measure and remember some positions of the already drawn.

9. Conclusion

Softwares developed for this research are touching software, drawing and painting software for the blinds and using the device, which is Touch-screen monitor, was able to promote the congenital totally blinds to perceive approximate colors and shapes of the painting art. They begin to access the artworks which are 2 dimensions painting. It was opened to exhibit the artworks for the blinds and all. On the other hand, the blinds were able to exhibit their artwork to the sighted people. That is the universal design in the arts.

The congenital totally blind is able to use the device in this research to express the drawing and painting with the original art figure. They are able to communicate the paint art to all people.

10. Discussion

The congenital totally blind who is the participant used the software and device,Touch-screen monitor, in this research. And receive the training such as, understanding the device, understanding the spatial related to the frame of the monitor and fingertip moving, and remembering the sound pitch of musical notes which represent colors using with the test methods, the results are as follow:

1) The participant is able to perceive some geometric shapes such as rectangle, triangle and circle, and Freeform shape. The participant understands that when drag the fingertip on the figure and the sound changed it means the border of shape, and the sound was not changed when drag it means the similar area and color.

2) The participant is able to perceive some colors on the figure, when point or drag the fingertip on the figure, able to describe what color it is and how to estimate shapes, explain the feeling while touching the figure and remembered the figure already.

3) When the participant touch the original art figure such as "The Starry Night" of Vincent van Gogh artist and "Horse in a Landscape" of Franz Marc artist, is able to remember and express the drawing and painting similar to the original.
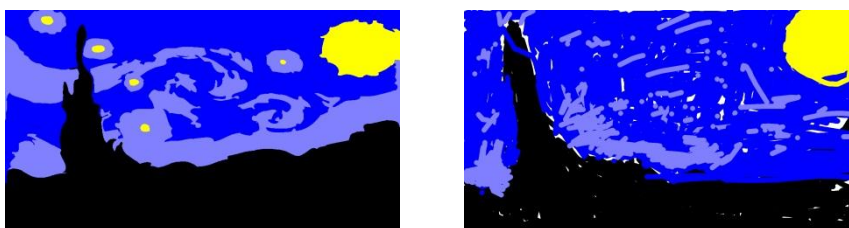

Figure 10:   Comparing the original of The Starry Night and the painting of the participant

Figure 11:   Comparing the original of Horse in a Landscape and the painting of the
              participant

11. Suggestion

1) To be able to use the tool in promoting learning and teaching art education for the students.

2) To develop software for other different devices as the operating system, may be to develop software on the tablets and other devices that apply touchscreen monitor.

3) In case the blinds use the devices to train and remember the sounds and colors to increase the ability to perceive and express the painting art may need more details.

12. Acknowledgements

13. Reference

English references:

Crosby, Neil. (2002). **FreeVBCode code snippet: MIDI Keyboard Player** [computer program]. Accessed April 25, 2010. Available from http://www.freevbcode.com/ShowCode.asp?ID=4213

Deutsch, Diana. (1982). **The psychology of music**. London: Academic Press.

Gebhardt, Volker. (1997). **Painting a concise history**. London: Laurence King Press.

GIMP 2.6.11 – The GNU image manipulation program [computer program]. (2012). Massachusetts: The GIMP Development Team. Accessed January 14, 2012. Available from http://www.gimp.org/downloads/

Gleitman, Henry. (1992). **Basic psychology**. 3rd ed. New York: W.W. Norton.

Graves, Maitland E. (1951). **The art of color and design**. 2nd ed. New York: McGraw-Hill.

Heller, Morton A., and Soledad Ballesteros. (2006). **Touch and Blindness: Psychology and Neuroscience**. New Jersey: Lawrence Erlbaum Associates.

Jaffé, Hans L.C. (1967). **20,000 years of world painting**. New York: Greenwich House.

Kennedy, John M. (1993). **Drawing and the blind: picture to touch** [electronic version]. London: Yale University Press. Accessed September 3, 2009. Available from https://tspace.library.utoronto.ca/handle/1807/1021

Lowenfeld, Berthold. (1981). "Effects of blindness on the cognitive functioning of children." **In Berthold Lowenfeld on blindness and blind people: Selected papers**. New York: American Federation for the Blind.

Microsoft. (1998). **Visual Basic 6.0** [computer program]. Washington: Microsoft Corporation.

Microsoft. (2009). **Windows 7** [computer program]. Washington: Microsoft Corporation.

Watts, Perry. (2003). **Working with RGB and HLS color coding systems in SAS software** [electronic version]. Accessed April 25, 2010. Available from http://www2.sas.com/proceedings/sugi28/234-28.pdf

Thai references:

Aongarj Naiphat. (2006). **Quantitative and qualitative research methodologies in behavioral and social sciences**. 2nd ed. Bangkok: Samlada. (องอาจ นัยพัฒน์. (2549). วิธีวิทยาการวิจัยเชิงปริมาณและเชิงคุณภาพทางพฤติกรรมศาสตร์และสังคมศาสตร์. พิมพ์ครั้งที่ 2. กรุงเทพฯ: สามลดา.)

Chalud Nimsamer. (1991). **Composition of Art**. Bangkok: Thaiwattanapanich. (ชลูด นิ่มเสมอ. (2534). **องค์ประกอบของศิลปะ**. กรุงเทพฯ: โรงพิมพ์ ไทยวัฒนาพานิช.)

Chatchai Auttapuk. (2011). **Composition of Art**. 7st ed. Bangkok: Pimdee Press. (ฉัตร์ชัย อรรถปักษ์. (2554). องค์ประกอบศิลปะ. พิมพ์ครั้งที่ 7. กรุงเทพฯ: โรงพิมพ์ พิมพ์ดี.)

Kitima Amornthut. (1987). **Meaning of Art**. Bangkok: Kurusaphaladprao. (กิติมา อมรทัต. (2530). ความหมายของศิลปะ. กรุงเทพฯ: โรงพิมพ์ คุรุสภาลาดพร้าว.)

Royal Institute of Thailand. (2003). **The Royal Institute Dictionary 1999 Edition**. Bangkok: Nanmee Book Publications. (ราชบัณฑิตยสถาน. (2546). พจนานุกรมฉบับราชบัณฑิตยสถาน พ.ศ. 2542. กรุงเทพฯ: นานมีบุ๊คส์พับลิเคชั่นส์.)

Rucharee Nopppaket. (1997). **Psychology of perception**. Bangkok: Prakayprueg. (รัจรี นพเกตุ. (2540). จิตวิทยาการรับรู้. กรุงเทพฯ: ประกายพรึก.)

Samrej Kommong. (2009). **All about music**. Bangkok: O.S. Printing House. (สำเร็จ คำโมง. (2552). รู้รอบครอบจักรวาลดนตรี. กรุงเทพฯ: โรงพิมพ์ โอ.เอส.พริ้นติ้ง เฮ้าส์.)

Siriaon Wichawut and others. (2007). **General psychology**. 5st ed. Bangkok: Thammasat
University Press. (สิริอร วิชชาวุธ และคนอื่นๆ. (2550). จิตวิทยาทั่วไป. พิมพ์ครั้งที่ 5.
กรุงเทพฯ: โรงพิมพ์ มหาวิทยาลัยธรรมศาสตร์.)

Somchai Promsuwun. (2005). **Principle of visual arts**. Bangkok: Active Print.
(สมชาย พรหมสุวรรณ. (2548). หลักการทัศนศิลป์. กรุงเทพฯ: โรงพิมพ์ แอคทีฟพริ้นท์.)

Suchat Thaotong. (1994). **Art Criticism**. Bangkok: O.S. Printing House. (สุชาติ เถาทอง.
(2537). ศิลปวิจารณ์. กรุงเทพฯ: โรงพิมพ์ โอ.เอส.พริ้นติ้ง เฮ้าส์.)

Taweesuk Noppakasorn. (2006). **Methodology of the qualitative research No.2**. 3rd ed.
Nakhonrachasima: Chokcharuen Marketing. (ทวีศักดิ์ นพเกษร. (2549). วิธีการวิจัย
เชิงคุณภาพ เล่ม 2. พิมพ์ครั้งที่ 3. นครราชสีมา: โรงพิมพ์ โชคเจริญมาร์เก็ตติ้ง.)

Wirun Tangcharoen. (1992). **Color theory for creative Art**. Bangkok: O.S. Printing House.
(วิรุณ ตั้งเจริญ. (2535). ทฤษฎีสีเพื่อการสร้างสรรค์ศิลปะ. กรุงเทพฯ: โรงพิมพ์ โอ. เอส.
พริ้นติ้ง เฮ้าส์.)