ชุดอิเล็กทรอนิกส์เพื่อการเรียนรู้อักษรเบรลล์เบื้องต้น

ประกาศิต ตันติอลงการ[1]

บทคัดย่อ

ผลงานวิจัยนี้ได้พัฒนาชุดอิเล็กทรอนิกส์เรียนรู้อักษรเบรลล์เบื้องต้นขึ้น ผู้เรียนสามารถกดสวิตช์ปุ่มกดที่อยู่ใกล้ๆ กับตัวอักษรเบรลล์เพื่อฟังรายละเอียดเกี่ยวกับอักษรเบรลล์ตัวนั้น ชุดอิเล็กทรอนิกส์เรียนรู้อักษรเบรลล์เบื้องต้น ประกอบด้วย 2 ส่วนคือส่วนที่เป็นซอฟต์แวร์และส่วนที่เป็นฮาร์ดแวร์ส่วนที่เป็นซอฟต์แวร์เขียนโปรแกรมควบคุมการทำงานของอุปกรณ์ต่างๆ ด้วยภาษาซี ส่วนที่เป็นฮาร์ดแวร์ได้แก่สวิตช์ปุ่มกดอักษรเบรลล์ ซึ่งประกอบด้วยตัวอักษร ก-ฮ สระ วรรณยุกต์ A-Z, 0-9 เครื่องหมายทางคณิตศาสตร์ แบบทดสอบคณิตศาสตร์และภาษาไทย ใช้โมดูล MP3 Player เป็นตัวบันทึกเสียง ไมโครคอนโทรลเลอร์ AT89C51AC3 เป็นตัวควบคุมระบบ การทดสอบความแม่นตรงของปุ่มกดหน้าสัมผัสอักษรเบรลล์ โดยเจ้าหน้าที่พิสูจน์อักษรจากศูนย์เทคโนโลยีทางการศึกษา กรมการศึกษานอกโรงเรียน กระทรวงศึกษาธิการ และจากศูนย์เทคโนโลยีทางการศึกษาเพื่อคนตาบอด มูลนิธิช่วยคนตาบอดแห่งประเทศไทยในพระบรมราชินูปถัมภ์ ทำการตรวจสอบตำแหน่งจุดนูนอักษรเบรลล์และเสียงบอกตำแหน่งจุดที่ได้ยิน ผลการทดสอบของทั้ง 2 ท่าน ปุ่มกดและเสียงบอกตำแหน่งจุด ถูกต้องตรงตามความหมายทุกตัว สำหรับการประเมินผลได้ทดลองใช้กับนักเรียนผู้พิการทางสายตาจำนวน 9 คนและอาจารย์ผู้สอนจำนวน 8 คน ในหน่วยงานการศึกษา 4 แห่ง ทำการทดสอบตามแบบทดสอบชุดเรียนรู้อักษรเบรลล์เบื้องต้น และประเมินผลความพึงพอใจหลังการทดลองใช้งาน ผลการทดลองปรากฏว่าผู้พิการทางสายตาและอาจารย์ผู้สอนเกิดความผิดพลาดจากการทำแบบทดสอบร้อยละ 3.89 และร้อยละ 0 ตามลำดับ ระดับความพึงพอใจของผู้พิการทางสายตาและอาจารย์ผู้สอนทั้งสองกลุ่มมีค่าเฉลี่ยอยู่ในเกณฑ์ระดับมาก ($\bar{x}$ = 4.307 และ 4.117) และมีความคิดเห็นสอดคล้องกันดี (S.D. = 0.788 และ 0.740)

คำสำคัญ: อักษรเบรลล์ ผู้พิการทางสายตา ไมโครคอนโทรลเลอร์ โปรแกรมภาษาซี โมดูล MP3 Player

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Electronic Braille Learning Set for Beginners

Prakasit Tunti-a-longkarn[1]

Abstract

In this paper, the author developed an electronic braille learning set for the visually-impaired, where the learner can press a push button switch near the braille letter to listen to the details. The electronic braille learning set constitutes both hardware and software components. The software, written in C program, controls the operations of the equipment, whereas the hardware comprises the buttons representing Thai and English letters, numerical systems and mathematical signs, tonal marks and vowels in Thai, as well as mathematics and a Thai test. Recording is operated through an MP3 player module while the overall systems are controlled by an AT89C51AC3 microcontroller. The accuracy of the braille button configurations and voice outputs were approved by 2 officers from The Center for Educational Technology, Ministry of Education, Thailand, and from Foundation for the Blind in Thailand under the Royal Patronage of H.M. the Queen. Exact results were derived from inspection. The assessment from 4 institutes of the blind, 9 visually-impaired learners, and 8 instructors undertaking the trial endorsed the user satisfaction on the whole towards the developed set. Only slight errors (3.89% and 0%) were discovered, while the satisfaction estimation from both groups were rated highly ($\bar{x}$ =4.307 and 4.117) and were correspondingly evaluated (S.D.=0.788 and 0.740).

Keywords: Braille, Visually-impaired, Micro-controller, C Program, MP3 Player Module

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Received 11 May 2012; Accepted 25 February 2014

1. Introduction

Nowadays, Thailand have an increasing number of disabled people, caused by accidents, chemical substances or disability from inheritance. The annual report from Thailand National Statistical Office, Ministry of Information and Communication Technology for the year 2007, shows that there were 1,871,860 disabled people, who have registered and only 370,088 (19.77%) of them have ID-Cards disabled. Among 226,121 disabled people between 5-30 years old, only 41,326 of them can go to schools. There were 543,331 people who are visually impaired (29.03%) from all the disabled, and 524 people aged between 0-6 years (0.1%) of all visually impaired [1]. For traditional Braille learning in Thailand, an instructor teaches how to read Braille by touching the raised cell of Braille letter to the learners with disabilities in the eyes. The visually impaired could read Braille by using their fingers of both hands running along the words, which need more skill to reading Braille and the progress of learning of each learner is not the same. For this reason, Electronic Braille learning set for the visually impaired can be helpful in learning and repeating the lessons by themselves, and can support those who are interested in reading Braille.

2. Methodology

2.1 Experimental Design

Experimental design is the process of planning a study to meet specified objectives. Planning an experiment properly is very important in order to ensure that the right type of data and a sufficient sample size and power are available to answer the research questions of interest as clearly and efficiently as possible. This research is a pre-experimental one shot case study research design.

2.2 The Research Samples

The author selected specific sampling (non-randomized) of the agencies involved in blind or the visually impaired. The data were obtained through one-to-one interviews [2], in order to know the needs of learners and instructors. The samples are identified as relevant to the education of the visually impaired blind from 4 institutes. They are Foundation for the Employment Promotion of the Blind Thailand, Center for Education Technology Ministry of Education Thailand, Educational Technology for the Blind Center Foundation for the Blind in Thailand under the Royal Patronage of H.M. the Queen and Thai National Institute for the Blind. The samples were divided into two groups, learners and instructors. Both groups using the Electronic Braille learning set.

2.3 Tools for User Satisfaction Evaluation

The tool for user satisfaction evaluation comprise of 2 parts. Part 1 is a questionnaire of 10 topics concerning the design of Braille learning set and 7 topics for a test of Braille learning set. The satisfaction levels range from 5 (strong) to 1 (weak). When more than one appraiser, the evaluation will be graded with follows:

Average between 4.50 to 5.00, the most.
Average between 3.50 to 4.49, more.
Average between 2.50 to 3.49, means.
Average between 1.50 to 2.49, meaning less.
Average between 0.00 to 1.49, weak [3].

Part 2 is for user suggestions.

2.4 Survey: The Needs of Electronic Braille Learning Set for Beginners

From the interviews of 2.2, the following are

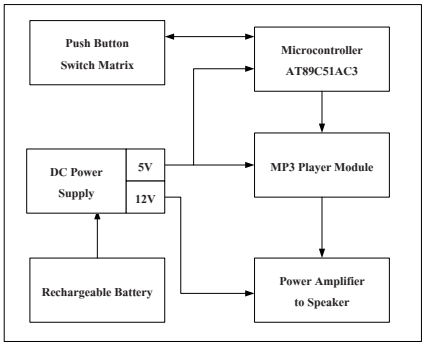

Figure 1 Block diagram of the Braille learning set.

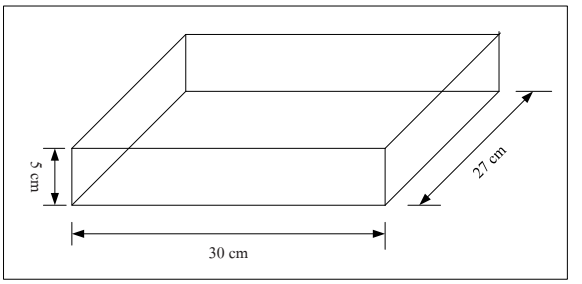

Figure 2 Dimensions of the Braille learning set.

a summary of the set requirements: desktop size, lightweight, non-conductive for electricity, safely operated, physically strong, Thai and English alphabets, numerical systems and mathematics signs, tonal marks and vowels in Thai writing, simple mathematics and Thais test can be used in the classroom or self study.

2.5 Design of Electronic Braille Learning Set

From the survey of 2.4, block diagram in Figure 1 was designed, it was shown the operation of Electronic Braille learning set, when the user press a push button switch matrix, it will send a signal of the address in row and column of the switch to the microcontroller running a C programme[4], and then send a signal to the MP3 player module[5] in order to play audio files, Then sends a signal to the power amplifier circuit to increase amplitudes of the signal received.

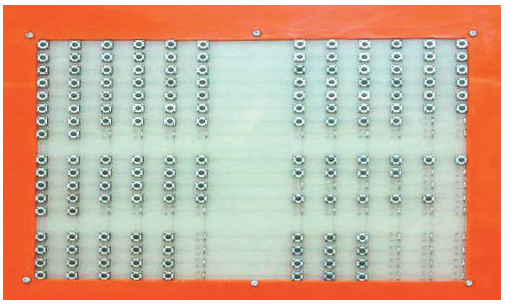

Figure 3 Matrix push button switches in the Braille learning set.

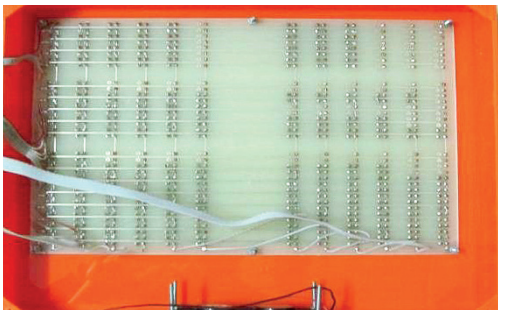

Figure 4 Wiring on the back side of the switchmatrix in the Braille learning set.

The variable resistor has been used to adjust the level of audio signal. The power supply of 12 volts and 5 volts are supplied to each circuit and the battery can be recharged.

2.6 Structural Design

The requirements of Electronic Braille learning set are small size, lightweight, non-conductive case, safety and physical strength. Figure 2 shows the dimensions of an acrylic box used a case of the set.

2.7 Design of Push Button Switch Matrix

The author designed a set of push button switches to be connected into a matrix of 12 rows and 17 columns, totally 204 positions. Figure 3 and 4 show the top

Figure 5 The characters near by each push button switch.

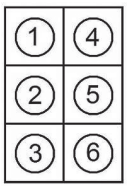

Figure 6 The Braille dots in a cell.

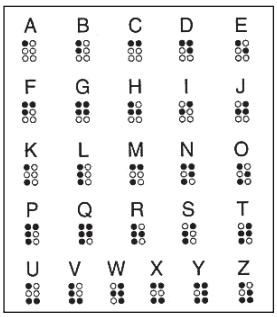

Figure 7 The English Braille letters.

and bottom sides of the switch matrix respectively. Figure 5 shows 157 frequently used Braille characters placed next to the push-button switches. Each Braille character, or cell, is made up of six dots, arranged in a rectangle containing two columns of three dots each, is shown in Figure 6. Figure 7 and 8 show sample of Braille letters in English and Thai respectively [6].

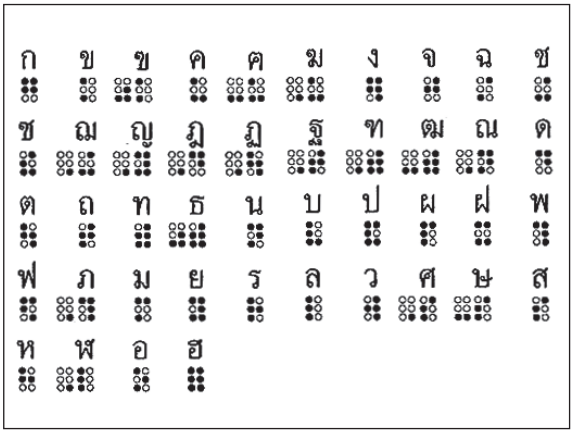

Figure 8 The Thai Braille letters.

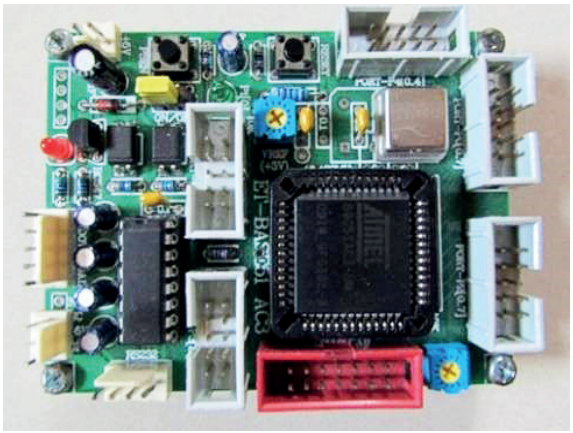

Figure 9 Microcontroller board.

2.8 Microcontroller

The function of microcontroller AT89C51AC3 [7] programme starts from checking the status of push button switches. If the switch is pressed, the microcontroller will determine the switch and send a signal to MP3 player module to play a corresponding each switch. For example, when the push button switch “A” is pressed, it will play the sound “A-dot-one”, or when the “Z” switch is pressed the voices “Z-dots-one-three-five-six” is played (Figure 7). The microcontroller board is shown in Figure 9.

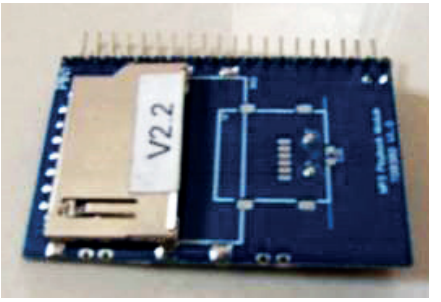

Figure 10 The top side of MP3 player module.

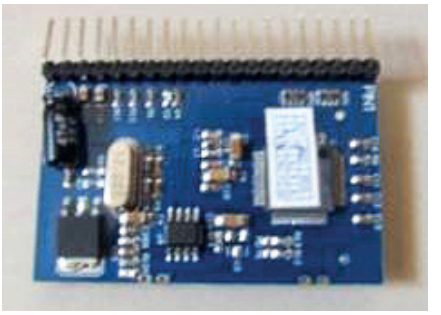

Figure 11 The opposite side of MP3 player module.

2.9 MP3 Player Module

Figure 10 and 11 shows the MP3 player module on top side and opposite side respectively, MP3 player module was stored with 157 audio files on a 1-GB SD card.

2.10 Power Amplifier

Figure 12 shows the power amplifier circuit, with an IC TBA820M [8] that amplifies the audio signal from MP3 player module. It can increase or decrease level of the audio signals by a volume knob shown in Figure 13.

2.11 DC Power Supply

Figure 14 and 15 show the DC power supply [9]. It supplies 12 voltages to the power amplifier and 5 voltages to microcontroller and MP3 player module.

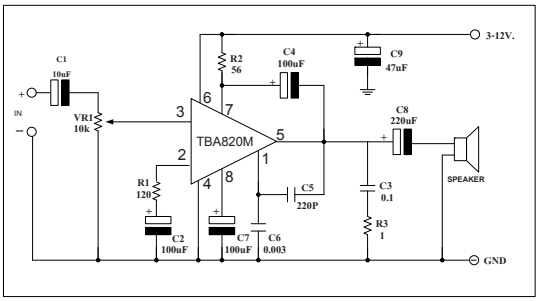

Figure 12 The power amplifier circuit.

Figure 13 Side view of Electronic Braille learning set.

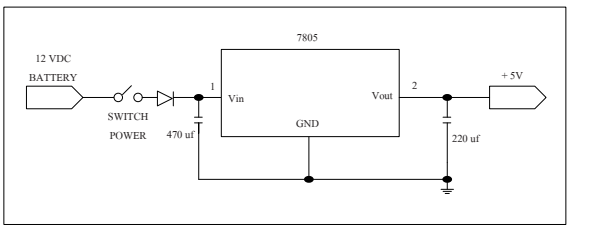

Figure 14 DC power supply circuit.

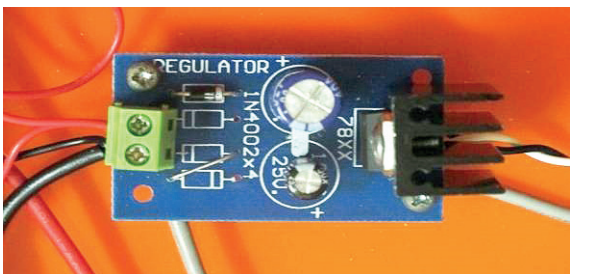

Figure 15 DC power supply voltage regulator.

2.12 The Battery Recharger Circuit

The Braille learning battery voltage can used in a given period of time. Energy in the battery will run out, so it need the battery recharger circuit as shown in Figures 16 and 17.

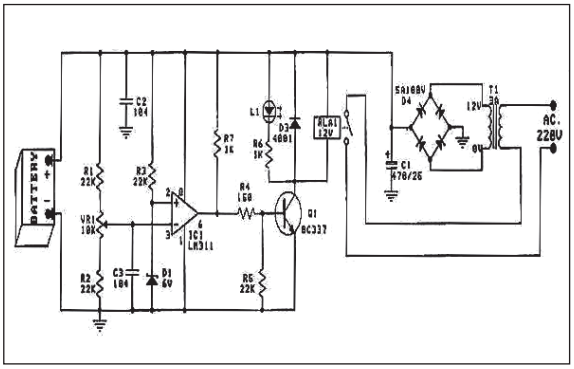

Figure 16 The battery recharger circuit.

Figure 17 The complete set of battery recharger.

3. Experimental Results

3.1 The Exact Test of Braille Letters and Push Button Switch Matrix

The tester are two expert officers from the Center for Education Technology, Ministry of Education Thailand and Educational Technology for the Blind Center, Foundation for the Blind in Thailand under the Royal Patronage of H.M. the Queen. The tester prove the Electronic Braille learning set by raised cell Braille letter by touching and pressing the push button switches of Electronic Braille learning set in Figure 18. After pressing switch, an audio narration corresponding to the position of Braille letter is played. Each Braille letters was tested 5 times. It was proven that the raised cell Braille letter and audio narration are perfectly fit.

Figure 18 The Electronic Braille learning set.

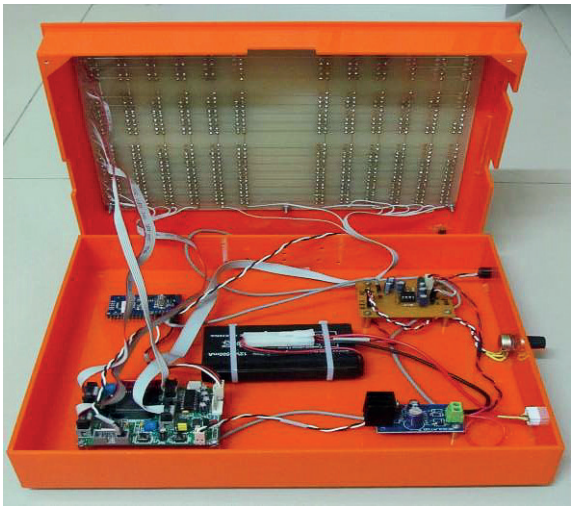

Figure 19 Inside the Electronic Braille learning set.

So the Electronic Braille Learning Set for Beginners can be used in the course correctly.

3.2 Tests of Braille Reading

Electronic Braille learning set shown in Figure 18, all components of Electronic Braille learning set are shown in Figure 19. The readers from 4 institutes of Blind were asked to read the Braille letters on Electronic Braille learning set to find out whether each key is

Figure 20 The test of learners in Braille reading.

Figure 21 The test of instructors in Braille reading.

Table 1 The satisfaction of learners.

Evaluation of Satisfaction	Mean	S.D.
The design of Electronic Braille learning set		
1. The clarity of the Braille letters	4.333	0.707
2. The exact of the Braille letters	4.888	0.333
3. Position of Braille letters are suitable	4.444	0.726
4. Sizes of the Braille learning set is suitable	4.111	1.166
5. Ease of use	4.444	0.881
6. The strength of Braille learning set	4.666	0.500
7. Ease of storage	3.333	0.500
8. The suitability of the material used to make the push button switch	4.000	0.866
9. The suitability of the material used to make the box of Braille learning set	4.333	0.866
10. Safety in usage	4.555	0.726
Summary of Design	**4.311**	**0.829**
The test of Electronic Braille learning set		
11. The suitability of the test	4.111	0.927
12. The method doing the test is appropriate	4.222	0.833
13. The appropriateness of the content-based instruction	4.111	0.781
14. The clarity of the sound	4.222	0.833
15. The correctness of the sound	4.555	0.527
16. The benefits of Braille learning set	4.555	0.527
17. Satisfaction in the Braille learning set	4.333	0.707
Summary of Test	**4.301**	**0.732**
All summary	**4.307**	**0.788**

readable. The test is done by reading 20 different characters by 9 learners and 8 lecturers with visual impairment. The test showed misreadind 3.89% and 0%, respectively. Figure 20 and 21 shows the example of Braille reading test of learners and instructors respectively.

3.3 The Satisfaction Evaluation of Electronic Braille Learning Set

The samples were divided into two groups, learners and instructors in Braille from 4 institutes of blind, with 9 learners and 8 instructors.

Table 1, the assessment of learners satisfaction, which is satisfied by Electronic Braille learning set, with an average score of 4.307. The score was high and in good agreement (S.D.= 0.788).

In part 2, the learners suggested that a bag should be provided for easy maintenance and should cover the top of the panel to prevent damage of the Braille characters.

Table 2, the results of the satisfaction evaluation of the instructors have been shown. In the part of design of Electronic Braille learning set, the highest satisfaction is in the exact of the Braille letters ($\bar{x}$ = 4.875) and the lowest satisfaction is in sizes suitability of the Braille learning set ($\bar{x}$ = 3.250). In the part of test of Electronic Braille learning set, the highest scores are in the appropriateness of the content-based instruction and the benefits of Braille learning set ($\bar{x}$ = 4.500) and the average minimum satisfaction is in the appropriateness to testing ($\bar{x}$ =3.875). The

satisfaction estimation of Electronic Braille learning set was high ($\bar{x}$ =4.117), and correspondingly evaluated (S.D.= 0.740).

In part 2 of the instructors suggestions, the recommendations are as follow:

1. Speaker should face towards the listener. Headphones should also be provided so that disturb others in the class.

2. Size of Braille learning set should be learning will not more compact for easy storage.

3. More Electronic Braille learning set should be provided.

4. More exercises on Electronic Braille learning set should be provided.

5. The background color and text color for each group should be different for those who are not blind to learn Braille, so that they can be easily identified and noticed.

Table 2 The satisfaction of the Instructors

Evaluation of Satisfaction	**Mean**	**S.D.**
The design of Electronic Braille learning set.	4.037	0.786
The test of Electronic Braille learning set.	4.232	0.660
All Summary	**4.117**	**0.740**

4. Conclusions

The Electronic Braille learning set for beginners are suitable for visually impaired people or those who would like to learn Braille. It can be used for teaching and learning in the classroom or self-study. The Electronic Braille learning set consists of software used to operate the equipment and hardware, including push button switches, Braille alphabet buttons, which consists of Thai and English alphabets (A-Z, ก-ฮ), numerical systems (0-9) and mathematics signs, tonal mark and vowel in Thai writing and Mathematic and Thai test.

C Programming was used in control the microcontroller which scans the switch from Column 0-11 and Row 0-16, totally 204 positions, but only 157 actually deployed. When the switch is pressed, it send the switch address to the microcontroller. Microcontroller sends an audio stored on a SD card signal to the MP3 player module to display audio files corresponding to the Braille letter.

To test the exact of Braille keypad. The Electronic Braille learning set was approved by the two expert officers who determine the correctness of the Braille, embossed Braille letters, as well as narration audio. The test results are correct in the sense of all. As for the evaluation of user satisfaction, the results showed that satisfaction rate of the learners and the instructors are $\bar{x}$ =4.307, S.D.=0.788 and $\bar{x}$ =4.117, S.D.=0.740, respectively. In conclusion, the developed Electronic Braille Learning Set for Beginners is good and consistent.

5. Acknowledgements

The author thanks the College of Industrial Technology for giving the opportunity and funding for research. The author also would like to thank the Foundation for the Employment Promotion of the Blind Thailand, Center for Education Technology Ministry of Education Thailand, Educational Technology for the Blind Center Foundation for the Blind in Thailand under the Royal Patronage of H.M. the Queen and Thai National Institute for the Blind, Mr. Natapon Phonnimit, Miss. Hathaikarn Homsuwan, for good cooperation and helpfulness.

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