Teaching and Learning Module on Learning Disabilities (LD) Using RFID Technology

Noor Maizura Mohamad Noor, Rosmayati Mohemad, Nur Fadila Akma Mamat, Wan Fatin FatihahYahya, Mohd Arizal Shamsil Mat Rifin, Mohamad Nor Hassan, and Mohd Pouzi Hamzah
Software Technology Research Group (SofTech), School of Informatics & Applied Mathematics, Universiti Malaysia Terengganu, Terengganu, Malaysia
Email: {maizura, rosmayati, mohamadnor, mph}@umt.edu.my, nurfadilaakma@yahoo.com, wanfatinyahya@gmail.com

***Abstract*—Over the last decade, there have been dramatic changes in the use of technology to enhance teaching and learning in special education domain. Traditional teaching and learning approach prevents children with learning disabilities (LD) from having opportunities to reach their maximum quality of life in terms of academic, social and emotional development. In addition, not all interactive learning materials is appropriate for LD children and may cause frustration if a child's difficulties interfere with its use. These, indeed, make both teaching and learning more challenging. Children with LD needs assistive technology tool to greatly improve the success of their learning process. In this paper, an emerging application using Radio Frequency Identification (RFID) called Children's Storybook Reading System (StoBook) is proposed. The system is developed for children aged around seven to twelve years old with disabilities in order to assist special education teachers, practitioners and parent in attracting and motivating these children to learn more. This RFID-based application is beneficial to stimulate teaching and learning process for the children to recognize letters and spell words, thus making the teaching and learning process enjoyable.**

***Index Terms*—learning disability, RFID technology, teaching**

I. Introduction

Nowadays, effective use of technology is central to enhancing both teaching and learning in special education domain. One of the great concerns is how to motivate the children with disabilities to learn during the learning process [1], [2]. Learning Disabilities (LD) is one of the category in special education which involves child with disabilities to receive, store, process, retrieve or communicate information. LD children are classified as those with down's syndrome, autism, Attention Deficit Hyperactive Disorder (ADHD), minimal retardation, and specific learning difficulties such as Dyslexia, Dyscalculia and Dysgraphia impact the area of reading, math and writing respectively [3], [4].

According to report from Utusan Online, 60 percent of student in level one in primary schools in Malaysia cannot achieve the basic of reading, math and writing [5]. LD children have a perception problem to compile, interpret visual and auditory information. They are normally lack of concentration, hyperactive and having difficulty in social and environmental adaptation. Each of LD children has a unique character and different learning styles either in terms of visual, auditory or kinesthetic. LD children have neurological difference in brain structure and function compared to normal children, thus having problem to remember verbal information [6]. However, the use of similar traditional approach in teaching and learning process of LD children prevents these children from having opportunities to reach their maximum quality of life in terms of academic, social and emotional development [7], [8]. In traditional pedagogy approach, LD children are normally having difficulty to engage and this could demotivate the children to learn. In addition, not all interactive learning materials is appropriate for LD children and may cause frustration if a child's difficulties interfere with its use [9]. This could affect academic performance of the LD children. Therefore, an appropriate, accepted and constantly used assistive technology tool is essential to support an interactive digital learning process of these children.

Assistive technology is defined as "any item, piece of equipment or system that helps people bypass, work around or compensate for learning difficulties" [10]. It includes any instructional technology tools designed as one solution to support children with special needs in education. Children with significant developmental challenges benefitted from the effective use of appropriate technology tools that play to their strengths and work around their disabilities in order to express ideas and demonstrate understanding [2], [11]. This can boost a child self-esteem and increase sense of independence by making the learning process enjoyable.

A large number of technological approaches to assistive learning technologies are being investigated such as voice recognition technologies, mobile devices, tangible technologies, surface technologies and symbol-based interaction, with some proposals also for the use of augmented reality, virtual reality and robotics [12]. Radio Frequency Identification (RFID) is one of the promising tangible technologies for supporting LD children. It use

Manuscript received February 25, 2017; revised May 10, 2017.

doi: 10.18178/ijlt.3.4.251-258

and manipulate physical objects for representing and controlling digital information. The use of RFID technology promotes an interactive computer-aided learning to create attractive learning environment.

Therefore in this paper, an emerging application using Radio Frequency Identification (RFID) called Children's Storybook Reading System (StoBook) is proposed. The system is developed for children aged around seven to twelve years old who are experiencing significant specific learning disabilities in reading. The aim is to assist special education teachers, practitioners and parent for attracting and motivating these children to learn more. Here, RFID tag adds associations to digital information onto specific physical objects. Meanwhile, RFID reader operates as the scanning device, which it is used to communicate with the tag by transmitting the data computer via radio waves operating at a certain frequency.

The paper proceeds in the following manner. Section II presents the RFID technology. Meanwhile, the methodology framework is detailing out in Section III. Section IV reports the implementation of teaching and learning tool. Finally, Section V concludes with summary of this paper and future research directions.

II. RFID TECHNOLOGY

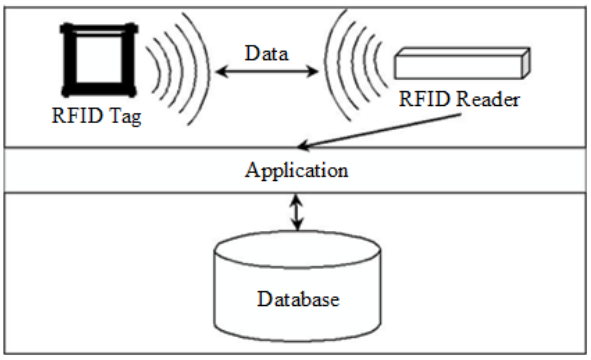

Figure 1. Flow of data in basic RFID system

RFID is categorized as tangible technology. It is a means of remotely retrieving and storing data by automatically identifying and tracking tags attached to physical objects through the wireless use of electromagnetic wave [13]. A great number of previous studies have applied RFID technology to optimize resource, increases efficiency within business processes, and enhance customer care, improve business operations [14]. RFID has the same concept as the barcode technology but uses radio waves to detect the data from the tag. In RFID-based systems, a physical object is embedded with a tiny silicon chip and an antenna, known as RFID tag. The chip encoded with a unique identifier, allowing tagged objects to be individually identified by an RFID reader using radio frequency waves. An RFID reader scans the tagged object for retrieving the data it contains and then send that information to the computer, which interprets the data stored on the tag. The data then is stored in the database. Fig. 1 shows the flow of data from in basic RFID system.

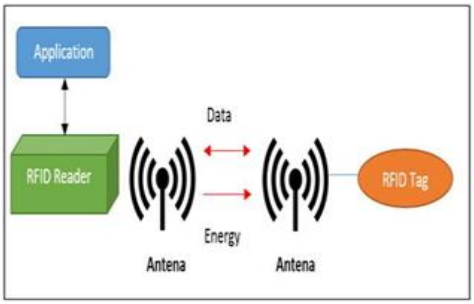

Figure 2. Process flow electromagnetic

The four key components of RFID are RFID tags, RFID readers, RFID middleware and backend database. These components are integrated to enable the implementation of RFID solution. RFID systems have the ability to deliver precise and accurate data about tagged objects. Fig. 2 shows the main RFID components.

An RFID system consists of various components that are connected to one another by a dedicated communication path (see Fig. 2). The individual components are integrated into the system to implement the benefits of RFID solution. The list of components is as follows:

- Tags–an object that is attached to any product and uses a unique sequence of characters to define it. It comprises of a chip and the antenna.
- Antenna–it is responsible for the transmission of information between the reader and tag using radio waves.
- Reader–a scanning device that uses the antenna to realize the tags that are in its vicinity. It transmits signals at a certain frequencies.
- Middleware–it is a communication interface to interpret and process data being fed by the readers into information. It takes into account all relevant ports of communication and a software application to represent this information.
- Backend database–a repository of information, which is designed specific to the application. The database stores records of data specific to individual tags.

Tag RFID has various forms and sizes as well as the characteristics of different combinations. RFID tags that were used in this application is a passive RFID tag with radio frequency transmitted to the reader and the strength of the signal wave from the reader to the tag is high, while the strength of the signal wave from the tag to the reader is low. Distance detecting signal for this tag is in three meters or less depending on the type of passive RFID tags. It is also more cheaply compared to active RFID tags, operate at frequencies which are low or high and ultra which is high frequency. Readers that were used were 4-port CS61 EPC Class 1 Gen 2. Readers of this model type are active RFID passive UHF frequency. Readers are supported by Impinj technology, with a very high level of preparation, speed tag and reader mode. Readers of this model are confirmed by EPCglobalTM Class 1 Gen 2 UHF RFID protocol.

III. Current Use of RFID in Special Education

There are other functions which tangible technologies are well placed to perform. First, they can provide a way of conveying information to LD children with limited language abilities; for example Parton *et al*. (2010) describe a system using RFID tags on a series of representative objects in order to help deaf preschool children to learn sign language, through the use of a game where scanning an object activates a video of a person signing the word for it.

For example, [12] describe a system using RFID tags to associate real physical objects with a video of a person performing a sign, as well as other images showing variations of the object, the written translation and an audio file of the spoken word. The advantages of this approach are that teachers can attach tags to real objects found in a child's environment, which the child can then scan at a computer point to help learn the sign for that object. The flexible and affordable nature of the tags means they can be attached to a wide variety of objects, and easily reused as a vocabulary expands, provided that time is spent in creating the digital materials which are associated with them. This can have benefits for young children who need to learn signs for common objects, but this approach may not work so well for concepts such as sentence structure, or non-tangible concepts such as 'hungry' or 'work'.

Technologies such as RFID tags can be used to cheaply add associations to digital information onto existing physical objects, and several hardware kits are available which allow a range of sensors and controls to be added onto physical objects with little programming knowledge required, for example phidgets18 [13].

IV. System Architecture

With the assistance of RFID, they are able to learn more easily and actively. With the advancement of RFID technology and fully integration with this application, it will meet the needs of interactive learning and LD children will communicate with this device. The device is a combination of storytelling book with multimedia elements and RFID technology. RFID enables the process of learning that is not limited and is not dependent on teachers in the classroom. LD children will be excited when they can actively learn in an interactive environment either at school or at home. In addition, teachers can enrich their teaching techniques and the LD child hopefully will never be bored and it promote an active learning as well.

The most significant problems in implementing learning through play are the activity of teaching aids. Planning and teaching for learning through play has long been considered a key feature of early childhood education. Teaching aids must be compatible with the concept that should involve all six components: language development and communication, cognitive development, physical development, spirituality and moral development, growth and development of creativity and aesthetics socio. These problems demonstrate that various problems can arise through the learning process. However, method for teaching for each skill can be set by the teacher according to students' level of understanding therefore the teaching and learning objectives are achieved.

The method that being adopted in this application is an interactive games and knowledge. The RFID tags are used in the game to put the toys in the form of letters and animal figurines (is a small statue that represents a human, animal or things). This application will basically contain an introduction to animal exercise and introduction to letters and numbers for the Malay language. Tag is placed inside the toys will be detected by the RFID reader and the data will be displayed on the computer about the toys information as shown in Fig. 3. This tag can only be detected when these tags meet the requirements specified for the module in this application.

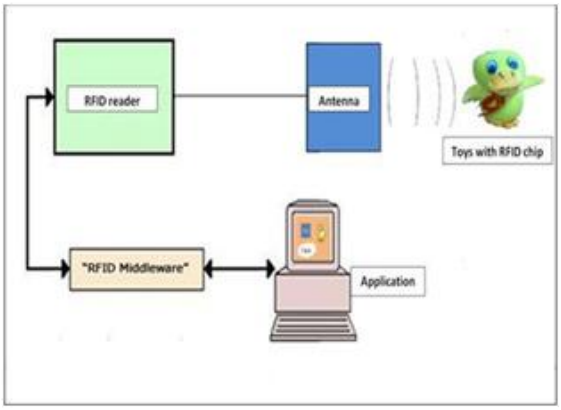

Figure 3. Example of application design

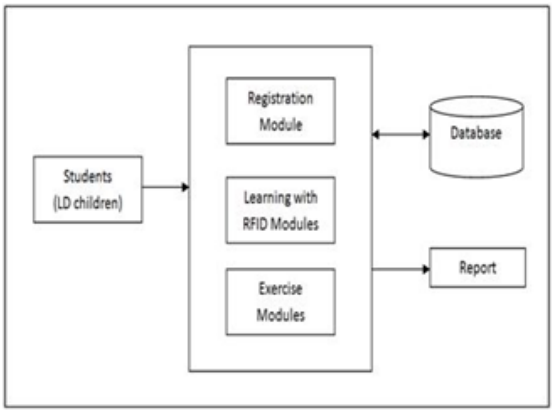

Figure 4. System architecture for teaching and learning module

This application enables special education children like LD children to use the computer tools and toys as a tool for learning. These applications will encourage LD children to move and play with the letters provided. The use of technology as a tool for teaching and learning enables knowledge to be delivered more effectively and can be easily remembered. Fig. 4 shows the system architecture for LD children.

In order to measure the effectiveness and reliability of this solution, we will be conducted the qualitative and quantitative analysis. Qualitative data are obtained through interviews and questionnaires to which they

relate. The researcher will ask questions to the LD children and record it in the video and analyze with a teacher or an observer to reaffirm the response by LD children. Teachers who teach children with LD will also help to validate the answer for each question given by the child. Quantitative data are obtained by examining the percentage or value of the stimulus accumulated by the group of special education children. Several groups of special education children will be taken as sampling to obtain accurate data

V. Implementation of Teaching and Learning Tool

The StoBook is an interactive learning tool develops and embeds with RFID's kit that can be used as an alternative for the implementation of active learning approach for LD children. This tool provides a step-by-step active learning process to stimulate and acquired an immediate learning approach throughout interactive and self-adaptive activities. Finally, StoBook will then indirectly reduce the traditional learning process between teacher and children and via-versa. StoBook is divided into two (2) parts, which are (i) for configuration module and (ii) learning module. Fig. 5 shows the structure of StoBook.

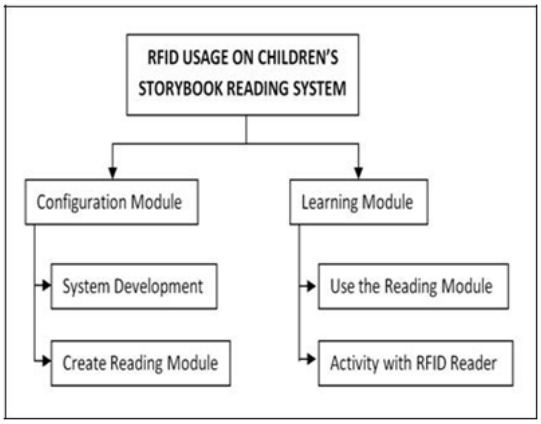

Figure 5. The module structure of StoBook

The graphical user interface (GUI) is designed and developed special for LD children. The appropriateness of the GUIs and arrangements of input and output according to the sequence of learning processes. Ironically, the elements of StoBook design is derived based on the interdisciplinary fields such as human computer interaction (HCI), best design practices and cognitive science. Fig. 6 shows the main page of StoBook.

Upon clicking this button, the next the interface displays the three modules of StoBook. Fig. 7 shows the interface design displaying these modules of StoBook. The interactive learning process focusing into two (2) phases. In the first phase, children will learn theoretical aspect of alphabetical by recognizing and identifying letters throughout module 1. Then, they been taught on constructing basic word and simple game via module 2. In the second phase, the children will engage with practicing what they have learned and achieved in phase one. Module 3 provides two short storytelling exercises for children to practice after mastering the first and the second module of StoBook. In this module, children will interact with the StoBook using flashcard (that embed with RFID's tag) and match the card to the proper place based on the scenario of storytelling. StoBook provide a flexibility to the children to iterate the learning process or to exit from the system and via-versa.

Figure 6. The Main Interface of StoBook

Figure 7. The Interface for several modules

A. Configuration Module

This module includes all the configuration of RFID's reader, antenna with the learning system; finally establish the connectivity between RFID's kit and the system itself. In addition, this module provides a feature to perform read/write mode for RFID's tag that embedded into flash card and the toys therefore that all the pre-defined data in RFID tag will synchronize with the system.

B. Learning Module

The learning module is basically a part of the whole system that will be installed in the personal computer locally to perform the functionalities of learning process upon the connectivity of RFID's kit established. The learning module consists of three (3) module of learning; (i) learning on alphabetical, (ii) basic word and game, (iii) finally short storytelling.

1) Sub module 1

Module 1 is known as 'MENGENAL HURUF ABC'*(RECOGNIZE ABC)*. The learning outcome of

module 1 is the LD children will be able to recognize and remember alphabetical and ready to use it in module 2. The following guidelines provide a step on how to operate module 1.

a) The LD children need to click the button 'MENGENAL HURUF ABC' to access module 1. StoBook will display interface learning alphabetical as shown in Fig. 8.

Figure 8. Interface for letter learning

b) To learn on each of the letter, LD children must firstly click on the letter. For example, if the LD children click the letter 'Dd' Fig. 9 will appear.

Figure 9. Interface for spell and pronounce

c) To hear the sound of 'DADU', click corresponding button 'DADU' and StoBook will pronounce as 'DADU'.

d) Repeat step (b) and (c) for the remaining of letters.

2) Sub module 2

Module 2 provides a way for LD children to test their understanding on each of alphabetical they have learned in module 1. The learning outcome of module 2 is the LD children will be able to construct recognize syllables in a simple and interactive way. The following guidelines provide a step on how to operate for the module 2.

a) Firstly the LD children must read the book.

b) The LD children need to click the button 'SUKU-KATA DAN GAMES' (SYLLABLES AND GAMES) to access module 2.

c) StoBook will display interface as shown in Fig. 10.

Figure 10. Word games

d) The LD children scan the syllable card (embed with RFID's tag) on the antenna.

e) StoBook will produce pronunciation and the way how to spell the syllable appears on the small box.

f) The LD children click to KE PERMAINAN SUKU-KATA button to play with the syllable's card.

g) StoBook will ask the questions to the children.

h) Then, the LD children answer using the syllable's cards.

i) If the answer is correct, StoBook will display the interface as shown in Fig. 11.

Figure 11. Output syllable

j) For second part of module 2, StoBook will prompt word or vocabulary the LD children learn from step i. as shown in Fig. 12.

k) For instance, the picture rabbit appears. The LD children will answer and spell it correctly by using the combination of two or more syllable cards and placed these cards near the antenna.

Figure 12. Test combine syllable to create a word

l) Fig. 13 shows the output the LD children answered it correctly.

m) Subsequently, the clapping sound will appear.

Figure 13. Output from the syllable games

3) Sub module 3

Module 3 provides a way for LD children to start a reading process by adopting the active learning process where the LD children will participate to stimulate learning mode rather than doing in a traditional way. The module consists of two (2) exercise related to short storytelling. The learning outcome of module 3 is the children will be able to perform basic reading using flash card and interact with the storytelling and via-versa. The following guidelines provide a step on how to operate module 3.

Figure 14. Reading story based on storybook

Figure 15. Answer question based on storybook in RFID usage on children system

a) The children need to click the button 'MEMBACA BUKU CERITA' (READING STORY) to access module 3. Fig. 14 shows the storytelling interface.

b) The children start to listen to the storytelling.

c) While listening to the story, the interactive learning occurs where LD children need to answer the questions appear in the story. The purpose of the question is to evaluate the LD children understanding towards the sequence of the storytelling.

d) The LD children provide an answer by using the picture (embed with RFID's tag) and put near the antenna.

e) The snapshot Fig. 15 shows one of the questions StoBook prompt to the children upon reading and listening to the story before.

f) If LD children provide correct answer, the output in Fig. 16 displayed .

g) Otherwise, the output in Fig. 17 is displayed.

Figure 16. Popup right answer in RFID usage on LD children reading system

Figure 17. Popup wrong answer in RFID usage on LD children storybook system

VI. CONCLUSION

The StoBook offers an interactive approach for LD children and kids learning processes by blending active learning with automatic identification and data capture (AIDC) using RFID technology. The children and kids will transform from traditional learning approach to the newest learning approach that emphasize on the creative learning, merely can nurture the basic knowledge to the children and kids in the faster ways. System testing and evaluation have been conducted at Taska Noorni in Kg. Pulau Rusa, Kuala Terengganu, Terengganu. The project team review all the feedbacks and comments gained from teachers and children for further improvement of StoBook either from technical aspects of the system and guidelines on how to operate thus such system. Based on the evaluations and comments received from various parties, StoBook has a potential to be introduced and promoted to the Social Welfare Department in Malaysia, which it can be used in the government pre-school education to enhance and improve the LD children learning environment.

The StoBook is a unique interactive learning tool that can assist teacher to nurture the basic knowledge to the children at their pre-school education. The solution is blended using active learning approach and enables RFID's technology. It can act as a catalyst to slowly transform the teaching approach from traditional learning approach to active learning approach where the children can start thinking and use their physical to support the learning process. The StoBook can be a starting point for the researcher and the team to explore more on the contents and designs of Stobook. Furthermore, the pedagogy used in this tool can be further improved based on the information and consultation obtained from childhood domain expert.

The RFID usage on Children's Storybook Reading System (StoBook) will give the best solution for the problem of recognizing the alphabet, the problem to understand the story (reading comprehension), become boring and passive in the classroom. Technology using RFID will help LD children to learn with fun because it needs the LD children to move their hands, eyes and the other organs. It is important for a developer to create a great interface, nice looks and attractive book by using the cute cartoon and colorful background. In addition, use the nice audio to read the book, read the letter and spell the word, indirectly it will be able to attract the children indirectly to use this system. The results expected by the study is that special education children can be taught to use RFID technology applications in teaching and learning to enhance their learning activities. For example children with dyslexia (one of the LD) have never failed in the use of information technology tools such as computers. With repeated pronunciation of these applications, LD children can make slow learning self-control, repeatedly and interact according to their own way. It will also attract LD children to focus on their attention of what they have learned.

For the future development, the system can be enhanced in terms of the features and functionalities. More languages can be added to StoBook to give opportunities for the LD children to learn more languages. In addition, the contents of storytelling can be further improved by inviting several domain experts in special education and learning contents to design and formulate the contents. It is based on the current Malaysian Ministry of Education (MOE) framework for childhood education. As s result, hopefully StoBook can be as one of the starter kits for early childhood education as the foundation for life-long learning and to stimulate LD children's creative and imaginative powers, and encourage them to enjoy participating in creative works.

REFERENCES

[1] E. A. Davydenko, "Artificial intelligence in education of children with learning disabilities," *Introduction to Artificial Intelligence*, pp. 1-9, November 2012.

[2] W. D. Beeland, "Student engagement, visual learning and technology: can interactive whiteboards help?" *Action Research Exchange*, vol. 4, pp. 1-7, Sumer 2002.

[3] United Nations Educational, Scientific and Cultural Organization (UNESCO), Jakarta Office, "Malaysia: National report on the provision of inclusive quality primary and junior secondary education for children with disabilities," presented at Sub-regional Workshop on Building Inclusive Education System to Respond to the Diverse Needs of Disabled Children, Jakarta, Indonesia, November 3-5, 2009.

[4] C. Cortiella and S. H. Horowitz, *The State of Learning Disabilities: Facts, Trends and Emerging Issues*, 3rd Edition, New York: National Center for Learning Disabilities, 2014, pp. 2-3.

[5] K. Utusan, "Guru punca pelajar gagal kuasai 3M?" *Utusan Malaysia Online*, February 14, 2010.

[6] R. B. A. Bolhasan, "A study of dyslexia among primary school students in sarawak, Malaysia," *School of Doctoral Studies (European Union) Journal*, vol. 1, pp. 250-268, July 2009.

[7] G. Alnahdi, "Assistive technology in special education and the universal design for learning," *The Turkish Online Journal of Educational Technology*, vol. 13, pp. 18-23, 2014.

[8] M. Israel, M. Marino, L. Delisio, and B. Serianni, *Supporting Content Learning through Technology for K-12 Students with Disabilities*, 1st Edition, Gainesville, Florida: The CEEDAR Centre, 2014.

[9] A. Price and M. Cole, *Best Practices in Teaching Students with Learning Disabilities*, 1st Edition, Calgary: Calgary Learning Centre, 2009.

[10] M. Raskind, *Assistive Technology for Children with Learning Difficulties*, 1st Edition, California: Schwab Foundation for Learning, 2000.

[11] S. A. Mulligan, "Supporting the participation of children with disabilities," *Beyond the Journal: Young Children on the Web*, vol. 1, pp. 1-2, 2003.

[12] L. McKnight and C. Davies, *Current Perspectives on Assistive Learning Technologies*: *2012 Review of Research Challenges within the Fields*, 1st Edition, Oxford: Kellogg College Centre for Research into Assistive Learning, January 2013.

[13] S. Nainan, R. Parekh, and T. Shah, "RFID technology based attendance management system," *International Journal of Computer Science Issues*, vol. 10, pp. 516-521, 2013.

[14] K. Ahsan, H. Shah, and P. Kingston, "RFID applications: An introductory and exploratory study," *International Journal of Computer Science Issues*, vol. 7, pp. 1-7, 2010.

Assoc. Prof. Dr. Noor Maizura Mohamad Noor is currently a deputy dean of academic and students. Previously she was a deputy director of Quality Centre and Academic Development (PKPA) University Malaysia Terengganu (UMT). She received her PhD degree from The Manchester University, UK in 2005. Her recent research work focuses on improving organizational decision making practices through the use of technologies. This includes research interests in the design, development and evaluation of decision support systems for analyzing and improving decision processes. Her research interests also focus on the areas of computer science, intelligent decision support system, clinical decision support system, and information system. She is an editor of books, conferences proceedings and also a reviewer and editorial board of International Journals. Her several awards including the Best Scientist Award, Product and Research Innovation Award for International and National Level of UMT. She is a member of ACM, IEEE and IACSIT.

Dr. Rosmayati Mohemad is currently a senior lecturer at School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu (UMT). She received her PhD degree in Computer Science from Universiti Kebangsaan Malaysia, Malaysia in 2013. Her research interests are in knowledge engineering and decision support system and currently focusing on modelling ontology for supporting decision-making process in special education and forensics domain. She is an editor of books, conference proceedings and also reviewer of international conference papers. She is a member of IEEE.

Mohd Pouzi Hamzah was born in 1962 in Terengganu. In 1986, he was appointed as a tutor at Universiti Kebangsaan Malaysia (UKM). He continued to further his study in 1986 at University of Glasgow and obtained his Master in Applied Science (Computer Science) in 1987. In 2006, he obtained his PhD in Information Retrievals from Universiti Kebangsaan Malaysia. He left UKM in 1996 to join management team of Terengganu Advanced Technical Institute in a call to establish skilled Diploma in Industrial Automation recognized by government of Switzerland. He then joined Universiti Putra Malaysia (Branch Terengganu) in late 1998 as a lecturer. He hold several administrative positions namely Coordinator of Computer Centre, Head of Computer Science Department, Deputy Dean, Director of Computer Center and Director of Academic Development Center. His main research interests are information retrievals involving forensic data, speech retrievals, question-answer systems, deep knowledge retrievals and game based learning.

Mr Mohamad Nor Hassan is a lecturer at University Malaysia Terengganu (UMT). He received MSc in Information Management University Technology Mara (UiTM) in 2005. Presently, he owned Microsoft Certified Professional (MCP), Oracle Certificate Associate (OCA) and Certified Tester Foundation Level (CTFL) governed by ISQTB. Previously he worked in industry for almost ten years in various as system developer, researcher, system analyst and SAP Application consultant. Current research areas are on the software quality and measurement, web technologies and embedded software such as RFID and Internet of Things (IoTs). He is a member of Malaysia Triz Association (MyTRIZ).