Using Speech Recognition in Learning Primary School Mathematics via Explain, Instruct and Facilitate Techniques

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Abstract

The application of Information and Communication Technologies has transformed traditional Teaching and Learning in the past decade to computerized-based era. This evolution has resulted from the emergence of the digital system and has greatly impacted on the global education and socio-cultural development. Multimedia has been absorbed into the education sector for producing a new learning concept and a combination of educational and entertainment approach. This research is concerned with the application of Window Speech Recognition and Microsoft Visual Basic 2008 Integrated/Interactive Development Environment in Multimedia-Assisted Courseware prototype development for Primary School Mathematics contents, namely, single digits and the addition. The Teaching and Learning techniques—Explain, Instruct and Facilitate are proposed and these could be viewed as instructors' centered strategy, instructors'—learners' dual communication and learners' active participation. The prototype is called M-EIF and deployed only users' voices; hence the activation of Window Speech Recognition is required prior to a test run.

Keywords

Explain, Instruct and Facilitate Techniques, Multimedia-Assisted Courseware, Primary School Mathematics, Visual Natural Language, Window Speech Recognition

1. Introduction

Teaching and Learning (T & L) is an activity or process in connection with the dissemination of knowledge or

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specific skills. It covers planning, management, delivery, supervision and evaluation in order to effectively disseminate knowledge. The model [1] divides T & L process into Teaching Objectives, Available Knowledge, Teaching Method and Performance Evaluation as shown in Figure 1.

The model in Figure 1 indicates that T & L includes a range of decisions and practices which might require personal contacts between instructors-learners; however, instructors’ personality is not the central element in T & L. The use of technological devices, team teaching and non-graded instruction will definitely modify the nature of contacts between instructors-learners. Depending on the requirement of the T&L situations, particularly on the knowledge available, the future classroom will provide for rather different personal contact to the present conventional classroom. The model implies a greater emphasis on instructors’ competence rather than personal charisma; however, it is useful to have these combinations.

The facilitation technique [2] is using questions. Previous research has shown that questioning is a key strategy that facilitators use to promote discussion in Problem-Based Learning (PBL). In this study, different types of questions is examined that experienced facilitators asked to promote discussion of teaching problems in professional development for science teachers. PBL sessions facilitated by three pairs of experienced facilitators are recorded. Data analysis showed that facilitators asked a set of questions to initiate and solicit ideas, to reframe ideas, to clarify ideas, to push for elaboration, to check for interpretation, and to connect to teachers’ classroom practice. This study has implications for the development of PBL facilitators.

T & L strategies can be classified as three key elements: instructors’ centered, concentration and learners’ centralization learning. These strategies are sometimes intertwined to each other in T&L process. The 5E model [3]—Engage, Explore, Explain, Elaborate and Evaluate—is modified by inserting a conscious pause in a learning cycle. It is called as an express phase to assess and ensure that learners progress adequately through early phases of the cycle. Ultimately, this revised cycle enables learners to meet the standards addressed in a particular lesson by providing differentiated opportunities.

Various technologies have been used to convey knowledge and the use of checklist [4] is common in Teaching and Learning (T & L) conventional qualitative studies. It is pointed out that the problem must be translated into mathematical terms and mathematical language before it is completed as the concepts contained in the structure of the problem. Some difficulties in T & L may arise, however, problems and difficulties [5] [6] might be overcome by using Information and Communication Technology (ICT). ICT environment [7] is urged to become personalized for T&L and it should be a full multimedia with an almost perfect online for community. T & L might be delivered in various forms and modes, such as entertainment and games. This makes T & L process [8] more interesting, interactive and fun.

The study [9] discussed on teachers’ educational beliefs, namely, constructivist and traditional as antecedent of computer use while controlling for the impact of technology-related variables in computer experience and general computer attitudes with demographical variables of sex and age. A multilevel modelling has been used in identifying differences in determinants of computer use in the classroom. For measuring primary teachers’ use of computers to support T & L process, a modified version of the Class Use of Computers scale [10] was used. The study supports the hypothesis that teacher beliefs are significant determinants in explaining reasons for adopting computers in the classroom. The impacts of computer experience, general computer attitudes and gender have shown positive constructivist beliefs on the classroom use of computers as opposed to traditional beliefs.

Multimedia is viewed as a dynamic approach when absorbed into education sectors for producing a new T&L concept with a combination of educational and entertainment approach. The rapid development in mobile computing, digital memory, internet resources, audio, video transmission, virtual imaging and wireless communication have created new possibilities for the use of technology in T & L. Multimedia technology [11] which com-
bines computer technologies, compact disc players; video and audio systems yield a better enhanced interaction among end users. Interactive multimedia in the context of education has played a vital role in developing a T & L process towards a more dynamic and quality. Moreover, this technology creates a big and deep impact in the field of communication and education by representing numbers with pictures and animations. This is supported by computer abilities in presenting information and also T&L applications [12]. To date, ICT is often associated with education where the technology provides various facilities in T & L process and increase learners’ interest in the subject being taught.

The goal in [13] is to acquire how multimedia video case studies can support the professionalization of primary school Mathematics educators. The use of multimedia is investigated to support educators in learning to mathematize, didactize and to learn how to use multimedia with students-teachers. The research study has an exploratory character; presents a framework for the use of multimedia as a tentative answer, grounded in the researchers’ experiments and design activities. Finding from the study is of one course result in a six-step framework for working with multimedia cases.

Building an accurate sign language recognition system [14] is of a great importance in order to efficiently facilitating communication between normal and deaf communities. The study is the development of speech recognition for Arabic Sign Language using Window Speech Recognition (WSR). The grammar is developed and embedded in Microsoft Visual Basic 2008 (MSVB2008). The Arabic alphabets and single numbers with their respective signs and avatar images are stored in different directories and invoked upon receiving a word uttered by a user. The system is a visual natural language model that might be used for communication by both groups in Arabic speaking countries.

Automatic speech recognition has now become a great benefit both to normal people and those with various disabilities. The study in [15] described T & L in an application of Talk Maths which used the output from a commonly-used conventional automatic speech recognition system. It enables users to dictate mathematical expressions in a relatively straightforward way. These are then converted into electronic formats and embedded in a document to be displayed in an editor or web browser. The process is used for preparing Mathematic teaching materials for online tests. By this, the learning should be relatively straightforward for users whose do not have extensive knowledge on computer or mathematics. The way in which the spoken mathematical expressions are analyzed, converted and encoded is a novel approach.

The current research [14] [15] shows the Speech Recognition application in some disciplines and with right T & L pedagogy and techniques, this surely will enhance the education for everyone. Though mathematics is seen as an abstract of study such as quantity, structure, space and change, it is feasible to be transformed into a WSR-assisted courseware for T & L. The presence of an Integrated/Interactive Development Environment (IDE) provides comprehensive facilities to computer programmers for software or courseware development. This research is concerned with the development of Primary Mathematics courseware prototype using Explain, Instruct and Facilitate Techniques (M-EIF) via WSR and MSVB2008 as IDE platform. The single digits and basic facts addition for these digits are used as the test bed materials for prototype development. The prototype could only be run by users’ voice uttering the selected words.

2. Materials and Methods

2.1. Windows Speech Recognition

In general, a speech recognition process [14] consists of processing the speech which is in acoustic, extracting feature and recognizing the speech. The process is based on a model as shown in Figure 2.

In this research, Windows 7 Speech Recognition [16] is applied since users’ voice can be recognized automatically by the system. Users are required to perform the following training in order to acquire the maximum possible recognized speech. In the system, a voice can be used to control a computer by simply saying commands that a computer responds to and also dictating texts to it. A microphone should be connected to a computer prior to the execution the steps in setting up WSR.

The success of speech recognition depends on the quality of the microphone and the headset and desktop microphones are commonly used. Headset microphones are considered better since they are less prone to picking up extraneous sounds. A 30 minutes WSR training tutorial will assist users to exploit the commands used. Figure 3 shows WSR pop-up widgets display for Starting Speech Recognition.

There is a unique voice profile used by WSR engine to recognize users’ voice and spoken commands. Once
**The WSR implementation**

The implementation [17] written for C# provides an overview and examples in Windows Forms application by the following operations:

1) Initialize the speech recognizer.

   \[
   \text{Speech Recognizer } SR = \text{new Speech Recognizer()}. \]

2) Create a WSR grammar.

   The grammar is created by using the constructors and methods on the `Grammar Builder` and `Choices` classes.

   For a simple grammar, an element is added in a `Choices` object using the `Add` method. Then the `Grammar Builder` instance is created and using the `Append` method to insert the elements in that instance. Finally, the `Grammar Builder` instance is initialized. A user must speak exactly one of the elements added by the `Choices` instance in order to attain the match between user speech and the grammar.

3) Load the grammar into the speech recognizer.

   The grammar created in the previous operation must be loaded and passed into the speech recognizer by calling the `Load Grammar (Grammar)` method.

4) Register for speech recognition event notification.

   The speech recognizer raises a number of the `Speech Recognized` events during its operation, when it accepts a user utterance with a grammar. A notification of this event is registered by appending an `Event Handler` instance via `SR_Speech Recognized` the name written by a developer.

5) Create a handler for the speech recognition event.

   A handler created for the `Speech Recognized` event displays the text of the recognized word or phrase using the `Result` property on the `Speech Recognized Event Args` parameter, e.

**2.2. Primary School Mathematics**

Mathematics is the study of measurements, properties, and relationships of quantities and sets, using numbers and symbols. It is a group of related sciences, including algebra, geometry, and calculus. It concerns with the study of quantity, shape, and space and their interrelationships by using specialized notations. These notations called mathematical operations and the process is to look for solutions to problems or studies of some scientific field. In this research, Primary Mathematics contents taught in Elementary Schools, Saudi Arabia [18] are considered. Figure 4 shows some materials taken from Class 1 book.

The basic topics in elementary mathematics are arithmetic and geometry. Elementary mathematics is used in everyday life activities such as dining, cooking, buying and selling things. It is also an essential first step on the path to understanding science. The contents presented are only covered basic digits 0 to 9 and addition operation for two single digits known as basic facts. By definition, the basic facts are any numbers or mathematical facts or ideas that can be instantly recalled without having to resort to a strategy to derive it. Table 1 shows the details for addition operation basic facts for two single digits from 0 to 9.
237

**Figure 4.** Part of Mathematics for Grade 1 contents.

**Table 1.** The basic facts addition operation for digit 0 to 9.

<table>
<thead>
<tr>
<th>Addition operation for digit 0 to 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 0 = 0</td>
</tr>
<tr>
<td>0 + 1 = 1</td>
</tr>
<tr>
<td>0 + 2 = 2</td>
</tr>
<tr>
<td>0 + 3 = 3</td>
</tr>
<tr>
<td>0 + 4 = 4</td>
</tr>
<tr>
<td>0 + 5 = 5</td>
</tr>
<tr>
<td>0 + 6 = 6</td>
</tr>
<tr>
<td>0 + 7 = 7</td>
</tr>
<tr>
<td>0 + 8 = 8</td>
</tr>
<tr>
<td>0 + 9 = 9</td>
</tr>
</tbody>
</table>

### 2.3. The Explain, Instruct and Facilitate ({EIF}) Techniques

Learning methods are frequently referred to as ways through which instructors deliver instructions and learners access these instructions. Several learning methods are described as traditional learning, e-Learning, blended learning, mobile learning, and personalized learning. These methods [19] accompanied with the advancements in technology and the paradigm shift from traditional learning to personalized learning methods. The proposed EIF technique, Explain (E), Instruct (I) and Facilitate (F) involves the development of theory and interactive courseware. Figure 5 shows that each stage has a different approach that involves a different role in T & L.

The Explain (E) stage is the process of explaining concepts for topics delivered. Many examples and other explanations are used to clarify in learning the concepts. Consequently, this stage can be viewed as presenting a textbook for topics are being studied. For a courseware development, it is like an electronic book and the questions can be varied using a random function, especially involving numbers. It is useful for self-learning for those who haven’t learned the concept presented. Instructors’ presence might be required to clarify or clear any doubts.

The Instruct (I) stage is a dual communication where the session is benefited by answering the given questions. Instructors provide the questions according to levels, from easy to difficult. It is a test of knowledge and should be nurtured so that they will not hesitate to answer any questions. The courseware developed is seen as a semi-interactive exercise book of students’ involvement in response to questions displayed on a computer screen. The numbers are delivered randomly and answers provided by students will be verified by computer. For any
difficulties the level Explain (E) can be referred again.

Learners’ full participation is needed at the Facilitate (F) level. They are required to utter both questions and answers whilst instructors’ tasks are to guide or act as facilitators. It is a full of interactive T & L session and a courseware developed at this stage requires knowledge for concepts of topics taught. In addition, the use of logic should be considered as computers assumed instructors jobs. At any higher level of difficulties, some tips for guiding learners should be provided. For the materials chosen in Figure 4 and Table 1, learners are required to pose questions and replied with answers which are verified by computers. Table 2: shows a general T & L process to be used in the developed software using EIF Techniques.

A courseware development requires methods and techniques appropriate to T & L that can help to improve learners’ understanding. The hardware and software specifications have to be determined as this has to be consistent with the requirements used for the development. Any cases relating to T & L should be studied to see the strategies are compatible with a computer-aided learning. In this research, the tools used are WSR and MSVB2008 running on a standard personal computer.

2.4. The Algorithm

By using WSR and MSVB2008, the idea is to build a language grammar that allocates word phonemes for a user’s voice to be recognized. The system is designed as such answers will only be accepted preceded by questions uttered. Table 3 contains the suggested words list and these are used in the source codes in section 3.2 and the respective interface in Section 3.3. The flow diagrams in Figure 6 and Figure 7 used the words mentioned in Table 3 and transferred into the source codes presented in Section 3.2.

3. Results and Discussions

3.1. Creating M-EIF Speech Recognition Grammar

The idea is to build the language grammar that allocates word phonemes in Table 3 for a user’s voice to be rec-
Figure 6. The flow diagram for numbers.

Figure 7. The flow diagram for addition.

Table 2. T & L process.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Approach</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Centered</td>
<td>From Simple to Complex</td>
<td>Explain (E)</td>
</tr>
<tr>
<td>Teacher Centered</td>
<td>From General to Specific</td>
<td>Instruct (I)</td>
</tr>
<tr>
<td>Student Centered</td>
<td>Multiple Stage Understanding</td>
<td>Facilitate (F)</td>
</tr>
</tbody>
</table>
Table 3. The words list used in the source codes for each interface.

<table>
<thead>
<tr>
<th>Interface</th>
<th>Words list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Menu</td>
<td>See, Say, Do, Learn, Check, Attempt, Numbers, Books, Flow, Exit</td>
</tr>
<tr>
<td>Explain</td>
<td>Show, Return</td>
</tr>
<tr>
<td>Numbers</td>
<td>Question, Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Nine, Return</td>
</tr>
<tr>
<td>Instruct</td>
<td>Question, Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Nine, Yes, Return</td>
</tr>
<tr>
<td>Facilitate</td>
<td>Show, Return</td>
</tr>
<tr>
<td>Explain</td>
<td>Question, Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Nine, Ten, Eleven, Twelve, Thirteen, Fourteen, Fifteen, Sixteen, Seventeen, Eighteen, Return</td>
</tr>
<tr>
<td>Instruct</td>
<td>Question, Zero, One, Two, Three, Four, Five, Six, Seven, Eight, Nine, Ten, Eleven, Twelve, Thirteen, Fourteen, Fifteen, Sixteen, Seventeen, Eighteen, Return</td>
</tr>
<tr>
<td>Facilitate</td>
<td>Return</td>
</tr>
<tr>
<td>EIF Flowchart</td>
<td>Return</td>
</tr>
<tr>
<td>Numbers up to 100</td>
<td>Return</td>
</tr>
<tr>
<td>Material used</td>
<td>Return</td>
</tr>
</tbody>
</table>

ognized. Figure 8 shows the M-EIF architecture.

In this research, a speech recognition application in [17] [20] is adapted to perform the following operations and based on MS-VB2008 structure. The following details are for the M-EIF:

1) The definition for M_EIF as a new Speech Recognition is defined as
   Dim WithEvents M_EIF As New Recognition.SpeechRecognizer.

2) The definitions for the grammar, alphabets, and loading them are presented as
   WordRule.Add(WordList).
   M_EIF.LoadGrammar (New Recognition.Grammar (WordFacts)).

3) The events, whether the defined M_EIF is recognized according to the grammar prescribed in Step 2, or otherwise and these require a subprogram defined as
   Private Sub M_EIF_SpeechRecognized (ByVal sender As Object, ByVal e As System. Speech. Recognition. Recognition EventArgs) Handles M_EIF.SpeechRecognized.
   which returns the value in e as e.Result.Text
   4) The values in Step 2 are connected to the chosen location to display an interface, digit or picture for words designated in Step 3. For example, on uttering the word “See”, the system executes frmNumberShow.show. The message “What was that?” in the widget is displayed when no matching is attained.

3.2. The Source Codes

The following source codes are based on the algorithm derived in Section 2.4. Figure 9 and Figure 10 show the source codes for M-EIF Main Menu and its Speech Recognizer (SR) procedure.

The source codes for other interfaces and their respective SR procedures are as follows. The words list used for each form is as given in Table 3.

   Number-Explain: “See”, Figure 11 and Figure 12.
   Number-Instruct: “Say”, Figure 13 and Figure 14.
   Number-Facilitate: “Do”, Figure 15 and Figure 16.
   Addition-Explain: “Learn”, Figure 17 and Figure 18.
   Addition-Instruct: “Check”, Figure 19 and Figure 20.
   Addition-Facilitate: “Attempt”, Figure 21 and Figure 22.
Figure 8. The $M$-EIF architecture.

Imports System.Speech

Public Class frmIntro

    Dim M_Speech As New Recognition.SpeechRecognizer
    Dim M_SpeechEvent As New Recognition.SpeechEvent

    Private Sub frmIntro_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load

        Dim WordsRule As New Recognition.SpeechGrammar.SpeechRule("M_EIF")
        WordsRule.AddWordList
        WordsList.AddWordsRule
        lblWord.Visible = True
        lblWord.Text = "See Say Do Learn Check Attempt Numbers Books Flow Exit"
    End Sub

Figure 9. $M$-EIF main menu.

Private Sub M_SpeechRecognized(ByVal sender As Object

    Select Case e.Result.Text
        Case "See"
            frmNumberShow.Show()
        Case "Say"
            frmNumberTry.Show()
        Case "Do"
            frmNumberSay.Show()
        Case "Learn"
            frmAddTo9.Show()
        Case "Check"
            frmInertil9.Show()
        Case "Attempt"
            frmDoltc9.Show()
        Case "Numbers"
            frmNumbers.Show()
        Case "Books"
            frmBooks.Show()
        Case "Flow"
            frmMIFChart.Show()
        Case "Exit"
    End Select

    Me.Hide()
End Sub

Figure 10. $M$-EIF SR procedure.
Imports System.Speech

Public Class frmNumberShow

    Dim WithEvents ShowNumber As New Recognition.SpeechRecognizer
    Dim Num1 As Integer

    Private Sub frmNumberShow_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
        Dim NumberGrammar As New Recognition.SrgsGrammar.SrgsDocument
        Dim Num1sRule As New Recognition.SrgsGrammar.SrgsRule("ShowNumber")
        Dim NumbersList As New Recognition.SrgsGrammar.SrgsOneOf("Show", "Return")
        Num1sRule.Add(NumbersList)
        NumberGrammar.Rules.Add(Num1sRule)
        NumberGrammar.Root = Num1sRule
        ShowNumber.LoadGrammar(NumberGrammar)
        Randomize()
        clearbirds()
        lblWord.Text = "Show Return"
    End Sub

    Figure 11. Number-explain main.

    Private Sub ShowNumber_SpeechRecognized(ByVal sender As System.Object, ByVal e As System.SpeechRecognizedEventArgs)
        Label2.Visible = True
        Label2.Text = e.Result.Text
        clearbirds()
        Select Case e.Result.Text
            Case "Return"
                frmIntro.Show()
                MsgBox() clearbirds()
            Case "Show"
                Num1 = Rand() + 10
                Showbirds(Num1)
            If Num1 = 0 Then
                Label2.Text = "Zero"
            ElseIf Num1 = 1 Then
                Label2.Text = "One"
            ElseIf Num1 = 2 Then
                Label2.Text = "Two"
        End Select
    End Sub

    Figure 12. Number-explain SR.

Imports System.Speech

Public Class frmNumberTry

    Dim WithEvents TryNumber As New Recognition.SpeechRecognizer
    Dim Num1 As Integer

    Private Sub frmNumberTry_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
        Dim NumberGrammar As New Recognition.SrgsGrammar.SrgsDocument
        Dim Num1sRule As New Recognition.SrgsGrammar.SrgsRule("TryNumber")

        NumbersRule.Add(NumbersList)
        NumberGrammar.Rules.Add(NumbersRule)
        NumberGrammar.Root = Num1sRule
        TryNumber.LoadGrammar(NumberGrammar)
        Randomize()
        clearbirds()
        lblWord.Text = "Question Zero One Two Three Four Five Six Seven Eight Nine Return"
        clearbirds()
    End Sub

    Figure 13. Number-instruct main.
Figure 14. Number-instruct SR.

Imports System.Speech

Public Class frmNumberSay

    Dim WithEvents sSayNumber As New Recognition.SpeechRecognizer
    Dim Num, Num2, Ctr, CtrQ As Integer

    Private Sub frmNumberSay_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
        Dim NumbersGrammar As New Recognition.SpeechGrammar(SpeechGrammarRule("SayNumber"))
        Dim NumbersRule As New Recognition.SpeechGrammar(SpeechGrammarRule("SayNumber"))
        Dim NumbersList As New Recognition.SpeechGrammar(SpeechGrammarRule("SayNumber"))
        NumbersRule.Rule = NumbersRule("SayNumber")
        NumbersList.Rule = NumbersList("SayNumber")
        NumbersGrammar.Root = NumbersRule
        sSayNumber.LoadGrammar(NumbersGrammar.Root)
        clearbirds()
        lblWord.Visible = True
        lblWord.Text = "Question Zero One Two Three Four Five Six Seven Eight Nine Yes Return"
        Ctr = 1
        CtrQ = 0
    End Sub

    Private Sub clearbirds()
        Num = 0
    End Sub

    Private Sub SayNumber_SpeechRecognized(ByVal sender As Object, ByVal e As SpeechRecognizedEventArgs)
        Label1.Text = e.Result.Text
        Select Case e.Result.Text
            Case "Zero"
                If Num = 0 Then
                    pbxArabic.BackgroundImage = System.Drawing.Image.FromFile("D:\SayNum")
                Else
                End If
            Case "One"
                If Num = 1 Then
                Else
                End If
        End Select
        clearbirds()
        CtrQ = CtrQ + 1
        Label1.Visible = True
        pbxArabic.Visible = False
    End Sub

Figure 15. Number-facilitate main.

Private Sub TryNumber_SpeechRecognized(ByVal sender As Object, ByVal e As System.EventArgs)
    Label1.Text = e.Result.Text
    Select Case e.Result.Text
        Case "Return"
            frmIntro.Show()
            Me.Hide()
            clearbirds()
        Case "Question"
            clearbirds()
            Num1 = End() * 10
            If Num1 > 0 Then
                ShotBirds(Num1)
            End If
            pbxArabic.BackgroundImage = System.Drawing.Image.FromFile("D:\SayNum")
        Case "Zero"
            If Num = 0 Then
            Else
            End If
        Case "One"
            If CtrQ = 1 And Ctr = 1 Then
                Num = 0
            End If
            clearbirds()
    End Select

Figure 16. Number-facilitate SR.
Imports System.Speech

Public Class frmAddito9
    Dim WithEvents ShowAdd As New Recognition.SpeechRecognizer
    Dim Num1, Num2, Ans As Integer

    Private Sub frmAddito9_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
        Dim NumberGrammar As New Recognition.SpeechGrammar.SpeechGrammar
        Dim NumbersRule As New Recognition.SpeechGrammar.SpeechRule("ShowAdd")
        Dim NumbersList As New Recognition.SpeechGrammar.SpeechOneOf("Show", "Return")

        NumbersRule.Add(NumbersList)
        NumbersGrammar.Rules.Add(NumbersRule)
        NumbersGrammar.Rules.Root = NumbersRule
        ShowAdd.LoadGrammar(New Recognition.Grammar(NumberGrammar))
        Randomize()
        lblLWord.Text = "Show Return"
        clearallbirds()
        clearNumbers()
    End Sub

    Figure 17. Addition-explain main.

    Private Sub ShowAdd_SpeechRecognized(ByVal sender As Object, ByVal e As System.EventArgs)
    
        Select Case e.Result.Text
            Case "Return"
                frmIntro.Show()
                Me.Hide()
                clearallbirds()
            Case "Show"
                Num1 = End() * 10
                If Num1 > 0 Then
                    DisplayBirds(Num1)
                End If
                If Num1 = 0 Then
                    lblNum1.Text = "Zero"
                    pxNum1.Visible = True
                ElseIf Num1 = 1 Then
                    lblNum1.Text = "One"
                    pxNum2.BackgroundImage = System.Drawing.Image.FromFile("D:\Say\One.png")
                ElseIf Num1 = 2 Then
                    lblNum1.Text = "Two"
                    pxNum2.BackgroundImage = System.Drawing.Image.FromFile("D:\Say\Two.png")
        
        Figure 18. Addition-explain SR.

Imports System.Speech

Public Class frmIntro9
    Dim WithEvents TryAdd As New Recognition.SpeechRecognizer
    Dim Num1, Num2, Ans1, Ans2, Ans3, Ans4, QType As Integer

    Private Sub frmIntro9_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
        Dim NumberGrammar As New Recognition.SpeechGrammar.SpeechGrammar
        Dim NumbersRule As New Recognition.SpeechGrammar.SpeechRule("TryAdd")

        NumbersRule.Add(NumbersList)
        NumbersGrammar.Rules.Add(NumbersRule)
        NumbersGrammar.Rules.Root = NumbersRule
        TryAdd.LoadGrammar(New Recognition.Grammar(NumberGrammar))
        Randomize()
        lblLWord.Text = "Question Zero One Two Three Four Five Six Seven Eight Nine Ten Eleven Twelve Thirteen Fourteen Fifteen Sixteen Seventeen Eighteen Return"
        clearallbirds()
        clearNumbers()
    End Sub

    Figure 19. Addition-instruct main.
Figure 20. Addition-instruct SR.

Private Sub TryAdd_SpeechRecognized(ByVal sender As Object, ByVal e As System.Speech.TextRecognizedEventArgs)
    Select Case e.Result.Text
        Case "Question"
            clearAllBirds() ' This is a placeholder function name.
            Ans1 = 0
            Ans2 = 0
            Ans3 = 0
            Num1 = Rand() * 10
            Num2 = Rand() * 10
            Ans = Num1 + Num2
            QType = Rand() * 3 + 1
            If QType = 1 Then
                If Num1 > 0 Then
                    DisplayBird1(Num1)
                End If
                If Num2 > 0 Then
                    DisplayBird2(Num2)
                End If
                ElseIf QType = 2 Then
                If Num2 > 0 Then
                    DisplayBird2(Num2)
                End If

    Imports System.Speech
    Public Class frmDolo9
        Dim WordNum, Number as New Recognition.SpeechRecognizer
        Dim QPlace, QPlace1, QPlace2, QPlace3 As Integer
        Private Sub frmDolo9_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
            Dim NumberGrammar As New Recognition.SpeechGrammar("Grammar")
            Dim NumbersRule As New Recognition.SpeechGrammar("Numbers")
            Dim NumberGrammar, Num = NumbersRule
            Dim Add(NumberGrammar)
            Dim ClearAllBirds() ' This is a placeholder function name.
            Dim PutQuestions() ' This is a placeholder function name.
            Dim pbCheck.Visible = False
            Select Case e.Result.Text
                Case "Question"
                    ClearAllBirds()
                    QClear() ' This is a placeholder function name.
                    PutQuestions()
            Case "Yes"
                If (Ans1 = 1) And (Ans2 = 1) And (Ans3 = 1) Then
                    DisplayBird1(Num1)
                    DisplayBird2(Num2)
                    DisplayBird3(Ans)
                    If (Num + Num2) = Ans Then
                    Else
                        pbCheck.BackgroundImage = System.Drawing.Image.FromFile("D:\No\")
                    End If
                End If
                Case "Zero"
                    If (QPlace = 1) And (Ans1 = 0) Then
                    End If

Figure 21. Addition-facilitate main.

Figure 22. Addition-facilitate SR.
3.3. The M-EIF Testing

The aim of this research is to develop T & L prototype in basic Mathematics, M_EIF based on techniques called EIF, Explain (E), Instruct (I) and Facilitate (F) using WSR and MSVB2008. The contents used are part of Elementary School Mathematics Curriculum, Saudi Arabia. Figure 23 shows the First Form upon executing M-EIF. The prototype only accepts users’ voice, hence WSR are required to be installed prior to the testing. The other forms with the details are as follows.

1) Number: Explain—“See”

Figure 24 is shown upon uttering the word “See”. By uttering the word “Show”, the Number-Explain form randomly displays a digit from 0 to 9, the corresponding graphics birds and word depending on the digit that appeared. Figure 25 and Figure 26 show some sample output “Return” forces the lessons back to M-EIF Main Menu, Figure 23.
2) **Number-Instruct—“Say”**

Upon uttering the word “Say”, the Number-Instruct form as in Figure 27 appears. The word “Question” must be uttered next for a computer to show randomly a digit ranging from 0 to 9. Figure 28 shows a sample output. And for a right answered, the display is as Figure 29, otherwise the “?” is unchanged.

3) **Number: Facilitate—“Do”**

The screen displays the interface as in Figure 30, upon uttering the word “Do”. Users have to utter “Question” and a number (0 - 9), then the graphics bird is displayed. For the answer, they have to count the number of birds and say the number again, then “Yes” to validate. Figures 31-34 shows the details for the right answer where Q and A stand for Question and Answer respectively. Figures 35-37 is the display the wrong answer.
Figure 31. Number-facilitate—“Question”.

Figure 32. Number-facilitate (Q)—“Seven”.

Figure 33. Number-facilitate (A)—“Seven”.

Figure 34. Number-facilitate—“Yes”.
4) **Addition: Explain**—“Learn”

The word “Learn” will show the main form. Figures 38-41 shows the random outputs by uttering the word “Show”.

5) **Addition: Instruct**—“Check”

By uttering the word “Check”, the display as in Figure 42 will be shown. The word “Question” will randomly show the position of bird graphics between the three different locations, *i.e.*, Figures 43-48 are a right combination for answers to a random question in Figure 43.

6) **Addition: Facilitate**—“Attempt”

Figure 49 shows the Main form for Addition-Facilitate upon uttering the word “Attempt”. From Figure 49, users are required to utter the first number and the computer will choose the location. For any number bigger than 9, the number will be inserted on the right hand side of the equation. Then, the rest has to be completed in turn with the final word is “Yes” to validate the answer. Figures 50-53 shows the details for correct answer whilst Figure 54 and Figure 55 are for the wrong and correct answer respectively.
Figure 38. Addition-explain main.

Figure 39. Addition-explain “Show”.

Figure 40. Addition-explain “Show”.

Figure 41. Addition-explain “Show”.

A. R. Ahmad et al.
Figure 42. Addition-instruct main.

Figure 43. Addition-instruct “Question”

Figure 44. Addition-instruct “Question”.

Figure 45. Addition-instruct “Question”.
Figure 46. Addition-instruct “Nine”.

Figure 47. Addition-instruct “Three”.

Figure 48. Addition-instruct “Twelve”.

Figure 49. Addition-facilitate main.
Figure 50. Addition-facilitate “Seventeen”.

Figure 51. Addition-facilitate “Nine”.

Figure 52. Addition-facilitate “Eight”.

Figure 53. Addition-facilitate “Yes”.

4. Conclusions and Recommendations

The rapid change in mathematics education in as many decades implies a wind of change in society. Starting from behavioral theory the 1950-1970, Cognitive Science (1970-1980) and from 1980 to the present theory, the constructivism has been on the trust. Besides, the e-learning system becomes an alternative educational tool that promises to play a prominent role in years ahead. An interactive approach in T&L Mathematics using Explain, Instruct and Facilitate (EIF) technique is expected to open a new wave in mathematical education. The prototype used the multimedia technology to support the viability and significant of the approach. The EIF technique could be deployed in a developed multimedia courseware and implemented at schools for T & L. Learners as beginners on Mathematics or otherwise will benefit from the courseware whilst instructors act an aide to facilitate them.

One of the criteria that are essential in developing multimedia courseware is attractive interfaces and graphic designs. These features should be compatible with the local environment and user friendly. The consistency between learning objectives and content of instruction are required for conveying the right pedagogy with the chosen materials. In this research, M-EIF is successfully developed with the contents consist of single digits (0 to 9) and the basic facts for addition operation with the graphics specially designed for the local environment. The concept of interactive techniques has been much emphasized via EIF. M-EIF could be used to assist learners in mathematics and also English. Regardless of their competencies, M-EIF provides random examples and questions in enriching T & L.

M-EIF has been developed for some topics in Primary Mathematics with simple graphics representation and voices using WSR. To develop better courseware, the expertise in Mathematics or chosen subjects, educational psychology, programming, graphics and animations are much required and work as a group. By this, then the rest of the contents either simple or abstract such as mathematical proofs could be done subsequently for the entire curriculum and followed by some tests in schools to acquire the feedbacks. The EIF techniques could also be applied in the higher levels of education, at secondary schools and university to judge its effectiveness. In addition, this technique could also be implemented and tested in other courses. With the availability of financial
resources and manpower, further improvement on M-EIF is certainly viable. The use of web technology might be considered in facilitating T & L to anyone, in everywhere and anytime. M-EIF might be regarded as the opening for the development of more sophisticated Multimedia–WSR assisted courseware in the future.

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