

THE INTERACTIVE WEB APPLICATION FOR TREATMENT OF THE ARTICULATION/PHONOLOGICAL DISORDER CHILDREN

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Abstract: Typically 5–8% of children under the age of 6 years exhibit developmental impairments in speech and language. Delayed language development produces serious sequelae in educational and psychosocial development. The purpose of this study was to design a WEB application that incorporates syntactic development knowledge and the descriptions of the data model for a set of reference instructional scenarios for Mandarin-speaking children. Such an application would allow the speech and language pathologist (SLP) to easily construct treatment materials. A suggestion procedure of speech therapy for children exhibiting a language delay with articulation and phonological disorder is as well proposed.

Introduction

Typically 5–8% of children under the age of 6 years exhibit impairments in speech and language, which represent the highest proportion of developmental impairments occurring in early childhood [1, 2]. Of these impairments, speech or language delay with articulation and phonological disorder may be the most common. Speech and language are crucial to human communication, and the inability to communicate with peers has a marked effect on well-being [3–6]. This results in a speech or language delay producing serious sequelae into adulthood in educational and psychosocial development.

Speech and language develop in different stages, with that during childhood being especially important. The literature on the Head Start program in the United States shows that preschool programs have a long-term impact on social outcomes [7–10]. Speech and language therapy can effectively improve children with relative developmental delays by enhancing language comprehension (receptive language) and expression (expressive language) skills. Studies in cognitive

science have suggested that constructive therapy models lead to improved outcomes [11]. In such models the subjects can learn to create or construct their own understandings of speech and language by active exploration. The treatment material and therapeutic-scenario design are key to the success of a constructive therapy model.

Speech and language pathologists (SLPs) are faced with a diversity of speech and language disabilities on a daily basis, which makes efficient and effective treatment both difficult and time-consuming. Another significant problem in many geographical areas is the shortage of speech and language therapists. Enderby and Davies assessed that approximately 26.2 SLPs are required per 100,000 populations [12]. However, in TAIWAN there are only 1.6 SLPs per 100,000 populations [2], and these can only be accessed through a few institutes for language rehabilitation. Moreover, the increasing concern by parents about language development in their young children has led to an increasing number of children being referred to speech and language therapy services. These pressures are hindering the treatment of language-disordered children, and hence methodologies and reference procedures of work and tools that significantly improve both the efficiency and effectiveness of therapy are needed.

The purpose of this study was to design a WEB application for speech and language therapy in Mandarin-speaking children. The application incorporates the knowledge of lexical and syntactic development of the speaking of Mandarin, and statistics on the frequencies of word occurrence. We also defined a set of reference scenarios, and provided a material-generation tool to support the SLP in developing training sessions for children with impairments in speech or language development. Additionally, a suggestion procedure is as well proposed for children exhibiting a language delay with articulation and phonological disorder.

Materials and Methods

This WEB application firstly established a Mandarin lexical database, and then a material-generation tool based on the database was used to develop reference scenarios and operation processes. These were finally integrated as the application platform for the SLP to produce treatment material.

The target words of a Mandarin lexical database were collected using diverse criteria from the treatment materials currently used in three language rehabilitation institutes. The 2095 identified words were refined into a database based on word class, articulation method, life situation, and knowledge of language development [13–15]. Finally the database was categorized into a structure with 6 categories, 10 subcategories, and 115 attributes (Table 1). Because daily life plays an important role in the treatment of language [16], multimedia pictures and films associated with the words also formed part of the database.

Table 1: Database Structure

Category	Subcategory
Life situation	
Word class	Noun Adjective Verb
Age	
Place of articulation	Bilabial Labiodental Apical Velar Dentalvelar Backing Dorsal
Pronunciation method	
Vowel	

The database was used to generate the treatment materials using a set of tools. The material-generation tool comprises two main parts: (1) the SLP sets a target syntactic development stage, from which the tools generate the possible combination of words according to the syntactic rules; and (2) these combinations of words are mapped into selected scenarios that the SLP can refine. The syntactic development of a child actually reflects his or her ability to integrate words. Some studies have revealed that the integration of Mandarin words can be divided into 19 sequential development stages [9], all of which involve utterances of less than three words, as indicated in Table 2.

The stage at which the complete treatment process for a speech or language disorder should begin depending on an evaluation of language ability of the child. To increase the child's motivation to participate in training sessions, the sequential development stages were merged into various scenarios of daily life, including performing pretending games. The following six scenarios were developed in the preliminary phase:

Table 2. The Syntactic Development Stages

01. Single lexis	11. Noun + adjective
02. Role + verb	12. "Want to" + verb + "again"
03. Animal + verb	13. "Want more" + noun
04. Vehicle + verb	14. "This is" + noun
05. Verb + noun	15. Role + "don't want" + noun
06. Role + verb + noun	16. Role + "don't want" + verb
07. Role + adjective	17. Role + "want more" + noun
08. Animal + adjective	18. Role + "want more" + verb
09. Adjective + role	19. Role + "have" + noun
10. Role + genitive + noun	

train through tunnel, role-play game, dollhouse, zoo, department store, and playground. For each scenario, the associated multimedia information for assisting treatment was also produced and stored in the system.

The architecture of the application platform consists of four layers: word-query layer, scenario-editing layer, multimedia-creation layer, and articulation-and-phonological-correction layer. Each layer allows the SLP to use different criteria to generate the treatment, and finally to help the SLP to execute a proposed therapeutic procedure.

Based on the aforementioned design, an operation procedure is proposed for children exhibiting a language delay with articulation and phonological disorder. The proposed procedure comprises the following steps:

- Step 1. Evaluate the language ability of the subject by measuring the mean length of utterances (MLU), the number of different words (NDW), and the percentage of intelligible utterances (PIU).
- Step 2. Identify the syntactic development stage of the subject and collect the treatment materials.
- Step 3. Determine the treatment scenario, and revise the scenario by integrating relevant multimedia data.
- Step 4. Perform long-term treatment and return to step 2 as needed for scenario or stage modification until the preset treatment period terminates. The treatment period was terminated when spontaneous speaking is greater than 80% for promotion to the advanced stage, otherwise it returns to a previous lower stage.
- Step 5. Measure the MLU, NDW, and PIU to evaluate the treatment effectiveness.

The MLU, NDW, and PIU were selected as objective criteria to evaluate the performance effectiveness of the speech therapy. The MLU measurement counts the number of sentences and words used by the subject, and then divides the total number of words by the total number of sentences. The NDW measurement counts the total number of different words.

The PIU measurement counts the number of words, and then divides the total number of words with clear intelligibility by the total number of words.

Results

The system structure of the WEB application includes the lexical database, treatment scenario, and language analysis tools, as shown in Figure 1.

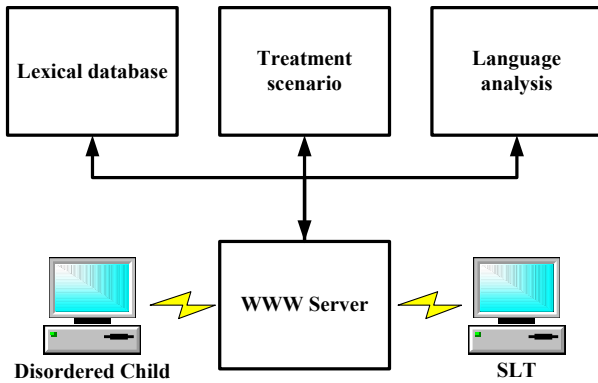


Figure 1: System Structure

After the language ability is evaluated, the SLP chooses an interesting scenario that is used to issue criteria of word class, age, and life situation, and the syntactic development stage is also specified in the word-query layer. The layout of the word-query layer is shown in Figure 2.

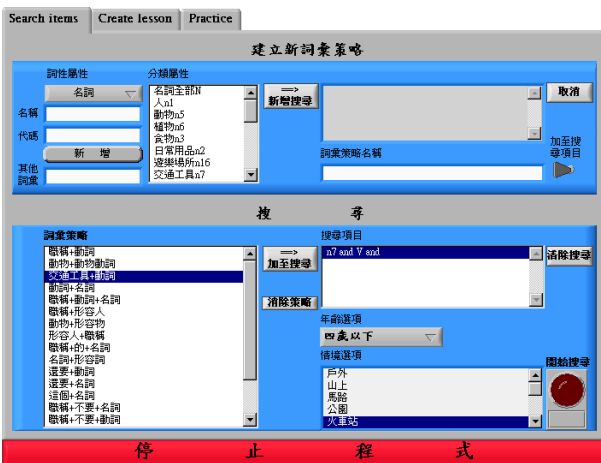


Figure 2: The Word-Query Layer

The criteria specified in the word-query layer are used to retrieve primary treatment materials and list them in the scenario-editing layer, as shown in Figure 3. In this layer, the SLP chooses an appropriate sentence from the list, and reassigns the syntactic development stage or revises the scenario.

The multimedia-creation layer follows the editing of the scenario, in which the SLP chooses relevant pictures, short films, and pronunciations to integrate into the scenario. A facility for multimedia manipulation is also

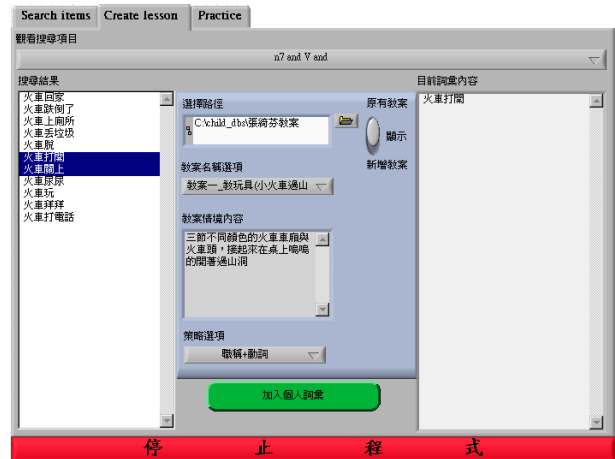


Figure 3: The Instructional Scenario-Editing Layer

provided for producing and editing multimedia data. The profile of the multimedia-creation layer is shown in Figure 4.

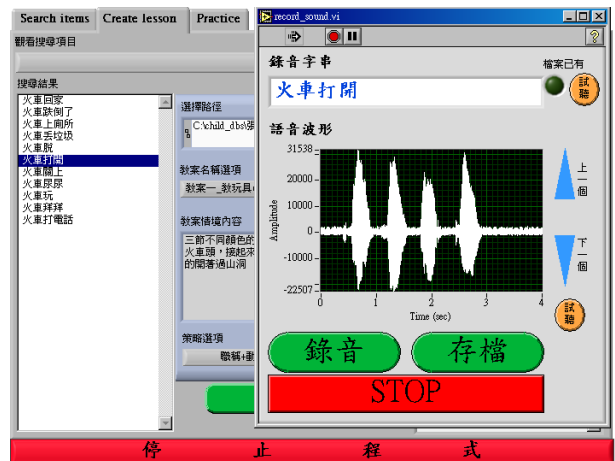


Figure 4: The Multimedia-Creation Layer

The articulation-and-phonological-correction layer is an auxiliary facility. For the usual articulation and phonological problems, this layer provides information about the place of articulation and vowel distribution for the words in the scenario, which allows the SLP to easily treat a language-delay child. The layout of the articulation-and-phonological-correction layer is shown in Figure 5.

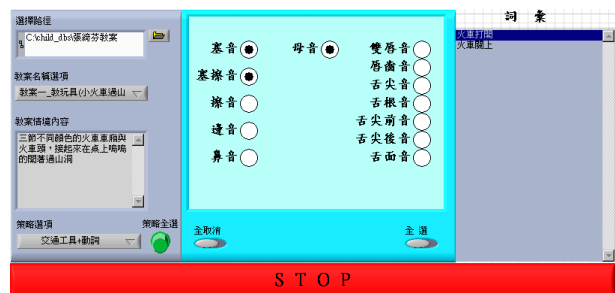


Figure 5: The Articulation Correction Layer

Discussion

In this study, we designed a WEB application incorporating the knowledge of the lexical and syntactic development of Mandarin-speaking children, and statistics on the frequencies of word occurrence. These types of information constitute the basic requirements for selecting appropriate treatment materials for a subject exhibiting a certain stage of delayed language development. Another important guideline came from two models of cognitive sciences that suggest improvements in the design of rehabilitation or instructional settings: (1) constructivist learning suggests that learners should be allowed to create or construct their own understandings by active exploration [11], whereas (2) situated learning suggests that learning is best achieved by solving problems that are contextualized [17]. In order to support the SLP in developing training sessions based on these strategies, we defined a set of reference scenarios and designed a description of the data model for the scenarios so that the developmental information and scenario setting can be integrated and manipulated by the material-generation tool. This system was implemented on a relational database, and the multimedia content corresponding to the set of scenarios was produced and stored as manageable learning objects.

The objective feedbacks from the SLPs reveals that the time required for designing a training session is reduced, the selection of training materials is more efficient, the child subjects participated more actively and willingly during the training session, and that it was easier for SLPs to provide a consulting service to the parents. Moreover, the suggestion procedure also supports program materials for practice in home. Most parents thought that their children were more motivated to participate and exhibited better progress.

Conclusions

This paper has presented a WEB application for the knowledge of lexical and syntactic development of Mandarin-speaking children, statistics on the frequencies of word occurrence, and a set of reference scenarios. The design of our application allows the inclusion of further knowledge of language development and scenario descriptions. We have developed a tool that facilitates the constructive design of training procedures and training materials for children with delayed language development by SLPs. We have also proposed an operation procedure generated by the application system. The tool allows SLPs to devote their time to specific problems that present during a therapy session. The tool also generates supplementing documents so as to extend the ability of therapists to meet the needs of parents.

Acknowledgements

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