Modelling pre-writing tasks to improve graphomotricity processes [1]

Beatriz Barros, Ricardo Conejo, Alberto deDiego-Cottinelli & Javier Garcia-Herreros
Departamento de Lenguajes y Ciencias de la Computación
Universidad de Málaga, Spain
{bbarros@lcc.uma.es, conejo@lcc.uma.es, dediego@lcc.uma.es, javihc@gmail.com}

Abstract. The paper presents the task model of a system to give support to pre-writing activities in the classroom using traditional methods (pen and paper) and computer-supported methods.

Keywords: pre-school, task modelling, pre-writing, graphomotricity

1. Introduction

Motor skills are an important part human development. A special kind of motor skills are those needed to write. Kids practice tracing and drawing with pencils crayons or even with their fingers to gain basic pencil-control skills. *Psychomotricity* and mainly *Graphomotricity* disciplines study formally the associated and *Pre-Writing* discipline considers the methods to learn writing. That is, *Graphomotricity* refers to the process and *Pre-Writing* to the training process to achieve basic movements that are essential part of letter writing and managing daily life objects [1]. These disciplines relate to studding eye, hand coordination, visual perception, writing direction, pressure of the pencil and proper pencil grip, and even postural adjustment since it is important to develop a comfortable position with the back resting on the chair; the feet resting on the floor, and the arms resting on the table in such a way that the position forms a straight line [2].

Children with normal development have to mature and acquire motor skills. Kids with special needs have a slower maturity process but they also train with similar elements at different learning rhythm. The only differences are the content of the activities, the difficulty and the requirements. In this paper we present a first prototype of a flexible system for training graphomotricity. We have configured it for kids with normal development but kids with special needs, just changing the activities content, could also use it.

Our approach is to use technology in the classroom for "learning with" computers [3] instead of "learning from computers", that means students use technology as a tool that can be applied to a variety of goals in the learning process [4]. Computer is yet another resource that helps working and playing in the classroom along with other

[1] This work has been partially supported by the ARTEMISA and RIADA projects.

traditional resources (paper and pencil, backboard, crayons, etc). Our aim is to define a computational model the graphomotricity-associated activities (tasks), and develop a learning environment to train them. This environment should be able to record the learning process, define automatic methods to assess the results and, in the future, define algorithms to infer disgraphias and a problem from the user's learning process. In this paper, we are going to describe the task model and its relationship with the interaction mechanism of the learning environment.

The schema of the paper is as follows: next section describes the pre-writing phases and their content for kids with normal development; in section 3, the task model is presented; section 4 describes how the learning environment works, using a workflow schema, to relate the different elements of the task model. Section 5 considers the different input modes used during the evaluation of this prototype. Section 6 summarizes our experiences in the classroom, and, finally, in the conclusions, some ideas for the future work are outlined.

2. Pre-writing activities

Ajuriaguerra [5] established that the writing process is developed in three phases: pre-calligraphic (5/6 to 8/9 years), calligraphic (8/9 to 12/13), and post-calligraphic (from 12/13 years).

Ferrero and Teberosky [6] focus their studies on this topic in a shorter period of time (between 4 an 7 years, (almost corresponding to the pre-calligraphic phase in the Ajuriaguerra's taxonomy) in which consider five phases in the development of the writing and reading process, considering that both process are interrelated:

1. *Non-differentiated writing*. In this phase, the individual can make some drawings, but they are not able to write letters.
2. *Differentiated writing*. In this phase, the individual can control some features as linearity, join or discontinuity, write a short number of letters and differentiate some of them.
3. *Syllabic*. The person can establish relationship between the symbols (drawings) and the sounds of some words. It is a production conducted by the syllabus of the words.
4. *Syllabic-Alphabetic*. The learner understands the intra-syllabic correspondences but they are not able to differentiate the sounds of a word.
5. *Alphabetic*. The learner knows the alphabetic correspondence for the words.

With these considerations, the work presented in this paper models tasks for the pre-calligraphy phase, focus in the first and second phases of classification: the *Non-Differentiated writing* and the *Differentiated writing*, for 3-4 and 4-5 years old kids respectively.

3. Modelling pre-writing activities

A pre-writing activity is defined as a whole set of tasks that should be accomplished to practice and assess motor skills for handwriting. That is, the instructor should prepare a sheet with attractive drawing for kids, and some guidelines to practice. The learner should draw on it, (using different devices as we will see), and finally the task should be recorded and scored. All these *tasks* are addressed as a pre-writing activity. A single *task* is defined by given:

- A *layout*, which describes the disposition of different components in the sheet Components, can be a *drawing area* (that contains an exercise that should be completed), a *lined area* (that contains reference lines or a grid to guide writing) or a *fixed area* (a non-writable area used only for amusing purposes). It is interesting to define different areas in the pane with diverse content to motivate learners. Figure 1 and 2 show different *layout* examples.

- A set of *exercises* that can be inserted into the non-fixed areas of the *layout*. Each *exercise* is defined by a *presentation*, that may include dotted lines or blank spaces to complete, and a reference *pattern*. The learner should fill the background pattern obtaining a *learner answer*. That is, a *task* might contain different *exercises* whose disposition is defined by the *layout*. Each exercise can be annotated with additional metadata as difficulty, format, etc.

Tasks can be generated manual or automatically and can be presented to the learner in different forms and processed accordingly: written in a sheet of paper to be completed with a pencil, or on top a digital pad; generated on a computer screen to be completed using a touchable screen, etc. (See examples later on). A set of *learner answers* are obtained using a scanner, or directly recorded by the computer device. These answers are compared to the *reference solution* and scored using an *assessment algorithm*.

The *assessment algorithm* obtains three data: *completion percentage* (how much has been completed), *correctness* (how many points of the drawing are on the dotted points of the reference solution relative to the total points handwritten by the learner) and *directionality* (considering the vectors that guide the trace).

3.1 Tasks for the Non-Differentiated Writing phase

During this phase kids practice differing traces following a sequence defined by the teacher. Usually, they first draw straight lines, then curves, and then a combination of both. The aim is to get pulse, hand coordination, visual perception; learn to grip the pencil properly; and practice writing direction and pressure of the pencil (or any other object used to write). Kids practice on drawings different types of traces.

In this case, the task *layout* is defined simply by a *drawing area*, in which a single *exercise* is inserted (figure 1). The *exercise presentation* is composed by dotted straight lines or curves and the *exercise pattern* is the same replacing dotted lines by

solid ones. The *exercise* can be labelled with metadata: types of traces[2], format and difficulty. When a learner completes the exercise, an *exercise answer* is created and stored including additional metadata like: user, date, input device, duration, thinness of the trace and a txt file recording all the process (to study or show the learning process). Finally, when the exercise is assessed and the results are expressed in terms of *completion percentage*, *correctness*, and *direction* of the trace.

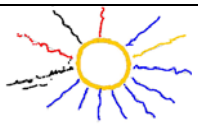
Presentation	*Pattern*	*Answer*
		
Format: dotted	Trace: oblique straight lines Difficulty: medium	User: Student3 Date: 2008/04/10 Input device: Tablet-PC Duration: 73 seconds Thinness: 9 Process: 20080410-3.txt

Figure 1. Data of an exercise example in the non-differentiate phase

3.2 Tasks for the Differentiated Writing phase

In this phase, learners begin to write simple signs that evolve to letters. Task layouts are more complex than in the previous phase, because the same sheet usually contains different exercises. There are two types of exercises (Figure 2). The first one fits into the *drawing area* of the layout and is similar to the exercises in the previous phase but using dotted letters or words instead of icons or pictures. The second, fits into a *lined area*, and is used to copy letters shown in an upper side into a squared or lined pane that appears below. These second type of exercises are completed writing letters, first isolated and then linked with others and are assessed segmenting each letter instead of comparing the *answer* with the *solution* as a whole.

The representation of an exercise is organized on a layout that can have some formats combining *drawing areas*, *lined areas* and some *fixed areas* to decorate (Figure 3).

[2] At the end of the paper, there is an appendix listing all the traces considered in this phase

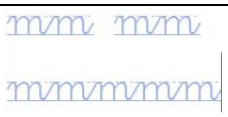
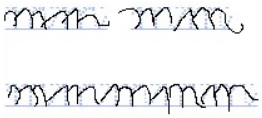
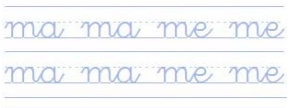
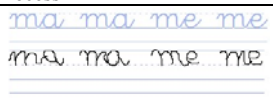
Presentation	*Pattern*	*Answer*
		
Format: guidelines dotted	Trace: letter m Difficulty: low	User: Student23 Date: 2008/04/14 Input device: Tablet-PC Duration: 121 seconds Thinness: 4 Process: 20080414-23.txt
		
Format: grid	Trace: sencence, leter E Difficulty: medium	User: Student46 Date: 2008/05/06 Input device: paper Duration: Thinness: 3 Process:
		
Format: grid	Trace: syllabus, letter m Difficulty: low	User: Student25 Date: 2008/05/15 Input device: Tablet-PC Duration: 81 seconds Thinness: 2 Process: 20080515-25.txt

Figure 2. Data of an exercise example in the Differentiated Writing phase

4. Getting all together

The figure 4 shows the workflow of the system processes. The educator describes the type of tasks for each phase. All of them are stored in a repository of tasks and exercises. S/he describes what a kid should be able to write in each level and the sequence of the different drawings and letters, formats, sizes, etc. depending on parameters age, maturity, motor skills, etc.

Then the learner solves the tasks. For him, the system interface may be a piece of paper where he has to draw or write, or a screen device with a white pane where he should write with a special pen or using his finger. The goal is to reproduces the same working environment that the learner uses regularly. However learner might not use the same skills, as we will explain in the evaluation section. For example, it is not the same to write with a pen on a Tablet-PC as writing with a pen on a paper, but both activities help developing motor skills. This suggests that the use of the system is not a substitution of the traditional methods but a complementary tool to help learning.

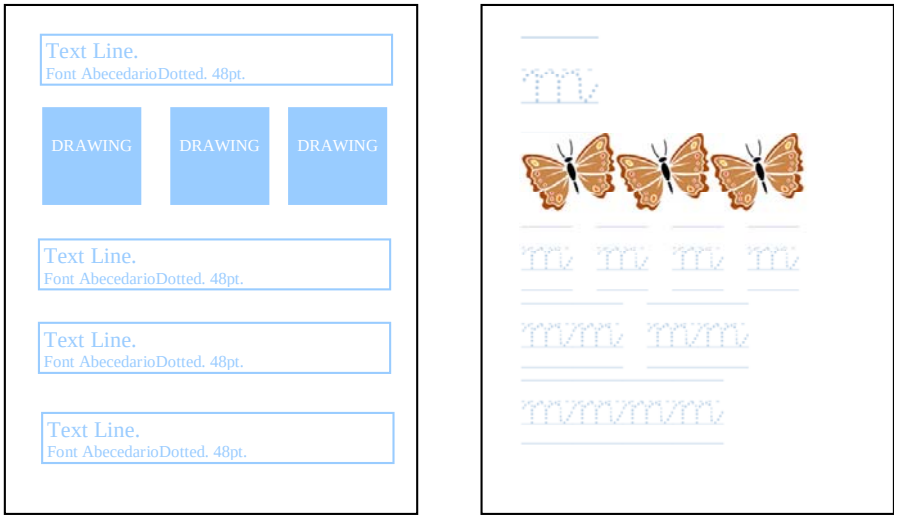


Figure 3. An example of a task, composed by four exercises, in the Differentiated Writing phase

When a task is finished, the exercise answers are automatically scored and saved and the learner model is updated comparing the score obtained by the student with the expected results, considering the data of the phase model (data about the knowledge of students with the same age in the same learning phase)

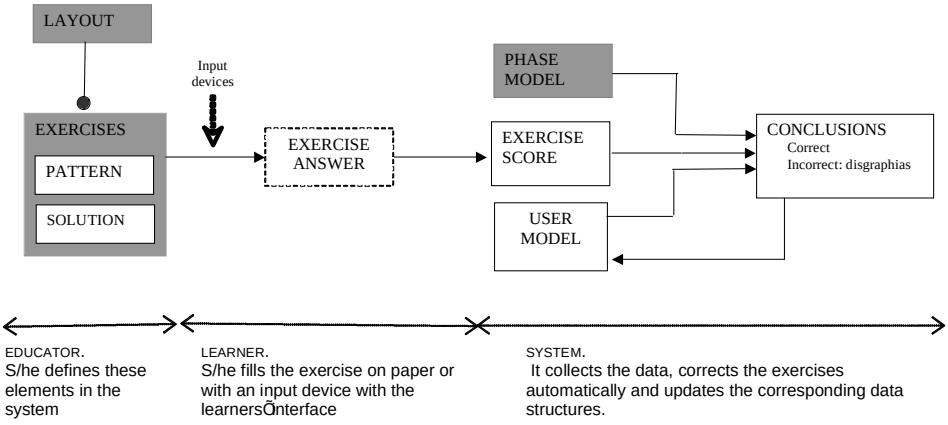


Figure 4.Workflow of the system

5. Evaluation experiences

The system permits input interaction form paper or supported computer. The tasks written on paper (see figure 5, ① Paper and Scanner and ② Paper on a digital

Notebook[3]) or computer supported (see on figure 5, ③ Tablet PC[4],④ Interactive whiteboard[5] and ⑤ Touchable Screen[6]). These two supports measure different features in relation with the writing skills. Teachers highlight the importance of using the traditional methods for handwriting improvement. They are also very open to the use of technology as an additional tool to improve writing and other psychomotor abilities. In this sense, they consider them as different and complementary tasks. During the evaluation, we have explored the possibilities offered by each device for each task (result and process) and we have observed the behaviour of the learner and his performance.

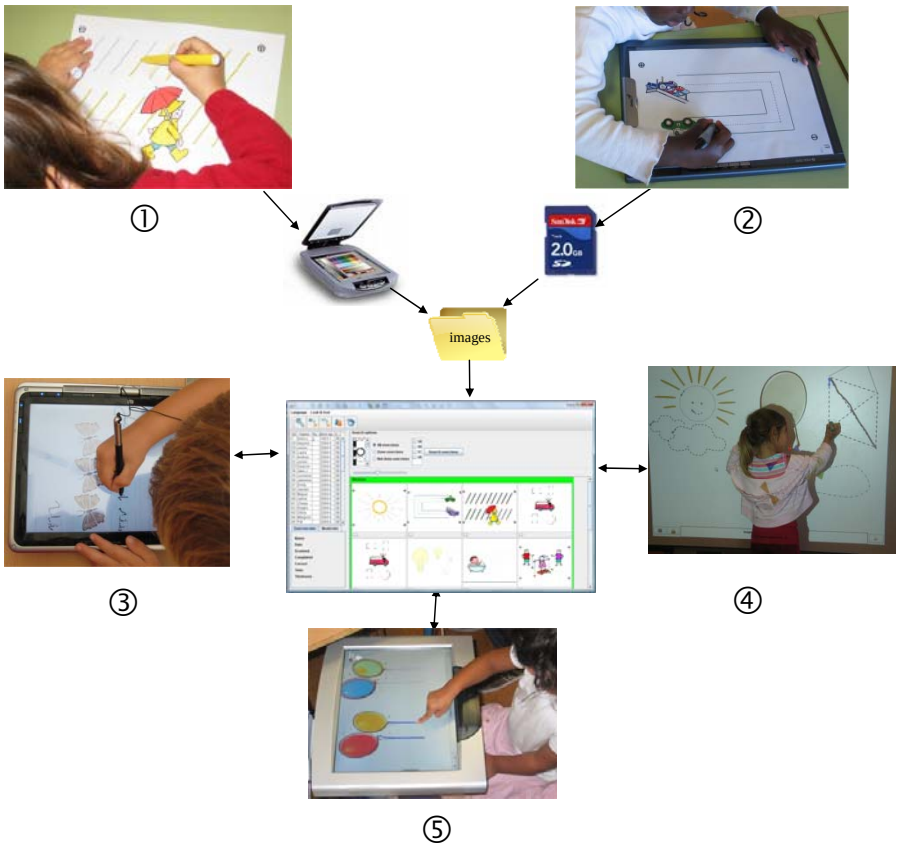


Figure 5. Schema with the different input devices used with the system: paper-based or computer-based.

[3] G-Note 7000 is a multifunctional digital device from Genius. It can capture your drawings and notes digitally. It uses normal paper on the digital pad and a special digital pen. What you wrote is immediately saved in the digital pad memory.

[4] HP Tablet-PC series TX1300

[5] Smart Interactive Blackboard

[6] TM 3000 - TFT LCD 17”

This system has been evaluated with pre-school kids, first level (3-4 years) in the pre-calligraphic phase and one group of 4-5 years during the year 2007/2008, second semester. About 60 children have used the system considering all the devices described in the previous section. The evaluation process has been very useful to test the system and refine its interface in a formative evaluation process. Data are being processed now at the same time that the assessment and diagnosis algorithms are tuned. Interviews with the teacher and philologist of the school have been very useful for the design and development of the system.

6. Reflection and future work

The first prototype of the system has been implemented and evaluated in a pre-school during the present year. The input processes are stable and have been refined thanks to the experience of working with the children in the classroom. It is possible to deliver several exercises for one user, functionality that permits to collect the learner answers efficiently. The tasks have been modelling as explained in this paper and a large number of exercises are stored in a repository.

The organization of the task model enables to define metadata linked to objects that take part in the process of defining, solving and correcting handwriting tasks. For teacher, it is also a way structure the exercises according with the level of their learners. Data could be modified if the exercises were designed for kids with special needs that might have other requirements depending on the maturity level and skills.

Currently, we are working on the user model and the phase model for each learning phase. The next steps will be to develop an adaptive module that suggests the exercises to be taken by each learner, and to analyze the influence of the different devices on motor skills.

7. References

1. Rius-Estrada, M.D. *Adquisision del Lenguaje Escrito: Grafomotricidad*. http://www.distraidos.com.ar/recursos/documentos/descargable/02_Intro-grafo.pdf (Spanish)
2. http://uas.edu.uy/OCCUPATIONAL%20THERAPY/index.htm
3. Reeves, TC. (1998). *The impact of media and technology in schools*. Georgia: The Bertelsmann Foundation
4. Ringstaff, C & Kelley, L. (2002) The learning return of our educational technology investment: A review of finds from research. San Francisco, CA:WestEd.
5. Ajuriaguerra, J. (1984): La escritura del niño. Barcelona. Laia.(Spanish)
6. Ferreiro, E., & Teberosky, A. (1972): Los sistemas de escritura en el desarrollo del niño. Madrid, Siglo XXI. (Spanish)