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Teaching A Turtle How to Spell

Using Computer Programming to Encourage and Enhance Children's Linguistic Play

by

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Children's intuition about the grammar of their language is a resource that children can use to leverage understanding of formal grammatical concepts. My work in Professor Seymour Papert's The Future of Learning Group at the MIT Media Laboratory focuses on how computer programming can be used to encourage and support children's intuitive explorations in the domain of formal linguistics. In an eight-week pilot study involving 21 children, computer programming was used to create a meaningful context in which formal grammatical concepts were introduced to children through the engagement and mobilization of their linguistic intuition. To this end, I created a computer program in which children could play at using their intuition about the English language to figure out the basis of a turtle character's linguistic judgments. In the context of working to understand how my program was made, children arrived at a meaningful understanding of the formal linguistic concepts I had used to construct my computer program. Furthermore, children personally appropriated the formal linguistic concepts for the purpose of modifying my original program and creating their own computer programs about language.

MOTIVATION

In the United States, language is mainly presented to students in school as a series of unconnected formulae instead of a structured whole. Furthermore, rote memorization of rules and facts is presented as the only route to mastery. The majority of students in the United States are taught "English" via lectures, followed by endless practice exercises in the form of worksheets on nomenclature or diagramming. Many students experience frustration about their instruction because despite a great deal of exposure to the same concepts and multiple practice exercises, they were never exactly sure they understood the basic concept [1].

On the other hand, children possess a vast amount of intuition about the grammar of the language that they speak [2]. The task at hand, then, should *not* be the instruction of children about grammatical facts and rules. A much better way to support children's understanding of formal grammatical concepts is to provide opportunities for children to discover how much they already know intuitively, use their existing knowledge to leverage enthusiasm for more knowledge, and encourage further knowledge construction by providing them with rich conceptual tools and activities. I believe that an environment in which formal grammatical concepts are introduced to children through the engagement and mobilization of their intuition about the grammar of their language would prove to be an effective context for formal grammatical concepts to become meaningful and purposeful for children.

Language as a problem space for children

Naturally, language is a domain of scientific inquiry for children. Between the ages of 3 and 5, children start to focus on the language that they speak as an object of cognitive attention — a problem space in its own right — and demonstrate an ability to reflect metalinguistically on aspects of spoken language [3]. In their interactions with the linguistic environment, children engage in the construction of "consciously accessible theories about how language functions as a system" [4]. In this constructive process, children are making generalizations, forming theories, testing the theories, and reformulating or refuting their theories.

The linguistic explorations of children contribute significantly to their understanding of linguistic phenomena and to their general cognitive growth [5]. Children can use intuition about their language to open an intellectual path to understanding language as a formal system. Therefore, children's intuitive explorations of language — their process of problem solving and theory building in the domain of language — should be encouraged and supported to continue.

PLAY SPACE: SPELLING PATTERNS

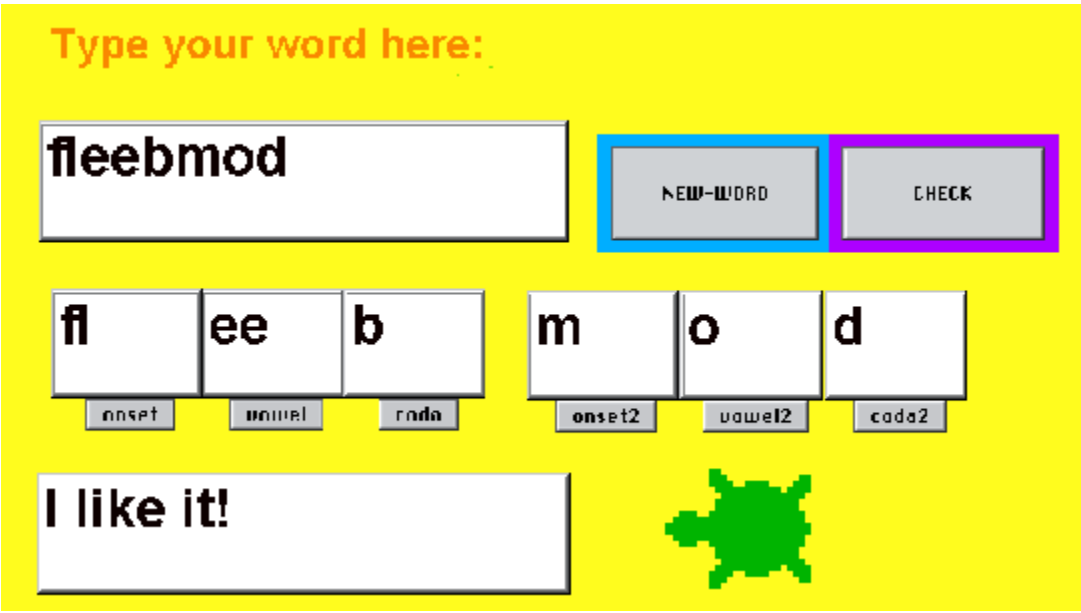
For the eight-week pilot, I chose to focus on the linguistic phenomenon of spelling patterns. There are regularities in the spelling of English words that reflect the underlying sound pattern. This is because each language has its own distinctive sound pattern, consisting of an inventory of sounds that exist in the language and constraints on how the sounds may be combined to form "natural-sounding words" in the language [6]. To illustrate this point, consider the following set of words: *plaft*, *thax*, *hlad*, *mgla*, *tesn*, *flutch*, and *srim*. Obviously, none of them are actual words in English; however, English-speakers intuitively distinguish *plaft*, *thax*, and *flutch* as possible words in the English language, whereas the remaining ones are not — and could never be — possible words in English [7]. Our ability as speakers of English to distinguish between possible and impossible nonsense words results from our intuition about which sound sequences are permitted in each part of the English syllable [8]. The syllable consists of three parts: a vowel, which is an obligatory constituent, an onset — a consonant or consonant cluster in syllable-initial position, and a coda — a consonant or consonant cluster in syllable-final position [9]. English speakers intuitively rule out words like *hlad*, *mgla*, and *srim* as possible English words because /*hl*-/, /*mgl*-/, and /*sr*-/ are not permitted sound sequences in the onset position. Along the same line, *tesn* is ruled out because /-*sn*/ is not a permitted sound sequence in the coda position in English. The phonology of a language is generally reflected in its representation in print,

although the degree of correspondence varies from language to language. For English, the relationship between letters and sounds is not an exact one-to-one correspondence [10]. Still, there are regularities in English spelling that reflect the underlying sound pattern, which I was able to capitalize on for the purpose of introducing to children the phenomenon of linguistic constraints governing the syllable.

Teaching a turtle how to spell

As a first step in my initiative to explore computationally enabled ways for children to engage in linguistic inquiry, I wrote a program in MicroWorlds Logo in which a turtle character expresses approval only for input words that conform to the English spelling pattern. The computer program works by taking an input word and parsing it into sub-syllabic units, then evaluating each element in the syllable against the defined set of allowed elements and combinations in the vowel, onset, and coda positions.

To play with the program, you type in a word in the textbox at the top of the screen, where it says, "Type your word here." Then you use the mouse to click on the button that says "CHECK." The turtle will then tell you in the bottom textbox whether it likes the word or not. When you want to type in a new word, click on the button that says "NEW-WORD", the top textbox will then become empty and you can type in your new word. The goal is to figure out what type of words the turtle likes and what type of words it does not like.



My English Spelling Pattern Program

The program served the purpose of being a stimulus to mobilize children's linguistic intuition. I let children direct their own inquiry and I let them grapple with difficulties they encountered in the program. When left to their own resources, children had to reason from within and appeal to their intuition about the English language. This was a setting in which children could freely exercise their linguistic intuition.

Computer programming works well as an expressive medium for linguistic explorations because it facilitates language modeling. Through this activity, children use their linguistic intuition and exercise their strategies in problem solving and theory building to explore aspects of linguistic structures. In this way, the computer was used by the children as an object-to-think-with and a tool-to-construct-with.

Participants' background

Twenty-one children from 6 to 12 years old (1st through 7th grade) participated in the study — eight girls and thirteen boys. All of the children speak English: two of the twenty-one are non-native speakers, the rest are native English speakers. Four of the children have prior programming experience: they have very limited experience with Logo. All of the children stated that they like using computers.

Before the first session, I asked the children to fill out a questionnaire. In the questionnaire, the majority of the children expressed that they like reading and writing, but also expressed that they are not "good at spelling", do not "understand grammar", and do not like to "think about language."

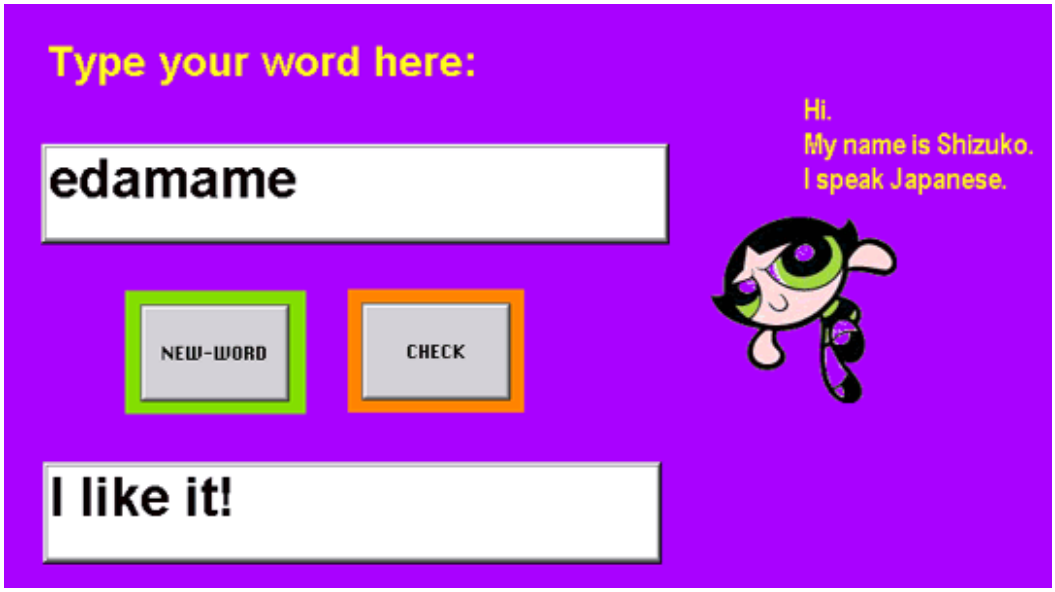
What did the children do?

For a period of eight weeks, children participants came to the MIT Media Laboratory in groups of three to five, for two to three hours each week. There were five groups of children total.

At my first meeting with each group of children, I presented to them the program I made about the English spelling pattern. I didn't tell them, of course, that it was a program about the English spelling pattern — that was one of the things they had to figure out. Children were asked to figure out the turtle character's criteria for accepting and rejecting words.

On average, the children started to develop ideas about what words the turtle likes and what words it does not like after about forty minutes of playing with the program. The children were able to use their intuition about possible and impossible words in English to come up with an intuitive explanation for the regularities observed in the turtle character's judgments. The children were very good at forming hypotheses based on what they observed and at coming up with words to test their hypotheses. They were eager to share their ideas and comment on each other's thoughts. Within an hour of playing with the program, the children — learning from their own and others' actions and verbalizations on word selection — came to similar conclusions about how the program worked.

There were children who speak another language as their native tongue, or have family members who speak another language as their native tongue. These children wanted to make programs that model the spelling patterns of other languages. To get them started, I asked them to compile a list of words that they felt were representative of the consonants, vowels, consonant combinations, and vowel combinations present in a particular language. I then helped them determine allowed sets of elements in that language, using the words from their list. Programs were made for Bahasa Malay, Polish, and Japanese. For Japanese, the children found out that they had to come up with a new algorithm for parsing and evaluating input words for a syllabic language.



A Japanese spelling pattern program

I also suggested to the children that they could come up with their own language — an invented language with a unique set of allowed vowels, consonants, consonant combinations, and vowel combinations. The majority of the children took to the idea of having their own "language." To go about doing this, they first had to decide which vowels and consonants would exist in their language and how the vowels and consonants would combine in their language. Then they had to replace the sets of allowed elements in my English spelling program with their own sets. After typing in the sets of allowed elements for their invented language, most of the children spent a lot of time playing with their program, making lists of allowed and disallowed words and challenging other children in their group to figure out what vowels, consonants, and combinations existed in their language. The children also worked hard to personalize their programs, decorating the screen with drawings and giving a name to their invented language.

A 7-year-old's new language, "Sravj"

CONCLUSION

At the center of this work lies my belief that children's intuition about the grammar of their language are resources, which children can use to leverage understanding of formal grammatical concepts. In working to confirm this belief, I used computer programming to provide a meaningful context in which formal grammatical concepts were introduced to children through the engagement and mobilization of their linguistic intuition.

This work was initiated with a computer program that I made about the English spelling pattern. Embodied in my computer program is the formal notion that spelling patterns arise from phonological constraints governing the syllable. Children were able to use their intuition about possible and impossible words in English to come up with an intuitive explanation for the regularities observed in the computer program. Children's intuitive understanding of my program was then used as a foundation on which I explained in formal terms the linguistic concepts embedded in my program.

It was very important that children's intuitive understanding, not the formalisms, came first. In this way, my explanations of formal concepts like "syllable", "onset", and "coda" were connected to the children's concrete experience with my program and to their intuitive understanding of my program. It was from this connection that the formal concepts derived their meaning and purpose. Children could see how I had used these formal concepts for descriptive purposes in my program and how they themselves could use the formal concepts to deepen the understanding which they had reached intuitively.

In their critical evaluation and modification of my program, children also used their intuition as a starting point for gaining comprehension on how my program worked, how they wanted to make it work differently, and how they could implement their ideas for program modification. Children further advanced their understanding of formal concepts describing the phenomenon of spelling patterns when they used my program as a template for extending the generative model to Malay and Polish, and to their own invented languages.

In essence, formal grammatical concepts like "syllable", "onset", and "coda" were appropriated by the children because these concepts became meaningful to children in the context of their intuition about language, and also because these concepts became purposeful to children in the context of programming the computer. In other words, children developed an understanding for the formal concepts because they could relate the concepts to what they already knew, and they could use the concepts to understand how something was made or to make something themselves. There is also a positive feedback loop at work here: in using the formal concepts to understand how something was made and to make something themselves, children further deepened their understanding of the formal grammatical concepts.

During a period of eight weeks, twenty-one children took part in and contributed to an intellectual culture in which formal grammatical concepts were not something valuable in and of themselves, but were valued to the extent that they could be meaningfully understood and purposefully used to deepen one's understanding of language and to articulate and make tangible one's ideas about language. In this intellectual culture, children discovered that they could make sense of English spelling after all, that they do understand aspects of grammar, and that they are quite good at thinking about language. More importantly, children gained confidence in their ability to be their own intellectual agents and developed an interest in further exercising their intelligence in the scientific domain of linguistic inquiry.

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[10] Ibid.

A closer look at the spelling pattern programs

Click here to download a Zip file containing the five programs described in this paper. These MicroWorlds projects will run in MicroWorlds Pro for Windows or Macintosh, or MicroWorlds 2.03 for Windows. They may be loaded into MicroWorlds 2.03 for Macintosh by using the IMPORT command. For more information about MicroWorlds contact LCSI.

If you don't have MicroWorlds you can still look at the Logo procedures that underly these projects. Click here to download a Zip file with a text document listing the procedures from the five spelling pattern projects.