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Visual Sentences for Educational Math Games

요 약

수학적 명제들을 사용하는 수학교육용 게임의 학습 도움말이나 안내말은 그래픽우선 인지스타일을 가진 게임세대의 학습자를 위해 그래픽적인 형태로 표현하는 것이 필요하다. 본 논문에서는 수학명제들에 대한 객체기반 비주얼적 표현방법을 제안하였다. 이 표현방법은 단어들과 함께 그래픽적 기호들과 수학적 기호들 사용하여 객체기반적인 표현방법의 규칙을 갖고 있다. 그래서 수학적 의미를 정확하게 표현하거나 이해하기가 쉽다. 그리고 학습자가 내용을 빠르게 읽을 수 있다. 제안된 방법은 게임세대 학습자들에게 교육용 게임을 통해 수학 학습의 스캐폴딩으로써 도움을 받기가 좋다.

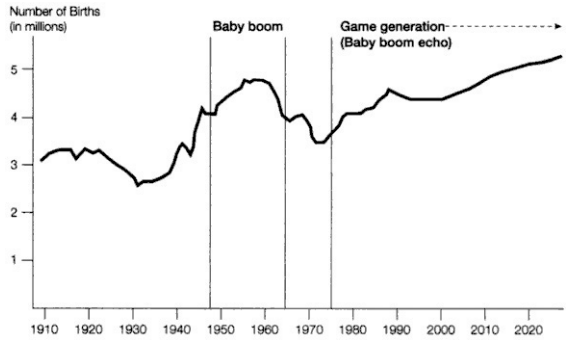
Abstract.

The help or guide sentences of educational math games which use mathematical statements need to represent graphical forms for the learners of the game generation whose cognitive style is graphic first. In this paper, we proposed an object-based visual representation method for mathematical statements. It has object-based description rules to use graphical symbols and mathematical symbols with text words. It is easy to describe or to understand accurately mathematical meaning and is also fast for learners to read for understanding. The proposed method is good for learners of the game generation to get the help as scaffolding for learning math by educational games.

Keywords: Visual sentence, Mathematical statement, Object-based visual representation

1. Introduction

Beck and Wade introduced the game generation who grew up with computer games [1]. The game generation was born after the mid-1970s as in [Fig. 1]. They have spent billions of dollars, and billions of hours, in the virtual worlds created by these machines [1]. Computer games have dramatically changed the way the members of the game generation think, behave, or learn something [1].



[Fig. 1] Boomer-Gamer Populace in U.S. [1]

Prensky shows ten of the main cognitive style changes in the game generation different with the elder generations as follows [2].

(1) Twitch speed vs. conventional speed
(2) Parallel processing vs. linear processing
(3) Graphics first vs. text first
(4) Random access vs. step-by-step
(5) Connected vs. standalone
(6) Active vs. passive
(7) Play vs. work
(8) Payoff vs. patience
(9) Fantasy vs. reality
(10) Technology-as-friend vs. technology-as-foe

An and Bonk told digital game-based learning is one of the few ways to meet needs of the information age as well as those of today's learners raised with digital media [3].
Educational games need to provide instructional scaffolding to promote learning [3]. Instructional scaffolding is the provision of sufficient support to promote learning when concepts and skills are being first introduced to students [4]. These supports may include a compelling task, templates, help, or guides in their learning and problem-solving process.
Our research is to propose a visual representation method for mathematical statements [5] as help or guide sentences in scaffolding of educational math games.
The help or guide sentences as the scaffolding of educational math games have the fol-

lowing requirements:

(1) Real-time readable for learners because learners should read and understand the help or guide sentences on game play in real time.
(2) Easy and accurate understanding of the meaning of the help or guide for learners
(3) Accurate description of the mathematical meaning.
(4) Graphical description for the learners of the game generation

But current educational math games provide text sentences with mathematical symbols as the help or guide sentences for learners. These text sentences make the learners of the game generation difficult to read and understand because their cognitive style is graphics first not text first [2]. Graphical description is needed for the help or guide sentences as instructional scaffolding for the learners of the game generation.

There is no research result to represent visual sentences of mathematical statements which are expressed by graphical symbols.

In this paper, we propose a visual representation method for mathematical statements. The proposed visual representation method is to describe object-based visual sentences which consist of objects, their modifiers, and their predicates. All objects and their modifiers of the object-based visual sentences are expressed by graphical symbols. So the learners of the game generation can more easily read and understand the object-based visual sentences than text sentences. Moreover these object-based visual sentences can accurately express mathematical meanings.

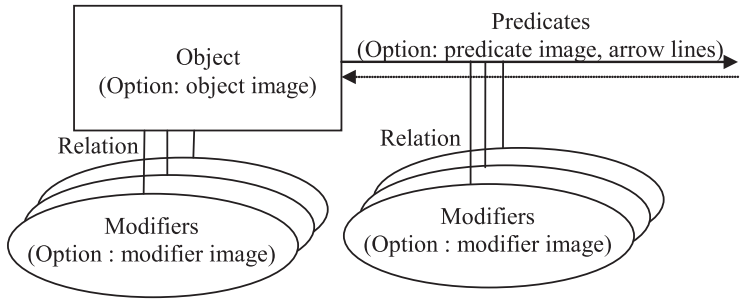
In 2, we present the proposed representation method and we conclude in 3.

2. Object-based Visual Description for Mathematical Statements

Our proposed method is the object-based visual descriptions with mathematical symbols [6] for mathematical statements. The proposed method is drived from the idea:

every sentence consists of objects which have their modifiers and their predications with the modifiers. The objects of sentences can be anything which would be visible, invisible, real, or unreal. These objects would be the subject or the object in the sentence. For example, in the case of the sentence 'The product of 8 times a number is 56', 'The product' and '56' are the objects, and '8 times a number' is the modifier of the object 'The product' and 'is' is a predicate of the object 'The product'.

The proposed representation method has the description rules for object-based visual sentences in [Fig. 2].

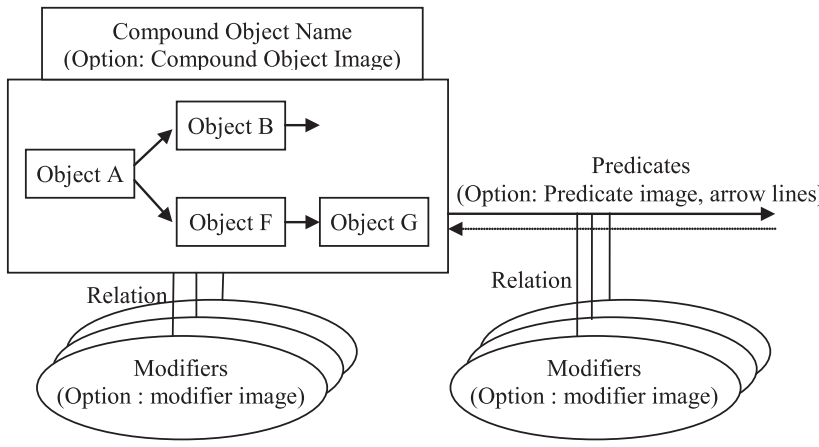


[Fig. 2] The description rules for object-based visual sentences.

The forward arrow line in [Fig. 2] represents the active predication and the backward dot line in [Fig. 2] represents the passive predication. When the predicate is the font of the object as the subject of the sentence, the meaning is for an imperative sentence. When the end of the sentence has the question symbol '?', the meaning is for an interrogative sentence.

The mathematical symbols [4] could be used together with this representation for describing mathematical meanings.

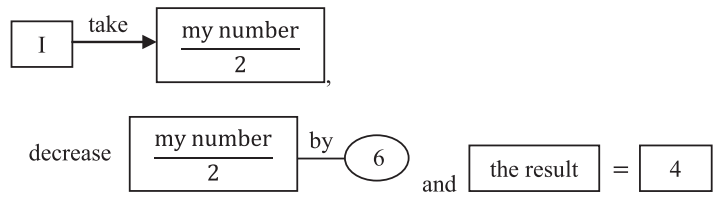
The compound object which is composed by several objects can be used for describing a complex object in [Fig. 3]. The compound object could be sentences, or paragraphs. It is convenient to use a compound object for representing a mathematical statement. The compound object name can be used as the name of the mathematical statement.



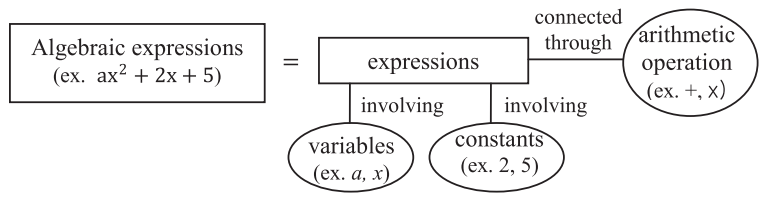
[Fig. 3]. The description rules for a compound object.

We give some examples for the object-based visual sentences of mathematical statements by the description rules in [Fig. 2] and in [Fig. 3]. Our examples give text sentences described by text words (we call the text sentence method as this method) and the proposed visual sentences made by the description rules in [Fig.2] and [Fig. 3] for the same meaning as follows:

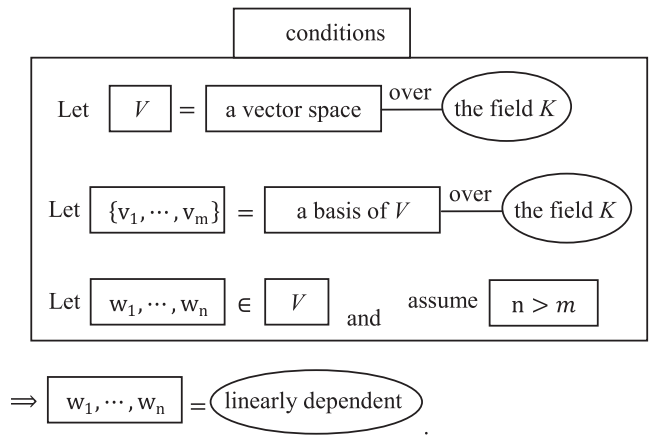
(1) I take half of my number, decrease it by 6 and the result is 4.



(2) Algebraic expressions are expressions involving variables and constants connected through arithmetic operations.



(3) Let V be a vector space over the field K. Let $\{v_1, \cdots, v_m\}$ be a basis of V over K. Let $w_1, \cdots, w_n$ be elements of V, and assume that $n > m$. Then $w_1, \cdots, w_n$ are linearly dependent.



We can compare the proposed visual sentence method with the text sentence method as in [Table 1].

[Table 1] The comparison analysis of the proposed visual sentence method with the text sentence method

	The proposed visual sentence method	The text sentence method
Description Rules	Using graphical symbols and mathematical symbols with text words	Using text words with math words
Mathematical Meaning	Easy to describe and to understand accurately	Possible to describe accurately but difficult to understand accurately
Real-time readable	Fast reading for understanding	No fast reading for understanding

In description rules, the proposed method uses graphical symbols of objects and their modifiers with text words and also widely uses mathematical symbols as the given examples. But the text sentence method use only text words not graphical symbols.
In ability of the describing and understanding mathematical meaning, the proposed method is easy to describe accurately because the description rules are object-based description with the relation represented by mathematical symbols or simple words. The text sentence method describes the meaning by the ordered words according to the grammar. This method requires to understand accurately the grammar for understanding the meaning accurately.
In real-time readable, the proposed method can be possible for learner to read quickly because of graphical representation for logical meaning. But the text sentence method describes the logical meaning by text words. This makes the learners difficult to read quickly the mathematical statements.

3. Conclusion

Computer games have dramatically changed the way the members of the game generation think, behave, or learn something [1].
One of the main cognitive style changes in the game generation is graphics first vs. text first [2]. This means the help or guide sentences in the scaffolding of educational math games need to be described by graphical symbols. The help or guide sentences in scaf-

folding of educational math games use frequently mathematical statements.
In this paper, we proposed an object-based visual representation method for mathematical statements. The proposed method has the description rules which use graphical symbols and mathematical symbols with text words. It is easy to describe and understand accurately mathematical meanings. And it is fast to read for understanding.
The proposed method is good for the learners of the game generation to get the help or guide in scaffolding for learning math by educational math games

References

[1] Beck, J. C., Wade, M.: Got Game: How the Gamer Generation Is Reshaping Business Forever. Harvard Business School Press, Boston (2004)

[2] Prensky, M.: Digital Game-Based Learning. Paragon House, St. Paul (2001)

[3] An, Y., Bonk, C. J.: Finding that SPECIAL PLACE: Designing Digital Game-Based Learning Environment. TechTrends, vol. 53, no.3, pp. 43--48. (2009)

[4] Instructional Scaffolding, http://en.wikipedia.org/wiki/Instructional_scaffolding

[5] Mathematical Statement, http://en.wikipedia.org/wiki/Proposition

[6] Table of mathematical symbols, http://en.wikipedia.org/wiki/Table_of_mathematical_symbols

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