Fourth graders' representations of time-related dance movements

Shlomit Ofer, *Shlomit.ofer@gmail.com*
School of the Arts Of Dance, Kibbutzim College of Education, Art & Technology, Tel-Aviv, Israel

Billie Eilam, *beilam@construct.haifa.ac.il*
Faculty of Education, University of Haifa, Israel

Abstract

The study focuses on 4th graders' self-generated representations of dynamic movement events as related to time units: (a) *Synchronous time-movement events*: one or more events transpire and are completed *within* a fixed time unit. (b) *Asynchronous time-movement events*: events maintained *across* more than a single fixed time unit.

Children learned basic dance movements, trained in their performance, and developed representations for short movement sentences. These in turn, were interpreted and performed by a decipherer, who participated in the learning and training – but not in representation development. Representations were improved in light of observed feedback perceived from the decipherer's performance of movement.

Findings suggested that in the synchronous case, distinct events were utilized for representing time units. In the asynchronous case, students brought forward in their representations either the movement events or the time units. The potential of such experiences for developing representational capabilities, observation and deeper understanding and conceptualization of representing and abstract concept like "time", is discussed.

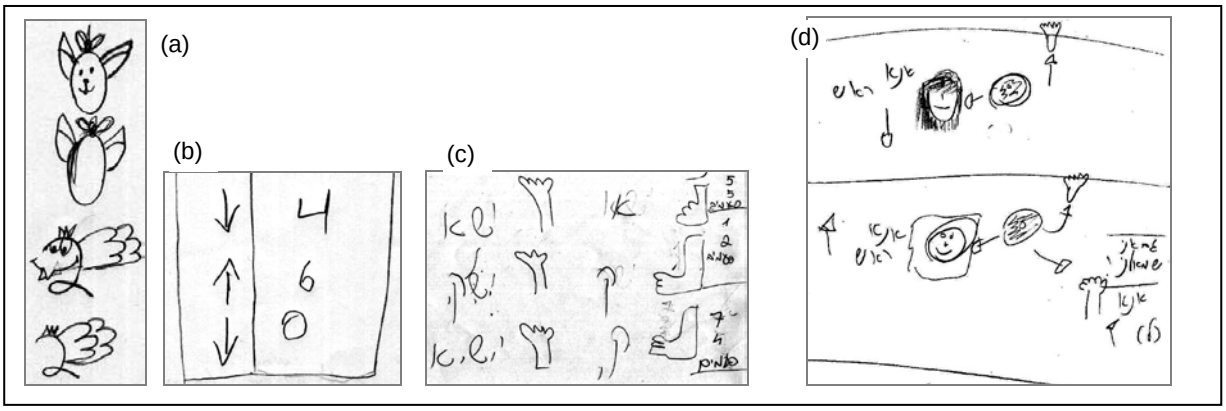


Figure 1. Examples of self-generated representations of dynamic movement events: synchronous time-movement events (a, b, c) and asynchronous time-movement events (d)

Keywords

self-generated representation; movement events; temporal aspect; elementary school children; constructionism

Introduction

"Papert's constructionism views learning as building relationships between old and new knowledge, in interactions with others, while creating artefacts of social relevance" (Kafai, 2006, p. 35). We embraced this view while designing a learning environment, that is based on young children's prior knowledge of representing and use of their own bodies, for engaging them in active learning; namely, an environment that facilitates collaboration and supports children's ideas and efforts in building new bodies of knowledge, while creating/inventing visual representations/language for communicating to others particular information regarding movement in time and space. Current studies suggest that children draw on cultural knowledge and past experiences for generating and creating visual representations. Among others, such prior knowledge may includes cultural norms of behaviour, cultural symbols and conventions, knowledge of drawing, sense of knowledge of one's own body or formally acquired knowledge regarding the use of symbolic languages for communicating information. Environments incorporating social interactions as well as explicit focused feedback, may increase children's meta-cognitive awareness of their own deliberations and the quality of learning products. We describe the designed environment and children's invented artefacts, while aiming to communicate movement events.

Theoretical Background

Dynamic movement events involve the temporal aspect, as well as the aspects of "space" – in which movement is enacted, and of "body" – its directions and the part/s that are moving (Ofer, 2001, 2009). These aspects' unique characteristics make them difficult to represent visually. We focus here on the representation of the temporal aspect only, in spite of its detachment from other aspects being artificial and frequently impossible. Another point to bear in mind is the spatial organization of symbols on the medium chosen for representing the movement.

Representing Time

Representing the entity of "time" is inherently difficult due to its abstractness and the inability to directly observe or feel it. Therefore, conceptualization of "time" evolves from individuals' daily embodied experiences, relative to experiences concerning moving and functioning in the environment. A sense of "time" is gained by comparing events or using successive iterations of specific events (Lakoff & Johnson, 1999). Hence, events' properties are projected onto "time", perceived as directional, irreversible, and continuous in nature, an entity that may be segmented and therefore also measured. Constituting a factor organizing representations into events, time may carry only a secondary role regarding representation and interpretation (Franklin & Federico, 2002)."Time" is referred to through the use of movement metaphors that map spatially conceptualized meanings onto their temporal meaning of expressions (Lakoff & Johnson, 1999). Changes occurring in time may be represented by: (a) a depicted series of objects or events at several time points, which enable inferences by comparisons, and (b) based on time equal units, fluidity and directionality, translation of "time" features into graphical spaces and the use of graphical means like time lines, or even timetables (Mackenzie-Taylor, 1999; Tufte, 1997; Tversky, 2005).

Spatial organization of symbols

Meaning of graphic-symbolic visual displays is conveyed by both the meaning of each of its symbols and all symbols spatial organization on the medium chosen for representing (e.g., a paper, a screen), which may be linear or spatial in nature. Since both are seldom random (Newcombe & Huttenlocher, 2005), interpretation is never easy or spontaneous, requiring the understanding of spatial relations among symbols as well as relations to relevant referents. The spatial display may be presented as viewed from an external point or as viewed from an internal

referential point (Levinson, 2003). This consideration may affect interpretation, for example, by requiring the mental rotation of the scene (e.g., left and right) or taking an internal reference point of view. An additional difficulty evolves from the need to represent 3D phenomena on the 2D spatial display (Tufte, 1990). Frequently, symbols spatial organization is used for emphasizing a specific idea, the outcome of which are inaccurate or inconsistent representations (Taylor & Rapp, 2006; Tversky, 2005). Therefore, everyday graphic-symbolic representations of spatial phenomena are designed to accommodate a particular purpose by means of emphasizing, deleting or changing relations among its symbols and their relations to referents. Tversky and Lee (1998) suggested that among other reasons, interpretation is possible in spite of these difficulties due to individuals' awareness of the following rules: (a) continuity - if a specific description of a starting point in a certain segment is not provided, one should continue from the end point of the previous segment, and (b) a forward progression - unless specified differently. Some of the described knowledge was evidenced in children's self-generated representations as is described next.

Children's self-generated visual representations of dynamic events

Engaging learners in processes of generating their own representations of a phenomenon is a practice anchored in the constructionist approach (Papert, 1980/1993). Studies demonstrated learners' difficulties to represent dynamic temporal events, and the relevant rich graphical solutions they come up with. Analyses of such solutions revealed learners' insight into the nature of representations and of issues related to representing "time" (*e.g.* Bamberger, 1991/1995; 2007; diSessa, Hammer, Sherin & Kolpakowski, 1991; Elkoshi, 2000; Nemirovsky & Tierny, 2001; Nemirovsky, Tierny & Wright, 1998; Sherin, 2000). For example, Sherin (2000), suggested that for representing motion, children draw on "constructive resources" like their accumulative experiences with drawing and with representation of temporal sequences (such as text), as well as the children's sensitivities to properties of figural elements (such as lines). Bamberger (2008) reported that children applied Gestalt law of proximity for grouping dynamic events (sounds) perceived as being adjacent. She (2007) described two styles of constructing meaning from musical events: "path-makers", constructing meanings regarding the unique function of contextually situated objects or events, and "map-makers", forming an outside, fixed reference structures, independent of the particular situation. Children's difficulties to represent motion occurring backwards in a graph were described by Nemirovsky, Tierney and Wright (1998). They suggested that in spite of individuals' natural awareness of "time" being irreversible and directional, the children's graph products exhibited their deficient understanding of the phenomenon. Another study reported that children who skipped a day of measuring a plant's growth did not leave a space for that day on the graph, suggesting "this day did not exist". Graph's homogeneity with respect to "time" was shown, and children's ability to bring forward those aspects they wished to emphasize (Nemirovsky & Tierney, 2001).

Objectives

We focus on children's representational expressions, modes of representing "time" units, as related to dynamic dance movement events. We examine these expressions as reflected in the symbols spatio-temporal organization, in the specific environmental design in which these artefacts have been generated.

Methods

Participants: Sixteen, medium SES, fourth grade girls, with normal spatial abilities and no movement limitations, volunteered to participate in a dance class and the study. At this age (9 to 10 years old) all have already formally encountered symbolic languages (e.g., mathematics, music notations or Hebrew), as well as constructed other resources to draw on for generating representations. Two roles were rotated among members of each group according to their wish:

(a) being a "Developer", 3-4 girls collaboratively developing scripts of dance notation, and (b) being a "Decipherer", one per developers' group, decoding the notation and performing its represented movement, thus providing "Developers" with feedback concerning the notation efficiency.

Study Context and Procedure: The conceptual framework used for developing the girls' knowledge about movement and for examining their representations included (a) the aspect of body directions (e.g., forward, right), (b) of the absolute directions of space (e.g., north, south), (c) of body parts (e.g., arm, head), and (d) the temporal aspect. This specially designed curriculum has been studied by all girls along the 29 intervention lessons. The girls acquired conceptual and practical knowledge through physically training, observing and analyzing the various aspects of movements, indicating the desired concepts. Following, the developers generated notations for a demonstrated (by teacher and video) short movement sentence (i.e., task: "put signs on the blank paper, so that your decipherer could understand the movements and perform the sentence"), and improved it in response to feedback cues perceived from the group's decipherer, who did not see the demonstrated sentence but performed it by interpreting developers' notations.

Data Collection: Two types of data were collected from all groups: (a) *video recordings*, of all lesson parts (instruction, training, notation development and accompanying discourses, decipherer's feedback and scripts improvement). These recordings exposed learners' understanding; and (b) *scripts,* learners' self-generated notations. These were scanned after each round of production and returned to learners' personal portfolios for continuous use.

Data Analysis*:* Video recordings were transcribed. The scripts, being *polysemic sign systems*, where the meaning of individual signs is driven from the consideration of the collection and combination of signs in which they are embedded, are subjective and debatable (Bertin, 1983). Therefore, our interpretation and analysis of scripts were based on and constrained by: (a) developers' recorded discourses, which revealed some of their considerations regarding the script generation; (b) knowledge of the acquired contents (conceptual and training), which constrained interpretation possibilities; (c) knowledge of the movement sentence to be represented, which provided clues regarding symbols chosen and their spatial organization; and (d) knowledge of the physical, social and cultural immediate context as well as knowledge of local and universal conventions regarding representations, symbols or their organization, that may have influenced script development.

Results

The aspect of time was exposed indirectly toward the end of the intervention, by the introduction and practice of movements involving the asynchronous enactment of several aspects. Till that point in time, all aspects of movement events were synchronous with time units. In spite of the fact that the aspect of time has not been represented explicitly, scripts concerning this synchronous time-movement events reflected developers' awareness of movement being changed with time. Later on, the representing of asynchronous time-movement events, exposed the temporal aspect as an element to be considered explicitly and directly. In both cases, expressions of the time aspect were found in: (a) modes of representing consecutive event sequences; (b) level of specification of movement elements as related to time units; (c) the selection and/or development of designated symbols for representing time; and (d) modes of symbol spatial organization on the script display.

We present first scripts representing synchronous time-movement events, transpiring ***within*** fixed time units and following those representing asynchronous events, maintained ***across*** more than a single fixed time unit.

Synchronous time-movement events, transpiring **within** a fixed time unit

Figure 2 presents a scheme of a synchronous time-movement sentence involving various events in all four movement aspects. Each column represents a single time unit.

Body directions	a	b	c	d	e	f	g
Spatial direction	A	B	C	D	E	F	G
Body parts	I	II	III	IV	V	VI	VII
Time units	1	2	3	4	5	6	7

Figure 2. A scheme of a synchronous movement sentence

A. Detailed representation of event sequences

Events were found to be represented linearly either from a point of view of an external observer or from that of an internal reference. The former is based on the common knowledge that events order in reality is linearly represented accurately by order of symbols in the script (Fig. 3).

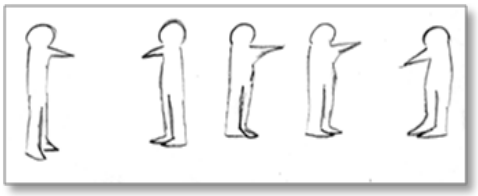


Figure 3. A linear consecutive representation of movement involving body directions "Left" and "Right"(pointed out by body parts) as viewed by an external observer

Interpretation of a script represented from an internal referential point is sensitive to the represented content (Fig. 4, body directions) and is based, in addition to the aforementioned factors, on the symbols chosen and their spatial organization rather than on external references. Sequence interpretation demands increased efforts as compared with the former case.

Figure 4. A linear referential representation of movement involving body directions "Forward" and "Backward", represented by arrows relating to the central figure; the order is indicated by numbers.

B. Abridged ("formulated") representation of event sequences

Whereas in the linear examples above, movement events are detailed for each time unit – even if repeated, some of the developers created "abridged" representation-type. This type is characterized by the grouping of repeated same events into a single symbol, indicating by numbers (or X and number) the amount of times they have to be performed (Fig. 5a and b).

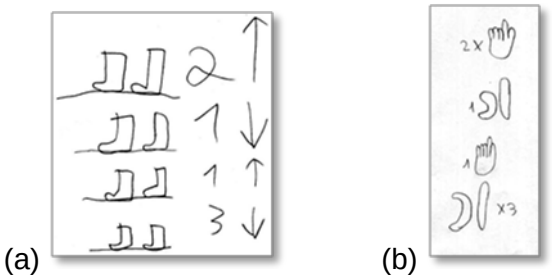


Figure 5. The "abridged" representation-type: (a) boots - representing steps to be performed, numbers – amount of steps, and arrows – directions of steps; (b) numbers showing the amount of times a movement has to be performed (1, 2X, X3), sequence order is represented top-down.

In the "abridged" representation-type, the girls perceived movement sequence comprehensively and were able to represent it schematically, while ignoring the representation of distinct time units. Lack of explicit direct relation between movement and time units may require the breaking up of representation into component events along time, for interpretation and movement enactment.

C. Selection and development of designated symbols for representing time

Different time unit representations were developed in the synchronous time-movement event framework. Each event coincides with a single time unit, represented as iconic, conventional, alpha-bet, verbal initials, and more. For example, the X symbol in Fig. 5b, constitutes a designated symbol that indirectly represents the number of time units along which the same event is enacted. Other examples (Fig. 6, 7) present arrows or a word designated for representing events enacted simultaneously – yielding several events in a single time unit in each line.

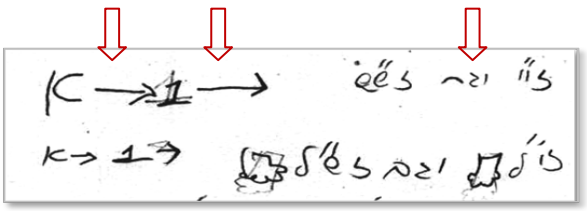


Figure 6. Arrows and a verbal symbol relate between events that are performed simultaneously (indicated by our added arrows).

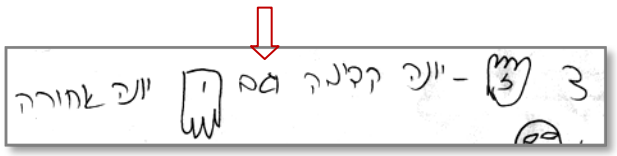


Figure7. A verbal symbol (see our added arrow) representing "simultaneous events".

When developers were required to represent movements in which more than a single aspect was enacted within a single time unit, the temporal aspect was represented creatively by either a table format or a compound format, with a small designated space between each event (Fig. 8a and b). In the table format, each dance aspect is represented in a vertical column of its own, in a manner that positions the two elements of these aspects (arrows and numbers) on the same line to denote their simultaneous enactment. In the compound format, different elements representing dance aspects are combined within each time unit (i.e., body directions, are represented by faces looking away from or at an observer, and spatial directions represented by disguised numbers), and sequential order is represented top-down.

(a)  (b) 

Figure 8. (a) a table format; (b) a compound format

D. Modes of symbol spatial organization on the script display.

Time units were represented by parsing graphical units – either by specific organizations or by both organization and additives like lines. For example, in Fig 9a and b, each horizontal line contain a representation of simultaneous events and order of consecutive events is represented top-down by consecutive lines, resulting in a more complex format than the table one (Fig 8a).

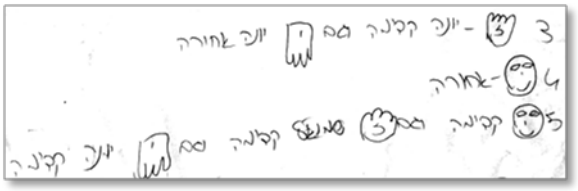
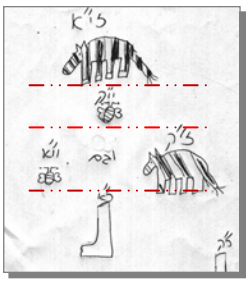
(a)  (b) 

Figure 9 (a) and (b). simultaneous events represented in horizontal lines

Asynchronous movement events, maintained **across** more than a single fixed time unit

In the synchronous movement events, time constituted a factor organizing representations into events. Things became much more complicated when movement events and time were asynchronous (see table on Fig. 10). Figures 11a and b present scripts representing the sentence presented in Fig 10; they represent two variations of parsing: (a) focusing on movement events (Fig 11a) in which the 4 "time" units (4 elements in the row) serve as a background, and the arm movement is brought forward – transpiring along two of these units. Time units are represented by parsing the sequential elements by small space; (b), time units are represented by horizontal lines (Fig 11b). The 4 distinct "time" units are kept as a main organizing device, representing twice the movement in each of the relevant units (3rd and 4th),

indicating movement starting and ending points. Hence, solutions created for representing the movement across these time units are different, reflecting different considerations.

Arm movement			I	
Spatial direction	A	B	C	D
Body direction	a	b	c	d
Time units	1	2	3	4

Figure 10. Table representing a-synchronic movement; the arm moves across two "time" units

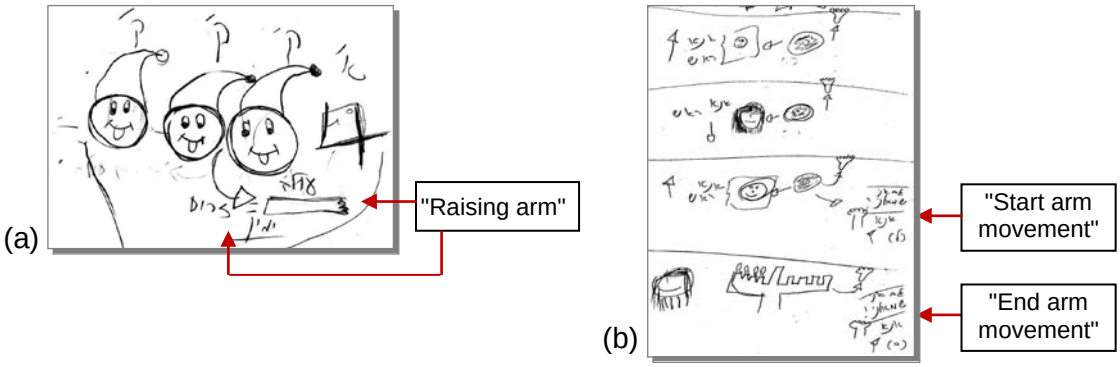


Figure 11. Two scripts representing arm movement across two "time" units: (a) bringing forward the continues movement; (b) bringing forward the separated time units

These differences in representing may be similar to Bamberger's notion (2007) of "path makers" who accounted for the event and "map makers" who accounted for the external "time" units references.

Concluding Remarks

Developers' spatio-temporal creative self-generated representations of movement reflected their perception and conceptualization of the aspect of time in dynamic movement event. Mostly, when possible, they used distinct events to represent time units. However, while representing movements transpiring across time units, either a continuous representation of the movement across the involved time units was used, or time units were emphasized, with a repeated representation of the movement in each of them. Many sources could be identified for developers' inventive ideas as reflected in their representations (choices of symbols and their spatial organization): use of universal symbols (e.g., arrows, ordinal numbers or numbers denoting amounts), use of local cultural elements (e.g., numbers and letters in costumes), use of conventions and elements of formally acquired symbolic languages (e.g., designating sequences order by numbers, by consecutive linear elements or top-down lines, using numbers, letters, words, verbal initials, abridged representation-type), etc. However, retrieved knowledge was adapted and transformed for the construction of new knowledge regarding representing dynamic movement events. For example, since participants were asked to avoid detailed verbal descriptions, manipulations on the verbal language were performed, using its basic symbols (e.g., letters, initials, verbal hints) for representing concrete aspect of an event (e.g., a direction) or an abstract idea like linking all events that transpire simultaneously.

Frequently, symbols received their meanings from the context they were embedded in. Arrows could represent a particular direction or represent the abstract idea that certain events are enacted simultaneously, or the use of numbers for representing events order or amounts.

Developers' interactions were social, affective and cognitive in nature, all influencing the resulting artefact. Previous representations, proven to be successful in communicating accurately the movement information to the decipherer, were sometimes neglected in favour of desires for new ideas, for showing off, for preferring and presenting one's ideas rather than another one's. Communication of information was frequently challenged by the desire to play and test decipherer's abilities. Criticism of other's ideas while praising one's own, constituted common components of the girl's discourse. However, many of their interactions were constructive in nature, increasing the girls' awareness of their own thinking (e.g., reasons for using certain symbols or the use of their own body for generating a solution to a problem), initiating imaging (e.g., taking another person's point of view), examining the quality of their products (e.g., flaws in the representations that may be misinterpreted or of ways to represent problematic referents) or of what representing means. Decipherers' feedback promoted the girls ability to observe a performance of the represented movement and compare it to the movement image held in their heads, identify specific differences and improve their representations by correcting relevant parts only for eliminating the identified differences. In this sense, the girls improved and greatly refined their representational abilities and their understanding of representations as communicational tools.

Hence, our environmental design enabled the girls to experience learning in which new bodies of knowledge have been developed, based on prior knowledge and linked to it. This new knowledge structure enabled the girls to represent complex information, while increasing and deepening their understanding of symbols, representing and representations.

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