Concept Formation: A Linguistic Construct

Rekha Sapra
Department of Family and Child Welfare, Bharati College, Delhi University, India

Abstract

The immense role of language in concept formation abilities of children has been explored in the paper. In context of various contemporary cognitive theories where interactionist approach is predominant it becomes relevant that the word meanings available to the child at any stage are understood critically. The changed use of language is mediated by social processes. Concept formation and language are so intricately interwoven that it is difficult to establish their precise relationship.

Science as a discipline is dynamic in nature and imparts analytical thinking ability to learners. Unfortunately, past research has indicated that the students are uncomfortable with science concepts and terminologies. The reluctance on part of the learners fosters memorization rather than an understanding of concepts. The significant role of teachers in providing explanations to enhance student understanding in most of the cases remains inadequate Language is thus denied the crucial role that it performs in concept attainment The ***Concept Attainment Model*** *views concept formation in a stepwise manner and concepts are taught in such a way that they are evolved rather than presented preformed to the students. The importance of the role of language in mental development and its vast potential in facilitating concept attainment has been the guiding principle for this model The model links the existing ideas in the learners' cognitive structures linguistically. The study was significant at 0.05 level of confidence. . The experimental group scored significantly higher on the various facets of attained concept like flexibility, applicability and retention.*

1. Introduction

Constructivism is an epistemology, a theory of knowledge used to explain how we know, what we know. This can be of great relevance to the teachers and trainers as referent. This perspective asserts that knowledge resides in the individual and their knowledge is not transferred from the heads of the teachers to those of the students. Learning and making sense of what happens ultimately rests with the individual child. Children's values, beliefs, feelings influence their conceptual development.

'Cognitivists' as the supporters of interactional view on language acquisition have maintained that language is learned as a result of the active role the child takes in that learning. The theory proposes that the child is born with the propensity to act on the environment, process information and reach conclusions about the structure of language. The relation between language and cognitive development has been of interest to linguists and cognitive psychologists for decades. Though Piaget, the pioneer in the field of cognitive sciences was very emphatic in his views and regarded language as subordinate to fundamental thought processes [1] but language ought not to be regarded as a 'passive' instrument operating on behalf of the intellect. Language plays a significant role in the development of concepts.

'Cognitive conflict' arises where the child is exposed to some new information which contradicts with the existing information. This causes disequilibrium and in resolving the conflict concepts are formed. Vygotsky described the concept as 'cognitive dissonance' [2]. In his evocative book 'thought and language' clearly distinguishes between the 'stream of thought' and the stream of language'. A stage theory was developed to understand the development of language. Stress was placed on the development of meaning of a word. Vygotsky places his views regarding the relation of thought and language in the perspective of theories phylogeny of intellectual development [3].

It has been argued by psycholinguists, the reflexive use of language brings with it an increased consciousness of the role of language. With this increased consciousness comes control over one's own behavior and extends to control over one's thinking. This changes the character of thinking along with the ways in which attention, memory and other cognitive functions are organized. The proper use of language facilitates the development of these cognitive faculties which are so essential for school learning. The cognitive or intellectual development is a process of the

decontextualization of word-meanings by means of child - adult social interactions in which the child's **zone of proximal development** is fruitfully utilized. Vygotsky was the first cognitive psychologist who conclusively stated that children tend to improve their learning in the company of those who are more skilled or knowledgeable. Potential learning ability or the Zone of Proximal Development is defined as the "distance between the actual development level as determined by independent problem solving and the potential development as determined by problem solving under adult guidance or in collaboration with more capable peers" [3]. These interactions help to further the cognitive and conceptual abilities of the child.

2. Language and concept formation

Education is something more than mere accumulation of knowledge and skills. It must be concerned with developing those skills and attributes that will promote self discipline, responsibility, self expression to be able to distinguish between right and wrong, and confidence. There should be an ability to reflect to reason and to analyze. Basic to the development these skills and attitudes are the ability and the motivation to think critically and communicate effectively with others. The development of a disposition to think and to reflect on experiences provides an impetus towards the more effective use of skills and greater understanding and appreciation of the knowledge and facts being acquired. A young child has a potential for using language and for developing ways of thinking critically about the experiences. Language therefore must be seen not only as an objective for early childhood education, but as a major means through which other objectives of education may be reached.

What is the connection between language and learning? Well, as Henderson and Wellington very succinctly put it, "The quality of the classroom language is bound up with the quality of learning." [4]. Wellington and Osborne, further explains that "language development and conceptual development are inextricably linked. Thought requires language, language requires thought" [5]. Explained from the Vygotskyian point of view, when a learner uses words, he or she is helped to develop concepts. Language thus acts both as a psychological tool that helps a learner to form thought as well as a mental function in itself. Therefore words are not containers whose meanings are in the words itself. They are based on the construction of individuals. Children try to make sense of what is taught by trying to fit in their own experiences. Thus, the child's socio -cultural background and linguistic tools available to him/her play a significant role in concept development. Knowledge is not directly transferred intact from the teacher's head to that of the learners'. The constructivist point of view emphatically stresses on language and its active role in concept attainment.

With reference to science education, Wellington and Osborne underlines that research findings indicate that language, in all its forms, matters to science education [5]. In particular, it is not just the language in itself but rather what educators do with language. This is because what educators do with the language inadvertently affects how the learner uses the language and that is fundamental to the learning of science.

Science teaching advocates discovery method, inquiry, observation, interpretation of observations. The crux of science learning involves analytical thinking and concept attainment. The concepts attained during science classes are essentially non-spontaneous in nature. The concepts form and develop under entirely different inner and outer conditions depending on whether they originate in classroom instruction or in the child's personal experience. The motives prompting the child to learn two kinds of concept are not the same. When systematic knowledge is imparted to the child, many things are taught which the child cannot directly see or experience. Vygotsky has strongly contended "since the spontaneous and scientific concepts differ in their relation to the child's experience and in the child's attitude towards their objects, they may be expected to follow differing developmental paths from their inception to their final form" [3]. In his article on 'Language and Concept Formation' Nelson Gordon argues that concepts seem to be fully expressed when words are joined in sentences. However, the ability to encode and decode words in sentences depends ultimately on seeing single words as "Concepts" [6]. A word does not refer to a single object, but to a group or a class of objects. Each word is therefore already a generalization" [3].

3. Language and analytical thinking

Science as a mode of inquiry imparts analytical thinking abilities to the learners. It is a discipline which is associated with enhanced critical and evaluative orientation. Along with these attributes it has the ability to enable the learners to form concepts which can be applied in understanding day to day phenomena. Research in science teaching has clearly reflected to the fact that a 'multiplicity of instructional methods and strategies are used'. Different strategies are used to enhance the learners' meta cognition which leads to corresponding conceptual understanding of the content. Unfortunately research has documented avoidance and reluctance on part of elementary teachers with respect to Science teaching. This results in teaching where in

the science concepts, analytical thinking, inquisitive disposition and curiosity to learn are not given a chance to blossom properly. These are the hallmarks of an elementary grader which are to be nurtured early in life.

According to Henderson and Wellington "For many pupils the greatest barrier to learning science is the language barrier" [4]. One of the major reasons why language becomes a barrier to learners is because scientific terms, whether technical or non-technical, are unique in nature and they are seldom encountered in other contexts or in day to day interactions [7]. Jarrett adds that academic language is more abstract than social language and that in Science; common words can take on specialized meanings [8]. As such, the most obvious challenge faced by children who are not familiar with English. Learning science concepts means the child has to learn a new scientific decontextualized vocabulary at the same time they are required to acquire new subject matter. It is thus not surprising that students sometimes experience difficulties moving to higher level of abstraction as they do not have the support of language connections. In the writings of **Bohr** it is clearly evident that in the evolution of scientific thought language plays a more active role than is implied by the 'passive vehicle' which only conveys the information. In the context of communication theory linguists themselves have pointed to the inadequacies of the traditional view point, for it is clear that the listener is as active as the speaker in understanding the content of the message. Wellington and Osborne observe that whilst research shows that one of the major difficulties in learning science is learning the language of science [5]. Shaw emphasizes the role of the content area teacher as a mediator. According to her, the science teacher must be cognizant of how to successfully mediate content knowledge and language instruction effectively to students [9]. This is in line with Vygotsky's notion of zone of proximal development and Bruner's concept of scaffolding whereby the teacher needs to adjust his / her instruction to support the learner's existing capabilities so that the learner is able to beyond his / her current level of functioning [12].

Anstrom, Lynch and Dicerbo explain that by giving English Language learners more opportunities for using the language of science, science content is made more accessible to the learners. They propose that teachers identify linguistic structures or discourse patterns associated with a particular topic and then incorporate appropriate language learning activities into their science lessons [10].

"We build many walls not enough bridges" as stated by Sir Issac Newton clearly focuses on the need to have knowledge which is not constrained by boundaries and rigidities. Science education will always play a central role in the creation of new knowledge structures. Science is perceived to be culturally neutral and uses language as a tool that incorporates technical terms and innovative grammatical structures to convey meanings effectively and efficiently [11]. People who cannot connect with this style feel left out. It becomes important that bridges should be built between students' culture and the culture of Science. If the bridge building is to be efficacious it should be culturally relevant, and the language, identity, prior understanding and knowledge of the learners should be considered.

The significant role of teachers in providing explanations to enhance student understanding in most of the cases remains inadequate Language is thus denied the crucial role that it performs in concept attainment. In a country like India these difficulties are more pronounced due to a paucity of resources coupled with an unacceptable student teacher ratio. The paper tries to overcome these difficulties of the present teaching learning system by developing a **Concept attainment Model** which explores the potential of Language in enhancing attainment of concepts and not just mere memorization. The models enrich the existing methods of science teaching to enable the learner to correlate the experiments and demonstrations with day to day activities. The **proposed model** views concept formation in a stepwise manner and concepts are taught in such a way that they are evolved rather than presented preformed to the students. The importance of the role of language in mental development and its vast potential in facilitating concept attainment as opined by cognitive theorists has been the guiding principle for this model The model links the existing ideas in the learners' cognitive structures linguistically. The other objective of the study was to prepare some lesson plans based on the model. These lessons were taught to children of 5^{th} grade. The students' were tested for the retention and flexibility of these concepts based on a retention test developed for the purpose. The study was significant at 0.05 level of confidence. The children who participated in experimental teaching were matched for their mental and linguistic abilities with that of the control group. The experimental group scored significantly higher on the various facets of attained concept like flexibility, applicability and retention. Language can play a particularly subtle role in the way students communicate with each other and the ways new ideas and concepts can be developed or blocked.

4. Contributions to knowledge

The Concept attainment model can best be described as an adapted language scheme which will unfold, rebuild and reconstruct cognitive structures in

the mind of the learner. The utility of the language as an instrument to develop the cognitive functioning with respect to science teaching was the most crucial guiding factor in the construction of the model. Concept attainment is an indirect instructional strategy that uses a structured inquiry process, based on the works of Jerome Bruner. In this strategy focus is on analogies, compare and contrast, identification of attributes etc. This helps in making connections between what the learners know and what will be taught. This also gives the opportunity to the children to examine the concept from different perspectives. Concept attainment as a strategy enhances the ability to understand the concept and not mere superficial understanding. The retention and transfer of concept in terms of application is better [6]. The strategy focuses on meaning and understanding of the concept. The child develops' thinking' skills and reasoning abilities as they examine concepts from narrative and expository texts.

The conceptual framework of the model is based on Vygotsky's school of thought. The ideas and concept like the **zone of proximal development (ZPD)** and the term pseudo-concepts were borrowed from this frame work. The facilitating role that language plays in the formation of new and more advanced concepts have consolidated the ideas regarding that language is a force in the formation of new and hierarchically more advanced cognitive structures.

Concept Attainment Model is essentially an image that we have of language arising out of the functions it performs. The concept formation has been viewed in a stepwise manner. The objective of the model is to help the students internalize the scientific concepts rather than foster mere memorization. The model aims at acquisition of concepts which are flexible and have broader applicability. The attainment of scientific concepts which are formed are evolved during the learning process rather than presented ready made to the child.

The proposed model does not in any way intend to replace the usual methods of teaching science like observations, experiments, discovery method etc. The model proposes to make these methods more effective by way of proper and meaningful use of language.

The concept attainment ladder of the Language Model is initiated by the process of **Scaffolding.** The term was first used by Bruner, Wood and Ross [14]. The teacher controls the learning that occurs between what is known and what is to be learned at a level appropriate to the learner. Scaffolding is the first initial impression on which the child can build**,** develop and refine his\her thoughts so that an idea emerges which is representative of the ultimate concept which is to be conveyed to the learner. The required anchoring support for the concept to proceed is thus provided. The aim of scaffolding is to ensure that this process of introduction of a new topic is intentional, deliberate and a regular feature.

Ausubel has used the term intellectual scaffolding as structuring the ideas and facts that are to be encountered during their lessons [16]. In his presentation of ' advanced organizers' Ausubel directly addresses the goal of learning the subject matter and advocates the improvement of presentation methods of teaching. Bruner used the notion of 'scaffolding talk' [14] in the context of cognitive development. It has been argued that talking by the parents to the child can at times even change the cognitive structures leading to the formation of higher cognitive structures. The scaffolding in the model will perform the crucial function of orienting the learner and directing the attention in accordance with the demands of the concept to be taught. The verbal instructions in the form of scaffolding talk should be descriptive in nature and should be based on the relevant features of the environment. "The scaffolding aims at 'sparking' the child's interest and channelizing the thought processes of the learner. The children can be engaged in activities that will connect their prior learning with the construction of new knowledge" [18]. The initial tasks are designed in such a way that which can be accomplished easily and encourage children to be curious for further information. Questions, exercises need to be designed where in the child continually moves to a more advanced level of understanding and move to a higher level of ZPD. Relevancy is evident in Vygotsky's cultural historical theory [2] which states that social interactions play a basic role in the formation of cognition and language is grounded in the relevant culture and history of the learner. Language acts as a tool to mediate the activity.

The scaffolding provided by the teacher will to some extent help the learner in a sort of 'categorization'. The categorization will be based on the learner's existing cognitive structures and previous experience with relevant materials. The categorization of information is an intermediate step The hazy picture developed by the learner with reference to the concept can further be refined and clarified by provision of a 'criterion' which can be described in the form of a facilitative question by the teacher. This will result in the formation of 'pseudo-concepts'. Process of categorization entails generalization and discrimination making categories powerful tools of thought. By noting similarities among stimuli and by grouping stimuli into categories, the child avoids the burden of treating each object as a category in itself [19].

Discrimination enables the learner to make distinction between groups of stimuli. The process of categorization is dependent on language. Conceptual

categories are formed through diverse processes. To facilitate the categorization process appropriate terms or words need to be used. The pseudo- concepts so formed will be concrete in nature because the basis of their formation will be some concrete example or question. These cannot be considered at par with mature concepts because they originate under the influence of concrete examples and secondly they are rigid in nature lacking in flexibility. The information is rigidly understood without taking into consideration its other aspects.

The third step in the proposed language model aims to introduce the scientific term. The scientific term is essentially a familiarizing process whereby the comparative and differentiation functions are also facilitated. The initiation into the specific vocabulary of the subject takes place. Richards [20] in his study conducted on Biology learning revealed that the 'scientific' term gives a direction to the child's thinking and provides with an anchoring to the child to think divergently. The scientific term promotes verbal knowledge by variety of concepts which can be symbolized in words.

In the usually employed methods of teaching the teacher provides the learner with the explanation of the process under study and later the scientific term is provided. The language model introduces the scientific terms in the initial stages so as to initiate the learner to the specialized vocabulary of the subject. This performs the important function of conveying the concepts and meanings more accurately. The scientific term cannot be replaced or substituted by any other word. The more a child is exposed to the subject specific vocabulary the more the child is comfortable with the concept. Studies have revealed that if the child is not familiar with the scientific terms or has difficulty pronouncing or remembering them it negatively impacts the understanding of the concept being encountered.

This step is followed by 'extended verbal explanations'. As the name suggests it makes use of examples, illustrations and elaboration. Explanations involve narration, description and it follows a logical sequence. These also include simple questions to clarify the doubts. 'Elaborated language code' need to be used [20]. An analogous principle will make it easier for the child to grasp the concept under discussion. Robyn Baker argues that knowledge of 'content' and' process' are elusive but the essential third component is the Syntactic aspect which is crucial for concept attainment [21].

This step is followed by 'guided activity' in the class room. The use of methods like observation, discovery methods, collection and categorization of materials, experiments is encouraged. The teacher can select the most appropriate and suitable activity according to the demands of the concept under study. These learning methods should make use of descriptive language. It is generally an accepted norm that experimental or other practical activities will reduce reliance on verbal explanation by the teacher. The descriptive language is normally cut short. The child receives very little frame work at the outset or during the activity. This puts the onus of selection on the learner and creates the need to hypothesize, define and eventually report and record as and when required. Linguistically these functions require complex language forms. The discovery methods make more demands on language than the traditional methods. To make these methods more effective, descriptive language should accompany the demonstration, experiment or project work. During an experiment or demonstration the children appear to grasp the process, but in many cases, they fail to report in a proper manner, what was observed. This loss is the result of lack of linguistic frame-work by the teacher; while demonstrating the experiment. Explanations and descriptions along with other methods will make them more effective and a meaningful activity in the recall of concept attainment. Explanations during and after the demonstration and experiments intend to connect between and among pieces of information. Teachers' effective explanation of science concepts and the students' ability to verbalize thought adequately were found to be positively related in the study.

Facilitative questions can be framed to judge a child's understanding of the attained concept. The length and breadth of a concept is divulged through the verbatim the child uses to explain the term or a process. Questioning is one of the important teaching techniques. It is the starting point of any educative activity. It is basically a problem solving and thought provoking device. Questions serve the following purposes:

Questions are good stimulators as they help children to think.

Test their knowledge and understanding.

Ascertain individual differences so far as different complex mental processes are concerned.

Help testing student's communication, so far as communicating language is concerned.

If challenging situations are created in the classroom and used at proper junctures of the lesson with due care and intelligence, it will help in enhancing conceptual development.

Encourage the habit of listening to others' point of view and a good habit of patience to allow oneself to ask questions and let others also ask questions. Appropriate wait time is crucial for the children to respond to the question.

It can be used for summing up a lesson as recapitulation.

Questions can be of different kinds depending on the age, grade, and interests of the students. The questions can be broadly categorized into three types –

- Eliciting questions,
- Probing questions, and
- Closure seeking questions.

Depending on the need and topic being taught to the students, a combination of different types of questions can be framed to test the student's knowledge and understanding of the concept which is to be attained. Questions in the form of 'true' or 'false', 'fill in the blanks', 'one word' answers, identification, 'drawing' and 'labelling' along with essay type questions can be framed. Different questions can be incorporated in the teaching plan itself.

Appropriate questions are the barometers against which a student's concept attainment is to be measured. While framing the questions care should be taken that the language used be such which can be understood by the students. In answering the questions, the child should be guided in reading, writing, oracy and expression. If the child is capable of using proper expressions and terms, it indicates that the child has attained the concept being taught.

5. Concept attainment

Concept attainment does not merely mean acquisition of the concept in a restricted sense. It should incorporate other related processes as well. 'Concept' refers to a variety of experience. Concept according to **Good's dictionary** of education is an idea/representation of common elements on attributes by which groups or classes may be distinguished. A concept is essentially a symbol which holds a large number of particular ideas together. Bruner, [13] stated 'concept as a way of grouping an array of objects on events in terms of those characteristics that distinguishes this array from other objects or events in the universal. Bolton [23] defined 'concept as a stable organization in the experiences of the reality which is achieved through the utilization of rules of the relation and to which can be given a name.' In Piaget's system, Favell states "Schema is a cognitive structure which has reference to a class of similar action sequences, these sequences of the necessity being strong bounded totalities in which the constituent behavioral elements are tightly inter-related. Schema is a kind of concept, category or strategy which subsumes a whole collection of distinct but similar action sequences" [24].

The process of concept formation (establishing a new category) which was initiated by scaffolding in the 'Concept Attainment Model' and proceeded through various stages essentially uses 'categorization', making effective use of ZPD. The categorization process entails both generalization and discrimination. Generalization and discrimination make categories powerful tools of thought. "Generalizations allow to reduce nature's endless diversity to manageable proportions" [19]. By noting similarities among stimuli and by grouping stimuli into categories, we avoid the burden of treating each object as a category in itself. Discrimination enables a learner to make important distinctions between groups of stimuli. Categories convey a large amount of information.

The categorization process is language dependent. The categories formed depend both on the linguistic and non-linguistic factors. Categorization depends on the needs of the learners. For example, categories of plants and animals, categories of plant eating animals and so on. When people discover new categories in nature, new words may be coined to facilitate communication. The categories are related to each other in hierarchy. The conceptual categories are often formed through diverse processes. Both analytic and non-analytic procedures are used to abstract attributes from the members of the category non-analytic strategies are also employed for forming a category. In an anon -analytic strategy, the learner memorizes instances of a category and compares those instances to novel stimuli in order to decide whether the novel stimuli belong to the category. These two are complementary strategies. In the proposed language model, both deductive and inductive methods have been used to facilitate the concept formation process. The pseudo -concept stage and guided activity can roughly be termed as deductive or abstraction processes in the formation of concepts. Extended verbal explanations, scientific terms can be described as the non-analytic or inductive aspects of concept formation.

The important features of concept formation which are evident in the model can be summarized as follows:

Concepts are formed in a stage wise fashion.

Concepts are formed when learners recognize resemblances among stimuli (characteristics which state that plants and animals are both living beings). It is assumed that the resemblances are a property of the subjects' environment and the task is to attend to those.

Progress in concept formation is from particular to general. Subject first observes particular events (germination of a bean seed) events and which is common to all cultures, then noting the resemblances between some of them, develops generalizations.

Concrete examples/concepts are primary in nature, i.e. they lay the foundation for the development of abstract concept (concept of presence of air everywhere, air occupies space etc.)

Wigenstein very emphatically favoured the abstraction of resemblances in attainment of concept by stating, "There is no common element to be found in concepts "games" or "tools" or beauty". Think of the tools in a tool box; there is a hammer, pliers, a saw, a screw driver, a glue pot, nails and screws. The functions of words are as diverse as the function of these objects" [23].

This clearly indicates that the abstraction is a very powerful tool in the concept formation. Diversity when studied carefully shows many similarities. When the concept formation takes place it leads to a higher stage of internalized mobile and flexible concept with a burden range and perspective. Concept attainment refers to the activity of discovering whether the instance belong to the category of formed concept or not. When the learner is able to extend the formed concept to other instances it can be said that the concept is attained. When the concept of a 'rainbow' is formed the child might say, to something which resembles a rainbow as "this looks like a rainbow". The child has abstracted the characteristics of a rainbow and can utilize the information for comparison and differentiation. This is the stage of concept attainment.

Diagrammatically, the Concept Attainment Model can be represented as follows:

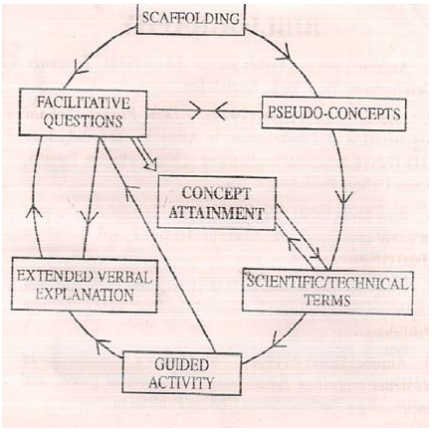

Figure 1. Concept attainment model

The diagrammatical representation clearly implicates the role of facilitative questions which are multifaceted. At every stage, these form an important aspect in the clarification of the concept to be formed. Active participation of the participants/learners is ensured by various questions by the teacher at appropriate junctures.

6. Conclusion

The model focuses on concept attainment in a step wise manner. Abstraction is a very powerful tool in concept formation. When the concept formation takes place it leads to a higher stage of internalize mobile and flexible concept with a burden range and perspective. Concept attainment refers to the activity of discovering whether the instance belong to the category or formed the concept or not. When the learner is able to extend the formed concept to other instances, it can be said that the concept is attained. The diagrammatical representation clearly implicates the role of facilitative questions which are multifaceted. At every stage, these form an important aspect in the clarification of the concept to be formed. Active participation of the participants/learners is ensured by various questions by the teacher at appropriate juncture. The 'usually' employed methods involve the use of meaningful and structured language. The model has relevance for teaching science especially in a country like ours. The model proposes to convey large amounts of information as meaningfully and efficiently as possible.

It can be argued that meaningful material cannot be 'presented' but must come through independent problem solving and manipulative experience. According to Ausubel, whether or not the material is meaningful depends on the learner and the material presented. The key to meaning involves solidly connecting the new learning material with existing ideas in the learner's cognitive structures linguistically. The experiments and demonstrations should also be accompanied by proper language use in order to facilitate the understanding of concepts.

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