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ISSN 2719-6550
ISSN online

„Journal of Education, Technology and Computer Science”
No. 1(31)/2020
www.eti.rzeszow.pl

Received: 18.03.2020
Accepted for printing: 3.08.2020
Published: 05.11.2020

DOI: 10.15584/jetacomps.2020.1.10

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Comment: ~~ICT~~ in Preschool

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Abstract

ICT Tools are not primary, but secondary learning source for teaching abstract mathematical concepts at preschool institution. As a matter of fact, for children ICT Tools don't have the power of immediate and practical experience or experimental work, which are the primary source of learning such contents. ICT Tools can only be used to revise knowledge after children have acquired it through direct manipulative activities and experiments, which require sensory experiences (eyes, hands). In that way children estimate volume of different liquids and their dishes firstly subjectively and then objectively.

Keywords: Experimental-manipulative work, working methodology, sensory experience, professionalism of preschool teachers, ~~ICT~~

Introduction

The nature of learning, knowledge, skills and habits acquisition have its own phylogenetic-psychological and methodically-motorically legalities, which ranges from showing, through presenting, to displaying, and in big number of subjects which involve sensual experiences, experimental work, repeating and practicing, which, even the most developed applications cannot replace (Kamenov, 1997).

In methodical procedure of acquisition of abstract mathematical concepts (for instance measuring of volume, mass, body length; notions: conservation and reversible operation), personal sensible experience of children and experimental work cannot be replaced with IKT in this moment (Hilcenko, 2019, 2017a, 228–229).

Unit for measuring liquid – liter

Development of the notion of **volume of liquid** and conservation operation (= unchangeability) of volume at children develops the slowest due to abstraction, usually when they are between 10 and 11 years old, which means, in 3–4 grade of primary school. By curriculum for pre-school institutions, it is anticipated that children meet this subject even in middle age group of pre-school institution. *"Why?"* The intention is to accelerate the maturation of children, especially their intellectual potential – through the development of notion of volume of liquid and conservation operation of volume associated with manipulative activities (Hilcenko 2017b, 355).

In development of the notion of liquid volume and conservation operation volume, the educator will rely on previous experiences of children (each played on the shore of the sea with sand, water, cans and small shovels, in a park in sandbox, bake cakes with mom or grandmother). The educator begins with subject by placing children in situations in which they play with familiar materials (liquid and bulk) in the centers of interest. In interestingly designed tasks, by playing, children will evaluate their characteristics and quantities (volume).

The educator's aim is not children to understand – *mathematical notion of volume as derived value from the length of cube's edge as basic value in physics!* It refers to understanding of volume only as another quantitative property of the object from immediate proximity – in other words, as characteristic of liquids and bulk materials; training for OBSERVATION and ASSESSMENT of relation between different "in which, all children's senses are irreplaceable – BUT WHICH CAN DECEIVE!"; perception of constancy of volume of liquid (material) during the change of the container's shape.

Also, in the case of assessment of liquid volume and conservation of volume, observation mechanism gives to the child unreliable data again due to insufficiently developed logical thinking, so it concludes intuitively. Only with the development of reversible operation and conservation operation (= unchangeability), child's opinion will become more logical. That is the reason of faster development of these logical operations, respectively, increasing of possibility to develop mathematical notions generally, creators of curriculum include this subject also in schedule of pre-school institutions.

It is educator's job to design suitable experimentally-playable activities with liquid and bulk materials. IKT applications are useful here, but only in testing phases, in knowledge establishing phase, and they are INCOMPARABLE with experimental experiences of children, in which they manipulate, compare with concrete didactical materials.

Elkind's research (1961), determined development of conservation operation at children depending on their age. It is noticeable that conservation of volume is not developed at majority of children, which were tested before age

11. Besides that, time frame was established for some other conservation operations too.

In methodical sense, it is the mostly meaningful to begin activities with children's playing around corners with different bulk materials: *sand, flour, bread crumbs, different cereals, soya, rice, beans, Styrofoam in small balls*… (while liquid materials should be avoided during free activities!). In activities in which children pour, count and compare, they are willing to participate! These tasks, at various corners, will refer to situational tasks in which children can mimic people's interests, who, while doing their jobs: pour and compare bulk materials (for instance clerk in supermarket; worker in dyehouse; organic food shop etc.). While playing, they will gain new experiences and intuitively understand relations between volumes of some containers, quantity relations (= number) and volume (for instance with how many plastic glasses will they fill two or more different containers – by shape or size – with some bulk material).

Educator take care for children, induce them to verbalize their observations during comparation of volumes of bulk materials in different containers. Activities with liquid materials require more control from educator and more fundamental preparations (covering of work surfaces with waterproof pads, sponges, empty buckets for collecting spilled water).

Thus, for instance, during the work on this subject, in **main part of activities**, it would be the most suitable that educator organize EXPERIMENTAL GROUP WORK with children, in which they will, in the most obvious way, expand their experiences in the field of developing the notion of volume of liquid and conservation operation of volume. If they use liquid materials in experiments (the most suitable is water, which, due to easier observation and mutual differentiation, is colored with ecological colors, and containers, which will be used, would be made from plastic transparent materials, different sizes and shapes and by one funnel.

We recommend the example of experimental work with 5 groups of four children. Educator earlier prepared "experimental stations", in which he/she allocated and equalized all children, and then frontally gave them all instructions for realization of 5 different experiments. During the work, educator visits children by "stations", monitors their activities and encourages them to verbalize their observations.

Upon completion of the experiments, results referring and conclusions generalization are following. If the work is organized on different experiments, as it is the case here, groups can be rotated in order to all children have opportunity to try all experiments.

After experimental work, the number of children, who will be able to precisely estimate relation of volume among containers and explain causes of this occurrence, will be increased. It is up to educator to permanently encourage children to announce their experiences, in which the notion of **volume** will be even more present. The essence of all, is to induce children to conclude properly (not to succumb to perceptual observations (which may be in the case of an educational software) – not to be hasty in making conclusions!) about that, that pouring (of liquid or bulk materials) does not change their volume: that if, at equal volumes in two identical containers, we transfuse one of them in container with different shape or more smaller containers, **its volume will stay the same** – it stays identical to original volume.

Experimental and independent group work of children (in which cooperation, experience/opinion exchange exist…) with educator's monitoring, will give best possible results. It is up to educator to create experiments (the way of realization: competition, types of liquids and materials, tidiness…) which are the most suitable in his opinion.

Regardless of the imagination of the experimental work, **reversible option** always follows in the end, in order to undeceive (prove!) children that they made a wrong conclusion concerning the volume of some liquid and container. Comparation analysis of liquid volume should always be observed in the context of the notion of number (for instance *"Total volume of 5 smaller glasses is contained in bigger container – carafe!"*), totally, the notion of the container's shape etc.

The experienced educator will continue to observe the work of every child during the adoption of notions of volume, and to see those who have difficulties in understanding certain concepts. They will give more attention to them, not only in the activities of mathematics, but also in every other convenient and spontaneous moment (for example, during play in the court-pedestrian, in gym, dining room, excursion, etc.). He will refer to the problematic part.

He will effectively ask everyone the questions such as *"Who can tell me, for example ...?"* We all know that *"Knowledge should not be known, but it should be known how to apply it!"* The educator will know to give to every child the necessary confidence and instructs him to check his doubts – experimentally – by proving! With every new experience, children will be rich in their knowledge, and in the activities organized in the form of experiments, educator will have a great ally when it comes to attention (interest, motivation, joy).

However, as we pointed out at the beginning, understanding of the abstract notions of volume and developing a volume conservation operation will be accepted by the educator as successful, if most of children adopt them at an intuitive level, verbalizing those experiences – *"loudly thinking"* during experiments, describing what they perceive, work, think and explain their views.

In the final part of the activity, as we have already mentioned, an appropriate relay game can be organized in which the main task is to fill a larger container in which children participate, filling each of their container with liquids (or working on e-tasks[1]).

Conclusion

The volume can be defined as size of part of some space which is occupied by certain matter, represented by – **spatial unit of measurement**. From the topic itself, which is also emphasized, the notion of conservation of material volume stabilizes the slowest and the latest. It could be seen on the examples of tasks which mostly included principle of obviousness[2]. We approach to this subject with different demands, depending on children's age. Regardless of age, it must always be spontaneous and directly in interestingly designed activities. And while, at younger age, they gain their first experiences and knowledges about the concept of volume (pouring-filling-emptying, pour various liquid or bulk materials from containers with smaller volume in containers which are bigger by the size and different by the shape, approximately compared and objective proving of perceptive estimations), while it is different at middle-aged children. Children of this age should be supported to come to the knowledge through the tasks of manipulative-logical character, whose solutions require thinking in a sense of, *"Who can fill the big washbowl with the lowest number of offered buckets* (of different shape and size)*?" etc.* In this way, they will gradually stabilize the knowledge of the effect of the container size on the volume (= quantity) of matter (liquid or bulk material). When it comes to older (pre-school) children, demands in perception and understanding of volume are even greater. We must demand thoughtful answers on questions such as: *"Why teeter outweigh on Milan's side, if he brought only two glasses of cereals, and NOT on Jelena's side, who brought 4 glasses of cereals?".* With such and similar game activities, we will create prerequisites in which children will notice the occurrence that the same level of volume (quantity) of some matter in containers of different sizes and shapes is NOT the same! Knowledge of this type will be sturdy, if their experiences in a sense of immediate manipulation (pouring, pouring of the same quantity of some matter in containers, which are different by the size and shape, subjectively judging-comparing their volumes) to be more numerous.

We will point out again the fact that during the cognitive activities of children in a sense of material volume, perceptive mechanisms influence is extremely expressed and lasts the most. As a consequence, we have the fact that children

[1] The example of e-presentation on the subject "Measurement unit – L" as auxiliary teaching tool for adopting this topic can only be addition, and not main teaching tool in adopting abstract topics, as well as when basic didactic-methodical principles are respected in the process of adopting this topic [Hilcenko 2014, p. 24–29; 2012a, 2012b, 2008).

[2] Similar to Dale's (1969) classification of medias, it can be said that, by growing of the abstraction of teaching content, obviousness of teaching tools, forms, methods of work are growing too and vice versa!

in the assessment of some volumes almost exclusively lean on **“what their eyes are saying”** to them, respectively, the level of matter (fluid or solid). In order to realize the **constancy of volume** – the quantity of some matters, a longer period of time is required, many experiential experiments (= analytical procedures), during which the processes of reversible operations become “conditions of all conditions” for constructing the notion of a **liter** as a constant of liquid volume.

To gradual understanding of the essence of volume measuring, it will come with organizing a series of focused activities in which the educator takes the children’s attention to the fact of **containing the unit of measurement-number** (= at the beginning of a conditional measure) **in the measured size** – quantity or volume of matter (*“How many times it contain in it?”*). This “conditional” initial unit of measurements – separated quantities of some matter (volume) at the beginning of the process of adopting the notion of volume of liquid can be literally everything *(= hand of rice, glass of water, water bottle of juice, carafe of milk, bag of sand, scoop of flour).*

What is important is to draw attention of children that, for instance, 10 spoons of flour together represent 1 packaging of flour in supermarket. In order to make even more precise counting-comparing of measured quantity of matter-volume (flour), we join 1 object (for example logical block) to each “conditional measurement unit”. In that way, we form countable equivalent sets: **1st set** of “conditional measurement units of volume” and **2nd set** of logical blocks in the process of measuring. In this process, it is important that educator draws the attention of children to the necessary precision in the measurement process, which implies that “conditional units of measurement” (glasses, pots, etc.) are filled to the top or to some marked measure-line (for example as with calibrated measure – a glass for measuring liquid). When practicing pouring, and especially during reversible operations, it is important that nothing is missing (neither spilled nor added) to determine that the amount (volume) of matter has not changed.

The aim of diverse and numerous play activities is that children gradually notice how the same amount of a substance (fluid) is measured with “conditionally**-different** measurement units” (= containers of different shape and size), respectively, **different volumes**. In fact, this diversity depends on the measure number of the size of measurement unit (= a container that measures the volume of a matter).

The educator will instruct children to compare volumes of “conditional units of measurement”, on the basis of which they should independently conclude that it is about the relations **GREATER ≠ SMALLER**. This would relate, for example, to activities for an older age group in which they may find that, for example, in the case of a measure which is 3 x greater than a small measure, and if it contains 3 x in the measured volume, it should be assumed that the smaller measure in the same volume contains 6 x.

Manipulative activities, in which children perform various pouring of liquids in containers of different shapes and sizes, contribute to the improvement of development of the concept of volume conservation. On that occasion, they gauge-evaluate (= approximately) the height of liquid column and their volume. The essence of activities with this kind of content is encouraging of development of children's abilities to do **compensation**, or taking into account some other characteristics of a filled container, for example, its width. Upon completion of a series of such manipulative activities, educator will also try to stimulate the thoughtful activities of children with questions. It can be in the form: *"Can it be confirmed only on the basis of the height of a container, in which of them there is more liquid?", "On which characteristics of a container, except its height, we have to pay attention to, when assessing the quantity (volume) of liquids in them?"* etc.

Generally speaking, for understanding of **volume constancy** (= quantity of matter), which should be assessed (= measured), there are two approaches:

1) reversible operation or returning the liquid (without spilling or adding) in primary container, and

2) by measuring the liquid with "conditional unit of measuremen" both in the 1st and 2nd containers, which should result in the same measures or the same measuring number.

Only after the systematic and long-lasting organized activities, when educator gets the impression that children are qualified to perform conservation operations, i.e., compensations – perception of several variables of containers, such as shape (height, width) as conditional measures, can approach the construction of the notion of **liter**. Liter (**L**) denotes a precisely determined amount of volume or **conventional** (= agreeable) **measurement unit for liquid volume**.

In that sense, based on focuses activities, educator organizes didactic games that simulate real life situations, such as a store where groceries are sold (yogurt, milk, juice, etc.) packed in various packaging-materials (cardboard, plastics, glass) and shapes. Common to all these packages is that it is about standard volumes of **1L**. By appropriate methodology, educator will demonstrate that regardless of the different outer form of these packages, it is always a volume of **1L**. Providing of evidence is carried out in such a way that a **container of standard volume of 1L** (= graduated cylinder) is brought in front of children.

It is necessary to pour content of any exposed packaging (for example juice from glass bottle with volume of **1L**) into graduated cylinder (= standard measurement unit – etalon) and vice versa.

An example of such an experimental task (in which the development of the notion of a liter is encouraged – measurement unit for volume of liquids) can look like this:

There are 4 different packaged groceries in front of children (*plastic bottle of vinegar, cardboard packaging of milk, glass jar of honey and glass carafe of olive oil*).

Educator offers to children to think about the problematic task: *„Does any of these packs contain more liquid?"* Perceptual impact will have a decisive significance on children's answers this time too! It is almost certain that no one will give the correct answer. In making the conclusion, they will be guided by different shapes of packaging volume. Therefore, the educator will suggest to children to jointly perform an experimental check (= proving) the (IN)accuracy of their assessments. For this purpose, educator has prepared 4 equal plastic bottles in which he will pour the content of packaged groceries and one funicular. After this procedure, children will unanimously conclude that the contents of all 4 plastic bottles are identical. By analogy, they should concluded that the content in the original packs of groceries was the same at the very beginning.

An important moment is following, in which educator asks questions like: *„Does anyone know, how much liquid is in all these packages?"* It is likely that most children have previous experiences regarding the purchase of groceries with their parents. If they did not hear it then, (or remember) the name for the volume measurement unit, educator told them. So, it is about measurement unit which purpose is to check the accuracy of the volume of the liquid and call it a **liter**. This moment is used to demonstrate them a **1L of calibrated measure**. At the end of the experiment, the last checking (proofing) is following – pouring of liquid groceries from plastic bottles to calibrated measures of **1L**, with the conclusion that all containers together are identical in volume of **1L**, despite the difference in shape and size.

From all this, it follows that the methodology of work (manipulation, repetition) must be used before ICT, whose applications can serve in phases, checks and knowledge determinations, but not as a basic / primary teaching tool in learning abstract (mathematical) notions!

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