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ABSTRACT

Quantitative aspects of biology play an important role in understanding biological phenomena; however, most students find mathematical tools difficult to understand and use. This paper offers a teaching approach to this problem and presents a research study investigating 9th grade students' learning achievement when a constructivist teaching approach is applied. (YDS)

Science for All: Making Science Accessible to All

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Biology is an important and compulsory subject at the Junior High School level in Israel, as a part of the subject "Science and Technology", in particular since most students will not study biology beyond Junior High School or the first grade of Upper High school. Being a compulsory subject matter, as opposed to optional ones (students may choose not to take it) or "selective" (the system selects the students according to some criteria), subject matters, biology must be taught in ways which are suitable to most of the students.

One of the problems is that biology is a quantitative subject. In some cases, quantitative aspects (i.e., mathematical concepts or principles) appear to be essential to the understanding of the biological phenomena. The size and direction of the influence of the independent variable can be predicted only by means of mathematical computations, using formulas and various mathematical tools. The definition of the variables (such as ratio, percentage, concentration, etc) actually includes mathematical concepts. In fact, such biological principles, labelled in this research "biological principles with intrinsic quantitative aspects", cannot be taught only qualitatively. However, since a majority of pupils find it difficult to understand and to use mathematical tools (*Heid,1995*), mathematics can hardly be considered to be a reasonable and efficient basis for the meaningful learning of such biological principles, and indeed, such a method has been very often found to fail. In addition ,students are afraid from mathematics (Zaslavsky,1994).

A possible solution to this problem is proposed here, namely, to teach quantitative biological principles without using formal mathematical tools, by reversing the sequence. The idea is that instead of taking the mathematic knowledge as a starting point, students' development of a meaningful perception of the nature of the quantitative principle to be learned, should come before they are required to perform computations by means of formal mathematical tools.

The strategy suggested here is of a constructivist type, based on the students' previous knowledge: The topic of learning is a "biological phenomenon with intrinsic quantitative aspects". At the first stages, the students try to deal with the biological phenomenon by using their existing knowledge, on which the process of meaningful learning will be built (Ausubel,1968; Vosniadou and Ioannides,1998). The biological context is expected to be more concrete to the students than mathematical concepts (*Shayer,1987*).

The aim of this research was to observe the learning behaviour of 9th grade students taught by the suggested method, when confronted with "biological principles with intrinsic quantitative aspects", i.e.,:

1) To identify the cognitive difficulties encountered by the students ;

2) To see if the students develop a meaningful understanding of quantitative principles, even before being taught to perform the relevant computations by means of formal mathematical tools;

3) In the case of a positive answer to question 2, to see if the conceptual change mentioned in (2) does ultimately improve the students'meaningful understanding and use of the related mathematical tools.

Two learning modules were designed, to teach two "biological principles with intrinsic quantitative aspects. The first module – "Inward and outward motion of matter or heat in organisms", deals with the influence of the ratio between the surface and the volume (the quantitative principle) on the inward and outward motion of matter or heat in multi–or mono–cellular organisms. The second module – "Nutrition: Percentages of water and dry materiel in food and organisms", deals with the caloric value of food (the subject which contains a quantitative principle).

The proposed teaching sequence in both modules includes three stages:

1. At the first stage, called *"The stage of conceptual change"*, the students perform a few experiments intended to lead to conceptual change and to the construction of a mental conception of the quantitative principles without using computations. The experiments are simple and their concrete results are directly perceived by the students. While performing these experiments, the students actually deal with the quantitative principles without mathematical computations and/or formal mathematical tools.
2. At the second stage, that of *"computing"*, the students learn to use mathematical tools to solve *biological* problems. The main characteristic of this stage is that the students use mathematical tools only when they already understand the quantitative principle which underlies the biological phenomenon under study.
3. At the the third stage, the stage of *"Application"*, the students are expected to apply their knowledge of the quantitative principle and of the computing tools, to new situations, some of them abstract (using symbols instead of concrete entities or precise dimensions).

The experimental sample

Four junior high school classes (about 100 students, 15 years old, with 4 teachers), studied the first module, and three similar classes (about 60 students with 3 teachers) studied the second. Altogether, the sample included 6 classes and only 5 teachers, because one class studied both modules. The sample, as well as the comparison classes, came from schools which are not characterised by any special learning difficulties, and its heterogeneity was similar to that which may be found in any Junior High School in any developed area in the country.

Evaluation instruments

Classroom observations were used as the main tool for the uncovering of *student's cognitive difficulties*. The lessons were audio–recorded and the scripts of the lessons provided additional information about the difficulties encountered by the students.

Also, a sample of students was interviewed (low, average and high achievers) during the learning period.

The same tools were used to observe the *development of the concepts* of the students and the process of conceptual change.

Teachers' and students' opinions regarding the teaching method: At the end of the learning period, all the teachers and a sample of students were interviewed about their opinions concerning the method, and about the difficulties they had been confronted with.

Quantitative evaluation

A multiple–choice test was designed for each module to check the *understanding of biological and quantitative principles*.

In some questions, the students were requested to justify their answers. The test consisted of three parts:

Part A) Understanding of the principle without computations(computation was actually made impossible);

Part B) Techniques of mathematical computations;

Part C) Computations of the size and direction of the influence of an independent variable on the dependent one. In this part, the student had to select the appropriate mathematical tools, and to use them correctly to solve a little problem.

MAIN RESULTS

QUALITATIVE RESULTS

The student's cognitive difficulties:

The types of specific difficulties encountered by the students during the various stages of the modules, and uncovered in this study, are delineated below:

DIFFICULTIES AT THE STAGE OF "CONCEPTUAL CHANGE"

1. Difficulties due to a lack of scientific background

Students often didn't feel able to cope with a problem, because they felt the need to develop first a concrete perception of the nature of some scientific concept, even when the concept itself was not directly essential to the solution of the problem. Answers of the type "Never mind now what X looks like, you will learn that when you are older" did not satisfy them, and they actually refused to go ahead with the learning activity without obtaining a satisfying perception of the concept. They appeared to be unable or unwilling to reason on the basis of an abstract entity, even when the precise features of such an entity had no role whatsoever in the reasoning process.

For example, while the class studied food absorption by one–cell organisms (any protista), a discussion flared up about the details of the function of one–cell organisms. Such details were absolutely irrelevant to the solution of the problem, which referred only to the size of the organisms. However, the students requested "satisfying" details about the life of protista, details which they did not need, and actually did not use in the solution of the problem.

The student's refusal to continue the lesson until getting "irrelevant" details, showed that the importance of the science background was not always because of it's direct relevance, but because the students did not easily reason on the basis of an abstract – to them – scientific entity.

Conflicts between students' preconceptions and the logical conclusions of experiments.

Students often rejected anti–intuitive conclusions from experiments, which contradicted their naive existing conceptions (*Champagne et al,1983*). When doing so, they prevented the occurrence of a planned cognitive conflict, since such a conflict was expected to arise from the discrepancy between the implications of empirical findings and students' previous knowledge. The important fact in such cases was not that misconceptions prevent understanding of formal scientific explanations, *but that even when confronted with empirical findings which explicitly contradict their views, students may reject the findings and tend to stick to their existing naïve interpretation of facts.*

DIFFICULTIES IN MAKING INFERENCES FROM EXPERIMENTAL DATA.

In each module, the main difficulty was that at some stages, in spite of being apprently "shown" what had happened in an experiment, the students failed to see what could be inferred from the experiment.

For example, when a block of agar was divided into small cubes, it became very clear that the surface of agar in contact with the external solution was much larger than in the whole block. However, the students did not infer from their direct observations, that *each small cube* had a bigger surface to volume ratio (more contact surface relative to the volume). The identification by the teacher of such obstacles to further learning was obviously crucial. Their treatment required specifically focussed teaching activities (in this case we used a so–called 3×3×3 cm "Hungarian cube", made of 27 small cubes of 1cm^3 each, the faces of which are coloured in different colours). However, since such activities overcame the obstacle, it can be said that difficulties in learning may not always derive from students' inability to understand concepts or to perform some task, but *from unjustified expectations of teachers, who are unaware of the complexity of some intermediary cognitive task they require from the students.*

DIFFICULTIES AT THE SECOND STAGE (COMPUTATIONS)

1. Difficulties in understanding the meaning of a mathematical operation

The idea of "Ratio" is an abstract quantitative conception that is not dependent on any specific reality. While studying the modules at the stage of "conceptual change", the students had reached a suitable perception of the meaning of the concept, in *reference to concrete situations*, e.g., "how many units of surface for one cube". However, when students learned to compute ratios between values, it appeared that some cognitive steps were not spontaneous in their mind, and could not be taken for granted by the teachers. When explaining the meaning of the mathematical operation they used to compute ratios, namely, a division ("something divided by something"), the students relied on mechanical, meaningless interpretations of the results of the operation such as "the surface is 3 times bigger than the volume".

In the other module, even when the students had developed a suitable understanding of the concept of percentage, they were often *unable to explain the relation between the mathematical operations and the concept itself.*

At the third stage, when applying the biological–quantitative principles to new situations, many students found it *difficult to cope with symbolic situations, which do not refer to specific concrete examples and precisely stated dimensions* ("how can I calculate if I don't know how much it is, let us try first with 2 ...").

This student's tendency to prefer situations of which every component was concrete and understood, surfaced also when they refused to work with shortcut formulae, that eliminate the need for several computations, but the meaning of which cannot be directly perceived (the surface to volume ratio of a cube can be computed rapidly by using the formula 6/a, where "a" is the length of the side. The students did not like the idea and preferred the lengthy computations of surface, volume and ratio, every step of which they felt they understood).

THE DEVELOPMENT OF STUDENTS' CONCEPTIONS

At the beginning, the student held naive–intuitive conceptions of the biological phenomenon. These conceptions, based on the students' personal perception and experience were, or were not, consistent with the scientific view *(Stavy and Tirosh,1996; Lewis and Linn, 1994).* The observed phenomena were often interpreted erroneously (e.g., when more particles of materials penetrate the organism in a given period, it is because the velocity of the particles is greater).

Then, while performing some activities focussed on the diagnosed difficulties, the students got the opportunity to assess the meaning and implications of their naive conceptions. The students' ideas, expressed in their own words, showed then that they had built correct interpretations of some concrete events and were able to use meaningfully the central mathematical principle, although they didn't use formal terms such as "ratio" (for example, they said "there are more sides to each cube") and used no mathematical tools.

Eventually, the successful students' responses showed that they had abandoned their preconceptions and constructed more scientific ones. They were less dependent on specific concrete events, and were able to apply the principles they had learned to explain relevant biological phenomenon and then to apply these principles to symbolic situations and even to formulate the principle in terms of symbols (see table 1 for a short example of such development).

Teachers' and students' opinions regarding the teaching method and the modules:

All the *teachers* mentioned that adapting examples to the students' experience had contributed to their understanding of the subject. Also, the teachers claimed that integrating biology and mathematics had contributed to the students' understanding of the biological and quantitative components of the phenomena under study. They thought that, although already at the end of the first stage (non–mathematical), the students had understood the principles which underlie *the biological phenomenon, after the second stage (computations), the biological phenomenon had gained a new "reality " in the mind of the students*. In their views, the three–stage gradual introduction of mathematics had also reduced mathematics anxiety.

The interviewed *students* themselves all claimed that they had reached a sound understanding of the main ideas before the computation stage (the second stage). They said that although they were "scared" of mathematics, they understood that it was impossible to ignore the quantitative aspects of biology, and also that mathematics were essential to "see the whole picture".

QUANTITATIVE RESULTS

For reasons of space, these results will not be presented here in detail. Let us only stress that the "post" study achievements of the experimental classes were significantly higher than the pre ones, and than those of the control classes, and most of them remained stable also after half a year. As for formal reasoning abilities, they were not an obstacle to the learning of the modules.

SUMMARY

Basically, the research hypotheses were confirmed:

1. The students achieved a meaningful understanding of the quantitative biological principles, even before performing computations and using mathematical tools. In other words, mathematical skills were not a necessary "gateway" to the understanding of such biological principles. It would follow therefore that, in spite of their "intrinsic quantitative apsects", the biological principles of the type referred to in this work *can be taught meaningfully without relying on formal mathematical skills*.
2. The students ultimately improved their understanding of relevant mathematical con-

cepts (ratio, percentage) and became able to define them in their own words, at least while referring to concrete situations. They learned to use mathematical tools only after understanding their purpose.

3. Most of the students progressed from a state of naïve and mostly erroneous understanding of the biological phenomena, to a stage where they were able to explain the phenomena on the basis of some mathematical principle.
4. According to the students' and teachers' testimony, even if mathematical tools were not the gateway to the understanding of the biological concepts and principles, their use enhanced the students' perception of the "reality" of those concepts and principles.
5. The teachers' opinions about the method and about the modules, were positive and quite similar in all the experimental classes. However, the follow up of the junior high school students' efforts to cope with biological quntitative phenomena, showed that the success of the method depended on the following:

- For the student, dealing with the biological phenomenon of the type described here, requires mastery of a) aspects of the scientific background, b) mathematical skills and understandings, and c) various cognitive skills (logical and critical thinking, etc.). The planning of the teaching method and sequence must take all these aspects into consideration, as well as various affective aspects of the learning situation (mathematics anxiety, refusal to accept anti–intuitive conclusions, etc.);
- The students tend to prefer to deal with concrete entities and situations, and may refuse to reason on the basis of abstract entities or situations. They may feel the need to construct a concrete mental image of such entities, before agreeing to use it in their reasoning, or before asking relevant questions or expressing opinions about them. As a corollary, as long as the students rely on their previous naive knowledge, they reason on the basis of something which they perceive as real and intelligible, and therefore become actively involved in the process of learning (asking questions, etc.). When switching to "teachers" knowledge, the students may lose the feeling of coping with real and undestood entities. They may become passive, or even refuse to learn and to accept the new knowledge.

  The students' stubbornness to stick to their concrete and, in their view, logical, perceptions of scientific or mathematical concepts or principles may bring about a refusal to adopt conclusions from experiments ("it's impossible"). In such cases, the students may not collaborate with the teacher in the learning process. As suggested by Posner and his colleagues (1982) the part played by *plausibility* in the construction of new (to the learner) concepts may be crucial;
- When student display difficulties in understanding the quantitative relations between variables, it is important to diagnose which are the quantitative concepts that are misunderstood (ratio, percentage, concentration). The teaching activity must then concentrate on the concretisation of these concepts by means of relevant

illustrative examples and experiments, so as to enable the student to construct an accurate perception of the concept, in relation to concrete situations. Students' talk enables the teacher to follow the process of concept development;

- Even when the students understand a biological phenomenon, not all of it's components may be concrete to them. Many entities and situations in biology are abstract. It is important to identifiy the concrete components of the biological phenomenon under study, so as to enable the students, already at the first stages, to participate actively in the process of learning;
- A critical situation during the learning process was diagnosed, when the link between experimental results and illustrations on one hand, and the expected conclusions or deductions on the other hand, was somehow abstract to the student. The teachers may be unaware of the fact that deductions from findings, which are obvious to them, may not be so to the students. The students appear not to see the logical link, and thus reach wrong conclusions. It is not that the students are unable to learn some concept or principle. In fact, the identification of such "too far" inferences and the splitting of a long logical step into shorter illustrative ones, will enable the student to participate again in the process of learning;
- Once the students switch from using mechanically the mathematical formulas to an understanding of the operations they perform, they tend to prefer lengthy computations, each step of which they understand over shortcut and convenient formulas, the meaning of which is not directly perceivable. Just as they require a concrete image of biological entities, they dislike abstract, if convenient, formulas;
- The fact that the mathematical computations cannot be the basis for the learning, doesn't mean that we should give up on dealing mathematically with the quantitative aspects. On the contrary, they appear to play an essential part in the learning of biological phenomena, for they confer them reality and concreteness. As far as the students are concerned, there is a type of interaction between biology and mathematics: biology imparts a meaning to the mathematical tools, and in turn, mathematical tools confer reality upon biological entities and processes;
- As shown by students' testimony, mathematical anxiety may be greatly reduced by using the learning sequence recommended here, i.e., starting without mathematics and using mathematical tools only when the students know exactly what they have to compute ,and why;
- In "concrete" situations, that is to say, when they deal with familiar objects with defined dimensions, most of the students can reach a state where they use correctly the quantitative principles they have being learning. However, a not–negligible portion of the students are unable to become less dependent on concrete situations and to apply mathematical concepts and principles to symbolic situations (problems in which objects and/or dimensions are represented by symbols). This does not mean that biological principles with intrinsic quantitative aspects cannot be taught at the junior high–school level.

REFERENCES

Ausubel, P.D.1968. *Educational psychology: A cognitive view.* Holt, Rinehart and Winston, USA, New York.

Champagne B.A., Gunstone, F.R, and Klopfer, E.L. 1983. Naive knowledge and science learning. *Research in Science and Technological Education*, 1(2), 173–182.

Heid, K.M. 1995. The impact of technology, mathematical modeling, and meaning on the content, learning, and teaching of secondary–school algebra. *Journal of Mathematical Behaviour*, 14(1), 121–137

Lewis, L.E.,Linn, C.M.1994. Heat Energy and temperature concepts of adolescents, adults, and experts: implications for curricular improvements. *Journal of Research in Science Teaching*, 31, 659–675.

Shayer, M. 1987 Data processing and science investigations in schools. *Research Papers in Education*, 1(3), 237–253.

Stavy, R., Tirosh, D. 1996. Intuitive rules in science and mathematics: the case of 'more of A– more of B '.International *Journal of Science Education*, 18(6), 653–667.

Vosniadou, S., Ioannides, C.1998. From conceptual development to science education: a psychological point of view. *International Journal of Science Education*, 20(10), 1213–1230.

Zaslavsky, C., (1994). *Fear and Math*, N.J. New–Brunswick, Rutgers University Press.

Table 1: The development of a meaningful conception of the surface to volume ratio in organisms of different sizes, and of its influence on inward or outward motion of food or heat. (Questions are shown in italics).

Students responses to questions	**Description of stage of understanding**
["Who will suffer more from cold?"]	
"The mouse, because he is smaller so he will loose more heat."	The student answered intuitively, on the basis of their experience
"The mouse, because he is small and that's why he will absorb cold faster."	
"The mouse, because he is small and material penetrates fast to things that are small."	
["Who will suffer more?"]	
"We can't know because it's relative. The elephant has huge surface area and volume, and the mouse	Here we see the misconception: the size doesn't matter, because a big

has small surface area and volume." " If we talk about volume, the small is more efficient and if we talk about surface area the big is more efficient. If we talk about both it is relative 1:1, it reduces itself and there is no difference between them." " The elephant, It doesn't sound reasonable but it is bigger, so its' ratio is bigger."	body has more surface and more volume *and* the surface/volume in ratio is constant (1:1) when size changes, or is bigger in big bodies.
"What does it mean that the ratio of surface area to volume is 3?"] " The surface area is grater 3 times than the volume." " It can be 3:9, 1:3, – Both give ratio of 3."	Students refer to a purely technical, meaningless mathematical operation.
While working with the "Hungarian" cube: *[" If we look at the small cube, from how many sides can it absorb material or heat?]* student: 6 [And the cube at the corner?] student: 3 [And the cube next to it?] student: 2 Student: and there are some cubes that haven't any absorption sides."	This exercise brings the students to understand , to actually see, the reason for the different ratios. They use meaningfully the term "ratio". No need yet for formal mathematical computations.
Later during discussion: *["The ratio is 6:1, what does it mean?]* Student: 1 unit of volume absorbs from 6 sides "	Students able to express their understanding of the concept of surface area to volume ratio
Finally, comparing the big and small cubes Student:" the cube at the corner has 3 sides to absorb but there are cubes that have just 2 sides or hasn't any sides at all. There are 27 cubes and 54 sides to absorb." ... Student: " the ratio of the big cube is smaller, it is 2:1 while the small cube has ratio of 6:1." Student:" the *same* volume in the small organism absorbs from more sides, so the surface area to volume ratio is bigger compared to the big organism."	The students express correctly the ratio of surface area to volume of the big cube and compute it by means of a division. The mathematical operation is now meaningful to the student

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