The meaning of the term "Research in Didactics of Biology"

A position paper prepared towards the ERIDOB 2014 conference symposium

Anat Yarden[1] and Michal Zion[2]

[1]Department of Science Teaching, Weizmann Institute of Science, Israel

[2]School of Education, Bar Ilan University, Israel

Towards the 10th conference of ERIDOB we were asked to define the term "Research in Didactics of Biology" and to highlight questions that should be addressed in this research area. We attempt to provide answers to those two tasks, from the Israeli perspective, below.

Defining the term "Research in Didactics of Biology"

We initiated our thinking about the definition of the term "Research in Didactics of Biology" with an examination of the current ERIDOB documents: the ERIDOB policy paper and the call for proposals. A careful examination of the ERIDOB policy paper reveals that the term "Research in Didactics of Biology" was not defined since the ERIDOB organization was established 20 years ago in Kiel, Germany. An examination of the current ERIDOB strands, that are listed in the recent ERIDOB calls for papers (from 2010, 2012 and 2014), does not reveal the meaning of this term either, as the majority of the strands are general and not specific for research in biology didactics (Table 1). It appears that only strands 7 and 8 specify specific content, namely "Environmental education and Biology education" and "Health education and Biology education", while all the other strands are general to science education research and do not specify specifically any biological content. Thus, we believe that raising this question in this symposium is timely.

Table 1: Current ERIDOB Strands

1. Student conceptions and conceptual change
2. Student interest and motivation
3. Student values, attitudes and decision-making
4. Student reasoning, scientific thinking and argumentation
5. Teaching: teaching strategies, teaching environments
6. Teaching and learning with educational technology
7. Environmental education and Biology education
8. Health education and Biology education
9. Social, cultural and gender issues
10. Practical work and field work
11. Research methods and theoretical issues concerning research in Biology education

The essence of research in biology didactics obviously stems from the actual teaching and learning of biology in formal and informal contexts. It relies on every nation's educational frameworks and opportunities that are available for the teaching and learning of biology. We found the framework for K-12 science education that was recently published in the US (National

Research Council [NRC], 2012), as suitable for the general framework of the formal biology curriculum in our country, and we believe it is probably suitable for the syllabi in other countries as well. The framework is built around three major dimensions: core ideas, crosscutting concepts, and scientific practices. If we take as an example the curriculum for high school biology in Israel (10^{th}-12^{th} grades, 16-18 years old), it includes: i) core ideas in biology that are expressed in three obligatory core topics (homeostasis in the human body, the living cell, and ecology) and in a few elective topics (i.e., inheritance, reproduction); ii) eight crosscutting concepts, or main principles that are emphasized in every topic studied (i.e., homeostasis, structure-function relationships, evolution, organization of biological systems); and iii) practices (i.e., asking questions, planning and carrying out investigations, analyzing and interpreting data, constructing explanations, communicating information), which are expressed in an inquiry project carried out by the students, in laboratory experiments, in papers students are requested to read, and throughout the learning of the various core ideas. The three dimensions are embedded one within the others in such a way that learners are engaged with the core topics, the crosscutting concepts and the practices simultaneously (Israeli Ministry of Education, 2011). Accordingly, we see research in biology didactics as focusing on each of those three dimensions and on the integration between the three with the aim of promoting biology education. This is carried out by examining all facets of the teaching and learning of biology, including the learners, the teachers and the settings in which they both act. Due to various queries that were raised in the recent ERIDOB 2012 conference in Berlin we would like to emphasize that we believe research that is focused only on the practices and / or on the crosscutting concepts while learning and teaching other contents than biology cannot be considered as research in biology didactics.

We hereby suggest modifying the ERIDOB strands to reflect the way biology is taught and learned in the field, while putting more emphasis on the biological aspects. We based our suggestion on the strands of the National Association of Research in Science Teaching (NARST) with adaptations to our field (Table 2).

The following main modifications were incorporated into the newly suggested strands:

1. The newly suggested strands do not include strands 7 and 8 that are included in the current ERIDOB strands (Table 1). The reason for that is that we suggest that the related fields that are more interdisciplinary in nature, such as environmental education or health education, will be integrated within the other strands and not stand out independently of the other strands. It is not that we think that those strands should not be represented in ERIDOB, on the contrary. Current research in biological sciences is interdisciplinary in nature and this should be reflected in the educational programs and educational research. However, we suggest allowing those strands to be represented along with the other topics.
2. The previous strands 1-4 were regrouped and are not represented in the newly suggested strands 1 and 2, which are focused on various aspects of the leaning of biology.
3. The previous strand 5 is represented now in the newly suggested strands 2 and 3, which are focused on learning biology (strand 2) and on teaching biology (strand 3).

Table 2: Suggested ERIDOB Strands

1. **Biology learning, understanding and conceptual change**
   How students learn biology for understanding and conceptual change, students reasoning, scientific thinking and argumentation
2. **Biology learning: contexts, characteristics and interactions**
   Learning environments, teacher-student and student-student interactions, factors related to and/or affecting the learning of biology including interest and motivation to learn biology
3. **Biology teaching: characteristics and strategies**
   Biology teacher cognition, content knowledge, pedagogical knowledge, pedagogical content knowledge, instructional materials and strategies
4. **Biology learning in informal contexts**
   Biology learning and teaching in museums, outdoor settings, community programs, communications media and after-school programs
5. **Biology teacher education**
   Pre-service and in-service professional development of biology teachers, pre-service and in-service biology teacher education programs and policy, continuing professional development of biology teachers
6. **Biology curriculum, evaluation, and assessment**
   Biology curriculum development, change, implementation, dissemination and evaluation, including alternative forms of assessment of teaching and learning of biology
7. **Cultural, social and gender issues**
   Equity and diversity issues, sociocultural, bioethical, multicultural, bilingual, racial/ethnic, gender equity studies related to biology education
8. **Teaching and learning biology with educational technology**
   Computers, interactive multimedia, video and other technologies used for biology education
9. **History, Philosophy, and Sociology of Biology**
   Historical, philosophical and social issues related to biology education

4. The newly suggested strand 3 is also focusing on teachers' knowledge, i.e. pedagogical content knowledge, which was missing from the previous strands and is extensively discussed in the recent ERIDOB conferences.
5. The previous strands 10 and 11 were eliminated as they are represented in the other strands, and also since no submissions to those strands were accepted in the recent ERIDOB conferences.

We suggest putting the newly suggested strands up for discussion among the ERIDOB members and reach a consensus on a new list of strands representing our community research work in the field of "Research in Biology Didactics" for future ERIDOB conferences.

What research questions should be addressed in didactics of biology?

We believe that the foundations for research into biology didactics consist of two intertwined elements: the content element and the scientific reasoning element. Research into content

alone would be no more than biology research; research into science reasoning alone would be general science education research. Accordingly, research in biology didactics should incorporate a biological element with a scientific reasoning element. Figure 1 shows that each element (content and scientific reasoning) includes sub-components. Biology didactics research offers a variety of interesting and creative connections between these sub-components and others being developed in the fields of science and of education. For example, research into the connections between:

- Understanding the nature of science and teaching the theory of evolution
- Developing scientific literacy by reading primary literature in genetics supported by ICT
- Developing critical thinking and systems thinking by doing open inquiry on plant hormones
- Professional development of biology teachers experiencing open inquiry themselves, on the subject of homeostasis in prokaryotes

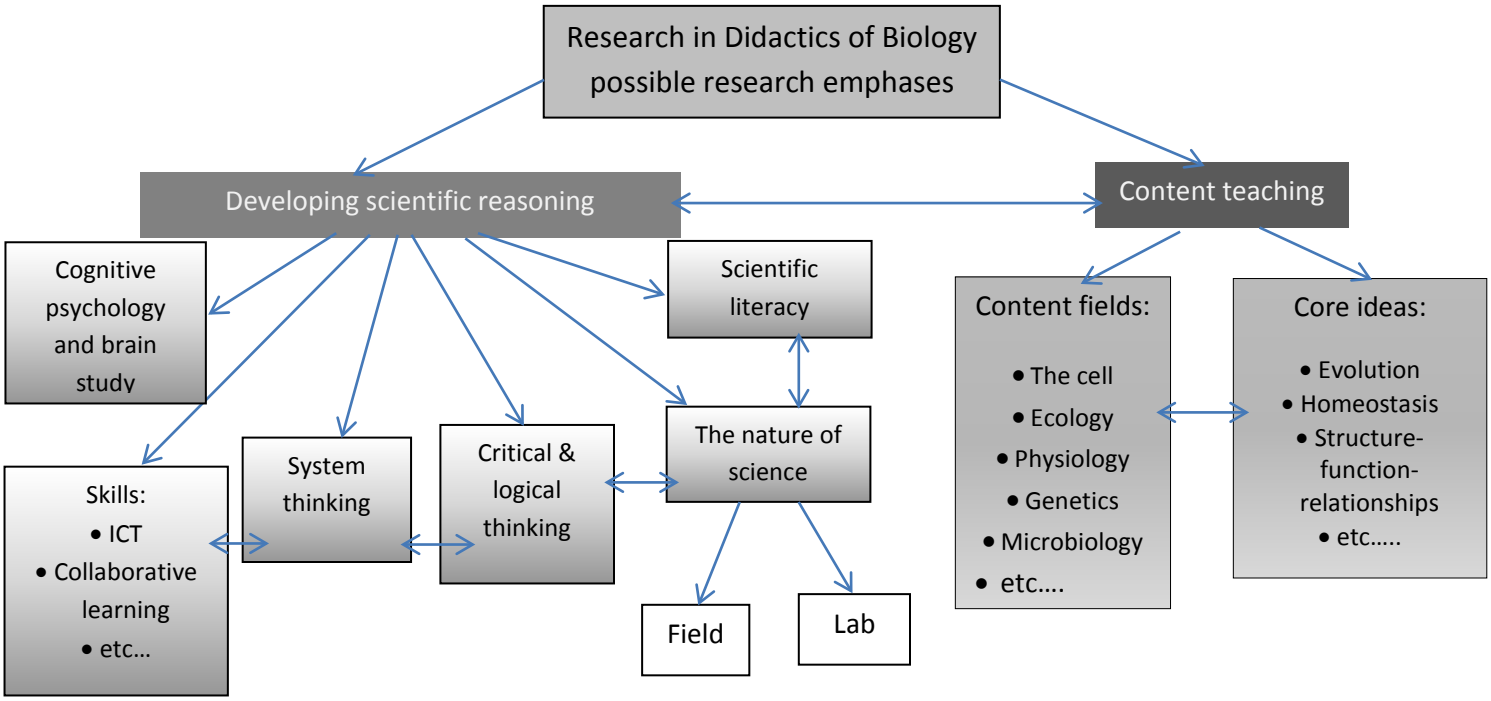

Figure 1: Emphases of Research in Didactics of Biology

References

Israeli Ministry of Education. (2011). Syllabus of Biological Studies (10th-12th Grade). Jerusalem, Israel: State of Israel Ministry of Education Curriculum Center (In Hebrew) http://cms.education.gov.il/EducationCMS/Units/Mazkirut_Pedagogit/Biology/TochnitLimudim/.

National Research Council [NRC]. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, D.C.: The National Academies Press.