# ICT-Based Collaborative Action Research in Science Education

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**ABSTRACT**

Action research is an important event-based method for science teachers' professional development. The study describes modification of action research in a web-environment using ICT and international collaboration between teachers and their students. This ICT-based collaborative action research in science education is outlined by the methodology used. Support for the development of science teacher professional competencies and students' motivation to learning science is determined through analysis of outcomes during an application within the European project EuSTD-web. The research outcomes indicate the value of ICT-based collaborative action research in science education for upgrading science teaching and learning.

**Keywords:** Action Research, Collaboration, ICT, Science Education.

## 1. INTRODUCTION

Science education today plays an important role in educational systems and in many systems has the goal of enhancing scientific literacy in students [1]. Scientific literacy is suggested as providing support for citizenship in a democratic society [6] and has the potential for enabling students to interrelate science with economical, technological and environmental aspect in striving towards sustainability development. Students' learning through school science in relation to context, terminology, subject specific concepts and so on, is expected to be the core focus in defining and developing teaching strategies in the context of a constructivist approach to science education. The creation of relevant and suitable curricular materials and the selection of appropriate teaching and learning strategies are seen as essential in facilitating students' conceptual change from their own views to ones seen as more scientific.

A weakness in science education is perceived to be a lack of a systematic or high quality in-service science teacher training. During the lifetime of a teacher's professional teaching duties which may last about 40 years, many new science discoveries appear and innovative educational technologies emerge. However science teachers tend to create their own individual PCK (pedagogical content knowledge), little influenced by poor quality in-service provisions and indicate little acknowledgement of these changes, or evidence of exchanges with colleagues. Therefore, high quality in-service science teacher training for practicing science teachers is very important in reducing the gap between scientific and educational research and the development of curricular materials and evidence-based teaching methods for school practice [3], [5].

## 2. RATIONALE

It is possible to identify two main barriers in promoting the use of innovative science education technology within school practice: the efficient dissemination of information to science teachers and the motivation of science teachers to learn and use innovative science educational technology. This study is a start towards alleviating these barriers, and also increases the familiarity of use of ICT for collaborative work with other teachers and trainers across the world.

Recognising the dimension of science education provides a good opportunity for the dissemination and upgrading of ideas and curricular materials amongst teachers through the use of ICT. It is proposed that a web-based environment can provide a very effective technology for initiating and substantiating science teachers' collaboration. Unfortunately this collaboration if solely amongst teachers has a risk of lacking expertise and hence it is suggested this collaboration should be based and supported by expertise from the wider science education community including teachers skilled in this area.

Disseminated curricular materials and technologies which have been previously implemented and evaluated within a reflective framework can play an important role in this regard as they have been validated by collaborative teachers-methodologists whose design and reflections on the science curricular materials ensure they are in line with acceptable school practice.

Our study has its origin in the project "European Teachers Professional Development for Science Teaching in a Web-based Environment" (Comenius project - 129455-CP-1-2006-1-PT). Project outcomes are a set of curricular materials for science teachers' professional development. All curricular materials are aimed at science teacher professional development developed in a web-based environment.

Our new core idea is to use action research in a web-based environment realised through the international collaboration of science teachers. Expected positive outcomes are targeted in two developmental directions: in-service science teacher training and students' learning of science. Teachers and students are an indivisible system.

## 3. RESEARCH QUESTIONS AND METHODOLOGY

ICT–based collaborative action research (ICT-BCAR) in science education as a topic of our research is defined and

described by modified conditions. The approach is via action research, also known as participatory research, collaborative inquiry, emancipator research, action learning, and contextual action research [2], [7]. In the case of this research the following simple structure is applied (Figure 1).

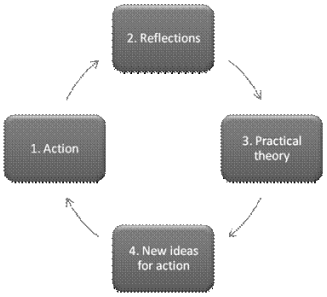


Figure 1. The diagram of action research methodology [4].

Action research is mainly used by one teacher in one class, but can be explored in modify conditions for example by two collaborating teachers, working on-line in two classrooms, in two different countries, using English in addition to home languages, and on-line instruction by use of ICT.

By undertaking a number of research cycle phases we can upgrade the outcomes from the action research with respect to the ultimate design of the collaborative action research. An important aspect of this approach is that participants in a collaborative action research are co-researchers. The principle of collaborative co-researches presupposes that each participant's ideas are equally significant as a potential resource for creating interpretive categories for analysis, as negotiated among the participants.

An open question is whether this is designed "meta"- action research. ICT-BCAR opens many problems and research questions. This study tries to answer a specific research question aimed at the efficiency of science education:

*Can ICT-BCAR offer meaningful and motivational support for the development of professional competencies of science teachers and for the process of students' learning?*

Our united working hypothesis connected to the research question is positive expressed as: *ICT-BCAR offers meaningful and motivational support for the development of professional competencies of science teachers and for the process of students' learning.*

The methodology we use to develop the learning situation and create a reflective framework involving science teachers from different countries is through ICT-BCAR. This develops and allows the implementation of innovative science educational technologies in the classroom, thus providing a unique, event-based, educational, professional development [8].

The "action" factor of action research (see Fig. 1) is ICT-BCAR in action among teachers and students from Portugal and the Czech Republic. This collaboration is intended to upgrade teaching and learning using motivational methods and the introduction of innovative school experimentation. Students are involved both cognitively and attitudinally in the process of learning and are encouraged to play a teaching role with respect to their peers in that they share in determining the use of, and the explanations associated with, the learning materials.

**(a) Selection of topic:** All science topics are not equally suitable for ICT-BCAR. In our opinion it is important to adhere to the following criteria for the topic selection: position of the topic in the curriculum of the countries, importance of the topic for students' cognitive development, and the level of interest for students. The authors stress particularly the relevance of the position of the topic in the national curricula. Not only does the selected topic need to be in the science curricula of both countries, but the positioning of the topic should also be similar. Based on these criteria, the topic chosen is "photosynthesis".

**(b) Selection of students:** The factors considered for the selection of students were age and ability. It was decided that the students should be approximately the same age, promoting an interest to collaborate. Furthermore they needed to be able to communicate in the English language and have skill in the use of ICT. Noting the topic chosen, students in intact classes were selected from secondary schools and 15-16 years of age.

**(c) Selection of objectives:** In the teaching of the topic of photosynthesis it was agreed between the two teachers that the objectives of the collaborative action research were to:

- Identify the concise problems to be tackled - how to motivate the students to learn about obtaining energy: photosynthesis and chemosynthesis and how to promote the development of skills in terms of concepts, procedures, values and attitudes, concerned to this topic;
- Ameliorate the principle of reflective critique concerned with the activities and experiences which have been planned, such as those related to factors influencing the rate of photosynthesis;
- Improve the interactions among students, between teacher and learners and, finally, instigate interaction between the teachers. This means that strategies to stimulate the collaborative nature of the work were made mainstream;
- Develop an international dimension based on the approach to interdisciplinary issues related to photosynthesis.

Clearly ease of communication strongly influences the collaboration between teachers and students. However international collaboration necessitated the use of "on-line" technologies. To communicate international, the teachers and also the students used email, ICQ, Skype, and video-conferencing.

For this study teachers prepared a schedule of their own and their students´ activities for each of the collaborative lessons. All curricular materials used were prepared by the same teachers. In this way the teachers collaboratively developed (in their own language and in English) worksheets, power-point presentations, videos, experiments, learning tasks, etc.

Reflection is a very important part of a collaborative action research so as to seek whether the evidence supports the hypothesis. In seeking evidence we used tests, questionnaires, observations, interviews, students and teachers portfolios. On the basis of interpreting the findings, the degree of success of the collaborative action research and thus the acceptance of the hypothesis put forward are determined.

## 4. RESULTS

The analysis of inquiry outcomes supported our hypothesis that ICT-BCAR offers meaningful and motivational support for the development of professional competencies of science teachers and for the process of students' learning.

Although much data was collected (on which the reflection phase of our collaborative action research was based) we present only that based on the questionnaires:

***Responses by Portuguese/Czech students (from the questionnaire for students):***

| **Do you believe that the online environment influenced your teacher's performance? N=27/21** | |
|---|---|
| Yes | 52% / 67% |
| No | 48% / 33% |

***Responses by Portuguese/Czech students (from the questionnaire for students):***

| **Do you believe that the online environment influenced your performance and learning? N =27/21** | |
|---|---|
| Yes | 89% / 90 % |
| No | 11%/ 10 % |

***Responses by Portuguese/Czech students (from the questionnaire for students):***

| ***In the statements listed below are some of the aspects related to the activities shared with your Czech colleagues. Choose the option which best expresses your opinion.*** | | | | | |
|---|---|---|---|---|---|
| ***N=27/21*** | *Disagree* | *Partially Agree* | *Agree* | *Strongly Agree* | *No opinion* |
| ***The partnership helped you to better understand certain aspects on this topic.*** | *7%*<br>*0%* | *33%*<br>*29%* | *42%*<br>*47%* | *14%*<br>*19%* | *4%*<br>*5%* |
| ***You would have achieved the objectives of this topic better by interacting only with your classroom classmates.*** | *33%*<br>*29%* | *52%*<br>*29%* | *4%*<br>*29%* | *4%*<br>*0%* | *7%*<br>*13%* |

***Responses by Portuguese/Czech students (from the questionnaire for students):***

| **Your teacher's performance (on the aspects listed below) contributed to learning the topic in an online environment. Choose the option that best expresses your opinion.** | | | | | |
|---|---|---|---|---|---|
| ***N=27/21*** | *Disagree* | *Partially Agree* | *Agree* | *Strongly Agree* | *No opinion* |
| **The teacher showed enthusiasm in sharing experiences between students from both countries.** | 0%<br>0% | 4%<br>14% | 33%<br>33% | 63%<br>48% | 0%<br>5% |
| **The teacher demonstrated a capacity to motivate students in this topic.** | 0%<br>0% | 7%<br>19% | 63%<br>43% | 30%<br>33% | 0%<br>5% |
| **The teacher demonstrated dynamism to conduct the present activities.** | 0%<br>0% | 7%<br>38% | 41%<br>33% | 52%<br>24% | 0%<br>5% |
| **The teacher's interaction and monitoring of students on-line work was effective.** | 0%<br>0% | 11%<br>14% | 33%<br>48% | 56%<br>33% | 0%<br>5% |
| **The teacher encouraged interaction both within and between groups.** | 0%<br>0% | 11%<br>19% | 41%<br>43% | 48%<br>24% | 0%<br>14% |

## 5. CONCLUSIONS AND IMPLICATIONS

These research outcomes support the notion that ICT- BCAR is important for upgrading science teaching and learning.

The main outcomes of ICT-BCAR (the elements of the practical theory of our action research) realized were:

1. Strong motivation of students and teachers especially by communication with colleagues in other country, new information, applications of new knowledge from abroad, new personal contacts etc.
2. Exchange of experiences between teachers (teaching methods) by comparing curricular material (textbooks, learning tasks, experimentation etc.).
3. Inserting of new educational methods based on research by teachers' application of action research monitored by science educational experts.
4. Teacher training in the use of action research.
5. Teachers' and students' improvement of skills to use ICT.
6. Teachers' and students' development of English language and partner country languages.
7. Acquisition of subject (biology) knowledge and skills (e.g. Van Helmont experiment).
8. Gaining of collaboration competencies between teachers and among students (needed more than usual communication).
9. Team collaboration among teachers inside the partner schools (support with ICT, English, organisation of lessons etc.).
10. Team collaboration among students within the partner schools (support with ICT, organisation of lessons etc.).

The international dimension of science education provides a good opportunity for the development and dissemination of ideas and curricular materials among teachers by use of ICT. A web-based environment can be a very effective technology for science teachers' and students' collaboration leading to upgrading of science education.

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