1.1 Stakeholders' Views on Science Education in Georgia – Curricular Delphi Study

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Abstract

This article indicates the views of stakeholders in science education in Georgia through a three round Delphi study. Outcomes from the study were used to guide the direction of a continuous professional development (CPD) programme under PROFILES promoting motivational inquiry-based science education. Details of the way the Delphi study outcomes impacted on the CPD programme are given. Revised curricula are anticipated in 2016 and related to this the differing views of stakeholders about science education in a future Georgia can be expected to have a significant impact.

Introduction

National educational reforms in Georgia began in 2004. During these years, several versions of new national curricula for both elementary and secondary schools were first piloted and then implemented. One focus in these processes was the current situation related to science education and the importance of a scientifically literate society. Much attention was paid to the development of new science curricula which acknowledged a more inquiry-based and student-oriented approach. In view of these developments, an important but belated consideration was to establish modern and contemporary understanding of the desirable science education in schools offering general education.

For an inclusive approach, taking into account the views and opinions of a wide section of those related to aspects of modern and desirable science education. It is necessary to bridge the gap between the differing view of diverse groups within the society, involved or having an interest in the science education offered in schools (termed here as "stakeholders"). This article relates to an approach seeking views and opinions using a Delphi study. The aim of the "Curricular Delphi Study on Science Education" – which the Ilia State University (ISU) conducted in accordance with (Bolte, 2008; Schulte & Bolte, 2012) is to engage different stakeholders in reflecting on the focus, content and aims of science education, as well as outlining aspects and approaches of their considerations on modern science education. In this regard, the Curricular Delphi Study on Science Education in PROFILES partner countries (PROFILES Consortium, 2010) is intended to offer comprehensive insights into opinions of different stakeholders in the society who have a concern or interest in the sciences and science education taught in schools, such as students, science teachers, science educators/researchers and scientists. This article does not relate to other sectors of society, most notable employers who engage young people in a variety of employment arenas.

The specific Georgian study involved participants in providing feedback in three rounds. The first round offers participants the possibility to express their ideas about aspects of contemporary and pedagogically desired science education through three open-ended questions regarding "motives, situations and contexts", "fields and methods" and "qualifications" (Bolte & Schulte, 2011).

In this article we present the results of the first and second round of the Curricula Delphi study on Science Education in Georgia. Also we provide an overview about the third round, as well as a short overview about the first round of the PROFILES continuous professional development (CPD) programme for science teachers.

Results from 1st and 2nd round of the Delphi Study in Georgia

In total, 186 potential participants ('experts') in Georgia were asked, via e-mail, to fill out the 1st

Group		Number of questionnaires sent	Number of responses	Response rate
Students		46	34	76%
Science teachers	Science education students at university	8	6	61%
	Trainee science teachers	2	2	
	Science teachers	29	14	
	Trainee science teacher educators	10	8	
Science educators		40	13	33%
Scientists		35	27	77%
Others *		16	6	38%
Total		**186**	**110**	**59%**

*Note 'Others' in the table refers to the people, who worked in science (physics, chemistry, biology), but they left their profession for different reasons.

Table 1. Structure of the sample, participatory groups and participation rates for round 1

round Delphi questionnaire. As shown in Table 1, 110 stakeholders responded in the different groups. The range of participants' statements from the first round were processed using qualitative and quantitative analyses and a final classification system was developed and established on the basis of the PROFILES system recommended by FUB.
The classification system consists of 100(+9) (9 categories are for the additional Methodological aspects); the categories are listed in Table 2. In most cases, the categories agree with categories established in previous Delphi studies in sciences (Bolte, 2008) and refer to guidelines and aspects of modern science education stated in educational literature (Bybee, McCrae & Laurie, 2009; Fensham, 2009). The category system developed in the Freie Universität Berlin was taken as the basis for the Georgian system as shown in Table 2 (Bolte et al., 2011). Table 2 presents an overview of the categories after the 1st round, where the additional categories of ISU are indicated in italics. From quantitative analyses, the frequencies of how often the categories were mentioned by the participants were determined.

Delphi – 2nd round

The second round of the Curricular Delphi Study is based on the questions which results from the areas of emphasis in the first round (Bolte, 2003; 2008; Häußler, Frey, Hoffman, Rost & Spada, 1980; Listone & Turoff, 1975; Mayer, 1992). Following the Delphi Method, the second round consisted of a two-part questionnaire which was sent to all participants responding to the first round questionnaire. As shown in Table 3, 83 of the 110 stakeholders who participated in the first round responded also to the second round questionnaire. There was an increase in the numbers of in-service teachers and science educators in the second round responses. It was predicted that this was because some participants changed groups – for example scientists, or trainee teachers became in-service teachers, etc.

I: Situations, contexts, motives	**II: field**		**III: Qualification**	**IV (Addition): Methodical aspects**
	IIa: (Basic) concepts and topics	**IIb: Scientific fields and perspectives**		
N = 19	**N = 21**	**N = 35**	**N = 25**	**N = 9**
• Education / general development • Emotional / personality development • Intellectual / personality development • Students' interests • Curriculum framework • Nature / natural phenomena • Everyday life • Medicine / health • Technology • Society / public concerns • Global references • Occupation • Science – biology • Science – chemistry • Science – physics • Science – inter-disciplinary • Out-of-school Learning • *Science development perspectives* • *Experiments, practical work*	• Matter/particle concept • Structure /function / properties • Chemical reactions • Energy • Scientific inquiry • Cycle of matter • Food / nutrition • Health / medicine • Matter in everyday life • Technical devices • Environment • Safety and risks • Occupations / occupational fields • *New Technology and its application / industrial processes* • *Modern scientific achievements/ scientific investigations* • *Agriculture* • *Universal science laws* • *Life processes* • *Physical Phenomena* • *Chemical phenomena* • *Connections between phenomena*	• Botany • Zoology • Human biology • Genetics / molecular biology • Microbiology • Evolutionary biology • Ecology • Inorganic chemistry • Organic chemistry • Biochemistry • Mechanics • Thermodynamics • Atomic / nuclear physics • Astronomy / space system • Earth sciences • Mathematics • Inter-disciplinary • Consequences of technological development • History of the sciences • Ethics / values • *General chemistry* • *Applied Chemistry* • *Cell biology* • *Life science* • *General biology* • *Relativistic theory* • *Electricity* • *Optics* • *Molecular physics* • *General Physics* • *Quantum mechanics* • *Biophysics* • *Biochemistry* • *Cosmetology* • *Pharmacology*	• (Specialized) knowledge • Applying knowledge / thinking abstractly • Judgment / opinion-forming / reflection • Formulating scientific questions / hypotheses • Being able to experiment • Rational thinking / analyzing / drawing conclusions • Working self-dependently/ structurally / precisely • Reading comprehension • Communication skills • Social skills / teamwork • Motivation / interest / curiosity • Critical questioning • Acting reflectively and responsibly • *Inquiry skills* • *Civic* • *Environmental awareness* • *Observation, perception* • *Classification* • *Finding information* • *Creativity* • *Safety skills* • *Life skills/ first-aid* • *Problem-solving* • *Numeracy* • *Metacognition*	• Interdisciplinary learning • Inquiry-based science learning • Using new media • *Learning based on previous knowledge* • *Project learning* • *Learning in small groups* • *Individual work* • *Using visual resources* • *Student based learning*

Table 2. Overview of the categories for the analysis of the experts' statements

Group		Number of questionnaires sent out	Number of responses	Response rate
Students		34	20	59%
Science teachers	Science education students at the university	6	6	87%
	Trainee science teachers	2	0	
	Teachers (in-service)	14	15	
	Trainee science teacher educators	8	5	
Science educators		13	14	100%
Scientists		27	19	70%
Others		6	4	67%
Total		**110**	**83**	**75%**

Table 3. Structure of the sample in the 2nd round Delphi study and participation rates

The first part of the questionnaire asked participants to assess the categories developed in the first round analyses in two different ways:

1. they were asked to rate the priority to the given categories, and
2. they were asked to evaluate how they think these categories are implemented in science education practice.
3. For both cases (priority and praxis) the participants used a six-tier rating scale.

In the second part of the second round study, the participants were asked to combine these categories to form a set of category bundles that seem to be especially important to their combination.

Table 3 shows ISU sample structure and participation rate for the second round. It is visible, that total number of participants 83 (75% of the participants from the first round) took part in the second round.

An increased number of in-service teachers and science educators were included in the second round. The reason for this is an exchange between the groups – for example scientists or trainee teachers became in-service teachers, etc.

The results from the second round were analyzed statistically. Categories chosen by the participants were clustered by means of cluster analyses and were interpreted as "conceptions for contemporary science education." Three such clusters were identified as:

Concept A: Awareness of the sciences in social and scientific contexts in both educational and out-of-

school settings.
Concept B: Intellectual education in contexts of scientific inquiry, development of general skills and occupation.
Concept C: General science-related education and facilitation of student's interest in contexts of everyday life using modern and various methods of education.

The labeling of these three clusters are based on the FUB concept (Bolte & Schulte, 2012) because of similarities and overlap in terms of content.

After the first and second rounds of the Delphi Study, it was clear, that Georgian stakeholders stress the importance of scientific context, as well as connections with everyday life in both educational and out-of-school settings. It is also worth mentioning the priority given of scientific inquiry and the development of general educational skills.

Delphi – 3rd Round

All 83 stakeholders who had participated in the 2nd round took part in the 3rd round of the study. The questionnaire for the 3rd round consisted of two parts:

1. Stakeholders were asked to assess the results of the Georgian responses from round 2, and
2. Stakeholders were asked to estimate the concepts, developed by the FUB PROFILES team on the basis of their clusters (Bolte & Schulte, 2013)

The analysis of this data is ongoing.

PROFILES CPD programme

Based on the outcomes of the 1st and 2nd rounds of the Delphi study, in which the Georgian stakeholders stressed the importance of scientific context connected with everyday life, both for in-school settings and for out-of–school activities, it was considered feasible to use the results of this Delphi study to guide the PROFILES CPD programme and to plan activities based on these, especially with respect to the differences between the priority and praxis. The aim of the CPD training and the classroom intervention using PROFILES modules was to encourage in-service teachers to implement motivational IBSE in their schools and integrate the PROFILES approach into their teaching practice.
In total, 19 science teachers from different regions of Georgia participated in the 1st PROFILES CPD programme (7 biology, 6 chemistry, and 6 physics teachers) and 5 inquiry-based modules were suitably adapted from PARSEL (www.parsel.eu), or other sources and implemented in Georgian schools:

1. "Stumbling over Biodiversity" (Pany, 2011)
2. "Preventing Holes in Teeth" (Lindh, Nilsson, & Kennedy, 2009)
3. "Brushing up on Chemistry" (Tsaparlis & Papaphotis, 2009)
4. "Traffic Accident: Who is to blame" (Holbrook, 2009)
5. "Cola and Diet Cola" (Streller, Hoffmann, & Bolte, 2011; Streller, 2012)

The relevance of these modules to society and the everyday life increased students' interest in the subject.

Findings from implementation of the PROFILES modules in schools.

The following feedback indicate Georgian teachers' impressions regarding their experience when implementing inquiry-based learning using PROFILES modules and teaching approaches after the PROFILES CPD programme:
a biology teacher (N1) mentioned:

> *"Students were involved with great interest. One boy, who was never active during the lessons, was seen as the best in all PROFILES activities";*

a physics teacher (N2) stated:

> *"Students became very active; they undertook measurements in the school corridor and involved students from other classes";*

a biology teacher (N3) said:

> *"All students were very active. They created a video in the dental clinic on their own initiative and brought their own resources to the classroom for investigation";*

a biology teacher (N4) said:

> *"After implementing PROFILES modules I was able to find my own way of teaching"; and*

a chemistry teacher (N5) answered:

> *"Students asked me to have similar lessons at least once a week and, during the lessons, they considered themselves 'great researchers'".*

This initial feedback shows the very positive attitudes of Georgian science teachers to the project and to the CPD. Further we observe changes in the teaching praxis of teachers after the CPD courses and implementation of PROFILES modules.

It is planned to implement a 2nd PROFILES programme along similar lines. During the programme the results of the Georgian Delphi study will be discussed in relation to the PROFILES philosophy and approach.

Conclusion

For many years in Georgia, the main approach to teaching has been to promote content-based learning. The system of education has been highly centralized, stemming from an imposition of unified methodological approaches implemented in the Soviet Union countries.

Interest in the Delphi study is caused by the National Educational Reform undertaken in Georgia, beginning in 2004. Although several versions of the new curricula were piloted and implemented during 2004–2010, another revised version of the national curricula for the elementary level was implemented in the 2011–2012 school year and in 2012–2013 this was extended to the basic and secondary school level for all public schools. These ongoing reforms radically change the educational system and new requirements are being suggested for science teaching as well. Inquiry-based learning and problem-based learning approaches were the main methods suggested from Ministry of Education and Sciences, although the PROFILES approach based on a wider philosophy incorporating education through science learning outcomes was also encouraged.
Nevertheless, new revised curricula are anticipated in 2016. And related to this, it is very important to capture the different views of stakeholders about science education in Georgia. The outcomes of the full three rounds of this study will be used to guide the CPD further and seek to enthuse teachers in improve science teaching in the country.

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