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4. INQUIRY AND CREATIVITY APPROACHES IN EARLY-YEARS SCIENCE EDUCATION

A Comparative Analysis of Finland and Romania

INTRODUCTION

The discourse on science education during the current decade has continuously referred to the significance of cross-curricular twenty-first century skills such as collaboration, critical thinking, problem solving, design and engineering skills, creativity, and ICT literacy (Craft, 2005, pp. 56–57; Webb & Rule, 2012, p. 379). The worldwide debate of educational stakeholders has highlighted the need to revive and reinforce the above-mentioned skills and competences for the next generation to complement their content-based school learning. The future society we are building requires people to have the capabilities and abilities to respond to the societal and economic challenges of a globalized and technologically oriented world. These twenty-first century skills have been defined as competences that students need for their future working life or to act as future responsible citizens. As societies have become more technological and multicultural, global cooperation, interpersonal communication, and critical thinking have become vital school subjects. At the same time, changes in local cultures demand innovative approaches for people to be successful in highly competitive environments. It is expected that these twenty-first century skills will be fostered in order to prepare students for globalization and increase students' abilities to survive in the new international context. The development of such skills and competences occur in specific cultural, national, or local contexts. Thus, international versus national contexts and backgrounds need to be discussed when analyzing educational policies designed to support such developments (Jean-Francois, 2015).

The topic we are discussing has led to various suggestions for planning school instruction to meet students' requirements. Science education plays a key role in this discussion because of its possible contributions to twenty-first century skills such as higher order thinking skills, inquiry approaches, and scientific literacy (Asay &

E. Kimonen & R. Nevalainen (Eds.), Reforming Teaching and Teacher Education: Bright Prospects for Active Schools, 89–116.

Orgill, 2010; Harlen, 2013). The European Commission reports (Cachia et al., 2009; Heilmann & Korte, 2010) nominate creativity as one of the core elements to focus on in school teaching and learning. Creativity-based abilities are perceived as a major component of twenty-first century skills, supporting other skills and being a driving force to them.

This chapter will review pre-school and elementary school teachers' conceptualizations and practices in regard to Inquiry-Based Science Education (IBSE) in early-years science education as well as the role of creativity in supporting this learning process. The European Union-funded project Creative Little Scientists (CLS, 2012; 2013a) organized a large-scale study covering nine European countries to map and compare policies and practices in IBSE and Creativity development Approaches (CA) in early-years science and mathematics education. The project reviewed the common features of the nine studied European countries and created recommendations for further practice and future research. Recent research (Dede, 2010) and the theoretical framework set by the CLS project (CLS, 2012) have acknowledged the common synergies between CA and IBSE, which closely resonate with the above-mentioned twenty-first century skills, and which are pedagogically associated with learning theories as promoted by constructivism and humanism. This chapter examines and compares IBSE and CA in the case of Finnish and Romanian early-years education teachers. The selected two countries have quite divergent educational policies and systems that provide fruitful societal and educational comparisons from a European perspective of the strategies used in early-years science education. We base our evaluation on data collected in the CLS project for Finland (Havu-Nuutinen, 2012; Havu-Nuutinen & Tahvanainen, 2013) and Romania (Sporea & Sporea, 2012; 2013).

INQUIRY-BASED SCIENCE EDUCATION AND ITS CONNECTION WITH CREATIVITY

IBSE definitions vary across studies. Nevertheless, notable agreement exists concerning the significance of IBSE in science education (Asay & Orgill, 2010; Harlen, 2013). IBSE is defined as an approach that emphasizes student-centered learning activities, advocating experimental problem solving. Inquiry is a term commonly used both within the education system and in everyday life to refer to the quest to obtain explanations and/or information by trying to answer formulated questions. Within scientific circumstances, it refers to research, investigation, or the "search for truth" (ibid.). In regard to schoolwork, one group of academics defined inquiry-based instruction as emphasizing understanding and variation of the skills developed in the process (IAP, 2010, p. 5):

> It is a process of developing understanding which takes account of the way in which students learn best, that is, through their own physical and mental activity. It is based on recognition that ideas are only understood, as opposed to being superficially known,

> if they are constructed by students through their own thinking about their experiences. In the classroom these experiences include direct observation and investigation of materials and phenomena, consulting information sources such as books, experts, the internet and discussion with others in which ideas are shared, explained and defended. This learning will involve the development and use of skills of observation, raising investigable questions, planning and conducting investigations, reviewing evidence in the light of what is already known, drawing conclusions and communicating and discussing results.

IBSE refers in many ways to the skills and procedures scientists employ in their investigative work to understand the world around them, and it is expected that students conducting "scientific investigations" will use similar approaches in the classroom. One of the core priorities of IBSE targets children's understanding of the nature of science and scientific phenomena in relation to their concepts and prior knowledge. Inquiry-based approaches in science teaching and learning aim to guide learners in finding alternative solutions to the problems they are facing, and to better decipher the world they live in. IBSE aims to deal with issues that are context related and require multifaceted understanding and action. Students should also develop an understanding of the way scientific ideas and knowledge are obtained, the skills that are needed for this, and the attitudes expected from students in seeking and using evidence (ibid.). For this reason, the development of skills supported by reasoning, justifications, or critical thinking is required in IBSE practice. In IBSE, students are encouraged not only to represent and communicate their findings but also to create an understanding of the way concepts are scientifically connected.

Besides the cognitive factors of learning, the inquiry approach involves affective factors such as motivation, curiosity, and enjoyment toward science-related activities. In addition, IBSE encourages young students' self-regulation, self-control, and the ability to reinforce self-esteem in order to overcome difficulties of the learning process (Harlen, 2013). Affective factors have been seen as extremely significant in young children's learning process. Young children's cognitive capabilities are limited, for which reason they need means to engage them emotionally in constructing their understanding of the surrounding world. With the support of emotional imagination, young children will be able to reach a scientific understanding of the phenomena under discussion (Fleer, 2013).

In early-years science education, the level of teacher's scaffolding in inquiry-type activities varies according to the pedagogical context, the novelty of the studied topics, and the age of students. Depending on the phenomena or intended purpose, teacher's involvement varies from a structured to an open approach. In the open approach, the teacher is less involved, stands aside, and gives more time and space to children's initiative. In the structured approach, ready-made materials and given work recipes are used and children participate in activities and perform suggested tasks under the teacher's guidance. Table 1 shows some essential features of the inquiry-based learning method in science education and suggests possible variations to be applied in the classroom.

Table 1. Essential Features of Inquiry-Based Learning in Science Education (see CLS, 2013a, pp. 69–70)

Feature	Open	Guided	Structured
Question: Children investigate a scientifically-oriented question.	The child presents a scientifically-oriented question.	The child selects from, or refines, a range of scientifically-oriented questions provided by the teacher, materials, or other sources.	The child is given a scientifically-oriented question by the teacher, materials, or other information sources.
Evidence: Children give priority to evidence.	The child determines what constitutes evidence or data and collects it.	The child selects from data/evidence provided by the teacher, materials, or other sources.	The child is given evidence or data by the teacher, materials, or other sources.
Analyse: Children analyze evidence.	The child decides how to analyze evidence.	The child selects from ways of analyzing evidence provided by the teacher, materials, or other sources.	The child is told how to analyze evidence provided by the teacher, materials, or other information sources.
Explain: Children invent explanations based on evidence.	The child decides how to formulate explanations based on evidence.	The child selects from possible ways to formulate explanations given by the teacher, materials, or other sources.	The child is given a way to formulate explanation based on evidence.
Connect: Children connect explanations to scientific knowledge.	The child independently finds and examines other resources and forms links to scientific knowledge.	The child is directed to other resources and shown how to form links to scientific knowledge.	The child is given other resources and shown the links with scientific knowledge.
Communicate: Children communicate and justify explanation.	The child chooses how to communicate and justify explanations.	The child is given broad guidelines on how to justify and communicate explanations.	The child is given all the steps to justify and communicate explanations by the teacher, materials, or other information sources.
Reflect: Children reflect on their inquiry process and their learning.	The child decides independently how to structure reflection on the inquiry process and his or her learning.	The child is given broad guidelines to structure reflection on the inquiry process and his or her learning by the teacher, materials, or other information sources.	The child is given a structured framework for reflection by the teacher, materials, or other sources.

As illustrated in Table 1, IBSE provides several options for independent and creative learning. Creativity is referred to as the ability to produce something novel or unique, or as a process in which different features of higher order thinking skills are employed (Sternberg, 2003). IBSE is a scaffolding learning process that offers opportunities for personal solutions in a flexible environment. Learners have plenty of room to exercise their learning skills and discuss conclusions. Basic thinking operations may be expanded to creative thinking through changing the learning environment (Daud, Omar, Turiman, & Osman, 2012, p. 471). However, what is needed to achieve creative thinking in IBSE contexts?

A review of the recent literature on creativity reveals the complexity of the concept. The following analysis of the theories of creativity is based on Kozbelt's study (2011, pp. 473–479). There are several theories that try to define what researchers mean by the concept of "creativity." Some of them focus on the theoretical definition of the concept, while others refer to the practical ways in which creativity manifests itself. The theoretical viewpoint considers the concept as an entity, the definition of which is derived from particular theoretical contexts such as psychology, cognitivism, economy. In these cases, creativity is often defined very narrowly, which makes defining it in school contexts challenging. In contrast, the practical approach analyzes creativity with respect to the contexts in which the use or emergency of creativity is exploited to capture the features of creative behavior (ibid., pp. 474–475). From this perspective, creativity becomes essential within school context.

In the practically oriented framework, not all instances of creativity are equal. More often, two definitions of creativity are employed according to the considered level of creative magnitude. A standard distinction differentiates the "big-C" (associated generally with history-making instances of creative breakthroughs belonging to eminent individuals) versus "little-c" creativity (a common, minor manifestation accessible to ordinary people). In recent years, two additional categories of creative magnitude have been proposed: firstly, a "mini-c" category that provides more room to subjective or personal realizations of creativity, and secondly, a "pro-C" category that characterizes professional-level creators who have not yet attained eminence but who are well beyond common creators in respect to their knowledge, motivation, and achievements (ibid., pp. 474–475).

School-based studies are often focused on little-c or mini-c approaches. Researchers have been interested in the creative processes in particular learning situations or in situations in which creativity appears as part of subject learning, for example, in mathematics teaching (Panaoura & Panaoura, 2014) or in science education (Daud et al., 2012; Webb & Rule, 2012). In these studies, creativity is understood as contextualized where domain contexts matter. In a school-based project, it is important to consider the way a traditional content-based learning process can be implemented as a creative process in which new methods and/or another context are emphasized. From this perspective, between IBSE and CA, common synergies can be identified, which makes our discussion more challenging and significant. Especially in early-years context, new context and approaches may produce creative outcomes and support personal investigative processes. This has been revealed with older students (Daud et al., 2012) and, additionally, defined in the theoretical framework of the CLS project (CLS, 2012, pp. 63–64). These synergies have been identified as follows:

– Play and exploration: Recognizing that playful experimentation/exploration is inherent in all young children's activity – such exploration is at the core of IBSE and CA in the early years.
– Motivation and affect: Highlighting the role of esthetic experience in promoting children's affective and emotional responses to science and mathematics activities.
– Dialog and collaboration: Accepting that dialogic engagement is inherent in everyday creativity linked activities in the classroom, while play has a crucial role in learning in science and mathematics. Play is a critical feature of IBSE and CA, enabling children to externalize, share, and develop their thinking.
– Problem solving and agency: Recognizing that a scaffolded learning environment can provide children with shared, meaningful, physical experiences and opportunities to develop their own questions and ideas about scientifically relevant concepts.
– Questioning and curiosity: These are central to IBSE and CA, recognizing that creative teachers often employ open-ended questions and promote speculation by modeling children's curiosity.
– Reflection and reasoning: Emphasizing the importance of meta-cognitive processes, reflective awareness, and deliberate control of cognitive activities, which may be still incipient for young children, but which have to be incorporated into early-years practice of scientific and mathematical learning in the IBSE framework.
– Teacher scaffolding and involvement: Emphasizing the importance of teachers' mediating the learning process to meet the child's needs rather than being under pressure to fulfill the requirements of a given curriculum.

Creativity is a process that can be developed and enhanced. Every person has a "dormant" potential, and therefore this potential should be discovered and enhanced by giving individuals the opportunity to "activate" their creativity. Young children are obviously curious and have an interest in testing their ideas. New findings are often emotionally fostered. However, young children need a scaffolding. Teachers have the responsibility to conceptualize and promote questions in order to encourage children to make discoveries on their own (Havu-Nuutinen, 2005). Hence, increasing teachers' competences and awareness of approaches that foster children's creativity in subject-related contexts is essential.

THE ROLE OF IBSE AND CREATIVITY IN EARLY-YEARS SCIENCE TEACHING

Although IBSE was widely launched as a leading and promising approach in science education, it is not being systematically used in classrooms. In secondary school or in higher education, science teachers use laboratory work more often than elementary or pre-school teachers, but even this does not cover the requirements for IBSE (IAP, 2010). Teachers without a strong background or subject knowledge often lack confidence in teaching science using the inquiry-based approach, and they tend to approach science teaching on their own terms and based on their own understanding (Tatar, 2012, p. 260; Webb & Rule, 2012, p. 379).

It also seems that hands-on activities are more common than IBSE in early years because the focus is on process skills development and discovery-associated learning. Through concrete explorations, which are natural to children, they start to find connections between scientific concepts and their everyday activities. Experimental explorations are often seen as a way to motivate young children (Kramer & Rabe-Kleberg, 2011). Discovery learning and hands-on activities are sometimes described synonymously in practice, causing confusion and challenging the researcher to identify practical implementations in IBSE. Generally, early-years science education rarely follows the procedure found in scientific research, and, in this context, no research design is used. In addition, early-years activities lack tasks encouraging children to develop their scientific reasoning and understanding. Kallery, Psillos, and Tselfes (2009, p. 1187) reported that the didactical activities they investigated in relation to early-years science education did not promote scientific understanding because of their occurrence at the representative level. This means that the activities mainly addressed the qualitative descriptions, and no links between evidence and theoretical aspects of phenomena were present in the instruction. However, IBSE seems to be effective for young learners when benefiting from appropriate teacher's scaffolding. For example, experiments that are supported with collaborative discourses could provide significant opportunities for understanding complex scientific phenomena. A strong social component is embedded in these processes (Siry, Ziegler, & Max, 2012; Fleer, 2013).

One of the common challenges faced in early-years science education is teachers' competence in setting up opportunities to conduct IBSE and CA. Many pre-school teachers have superficial training in the methods used to integrate science teaching into their classrooms activities, and they may also lack adequate scientific subject knowledge to support children's learning (Moomav, 2012, p. 58). Early-years teachers' education addresses science education quite cursory, which naturally leads to their reticence in teaching science. Inquiry-based science teaching should be integrated into pre-service teacher education curricula, where the basis for future classroom practice is created.

Teachers' educational practice is strongly affected by their educational beliefs and knowledge of child development (Einarsdottir, 2003), as well as their own values (Craft, Cremin, Burnard, & Chappel, 2007). This means that teachers who fail to understand the significance of science education in child development are not prepared for using an inquiry-based approach. According to Westman and Bergmark (2013), pre-school teachers value scientific exploration, but they seem to emphasize the more esthetic and social aspects of learning.

Similarly, teachers are aware of and recognize the importance of creativity, but they do not know how to nurture it (Webb & Rule, 2012). Often, there is no opportunity or explicit need to conduct creativity lessons, and so it becomes crucial to find the most appropriate ways to develop CA and merge it with IBSE in teachers' pedagogy. According to Webb and Rule (2012), creative approaches are challenging for young children because they are unfamiliar with them, but, in the end, such alternative approaches to science teaching produce more enjoyable and better outcomes.

Regarding the findings recently reported in the literature, we can say that science researchers perceive IBSE as highly conceptual and procedural, while teachers have a practical approach to IBSE based on collaborative explorations that provide time for communication and sharing of ideas. However, both methods together set up a frame that refers to the creative approach, in which problem solving, agency, and engagement have a crucial role to play. Creative science learning involves communication and emotional features, in addition to requiring innovative conceptual constructions. To conduct creative teaching in the classroom, these dimensions should be nurtured and supported (Daud et al., 2012). Teaching, especially creative teaching, is also perceived as a process in which cultural artifacts play a significant role.

IBSE and CA are highly recommended and supported by several European Union-funded projects as methods highlighting and reinforcing the skills recognized to be significant in the future world we are building (see Sporea & Sporea, 2014). Research published widely across Europe has identified existing challenges in local practices (Pell, Galton, Steward, Page, & Hargreaves, 2007). The remainder of this chapter discusses the use of IBSE and CA in Finland and Romania, at the pre-school and elementary school levels. It tries to identify the challenges confronting these countries in science education (Kärnä, 2012; Ciascai & Haiduc, 2009). However, the major contribution of this discussion is to provide detailed information on the early-years context, as most published research focuses on the later years of schooling.

COMPULSORY EDUCATION AND TEACHER EDUCATION IN FINLAND AND ROMANIA

Early childhood education and compulsory education have some differences in the Finnish and Romanian educational systems. In Finland, pre-school is a compulsory school year before comprehensive school, while in the Romanian educational system, pre-school refers to early education from the age of three to the age of six. In both countries, similar laws have been adopted, and obligatory education starts in both at the age of six. In Finland, this means a part-time pre-school approach, while in Romania, it means full-time compulsory education (MECTS, 2011). A Finnish child usually starts comprehensive school at the age of seven and a Romanian child starts it at the age of six. In both countries, compulsory education spreads over the elementary education and lower-secondary education levels, taking ten years.

There are also some differences in school practices. In Romania, at pre-school level, group size counts for up to fifteen children, but no fewer than ten and no more than twenty, while for elementary school, the mean number of children is twenty. However, a class cannot be organized with fewer than twelve students or more than twenty-four students (ibid.). Only one teacher is responsible for each group of children. In Finland, the government does not regulate the group sizes in this manner, but rather according to a law (see OAJ, 2015). One professional adult is needed for four under three-year-old children. In pre-school, one competent teacher is required for twenty-one children. Generally, pre-school groups consist of six to twenty children. In elementary school, the teacher is responsible for his or her class, which may have a maximum of thirty-two students. Assistant teachers are temporarily used in subjects like arts and crafts.

The major differences between the two countries occur in teacher evaluation. In Romania, teachers are evaluated using the following methods: (a) self-evaluation; (b) peer evaluation; and (c) evaluation by the administrative council, based on certain files that must be submitted and an interview (MECI, 2009). Direct evaluation of teachers is done for classroom activities and extracurricular activities using questionnaires and/or interviews with students, parents, and other interested parties. These results are correlated with an analysis of teacher activities' outcomes such as publications, books, guides, students' notebooks, and practical material. Teachers attending courses devoted to special training programs receive recognition based on their portfolio and practical work. Indirect evaluation of teachers is done during national tests for students when teachers' qualifications and results are assessed (ibid.). In Finland, teachers are not evaluated according to any specific national standards. Students' achievements and outcomes are made publicly available and presented over the year in public ceremonies and festivals, but this is not done in terms of any evaluation. All school activities are public and any one can follow teachers' and students' work over the school year. Teachers are responsible for informing the parents about their schoolwork and assignments. They conduct discussions with parents and other educational professionals if they have difficulties achieving their planned goals with their students, or if special education is needed. Again, these processes aim to support students' learning, not to evaluate teachers. Finland has no national tests, tlineschool ranking lists, or inspection systems.

Teachers in both countries receive their training at a university. In Romania, graduates of "educational sciences" are certified at the bachelor's level. Students gain a diploma after they attend specific courses, some of them compulsory and others optional (Bîrzea et al., 2006; MECTS, 2011). In both countries, minor studies focus on science education, while major studies focus on educational sciences. The Finnish government regulates the norms and qualifications necessary for students to participate in teacher education, but a national teacher training curriculum does not exist in Finland and the content of teacher education is determined by each university. In Romania, teacher education is governmentally regulated.

Despite the differences in educational systems, both countries have actively analyzed the impact of national education and followed the international discussion about the role of creativity and inquiry-based science education. Both countries confirm the existence of similar challenges in science education and aim to strengthen the educational outcomes. As members of the European Union, even though we come from different cultural backgrounds, we have "embarked on the same boat."

We thus consider this comparison between Romania and Finland to be of interest to the international educational community as a comparative study of the ways in which IBSE and CA merge with each other within different educational systems.

This chapter reviews Finnish and Romanian teachers' conceptualizations and practices in respect to inquiry-based science education and the role played by creativity in this context. More specifically, it analyzes how teachers conceptualize their aims, approaches, and pedagogy from the viewpoint of inquiry and how they determine the role of creativity in these settings. Finally, it compares teachers' conceptualizations with the actual classroom practices observed for some selected participants.

RESEARCH METHODOLOGY

The data for both countries were collected as part of the CLS project during 2012 and 2013. The data collection occurred in two phases employing quantitative and qualitative approaches. Teacher survey was used to understand teachers' conceptualizations and classroom experiences with regard to IBSE and CA. The survey focused on teachers' approaches in early-years science teaching, in learning and assessment, and on the role, if any, creativity plays in these instances.

Teachers' classroom practices were examined from the following three perspectives: (a) aims, purposes, and priorities; (b) teaching, learning, and assessment; and (c) contextual factors. This chapter focuses, in a comparative manner, on aims and purposes, teaching and learning approaches, and pedagogical methodologies, to determine the manifestation of inquiry-based science education and creativity in teachers' conceptualizations and in practice in Romania and Finland.

Apart from the teachers' survey, a fieldwork study examined the ways in which the approaches used by teachers foster children's interest and motivation in science learning. For the fieldwork, the observation protocol and instruments employed were developed by the project consortium and were completely reported in the project deliverables (CLS, 2013a; 2013b).

In both Finland and Romania, the core instruments for the fieldwork and data collection were as follows: field notes, videotapes, digital photos, teacher interviews, a map of the classroom or the learning area, and children's artifacts such as drawings. In addition to these, there were supplemental instruments such as planning sheets, local curricula, evaluation sheets, and learning material created and/or published by the teachers involved in the research, teacher journals, Fibonacci style tools to support diagnostic observation, Involvement Scale, Reggio style documentation, and conceptual drawing. Furthermore, the Finnish team collected some additional data through group interview with children and learning walks. These tools were not used in the Romanian research.

In both countries, the teacher survey was conducted during May 2012 using the electronic survey tool Survey Monkey. The project questionnaires, translated into the local language, were sent to selected teachers, and adequate response rates were achieved. In Finland, the questionnaires were sent to randomly selected 400 pre-school and elementary school teachers, while in Romania, the teachers were reached through national associations, professional networks, or researchers' e-mail contacts, in order to reach a large audience, spread across the country.

All the participants were certified teachers having high expertise; more than half of the teachers had over ten years' working experience. Nearly sixty percent of the Finnish teachers and thirty percent of the Romanian teachers had a master's degree.

The fieldwork data consisted of six teacher cases from each country. These six cases represented different scenarios, including teachers from pre-schools and from the first and second grades of elementary schools. The teachers' distribution in the two countries is presented in Table 2.

Table 2. Distribution of Participants from the Two Countries

Country	Pre-School Teachers		Elementary School Teachers		Total	
	Survey	Fieldwork Observation	Survey	Fieldwork Observation	Survey	Fieldwork Observation
Romania	101	3	140	3	240	6
Finland	13	3	57	3	70	6

Survey data were analyzed quantitatively using descriptive statistics to map frequencies of conceptualizations for the different topics under discussion. Histograms were used to compare the data.

The recordings of field study were transcripts aiming to create narrative episodes of each teaching sessions. A narrative episode was defined as a written narrative account that described an observed event or series of connected events of science teaching/learning with a focus on IBSE and creativity. Each narrative episode formed a coherent story by itself. These episodes were used to analyze the observations for their relevance to the research questions and the factors of analysis.

This chapter presents and discusses the outcomes of these two sets of data in relation to the research tasks focused on in this study. It presents here the summary of two different sets of data, in Finland and Romania, based on the national reports the authors have created for the project deliverables. Within this context, the focus is on a parallel comparison of teachers' conceptualizations and observed practices with respect to inquiry approaches and the role of creativity in the aforementioned context.

When assessing the subsequent findings and when drawing conclusions from this work, the following limitations need to be considered: the survey was not conducted during an appropriate time in the school year and thus only a small sample of teachers responded to the questionnaires in Finland. The field study covered only a limited number of schools and timescale of the school year (i.e., during the wintertime classes). There might be several other activities and drivers, not captured in the study, used by early-years teachers in their science education practice, in both countries.

INQUIRY APPROACHES TO TEACHING AND LEARNING IN SCIENCE EDUCATION AND THE ROLE OF CREATIVITY

Aims and Priorities in Science Teaching

Learning goals today are broadly aimed at inquiry-based learning, in which social factors are merged with teachers' conceptualizations. In both countries, teachers aim to create opportunities for collaboration among children and to develop children's positive attitude toward science. Over eighty percent of surveyed teachers see collaboration as the driving force to achieve the expected outcome in science learning. Science education is clearly seen as having the potential for engaging children's social skills, including communication skills such as asking questions about objects, organisms, and events in the surrounding environment and trying to formulate evidence-based answers to these questions. Therefore, the socio-pedagogical approach becomes the philosophical background for teachers' conceptualizations in regard to the aims and objectives of science teaching.

The other clearly identified goal in science teaching is the development of children's attitudes, as indicated by most of the Finnish and more than half of the Romanian teachers. Positive attitudes toward science learning or learning in general are highly ranked as an outcome of the educational process. When interviewed, teachers indicated that interest and motivation are essential parts of early-years science education, with emphasis placed on creating knowledgeable citizens. This proved to be of major interest, as several studies have indicated that students' attitudes toward science learning during later school years tend to become less favorable, so more focus should be placed on these issues during early-years education.

Cognitive outcomes are seen in both countries to be similarly significant, but they are not a priority. Almost all teachers showed an interest in promoting children's understanding of scientific ideas and concepts. Scientific processes were fostered by sixty-five percent of the teachers in Finland, and by seventy-seven percent of the Romanian teachers. According to established practice, teachers understood their responsibility to encourage children's conceptual and procedural learning. However, there was more variation in terms of fostering scientific inquiry skills such as understanding scientific investigations and the way scientists work. Only one third or less of the Finnish teachers often or very often foster these learning outcomes, while seventy percent of teachers in Romania are preoccupied by this aspect. Finnish teachers tend to focus on scientific procedural learning by enhancing process skills. Romanian teachers set targets on outcomes with an impact toward formulating questions and understanding scientific processes.

In both countries, teachers do not show the ability to encourage children to conduct scientific investigations and do not place enough emphasis on describing issues related to the ways scientists perform such investigations in a manner enabling others to repeat the process.

Conceptualized and Practiced Teaching and Learning Approaches

Teachers report in the survey on the use of teaching activities that facilitate children's process skills development, such as observing and describing their immediate surroundings, and that support children comments about their observations. Teachers also regularly focus on questioning, both those addressed to students and the ones promoted by their teacher students during investigative work. Based on teachers' conceptualizations, the foundation for an inquiry approach is created in early-years science education, as is shown by the survey responses in both countries. The skills needed for explorations leading to enhanced knowledge and to an understanding of the natural and man-made world through direct interaction are supported through the collection of data to be used as evidence in formulating explanations of phenomena and events (Harlen, 2013). However, early-years teacher do not always assign sufficient time to concrete experiments as required by a true inquiry-based approach. Teachers in both countries have different options in planning and conducting investigations. In Romania, the inquiry-based approach is practiced through investigative means more often than in Finland. Table 3 presents the science teaching activities that are focused on often or very often for the majority of teachers. More than seventy percent of teachers in Romania teach the essential skills for scientific investigation. Finnish teachers focus on interactive approaches with a corresponding lack of focus on data collection and designs of studies.

Divergent tendencies are also visible in teachers' conceptualizations about the role of creativity in teaching activities. Finnish teachers report observing, describing, and communicating activities to be the most creative approaches. They put less emphasis on investigative approaches such as planning and conducting investigations; however, this study indicated a potential for creativity-focused methods. Romanian teachers encourage investigative approaches and processes in which children have the opportunity to create their own projects.

In this respect, teachers' conceptualizations, with some exceptions, became evident in the analysis of case narratives. In both countries, teachers fostered process skills, but in some cases, Romanian teachers went further in regard to developing inquiry skills, such as group work or communication. In Finland, observations or classifications of objects or phenomena are seen as sufficient for science teaching, while explorations are rarely used for reasoning or additional problem-solving development. Observations are systematically recorded and sometimes elaborated with teacher support, as indicated in the following:

Table 3. The Order of Science Teaching Activities as Perceived by the Majority of Teachers That are Focused on Often or Very Often

Activities in Romania	Activities in Finland
– Observing natural phenomena, such as the weather or a plant growing, and describing what is seen	– Observing natural phenomena, such as the weather or a plant growing, and describing what is seen
– Asking questions about objects, organisms, and events in the environment	– Asking questions about objects, organisms, and events in the environment
– Communicating the results of investigations and explanations	– Communicating the results of investigations and explanations
– Employing simple equipment and tools to gather data as an extension of the senses	– Using data to construct reasonable explanations
– Designing or planning simple investigations or projects	
– Conducting simple investigations or projects	

In this learning activity, the children study snow and the natural states of water. Here they had a problem-based activity: what happens when snow is heated? Children collected snow using various measures, and in doing this they also learned measurement units (e.g., 1 liter, 0.5 liter, and 3 deciliters). Because a camping cooker was used to heat the snow, the activity was partly in form of a demonstration. The teacher was strongly involved in the activity and asked questions about the phenomena involved.
Teacher: What do you think, how much water will we collect when the snow has melted?
Children: More. ... Less.
Teacher: What can you see here? [pointing to the steam]
Children: Steam.
The teacher pours water back into the dish.
Teacher: What do you think now: is there more or less water than when it was snow?
Children: Less.
Teacher: Could you tell me how much there is, approximately?
Children: There are three liters. ... There is half a liter. ... There is one liter.
After discussion, they agree that there's about a half liter of water.
Teacher: How much snow did we have?
Children: One liter.
Teacher: So when water is in the liquid form, it takes up less space than when it is snow.
(Mary, Case 1, Finland)

In the above example, the teacher guided the learning process by organizing an experiment. They were faced with a problem to be solved through the activity ("What happens when snow is heated?"), and together they tried to find an answer to this problem. In this way, the children were highly engaged in the activity. The results of the experiment were individually reported by making drawings, but they were elaborated and reflected on with the teacher's assistance. This example also proves children's minor role as investigators. The children were not encouraged to collect more data, to prove evidence, or to justify their observations.

However, teachers place emphasis on the creative potential of investigations. To exemplify, the investigations were ranked as the third most creative approach in science education by nearly half of Finnish teachers. Additionally, over half of Romanian teachers were interested in conducting investigations, designing and planning investigations, and asking questions. Observation and communication were most often valued by Finnish teachers, while using data to construct reasonable explanations or to employ simple equipment and tools to gather data, was perceived as potentially creative only by one third of them. Table 4 presents the most creative approaches as ranked by the teachers.

Table 4. The Most Creative Approaches in Science Education as Selected by Teachers

Approaches as Ranked by Romanian Teachers	Approaches as Ranked by Finnish Teachers
– Conducting simple investigations or projects	– Communicating the results of investigations and explanations
– Designing or planning simple investigations or projects	– Observing natural phenomena, such as the weather or a plant growing, and to describing what is seen
– Asking questions about objects, organisms, and events in the environment	– Asking questions about objects, organisms, and events in the environment

Communication and observational activities were used in very creative ways in Finnish case studies, in outdoor contexts, which were selected as authentic learning environments for the development of process skills. Finnish teachers often took children outdoors during severe winter weather, and data were collected in these conditions. The outdoor context offered each child the opportunity to gather information from the surrounding environment and to find creative solutions to problems proposed by the teacher.

Learning activities are strongly focused on cognitive dimensions such as gathering evidence and making connections in various contexts. The activities were carried out in both large and small group settings in which the teacher played the role of a facilitator by asking questions. The teacher presented a problem or task (e.g., "Try to find a plant that is smaller than yourself.") and scaffolded children by providing necessary instruments and posing supportive questions.

Teacher: What have we done every time we've been here?
Child: Measure things.
Teacher: What have we measured?
Children: Ice. ... Water. ... The temperature of water.
Teacher: What else have we done every time since August? ... We have done this before, in August.
The teacher says that they are going to find something smaller and something taller than the students, and that for this purpose they are going to use measuring sticks.
Teacher: Now look for something smaller than yourself. ... Think just to yourself, don't follow anyone else.
Teacher: What did you find? ... What could that be?
Teacher: Look for something bigger than yourself.
Child: I found a pine tree, it's bigger than me.
Teacher: Which tree is it?
Teacher: Can you find something with the same height? ... This is one meter.
The teacher gives measuring sticks to everyone.
In the second phase of the learning activity, the children measure the temperature of snow.
Teacher: What's the figure you are reading? ... Is there a minus or a plus sign?
Teacher tells the children to put the thermometer above the snow.
Teacher: What happens now? ... Is it warmer under or above the snow?
Child: Above.
Teacher: When there are minus degrees, the bigger the number, the colder it is.
(Kirsten, Case 3, Finland)

In practice, Romanian teachers undoubtedly rely on experiments. In most of the narratives included in the CLS reports, small-scale experiments are presented in which the children have high agency and enough space to express their own ideas and thoughts. However, in many cases, the experiments are strongly guided and modeled by teachers, so few opportunities for creative and flexible approaches to solve problems are left to students.

Teachers believe that they are incorporating different forms of inquiry approaches in their teaching (see Table 5). A similar tendency seems to be valid for both countries; teachers most frequently follow open or guided inquiry with young children. The method varies depending on the nature of the task to be fulfilled. Finnish teachers mostly apply a guided approach to find evidence, to connect ideas to scientific concepts, or to reflect on the results. On the other hand, the social dimension of learning activities (i.e., explaining and communicating) more usually follows open inquiry. Romanian teachers highlighted similar approaches in their answers, but they were more predisposed toward an open approach. The conclusion can be drawn that in Romanian classrooms, children have more options for their ideas and thoughts.

The study findings in the observed cases indicate that several features of the guided inquiry approaches were identified. The observed activities included the characteristics and contexts of inquiry approaches; however, several major requirements such as (a) experiment design, (b) hypothesis formulation, or (c) reasoning were lacking. The experiments were child centered and had a great

Table 5. Inquiry Approaches Used by Teachers in the Classroom

Aspect	Country	Open	Guided	Structured	N/A
Question: Children investigate scientifically oriented questions.	Finland Romania	22% 42%	47% 42%	30% 15%	1% 1%
Evidence: Children give priority to evidence.	Finland Romania	22% 24%	65% 53%	13% 21%	 2%
Analyze: Children analyze evidence.	Finland Romania	16% 25%	61% 47%	22% 26%	1% 2%
Explain: Children formulate explanations based on evidence.	Finland Romania	73% 43%	22% 36%	4% 19%	1% 2%
Connect: Children connect explanations to scientific knowledge.	Finland Romania	15% 30%	67% 55%	10% 14%	8% 1%
Communicate: Children communicate and justify explanations.	Finland Romania	50% 21%	45% 53%	3% 19%	2% 7%
Reflect: Children reflect on the inquiry process and their learning.	Finland Romania	21% 31%	53% 46%	19% 20%	7% 3%

potential for inquiry, but unfortunately, strong evidence of the teacher's engagement was often present. There was still room to formulate children's initial thoughts and their solutions in framed contexts, as textbook-defined inquiries were seldom used. Note the following floating and sinking experiment in Romania:

> Maria introduced children to the story of the dove that is expected to save an ant from drowning in a river. She has a list on the whiteboard of possible materials to be used as materials that float. She suggests that the students run an investigation in order to identify the best idea to solve the problem. Children are given small containers of water in order to verify what materials existing in the forest can be used as little "boats" for the ant: nuts, feathers, wooden sticks, leaves, pebbles, acorns, pieces of bark, fir cones, etc. Maria asks every group to come to the front table and to take the materials they think to be most suitable for the task to save the ant. Children have to evaluate *a priori* what objects float. (Maria, Case 1, Romania)

Finnish teachers seemed to prefer guided inquiry activities in which children followed the teacher's designed experiment. Often, the experiments had some exceptional feature to make work more exciting. When interviewed, teachers argued that the IBSE approaches are appropriate to increase children's willingness and curiosity to explore scientific phenomena.

> Children had their own volcanoes and they all stood close to the table. The teacher provided a working sheet that was intended for making predictions: which ingredients, when mixed together, make a volcano erupt? Before each experiment, children marked down their prediction and after it, they marked down the results. Children measure the sugar content into the volcano mixture, and the teacher gives them the vinegar, allowing them to smell it.
> Children: Terrible smell!
> Teacher: Who knows how much vinegar is in this dish?
> Children: 600 liters. ... One liter. ... Half a liter.
> Teacher: The size of a milk bottle is one liter. Is this the same size?
> Children: No.
> Teacher: This is one deciliter and you can put ten of them in one milk bottle.
> Teacher: Many of you predicted that the volcano is going to boil over with these ingredients. Let's see what happens.
> Teacher: When you have poured the vinegar into the volcano, you should move back. Please, now you can start.
> Children pour the vinegar and move back looking excited.
> Children: No, nothing is happening.
> Teacher: OK, please come and mark your result on the work sheet.
> Nothing happens and the children mark the outcome onto the work sheet. Then they pour the sugar and vinegar away and mark down the second prediction.
> Child: I knew it!
> Children measure the salt into the volcanoes, and the teacher gives them the vinegar.
> Teacher: How did we work in the first case?
> Child: You will give us permission and then we will pour carefully.
> Teacher: Yes! And then?
> Child: We step backwards.
> The teacher asks the children how they should work with the ingredients and then gives permission for them to pour the vinegar.
> Children: Nothing!
> Nothing happens, and the children once again mark the outcome on the paper form. Next, they mark the predictions for the last pair of ingredients (baking soda and vinegar). Children measure the baking soda into the volcano mixture, and the teacher gives them the vinegar, asking them to move the volcanoes to the middle of the table. The children pour the vinegar, looking happy and excited when the volcano boils over. The children laugh.
> Teacher: Did you manage?
> Children: Yes.
> Child: My volcano can erupt once again!
> Children mark the outcome on the work sheet.
> One child wonders why the liquid on the table is violet and is told that the color is from the paint on the volcano.
> (Rita, Case 2, Finland)

Although the teacher involvement was recorded as high, the children seemed to have the opportunity to learn the basic methods of gathering data and reporting their findings. The experiment provided the initial experience for the children to engage in scientific inquiry and to use different data collection methods to solve the problems they are facing.

In conclusion, teachers' conceptualizations emphasize IBSE education more than can be observed in their actual practice. The approaches teachers use are often experimental and support young children's abilities to learn, but teachers' engagement and preparation play a crucial role as well. Learning approaches foster social skills such as communication, which in one sense supports conceptual learning at the same time. To reflect the characteristics of IBSE, teachers place less emphasis on the role of investigation in children's initiative experiences or knowledge, and they design investigation activities together with children. In addition, the role of higher order thinking skills, such as criticism or optional opinions, is rarely addressed.

Pedagogical Approaches: How Does the Teacher Facilitate Learning?

The pedagogical approaches used by teachers incorporate several methods to facilitate learning. According to the survey, nearly all early-years science teachers try to build their teaching on children's prior experiences. Teachers reinforce the idea of family, and the environment in which the child grows up shapes his or her role as a future citizen. In addition, teaching is related to everyday life and is often considered to be interdisciplinary. For example, in one case study, the teacher Maria started the demo session based on students' previous knowledge and experiences from everyday life. Maria interrogated them about the characteristics of water:

> Teacher: What are the characteristics of water we learned about based on the experiments we conducted in the last lessons?
> Child 1: Water is a liquid.
> Child 2: Which flows.
> Teacher: What are the properties of liquids?
> Child 3: They have no form.
> Teacher: What forms do liquids have?
> Child 4: The form of the glass.
> Teacher: Anything else about water?
> Child 2: Water has no smell.
> Teacher: Clean water has no smell.
> Child 5: Water has no color.
> Child 6: Water does not poison you and has no acid.
> (Maria, Case 1, Romania)

As the teachers indicated in the survey, problem-based learning seems to be an approach that is often used. Teachers have the clear intention to develop children's problem-solving skills through small-scale experiments. Problems are related to children's immediate living environments, to particular science concepts, or to phenomena such as sinking and floating, water characteristics, colors, and the like.

Imagination is fostered by almost all teachers. Play and exploration are systematically used in science teaching, but it seems that free pretend play is not used in Finnish school learning. In Romania, on the other hand, it is widespread and more than eighty percent of teachers use it often. However, drama is not so often applied in science education contexts. As mentioned earlier, social approaches such as collaboration and dialog are used by more than seventy percent of Romanian teachers.

The following narrative episode refers to the Romanian teacher Maria, who is teaching about floating and sinking. This is an example of how imagination is used to engage children in a scientific context:

> Maria asks children what a forest is and what kind of trees can be found in a forest. There is a permanent dialog with children, who respond to the teacher's questions. The little ant is looking for food. During what seasons do ants gather food? All the children are engaged in the dialog, and they are asked if they agree with the answers. The ant arrived near the creek and dropped into water. A dove flying around saw what happened and came to help the ant. When telling the story, Maria shows children some drawings representing the ant and the dove. She speaks slowly, pronouncing all the words very clearly, both in Romanian and in English. The children are asked to describe and then compare the two characters. How can the dove help the ant?
> Teacher: What do you think the dove could have done to save the ant?
> Child 1: It could take the ant with its beak.
> Child 2: That would not work; the dove's beak is too strong.
> Teacher: Then the dove looked around to find something to help the ant out of the water. I wouldn't tell you what it found. I shall leave you to guess what it used. You have to discover what the object is that the dove used.
> Child 3: Let me tell you. I know what it is about. The dove helped the ant with its feet. With its paws.
> Teacher: Let's pay attention. Where was the ant? Where was its mound located?
> Child 4: At the edge of the forest.
> (Maria, Case 1, Romania)

Reviewing the rest of the narrative episodes, we can see that the stories or imaginative contexts were used as an introduction for the science explorations. The stories work as training aids when unknown scientific concepts or phenomena are introduced. On the other hand, stories or imaginative settings are invoked in the experiment, and by playing a game, children learned to solve problems.

Although the teachers who were surveyed emphasized the role of investigations as creativity potential, their pedagogy did not include it in carrying out investigations. Their teaching approaches show only a few signs that their longitudinal research projects have the design of a scientific investigation. In addition, ICT tools are not used systematically, and only one third of the teachers mentioned using them often. In the case studies analyzed, nearly all schools and kindergartens had access to several ICT tools such as interactive whiteboards, PCs with appropriate peripherals, and the Internet. It was recognized that available devices were not used in an effective way, despite the fact that these were present in school resources.

According to the rankings given by Finnish teachers, the most creative teaching methods are physical exploration and outdoor activities, while Romanian teachers emphasized the importance of integration with other subjects. Play and imaginative activities were seen as fostering children's creativity in both countries as well as in widely used case studies. Although the stories and fairy tales were not ranked as leading creative teaching methods, they were systematically used by teachers in practice to capture children's attention and interest. Learning activities were often tied up with imaginative figures or contexts to increase children's engagement and motivation. However, Finnish elementary school teachers do not explore the potential of the imagination as much as their pre-school Finnish colleagues, and elementary or pre-school Romanian teachers.

Using history in science teaching is not seen as an element that develops creativity in early-years science. The teachers used approaches that showed no signs of historical elements being used and thus they ranked this practice very low. In addition, field trips or visits were not seen as very creative, although these were included in instruction.

Teachers' reflections about their role in the learning process used by children illustrate their pedagogical thoughts about IBSE. Teaching is seen as a problem-based activity, where ready-made answers have a minimum role. In both countries, teachers perceive their role in inquiry approaches as facilitators, and children's own inquiry supported by the teacher is considered to be significant. Teachers also recognize that children need to have enough time for their own explorations, and most of them aim to avoid explicit instruction. These conclusions prove that teachers in both countries know the value of supporting children's own work and efforts in seeking solutions to scientific questions, and they do not aim to impose their opinions on children. Most of them seem to realize that children need more time to spend on their personal investigations.

As highlighted earlier, this practice does not fit teachers' conceptualization in inquiry-based learning. As facilitators, teachers play the role of leaders, and in nearly all observed cases, the experiments are pre-prepared by teachers. There is no room for improvisation according to children's ideas or suggestions. The activities were planned to be conducted as child centered, but not child initiated.

Similar to learning approaches, the most creative teaching approaches are related to investigation and problem solving. In addition, child-initiated investigations are seen as mostly creative. Imaginative teaching approaches are valued by Romanian teachers, while problem finding is valued by Finnish teachers. The comparison of ranked approaches in both countries is presented in Table 6.

The children's own ideas and imagination came out in the cases studied. These creative episodes often follow open inquiry and are more flexible in relation to children's own decision-making processes. The following episode is an example of an extracurricular activity in which the interdisciplinary context emerges clearly. The

Table 6. Teaching Approaches That Most Likely Contribute to the Development of Children's Creativity

Approaches as Ranked by Romanian Teachers	Approaches as Ranked by Finnish Teachers
– Fostering imagination	– Encouraging problem finding
– Encouraging children to try out their own ideas in investigations	– Encouraging children to try out their own ideas in investigations
– Encouraging problem finding	– Relating science to everyday life

session was designed for informal science learning as an experiment in which the number of various materials was mixed with play.

> The lesson starts as children are invited to watch an animated movie about the squirrel Scrat, kept prisoner on a sea shore, having its supply of acorns inside ice cubes. In order to survive it has to take out the acorn from the ice. At this point, the movie stops and the teacher introduce a challenge in order to catch the students' attention and induce an emotional state. She writes an encrypted message on the whiteboard, in which a string of numbers has to be replaced by letters, according to a provided legend in order to decrypt the message. Children receive worksheets to use for this task and they are asked to discover the hidden message. The message decrypted, reads in English, "HELP SCRAT." It is actually a brief version of the topic of the problem to be solved by the children. This intervention, as an interdisciplinary approach, is a mixture of English language literacy and mathematics. Group work is the key to discovering the answer to the encrypted message. It is expected that the investigations will run based on children's previous life experience and knowledge. (Stela, Case 2, Romania)

Collaboration or using questioning count for less than one fourth in fostering creativity, but these approaches were reported as often being used as learning methods. In addition, only about a fifth of the teachers believed that "building on children's prior experiences" contributes substantially to creativity development in relation to science learning. Prior experiences were used frequently as a teaching method in both countries.

Problem finding and solving episodes were more often present in Romanian teachers' teaching plans than in Finnish classroom practice. The major difference between the teachers was noted with perceptions relating to experimental short-scale explorations or experiments. In Romanian classrooms, children are actively engaged in conducting problem-solving activities, and this expresses their high agency in the activities.

> Stela asks students to formulate the task to be performed clearly. Children are invited to work in teams and to offer some solution to help the squirrel to reach its food. A bowl of ice cubes, each with an acorn inside, is distributed to each table. Stela explains

> the tasks both in Romanian and in English. Each group starts looking for a solution by formulating an experiment. Various items that can be used in the experiment (teaspoons, salt, sugar, a small hammer, plastics containers, hot water, worksheets) are displayed on a table in front of the class. (Stela, Case 2, Romania)

In general, the teachers' pedagogical skills and understanding of child development are seen to show genuine competence. The teachers also seem to have the clear aim of using inquiry, which they value. However, the practice needs more elaboration if it is to fulfill the requirements for IBSE implementation. More potential exists for conducting IBSE classes with young children. Creative approaches in science teaching have also proved to have synergies with IBSE, but the issue of how creativity is developed through IBSE is not evident in practice.

CONCLUSION

Major Similarities and Differences between the Countries

As stated in the introduction, twenty-first century skills such as problem solving, creativity, collaboration, and ICT literacy have been found to make a significant contribution to science education. These skills should play a key role in early-years education and provide a basis for a spiral learning process in later years. This chapter has discussed and compared Finnish and Romanian teachers' conceptualizations and practices with regard to IBSE and analyzed the role of CAs in these settings.

In both Romania and Finland, teachers emphasize cognitive and social factors of learning, considering both conceptual and procedural skills. Most teachers who contributed to the project valued the common attributes of inquiry-based science teaching and, in theory at least, seemed to accept the significant role played by IBSE in early-years education.

However, Finnish teachers do not systematically target inquiry skills in the educational process, but rather pay attention to cognitive and social process skills such as observation and communication skills. Romanian teachers, in contrast, lay greater emphasis on developing investigative skills.

Reflecting on their conceptualizations on the scope of scientific approaches and methods, teachers use several attributes of scientific inquiry such as formulating questions, promoting problem solving, and debating the results, but not always based on evidence. Despite the fact that several teachers declared during the interviews that they were familiar with scientific inquiry and problem-based teaching, it seems that they lacked a full understanding of the concepts involved and failed to implement them in practical classroom work. Their approaches, in most cases, do not include the planning or the design phase. Neither identifying evidence, nor post process reflection is always included in the learning processes. If scientific phenomena are to be understood they need to be considered in terms of existing evidence in a set context. Considering these aspects from several viewpoints supports children's abilities to develop understanding of concepts in later years.

There seem to be more opportunities to apply scientific inquiry for teaching and learning than teachers use. There may be several reasons for a lack of fully finished approaches, but there is proof that educational systems do not include well-defined training programs for teachers on these issues in either country. As Yager and Akcay (2014) argued, most science educators use the term, but many lack an understanding of what "science inquiry" is, of what it looks like in the classroom, and of the specific changes it requires in terms of instruction and an organizer for the curriculum. Teachers use several synergies of IBSE and CA (see CLS, 2012, pp. 63–64), but the rational of their conceptualizations and practice is clearly not evident to them. It seems that creativity is not clearly and constantly embedded into their pedagogy.

A comparison of the two countries reveals major differences in the implementation of inquiry. As teachers conceptualize their aims, Finnish teachers often concentrate on using process skills, while Romanian teachers scaffold children in problem-solving situations, in which reasoning and decision making are involved. Finnish teachers conceptualize the issues, their practices being focused on the description and the comparison of emergent findings, with few signs of reasoning or searching for evidence. Romanian teachers emphasize the investigative approaches more than their Finnish counterparts do, and their practice includes some characteristics of investigations. These differences can be found in their practice as well. Romanian children have the opportunity to conduct investigations using different methods as well as to compare the results they obtain.

Most of the teachers addressed the frequency with which they used guided or open inquiry approaches. Several activities had more features of a guided inquiry than an open one, but meanwhile, the role of the teacher seemed to be more structured. Teachers were questioning children and giving guidelines for the experiments. Experiments were fully prepared by teachers, often with little room being left for children's initiatives. However, science-related activities followed the child-centered approach and encouraged the children to use skills needed for IBSE.

Teachers' intention to develop children's communication and problem-solving skills became evident mostly in cases when they are using questioning. Teachers in both countries frequently used sessions in which they address questions and lead the discussion in this particular way. However, communication was focused more on comments on results than on offering explanations. Communication about results was linked in most cases with defining the problem in a written form and using data recording on worksheets, two basic attributes of scientific inquiry. Results were shared with the entire class and discussed by the end of the lesson. A major drawback of the education systems in reference to the IBSE concepts was that students were not trained to look for evidence or to offer their own explanations in relation to a studied subject.

Teachers systematically ranked the features of IBSE as having a creativity potential. Instead of using investigations in their pedagogy, the teachers preferred investigations as creative approaches to learn science. Designing, planning, and conducting investigations were more highly valued in Romania than in Finland,

and in the latter case, communication and observations were ranked to be the most creative activities. The gap, which is recognized in practice and highly valued, is not clearly stated by teachers themselves. It seems that teachers value and like to teach, without recognizing the ample opportunities offered by IBSE. In practice, the teachers tend not to urge the children to develop their skills even if these are needed and practiced in inquiry. The definition of IBSE is not always clear for the educators, and the transfer of the conceptual description into actual practice is not easy for the teachers.

Imagination and play have a crucial role in teachers' pedagogy. The experiments or explorations are often merged with multiple aspects of imaginative situations or play settings. The approaches are evident in practice as well. However, some country-related differences also exist. In Finland, these features of pedagogy are involved only in pre-school and not in elementary school, while in Romania there is no big difference between the two. Finnish comprehensive school teachers seem not to value the affective aspects in their pedagogy as highly as their Romanian colleagues do.

Recommendations

In science teaching, inter-disciplinary approaches can be an efficient vehicle to promote creative teaching, as both teacher and students have to assemble different types of knowledge and various experiences to come to a conclusion. Integration between the school subjects was ranked as a creative approach for teaching but did not systematically occur in studied cases. Some fruitful implementations were identified, although only to a small degree. Science and mathematics were integrated in both countries, and Romanian teachers combine, in some situations, science contents with English language learning, as Finnish teachers do with Finnish language learning. Advanced integrated project or investigations rarely occurred, and teachers needed more resources to conduct interdisciplinary inquiries with young children.

Teachers need more practice in setting small-scale investigations appropriate for early-years children and in learning to maintain the proper distance, thus providing children with a chance to look for or find evidence and draw conclusions. In addition, teacher education programs should concretely guide the pre-service teachers to conduct IBSE and reflect on their experiences regarding the theoretical descriptions. Pre-service teachers need more practice and scaffolding during their education if they are to reach the confidence and acquire the capabilities necessary for the preparation of learning settings for young children. Generally, teachers have a good relation with children and they are experts in collaborating with early-years-aged students, but the intention is not sufficiently ambitious. It seems that there are more opportunities to enhance young children's curiosity, attitudes, and inquiry skills than there used to be. Nevertheless, the appropriate settings are not exploited efficiently.

Although the collaboration and social aspects of learning constitute teachers' strengths, using them more effectively should be encouraged. Teachers in the cases studied used the question-based approach, but the evaluative and conclusive questions are still missing. Teachers could foster children's skills through well-formulated scientific questions as well as by providing optional questions to scaffold the children quest so that they could perceive their observations critically.

According to the survey and field observations, IBSE and CA can be fostered in early- years science. Teachers are capable of facing the synergies of IBSE and CA with young children and the approached used in practice revealed several interesting and emotionally loaded learning processes. More encouragement should support teachers' attempts to use IBSE and CA. Teachers have the potential to scaffold the children, but more ambitious pedagogy should be applied. A need exists to analyze challenges strictly and encourage teachers toward using more open and guided inquiry, as appropriate.

This comparative research shows the general tendency in conceptualizations and practices followed by early-years educators in the two European countries studied. Major differences were observed when analyzing how dimensions of learning are emphasized as well as in how learning settings are organized. The reasons for the differences might be cultural, such as using outdoor learning environments in wintertime, but these cultural differences provide a creative way to add value to local education and find more appropriate methods of learning. In Finland as well as in Romania, school curriculum re-design is needed in order to reform school education. Local experiences such as those discussed in this chapter can provide us with the elements necessary to create a global education system capable of fostering the skills needed in the society of the future.

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