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ROMANIAN TEACHERS PERCEPTION ON INQUIRY-BASED TEACHING

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Abstract. The paper analyses the results of a survey related to the perception of pre-school teachers on the way they implement in science classes inquiry-based methods. The survey is based on the "Self-reflection tool for kindergarten teachers", developed in the frame of the FP7 project "Fibonacci", and it is, according to authors' knowledge, the first report on the application of this tool at European level. Six pre-school teachers were asked to fill a questionnaire of 38 questions associated to criteria reflecting inquiry-based science education (IBSE) practice concerning: teacher's relation with learners; pupils' activities in science class; pupils' records in science learning.

Key words: inquiry-based science education, science teaching, teachers self evaluation, teachers survey.

1. THEORETICAL FRAMEWORK AND CONTEXT OF THE STUDY

The principles of inquiry-based teaching and learning (IBT/ IBL), as they are promoted today, centred on the learner, focused on class activities similar to the investigations carried out by real scientists [1–4] in close cooperation with peers, in an environment where the teacher acts as facilitator or mentor through scaffolding, where conclusions are based on evidence [5], dates back to Dewey's study [6] and passes through the works of Piaget [7] and Vygotskii [8], or other constructivist strategies [9]. Various means were used to increase students' interest and motivation [10] into science learning [11–14].

Successful implementation of inquiry education (IE) in the classroom is based on two changes the educational system has to undertake: IE introduction into the science and mathematics teaching at early age [15] and teachers' initial training and continuous professional development [16]. Within this context of expected change, teachers' classroom practice is highly dependent of their perceptions and believes [17, 18], and for this reason, various surveys are organized [19].

The Center for Science Education and Training (CSET) is managing at national level the research project “i-BEST, Inquiry-Based Education in Science and Technology”. Previously, CSET coordinated Romanian schools participation to the FP7 project “Fibonacci” [20]. The present study reports the results of a self-evaluation tool for teachers, as it was used in the assessment of the pre-school teachers’ IBSE practice. The survey results are discussed in connection to IBSE principles as stated in the relevant literature.

2. RESEARCH APPROACH AND METHODOLOGY

The objectives of this investigation refer to Romanian pre-school teachers’ perception on the way they apply IBSE principles in their classes. The research questions are: “What are teachers’ approaches in building new knowledge based on children previous knowledge?”; “How much teachers encourage pupils to run their own investigations?”; “How teachers guide children in formulating their own conclusions?”; “How much pupils’ collaboration is encouraged?”.

A survey was organized for pre-school, primary school and lower secondary school teachers volunteering to participate to the “i-BEST” project. Six of the pre-school teachers, from Bucharest and different counties of Romania, provided comments to their questionnaires answers.

For this survey the “Self-Reflection Tool for Teachers” was used, as published in the “Tools for Enhancing Inquiry in Science Education” brochure [21], a research document issued in the frame of the Fibonacci project. The “Self-Reflection Tool for Teachers” section of the brochure defines the objective of this tool as “a list of indicators for judging the implementation of inquiry-based teaching through self-analysis of classroom practices”. This list includes criteria to which teachers have to answer in order to be able of self-assessment of their approach in inquiry based teaching. The criteria are organized into three sets: teacher’s relation with learners; pupils’ activities in science class; pupils’ records in relation to science learning, and they are available in Romanian [22].

The present paper addresses *only the survey of pre-school teachers* in relation to their IBSE practice in the classroom. Comments included into this study are associated to codes assigned to each participant teacher (*i.e.* PS1 – the answer of the first pre-school teacher’). To authors’ best knowledge, this is the first report on the use of Fibonacci self-assessment tool from its launch in 2012.

3. FINDINGS AND ANALYSIS

In order to obtain an inside view on teachers believes in relation to IBSE practice *only the answers which include comments* are considered, for further analysis and data interpretation, as far as they reflect teachers’ attitudes, perceptions, interpretation of the official policy, practice, etc. Because of the limited space allowed for the paper *only answers relevant to the study* are reproduced here, but all other answers were considered in the qualitative analysis and cited as appropriate. These additional answers along with the number of respondents who included in their answers comments to each criterion can be found as supplementary material on the project web site [22].

3.1. TEACHER – CHILD INTERACTIONS: BUILDING KNOWLEDGE ON CHILDREN'S OWN IDEAS

Criterion 1a: "Did you ask questions requiring children to give their existing ideas?"

PS1: "*Open questions are the only ones that lead to the discovery of responses by children. They can be formulated in a way to conduct the investigation in the right direction without limiting children's contribution to the investigation*".

PS2: "*By the way a child gives an answer, the teacher can identify the knowledge that the child holds (in the investigation or in general).*

PS5: "*Because I work with a group of children of different ages (from 3 years to 6 years old), at the German speaking department, it is very important to me that pupils express themselves by using sentences.*

The teacher has to refer to open questions asked during the lesson, expecting from the children a more or less structured answer. Two out of five respondents referred to children questioning as a means to engage them into the learning process, as teachers use this procedure for guided inquiry (PS1) or formative assessment purposes (PS2). The other teachers perceive questioning less connected to inquiry and more as an opportunity to correct and improve language skills (PS5). In any case, at this age cross-curricular inquiry (*i.e.* science and language) plays a vital role in improving children literacy and communication skills. In this context, combining the two pedagogical approaches along with science teaching into a multilingual classroom can be considered as part of an IBSE strategy. An interesting idea comes from PS5 who mixes children of different ages who have to come together to a common understanding, learning one from the other. Building new knowledge on children initial ideas is one of the driving forces of IBSE [23, 24].

Criterion 1b: "Did you help children to formulate their ideas clearly?"

PS1: "*Addressing additional questions or by suggesting words to be used, children can be helped to clarify the meanings. Surprisingly, they often express in simple words scientific truths*."

PS2: "*Always I try to create the atmosphere for the exchange of information between children. I think that's one of the most effective methods to learn new things and to identify starting points for additional research.*"

PS3: “*As they present their ideas along with the entire group or individually in front of the class, always appears an opportunity to learn one from the other*.”

It is presumed that teachers put additional questions to children in order to push them to offer some explanations and give them time for thinking and even to consult each other in small group work. Almost all answers support language learning and the proper use of terminology as a good vehicle to transmit scientific ideas or to clarify employed concepts [25]. The answers exemplify the three roles of language in science learning: a “system for the transmission of information” (PS1), an “interpretative system for making sense of experience” (PS2), a “tool for participation in communities of practice” (PS3) [26]. Such verbal interaction can occur either during small group discussions (PS3), during the individual or group presentation of results (PS3) or even during occasional exchange of opinions among children (PS2) [27]. PS1 highlights the fact that may be complicated concepts can and have to be presented in simple words. Learning from mistakes is considered also a good opportunity to enrich somebody knowledge. Additional questions are a mean to clarify some terminology or concepts, by involving the child to structuring an explanation (PS1).

Criterion 1c: “Did you provide children with positive feedback on how to review or take their ideas further?”

PS1: “*It is important during the investigation to remember and remind the starting point: the question and the assumptions that led to the investigation. This helps them, orders and clarifies their ideas, brings changes in the planned implementation of the experiment*.”

PS3: “*Guiding children throughout the learning / evaluation process has to be done permanently, to achieve a better understanding of the transmitted knowledge or to perform the tasks as accurate as possible*.”

The teacher has to refer to pupils ideas in order to encourage them to pursue their thoughts. The answer to this question indicates some sort of confusion among teachers. PS1 is closer to an answer reflecting her intention to encourage children to continue on their own ideas and solutions. She insists on reiterating the problems to be solved and the proposed solutions to be tested. The guiding role of the teacher in the process of learning comes one more time into discussion (PS2). The third answer reflects teacher understanding of her role in directing children’s activities.

3.2. TEACHER – CHILD INTERACTIONS: SUPPORTING CHILDREN’S INVESTIGATIONS

Criterion 2a: “Did you encourage children to ask questions?”

PS1: “*Such type of questions allows children to identify future directions for the development of the investigation and to contribute to the planning of activities to be conducted in the best interest of children, according to their knowledge*.” PS3: “*The most effective method of learning is to encourage children to ask* *questions; in this way, the teacher has the opportunity to discover what the issues kids do not understand are*."

PS5: "*In fact, this is the most stimulating factor for their interest, as problems to be solved emerge; kids are interested to know the answers, so they always express a desire to learn more about such subjects*."

The teacher tries to educate children to formulate their own questions [27]. Most of the teachers are aware about the power of children formulated questions in increasing their interest and enhancing their commitment to the tasks to be solved (PS5, PS6). Pupils formulated questions can be a driving force for further extension of their interest and efforts (PS1). Questions initiated by children have the power to reveal their understanding on some subject (PS6). Children questions can be another opportunity for the teacher to hold back and just guide pupils' activities.

Criterion 2c: "Did you encourage children to make predictions?"

PS1: "*Children need to understand that the craziest ideas can sometime prove scientifically correct. Practically, it might be that there are no wrong ideas, may be their validity had not been demonstrated yet….*"

PS3: "*It is very important to encourage children in doing this; it is an opportunity for them to understand more easily the contents*."

PS6: "*Hypotheses can help avoiding some mistakes and to correct some failures*."

The teacher has to provide to the child the opportunity to express his/her opinion on the outcomes of an investigation, to formulate some hypothesis [28]. The inquiry step of formulating predictions seems to be an important issue for the participants. PS1 is right when highlighting the innovative character of the inquiry, to provide to the researcher a better understanding of an unknown phenomenon. They consider the hypothesis as one of the guiding principles of investigative work. Formulating hypotheses help children to organize their activity (PS2), to understand new content (PS3). In early education, the investigation premises are expressed usually in oral form. It is questionable the assumption that formulating a hypothesis helps the investigator to avoid possible mistakes (PS6). At this point it is a misunderstanding from the part of the teacher concerning the role played by a prediction in a research project. Within this context, some teachers (PS2) encourage pupils to explain the investigation they are carrying out and to make a projection on the expected results (PS2).

Criterion 2d: "Did you involve children in planning investigations?"

PS1: "*Of course if the teacher controls totally the experimental work a lot of headaches can be avoided (i.e. loss of material made available to children, the annoyance caused in the classroom, etc*."

PS2: "*Once the children consider themselves as the initiators of investigation they see the planning of the investigations as natural to be set-up by them.*"

The teacher has to suggest a plan and ask children for approval after understanding it. Planning an investigation is one of the process skills targeted to be developed through inquiry teaching [27, 28]. The respondents consider that involving pupils in planning the investigation is the best way to catch their interest and participation (PS1). A tension emerges here as the teacher has to choose between a tight control of the class, in a traditional science teaching, and a permissive approach when children are given room to manifest themselves more creatively. This last mentioned approach makes possible teacher's mentoring/ supervising/ scaffolding with less intervention (PS2) [24, 25].

***Criterion 2f**:* "Did you encourage children to check their results or observations?"

PS1: "*In carrying out the measurements and observations we rely on the five senses. Disclosing the sources of error and identifying the correct results are extremely educative*."

PS2: "*There are situations when the obtained data are considered as such and accepted by children, as they have the endorsement of an adult. Repeating research would require more time and energy resources from children*."

PS5: "*Checking the results is part of the strategy I use, I do it every time*."

At this point teachers are encouraged to ask pupils to repeat the measurements or to make additional observations in order to validate their findings. The great majority of teachers answering to this question have a clear idea on the function played by results checking. Double checking the results is part of the science teaching pedagogy (PS3). They are working on identifying the error sources (PS1) and on forming this habit to children at very early age (PS3). Some others rely on the verification and approval of results by an adult (PS2). This limits children own judgment on investigation outcomes. This process (results verification) must not be part of the self assessment process, as one of the teacher suggested (PS6). Barriers in running multiple observations or measurements are the lack of time and resources. Here (PS5) it is confusion as the teacher perceives the results checking as the final goal of the investigation, instead of some conclusions based on evidence [28]. A pertinent remark refers to the use of senses at this age (kindergarten) to explore the surrounding world. Investigation of these senses limits conducts very easily to the needed of more impersonal measuring means – the instruments, able to confer reproducibility and accuracy to the investigation.

3.3. TEACHER – CHILD INTERACTIONS: GUIDING CHILDREN TO CONCLUSIONS

***Criterion 3a**:* "Did you ask children to state their conclusions on their work?"

PS1: "*Drawing conclusions and asking children to present these conclusions help them to clarify, to order and to synthesize ideas.*"

PS3: "*Regardless of the run activities concluding is mandatory, for example: understanding the message conveyed by a story, poetry; the knowledge of the environment - nature, plants, animals ... etc ...*"

At his stage, the teacher has to ask pupils to draw conclusions of their work, not only to report some observations or differences between some conditions. All participants value the educative importance of presenting the results of an activity and concluding on its outcomes. All results, good or not so good, are sources of knowledge and occasions to learn (PS6). Only two respondents from six are able to distinguish between the results and the conclusions of an investigation. It seems that they concentrate on the particular outcome of an experiment, neglecting the importance of the generalizations formulated as conclusions. They are still prisoners of the demonstration, missing the understanding of the research act, the conclusion being the validation or the non-validation of the hypothesis through results, trying to answer questions such as: "What happened?", "Is this what you thought would happened?", "Did anything surprise you?" [25].

Criterion 3c*:* "Did you ask children to compare their conclusions with their predictions?"

PS1: "*Children enjoy a lot to discover that their assumptions match the results. Initially, they might be disappointed when the results do not match the hypothesis. By assisting them to use the false assumption in planning other investigations they become more flexible in accepting their errors as something natural, and this can be the starting point to another activity*."

PS2: "*In the case we are running some complex experiments when pupils were asked to apply a broad range of skills, knowledge and abilities, I think it is better to focus on the activities we are engaged in, being less important for me the hypothesis formulated at the beginning of the work*."

PS3: "*It is obvious because often a study can start from an idea suggested by the teacher or already known to children and, at the end, another idea emerges, and it is important for children to be aware of the difference existing between the two situations*."

The teacher has to make a connection between the hypothesis and the results, asking pupils to compare the two situations. Asked that way, most of the teachers establish a straightforward link between inputs (predictions, hypothesizes) and outcomes, developing in this way some process skills such as: "interpreting the evidences and drawing conclusions" [24]. There still exists the confusion between results and conclusions (PS1, PS5). There is even an opinion (PS2) that the hypothesis is less important than the process (demonstration, experiment) during the research work. Nevertheless, a discrepancy between the conclusions and predictions can constitute a new challenge, a new beginning (PS3).

Criterion 3d*:* "Did you ask children to give reasons or explanations for what they found?"

PS1: "*Connections between what children already know and the new acquisitions are very important. Long-term memory relies on them*."

PS5: "*Reasoning, arguments concerning the answers, explanations, comparing the results are also part of my strategy. I stimulate children in doing this*."

The teacher must involve children in providing explanations and not just simply refer to what they observed. With only one exception (PS5) all teachers offered answers with no connection to the question. They seem to miss the importance of explanation associated to the obtained results. They are not trained to look behind the apparent facts and figures. May be they simply are not able to establish a causal connection between cause and effects. Looking for explanations can lead to alternative solutions [28].

Criterion 3f*:* "Did you help children to identify new or remaining/ further questions?"

PS1: "*Especially for children it is extremely important to establish connections between what they already know and what they just discovered. Children make very easily further links between the newly discovered information and what they would like to learn more about, thus enabling the teacher to plan new activities according to children interests*."

PS6: "*In preschool this is very difficult to apply*."

The teacher has to investigate if children are able to find new points of interest in the carried investigation. The question seems to be a difficult one as focusing on new aspects of the investigations is hardly to deal with at early ages (PS6). The idea of making connections between past knowledge and the newly acquired information (PS1) is valuable for IBSE implementation, it represents an opportunity to "create links between events having a common explanation" [24].

3.4. PUPILS ACTIVITIES: CARRYING OUT INVESTIGATIONS

Criterion 4a*: "*Did children pursue questions that they identified as their own, even if introduced by you?"

PS1: "*Often I rephrase children's ideas and ask them to confirm if I understood correctly what they wanted to say*."

PS6: "*The sense of ownership in formulating questions is less developed at this age*."

Children have to be able to express in their own words what their intentions are, in order to prove the ownership of the ideas. Pupils' capabilities to promote own ideas are limited at pre-school level. In order to express openly their ideas children need the assurance that they will not be blamed for wrong answers and that they will receive the deserving respect [27]. Such an attitude will not restrict their expression. "Rephrasing" children statements help the communication and overcome their inhibitions [27].

Criterion 4b*: "*Did children make predictions based on their ideas?"

PS1: "*Often their arguments are very funny, but nevertheless they are arguments ... I like their assumptions that capture the essence of a phenomenon in a few words. In a way, it is reinvention of the wheel, without any claim for the copyright*."

When making a prediction, children have to be able to offer some sort of explanation, to prove that they thought about the issue under discussion. Stating explanations and predictions are major abilities associated to inquiry [25, 28]. Developing predictions is related to problem-finding. Studies on 2 and 4 grade kindergartners indicate their capability to set up a path to an open research problem. "Students who selected their own problem, are more likely to be involved into research" [29].

***Criterion 4c**: "*Did children take part in planning the investigation?"

PS1: "*Sometimes because of the lack of time or because we try to minimize material consumption, we propose (in most situations) the work plan.*

PS3: "*Children can actively participate in planning activities, we often scheduling these activities considering their interest and novelties they want to learn, the additional questions they addressed*."

PS6: "*Any proposed investigation plan, even if it is not proposed by children, arouses curiosity*."

It is not mandatory for the children to propose their own plan for the investigation, it is important that they understand and comment on a proposed plan. Most of the teachers involved into the study agreed that pupils' contribution in planning the investigation is crucial. Even very young children can be attracted in this process, if the teacher has the ability to raise their interest and dialogs with them. Repetitive, more or less routine sequences of operations can be easily programmed by youngsters (PS1). The major driving force into this demarche is their curiosity and readiness to learn (PS3, PS6). The teacher has to train pupils to "think ahead", starting from the sketch of an activity plan, assisting them in expressing in advance what they intend to do [24].

***Criterion 4e**: "*Did children carry out their own investigation?"

PS1: "*There are clear differences between demonstration and hands-on activity. Demonstration in pre-school is used sometimes as a starting point for further investigations carried out by children. Demonstrations can trigger children's interest on a particular activity.*"

PS2: "*Depending on the availability of prior information and materials to be used, I favor individual study as a mean of learning, with long lasting effects*."

Teachers have to consider if children use various resources (measurement results, data from their observations, information obtained from books or other sources) in their investigations. PS1 noticed very well the difference existing between a demo session and a personal experience as it is carried out by the child based on his / her own efforts, supported by his/ her skills and capabilities. This remark is very important as far as in most situations at pre-school investigations type activities are very few, all the acquired knowledge being passed through demonstrations. In this way, child contribution to his / her scientific education relys on the observation of an experiment. Two of the participants to the survey mentioned their interest towards individual investigation/ observation at the beginning of the lesson (PS2, PS3).

***Criterion 4f**. "*Did children gather data using methods and sources appropriate to their inquiry question?*"*

PS1: "*Pupils in pre-school do not know to read and, even if they do, they are not able to handle too long information and / or requiring a rich and complex vocabulary.*"

PS3: "*In some situations, children collect data on a subject we have to discuss with the entire group*."

Teachers have to consider if children use various resources (measurement results, data from their observations, information obtained from books or other sources) in their investigations. For the group age under discussion, teachers have difficulties in understanding the meaning and role of appropriate methods and (re)sources needed for an investigation, and for these reasons, their answers are out of topic (PS1, PS2, PS3). The selection of methods and the resources to be used is an essential part of the investigation planning process [24, 25].

***Criterion 4g**: "*Did the data gathered by children enable them to test their predictions?"

PS1: "*It is very important to correlate the measured data or observations to the initial hypothesis and to the original question. Children need to keep in mind throughout the investigation what they are doing, why they do this, and what they want to know.*"

PS6: "*Under the guidance of the teacher, these assumptions can be checked*."

Teachers have to answer the question: "Are the collected data significant for the investigation children are doing?" Most of the respondents' answers fulfill the expectations at this point. They proved to be able to correlate the activities they are running with the scope of the investigation. It is a very good point for them that they do not follow only the procedure but are concerned about the way the results/ measurements/ observations support the demonstration they planned. In any case, two of them (PS4, PS6) underlined the necessity that teacher supervise children acts, by guiding them. It is a valuable achievement considering the age of the pupils involved. Children have to learn from early age that real scientific research means not only observation, measurements, comparison but also data collection and handling in a structured manner as sometime major "breakthroughs in science are made in the analysis of carefully collected data" [25].

***Criterion 4h**: "*Did children consider their results in relation to the inquiry question?"

PS1: "*Sometimes they are disappointed when they did not get the expected results or results similar to those of their peers. When they understand that these results lead to important conclusions their good mood comes back.*"

PS5: "*If you insist on this matter: yes. I am trying every time to get them used to it*."

Children have to use, during discussions or presentation of results, the evidence obtained through the investigation in supporting their predictions. Justifications provided by PS1 in relation to results out of children expectations as being valuable information which can offer an inside view on the process and can locate mistakes or misunderstandings prove her having a good intuition of the investigations principles. Bad results do not mean a failure; they can lead to new opportunities for research and clarifications. As it concerns PS6 response probably a better approach would be to make pupils aware of the relation results-investigated problem. The same teacher brings into discussion another important term of IBSE: evidence. In scientific research, evidence is the cornerstone of the understanding the investigated subject and its internal relations and interactions. Despite of the important role played by evidence in scientific demonstrations, studies indicated that, generally, science teaching practice offer few opportunities to students to understand the importance of this tool and to practice its use [30]. Use of evidence is considered as one of the basic abilities to be developed in relation to IBSE [28].

Criterion 4i*:* "Did children try to give explanations of their results?"

PS1: "*Explanations offered by children are full of charm. I think that in some instances children's explanations often catch the essence of a problem and it happens to hear some solutions I did not consider before.*"

PS2: "*I encourage them to identify the causes of variations of results recorded by different individuals or at different time intervals*."

PS6: "*Usually, the results they obtain do not have an explanation or the explanation is a simple one: "This should be.*"

Teachers have to look for proves that children have explanations for their findings, based on previous or acquired knowledge. At this question teachers seem to miss the essence of the problem. They do not confer enough importance to explanations of the results. It might be because of the age of their students, not being able to articulate sound explanations. In any case, teachers have to concentrate on this issue as far as an experiment run under inquiry circumstances does not represent a demonstration, a show; it has to offer support to some conclusions backup by appropriate explanations, "explanations which are ways to learn about what is unfamiliar by relating what is observed to what is already known" [28]. In this approach, explanations are bridges from known towards the knowledge to be discovered, bridges built by the learner himself. IBSE principles require children to formulate explanations starting from evidences obtained during the experiment and to continue their research activity by examining alternative explanations [28].

3.5. PUPILS ACTIVITIES: GUIDING CHILDREN TO SHARE IDEAS

Criterion 5a*:* "Did you encourage children to make group drawings, posters, or models of what they produced?"

PS1: "*Writing, drawing, or preparing graphical schematic representations of the task steps or of the measurements results help children to draw conclusions and to present these conclusions.*"

PS3: "*In some cases, working in groups to prepare a model, various works, etc. is beneficial.*"

The teacher has to bring together children to develop some common product by sharing ideas (PS1, PS3) [27]. Group work and cooperative learning set the basic of children "cognitive, social and affective development" [31]. Hence, early age training on these approaches is relevant for pupils' future response to science learning.

***Criterion 5b**: "*Did you take notice of children's ideas and encourage children to do the same?"

PS1: "*Different views of children can be discussed considering them of equal importance; no answer is less valuable than the others. Children need to understand that we are learning from mistakes.*"

PS3: "*Encouraging children has to be permanent because it increases self-confidence and makes them feel useful*."

Under this criterion it is important to evaluate the question "Does the teacher use children words to underline their ideas, without ranking the answers?" Not ranking answers, accepting all statements (PS1), treating equally all children participating to a debate (PS5) are the key factors in supporting the development of self-confidence (PS3), self-determination, self-motivation [32].

***Criterion 5d**: "*Did you encourage children to listen to each other?"

PS1: "*Each one is speaking on his / her turn. If you want to be listened you have to listen to others; it is one of the rules we observe*."

PS3: "*Learn the mutual respect, listen to be listened to*."

The teacher has to observe that children are speaking one at a time while the others are listening to the speaker. They have to be trained to respect each other (PS1, PS3, PS6).

3.6. PUPILS ACTIVITIES: CHILDREN'S RECORDS

***Criterion 6a**: "*Did children make a simple record of what they did and found?"

PS1: "*At pre-school level, written records are short, often fragmented, but they are very important for learning working skills, required for this type of activity. Sometimes children show little interest in filling worksheets, but, when they see how important they are in formulating conclusions and during presentations given in front of their colleagues, inconveniences caused by this part of the activity vanish*."

PS6: "*I use records rather than drawings or worksheets.*"

The teacher has to think if there is any individual or group record available on the investigation results (text, drawings, or filled worksheets) [33]. In Romanian kindergartens there is the practice of keeping records and artifacts which prove the results of children work. Teachers are aware of the importance of these evidences in tracking children evolution. Records keeping and reporting have to be usual practice in science teaching [24, 25].

Criterion 5c*: "*Did children share their records of what they did and found with others during reporting to the class?"

PS3: "*Each pupil in pre-school can express his/ her views about the discussed topic, listening to each other and thus they gain a better understanding of the message*."

PS5: "*Children are eager to express their ideas, to show the results*."

The teacher has to observe if children discuss among them and compare results. The educational process has to include the development of social and communication skills, starting from the pre-school level, communication being part of the science process skills (PS1, PS3, PS5) to be supported through IBSE [19, 20, 22, 23].

4. DISCUSSIONS AND CONCLUSIONS

Romanian pre-school teachers, educators in kindergartens, run their science teaching activities starting from children own ideas, helping them to formulate in their own words the problem identified as being of interest for investigation, encouraging them to ask questions. Their children are guided to make predictions on problems to be further investigated and to plan these activities. Pupils are trained to check the results of the observations carried out or the measurements done. In most of the situations, children are asked to formulate conclusions on their work, and compare these conclusions with the predictions made. By the end of the day, pupils try to verbalize some explanation regarding the outcomes. Pupils' dialog, group work and results sharing are supported. More than 80 % of the participants gave an answer to questions related to these issues. Surprisingly, about 40 % of the participants were not able to provide reasonable answers in relation to children involvement in planning and carrying out their personal investigations, selecting methods and resources to be used, or gathering data on the purpose to verify hypothesizes. It seems that pre-school teachers are reluctant to involve children in such activities. 50 % of the participants have difficulties in assisting children to identify additional questions to be answered, to offer some explanations on the results obtained, to make systematic record on their findings. The most problematic issue to understand and to apply in science classes seems to be the education of pupils to derive predictions on investigations outcomes starting from their own ideas, which in fact is the key to the creative children interaction with the surrounding environment. Over 70 % of the asked teachers are not accustomed with this practice.

The results of the study are promising considering the fact that none of the teachers involved in the survey was previously trained systematically in running IBSE classes. Nevertheless, some major deficiencies were localized. Most of the pre-school teachers are not able to follow in their demarche during science lessons the basic steps of an inquiry: identifying the problem, formulating a hypothesis, planning and experiment by selecting methods and resources, collecting data, interpreting the results based on evidences, providing conclusions and presenting them to an audience [24, 25, 28]. Often, teachers do not realize the difference between results and conclusions, are not aware about the importance of evidences in clarifying a problem and do not ask children to formulate explanations. The records in science learning miss the importance they deserve. A natural continuation of this research has to be the organization of training course and demo sessions in order to foster inquiry tailored to early education. These could be a good opportunity to clarify the methodology and to offer practical examples of IBSE implementation. Curriculum changes and development of training aids for science teaching have to accompany these efforts. Teachers perceive as limitations in the implementation of IBSE practice in pre-school education the lack of time and resources and the age of pupils. Some times they pay tribute to their old fashioned approach in science teaching, as they try to control too much the investigations development.

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