THE HUMANISTIC AND INVESTIGATIVE INQUIRY ORIENTED MODEL AS A TOOL TO ENABLE PRIMARY SCHOOL STUDENTS' LEARNING PROCESS: THE SWEDISH EXPERIENCE

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Abstract

Monitoring and measuring of the primary school students' level of knowledge and skills in math by Swedish State Authorities show a dangerous decreasing in them. Primary school students in Sweden consider math as a not interesting and difficult subject. A variety of teaching methods and technologies at Swedish primary schools generally stands on the traditional way of teaching with the implementation of some modern elements such as IT, collaborative work and etc. Our analysis of the praxis in Swedish primary schools shows that the main tendency in the teaching process can be described as "overstructured" and "overinstructed" facilitation. In order to change students' attitudes toward learning math and make this subject more interesting, we implemented the Humanistic and Investigative Inquiry model. This model is a modification of well-known HSIO-method which was developed and tested in Finland. We investigated and found the ways of modification and implementation of this model into the diverse subculture of Swedish primary classrooms. The Humanistic and Investigative Inquiry model is based on the interdisciplinary approach. This approach was used to create an interdisciplinary curriculum in math without destroying the goals of the Swedish National Curriculum. Our survey showed that primary school students' Knowledge Increase (KI, %) was 62%. Index of Interest was approaching 90% and Parents-Satisfy-Index was 95%. Creating the Interdisciplinary Learning Environment according to the Humanistic and Investigative Inquiry model enable the interest in learning, self-planning, and increasing self-confidence. Interdisciplinary Learning Environment encourages students to use their knowledge and practical skills of modern technology as the natural element of their subculture.

Keywords: Interdisciplinary Curriculum, HIIO-model, Humanistic teaching, Modern Technology, Diverse Classroom, Interdisciplinary Math, Learning Environment.

1 INTRODUCTION

The Swedish national curriculum for compulsory school defines school mathematics as a creative, reflective, problem-solving activity that is closely linked to societal, social, technological and digital development [1]. Mathematics as a subject is divided into three levels – from grades 1 to 3; grades 4 to 6 (the middle school), and grades 7 to 9. The last fifteen years of the Swedish school development characterized by several educational reforms in order to improve the students' low interest toward school mathematics. The interest is dramatically decreasing after grade 3 despite the compulsory national test for all students. Decreasing the interest in school mathematics affects the students' level of knowledge and skills which is low compared with the international level [2]. Mathematics as a middle school subject contains the necessary prerequisites for the development of the cognitive abilities of students. It forms and corrects such forms of thinking as synthesis, comparison, analysis. Mathematics develops the student's ability to generalize and concretize, creates conditions for the correction of memory, attention and other mental functions. During the learning process, the student's vocabulary is enriched with special mathematical terms and expressions. When students explaining the solutions to a particular problem, they acquire the skills of a rational explanation of their actions. This all the above become very challenging for teachers. Teachers tend to use a variety of activities in order to secure students' knowledge and skills in mathematics which are stated in the national curriculum. How effective are those activities? In our case-study, performed in three schools in the Stockholm region (Sweden), 75% of students replied to the question "What did you learn during the last math lesson?" that they "didn't learn anything new". Furthermore, 92% answered the question "Why you are studying Math?" that they "must go to school", and 35% of students experiencing that "Math is a very boring subject and monotonous subject". From these results, we concluded that the teaching and learning math in the Swedish middle school needs to be re-analyzed and we have examined the process of teaching middle school math from different angles.

1.1 The process of teaching Mathematics in the Swedish Middle School

Analysis of the Swedish national curriculum, articles, and observations of teachers' practice in the schools show that teaching practice is mostly "teacher-centered" with its different variations. The main idea of "teacher-centered" facilitation is "transmitting sets of established facts, skills, and concepts to students" [3]. At the beginning of the lesson, the teacher demonstrates specific procedures for solving problems. Then students receive instructions for independent practice these procedures. Instructions generally are in printed forms with repeated possibilities (worksheets) with a mix of digital tools. The main goal of teacher-centered facilitation is increasing student's procedural fluency in applying explicitly taught and repeatedly practiced sets of procedures. The purpose of this practice to prepare students for more effective use of higher-order thinking and problem-solving skills [4]. The teacher-centered facilitation is characterized by the triadic dialogue of Initiation-Response-Evaluation (IRE). The content of math in this mode is less frequently related to students' everyday experiences and represents exactly measurable parts of the knowledge and skills listed in the syllabus. Teachers place firm limits and controls on students and have generally little verbal exchange with them. Some teachers allow students considerable autonomy but provide them with little support for developing learning skills or managing their behavior. This kind of teacher-centered facilitation called the Direct/Interactive Approach.

The Direct/Interactive Approach is divided into three parts according to teacher/student activity – Content, Process, and Product. The content includes teacher planning which is non-collaborative activity and as the result is teacher-defined outcomes and schedule. The Curriculum is not flexible, is textbook driven and siled per subject. In order to support the content teachers choose the resources which are limited, generally the same options for all students. Resources include different study guides. The following step of teacher-centered facilitation is Process. The process is characterized by activity in the class. The teacher starts with lecturing (usually to a passive audience) and students listen, watch, read, and take notes. There is a place for research activity as well. Research activity is generally limited in scope and defined by pre-digested knowledge. Students use technology as a tool for assembling work products or looking for information and usage is procedural. There are Practice and Assignment activity during the process of learning. The practice is generally organized by the following chain: worksheet then homework and then a quiz. Assignments are sequential.

The final part of the teacher-centered facilitation is Product which can be divided into two phases – Student Work and Assessment. In general, student work must be completed individually in order to be evaluated by the teacher [5].

1.1.1 Difficulties of the teaching mathematics according to teacher-centered facilitation

Teaching according to the teacher-centered model is challenging for all teachers. The main challenge is discipline. In order to keep discipline during the lecture, teachers use different technics and methods. Teachers tend to be authoritative. Unquestioned authority and, as a result, at the lessons of such teacher students are more engaged and diligently trying to get teachers praise. It is easier for the authoritarian teacher to convey training material to students. It is very easy to work with students who have the ability for mathematics. Such students grasp the teacher's explanation very quickly, easily perform mathematical operations and solve problems of different difficulty levels. As a rile, there are few such students in primary school. The content of the middle school mathematics in Sweden is cyclically constructed, and as a result, a student who has difficulties with addition and subtraction in preschool prevents them from the learning of future mathematical material [6]. Since math problems become more complex over time, the learning problems of these students are exacerbated. It is very important that the teacher can figure out the number of such students in order to help them. Primary school teachers solve this problem in different ways. Unfortunately, there are few studies that have examined whether and to what extent a range of factors contribute to early mathematics achievement, especially for students with learning difficulties [7]. Even fewer studies have examined the effects of specific teaching technologies that primary school teachers use in order to increase student's achievement in mathematics. It is currently unknown to what extent these technologies are effective on all students or have different effects on them [8]. Such a situation and findings highlighted the importance of researching classroom instructional technologies.

1.2 The process of teaching Mathematics according to Student-Centered Approach

The effectiveness of the Student-Centered Approach is well tested in teaching Middle School Sciences [9], [10]. According to this approach, teachers are authoritative. It means that students in the classroom

tend to be self-reliant, delay gratification, get along well with their peers and show high self-esteem. The teacher engages students in considerable verbal give-and-take relations and shows a caring attitude toward them. Such teachers clarify rules and regulations, establishing these standards with input from students. Student-Centered facilitation encourages students to be independent thinkers and doers but still involves effective monitoring.

The Student-Centered facilitation is divided into three main parts: Content, Process, and Product. The Content part contains collaborative units, such as Planning, Curriculum, and Resources. The planning is a collaborative activity with students, it has a more flexible schedule and teachers collaborate with students about the content of assessment criterions. The curriculum is set by teachers and students and is interdisciplinary.

During the Process part, students prepare and conduct research, they ask questions, draw conclusions and share findings with others. They work with peers, teachers, and outside experts. Such collaborative mode required good self-management skills. Students going to solve problems, make decisions and think creatively. Furthermore, students naturally use modern technology in order to do open-ended research. Modern technology is used for communication and exploratory reasons. During the process, time teacher has the possibility for ongoing formative assessment in order to check the students' progress against goals.

The final part of the Student-Centered Facilitation is Product. During this stage, students show how their learnings can be applied to the authentic context. Students are able to make connections to future learning goals. Student work is in the form of e-Portfolios, which are often created collaboratively. The final part ends with Summative Assessment which is conducted by the teacher(s) and student(s). Evaluation is with rubrics and checklists [11].

1.2.1 Difficulties of the teaching mathematics according to Student-Centered facilitation

The key differences between Teacher-Centered and Students-Centered facilitation are the main difficulties for teachers. The key differences include goals, roles, motivation, assessments, and students' interactions. Most difficult for teachers is the assessment of students because the purpose and methods of assessment differ by definition. In Teachers-Centered facilitation, teachers use assessments to determine grades. The grades are used for student's motivation and inform parents about their children's progress [12]. In Student-Centered facilitation teachers use open-ended assessment procedures that are designed to involve students in examining their own learning, focusing their attention on their learning needs and changing understanding rather than on a grade [13].

Another factor that makes the teaching of mathematics difficult according to Student-Centered facilitation is teachers' beliefs. When a teacher is confronted by a novel situation in which they lack knowledge structures and cognitive strategies, they tend to fall back on their beliefs to guide the decisions they make [14]. Teachers who attend the implementation of Student-Centered facilitation are likely to rely on the educational beliefs they have developed during their experiences both as a student and a teacher. This process is not easy. Teachers' beliefs will surely shape the way how implementation would be designed.

2 METHODOLOGY

This article reports a case-study of teachers who implemented the Student-Centered Approach according to the Humanistic and Investigative Inquiry Oriented model (HIIO-model) which is developed by ILET & Schooling Group. The authors of this qualitative study are members of the design team for ILET & Schooling Group. The first author implemented this model in his class at Norrvikens School (Sweden). We have used HIIO-model with middle school students for two years. We are conducted both formative evaluation and research with it. The prior to the case-study, reported here, is students' attitude toward mathematics and their knowledge increase.

2.1 Participants

Three middle school teachers participated in the study; all teachers participated in individual and group interviews. The number of years teaching experience of these teachers ranged from 3 to 39. One teacher is going the teacher training program at the university.

All groups of students are culturally diverse with different levels of knowledge in mathematics and are in grade 4.

2.2 Material

The authors were designed working synopsis under the name “PIZZA”. The content of this material is interdisciplinary. Students were grouped by 4. The interdisciplinary content was presented as context-related within Mathematics, Home Economics, Science, Languages, Mother tongue, and Technology. Each group was asked to find how decimal numbers, operations with them, protractors, angles, percent, fractions, circumference, and area can be applied in interdisciplinary areas.

The outcome of their work should include workflow, content, and findings.

Students started with collaborative activity and decided about working scenarios, they used laptops and smartphones as a tool to keep documentation. Students face several challenges during their work. They should find how to convert currency and get a needed approximation of the home budget.

Teachers are expected to (1) introduce the steps of investigative inquiry, (2) promote the knowledge about collaboration with the peers in the group, (3) identify any hazy solutions and explanations or identify any missing information which can affect the development of their progress, (4) help students with connection of math concepts with their prior knowledge, (6) check the individual progress of the students.

2.3 Data Sources

In order to get information about effectivity of used model we collected information through (1) interviews, (2) observations, (3) students reflexive journal, (4) pre- and after-test results, (5) students’ evaluation of the topic, and (6) students’ final presentation.

Each student and teacher were interviewed twice: once before the introduction of the topic and once after the final presentation. Each interview contained the same questions and was structured into two parts – experiences about mathematics and how participants imagine the best way for learning. Questions were open-ended with additional questions in order to get more specific information. The purpose of observations was to identify teacher’s and student’s activity during the lessons, how students collaborate and make progress in their plans. All students and their groups were asked to plan their activities during the lessons in “GoogleDocumnet” and share with the teacher. After the lesson students made a comment about their work. At the beginning of the topic the teacher treys the prior knowledge of mathematical concepts which will be involved in the process of construction of the new knowledge. A similar test applied for the measurement of the final results of students learning. Through the evaluation of the topic and final presentation, the data according to criterions were collected.

It should be noted that the duration of this topic was 4 weeks, so this is the beginning of the next research.

3 RESULTS

As it was noted that teachers’ beliefs affect the implementation of the Students-Centered facilitation. All results indicate that teachers during this experiment mostly wanted to get proof that constructivist ideas and HIIO-model are working. According to teachers, it is easy to declare that learning takes place through the individual’s own activity, through experimentation and exploration. In addition to that, it is easy to understand that social constructivism which emphasizes relationships between groups, situations, individuals, languages and the local environment. Learning takes place in a social context.

Teachers found difficult to acknowledge and implement the collaborative basis of teaching and learning, especially to create the proximal development zone or nearest development zone, which focuses on the cognitive processes.

Many students’ everyday lives are characterized by digital tools, which are components of their environment and security as well. IT should be compared with other materials to be used in teaching and by integrating IT as a natural part of the learning environment, students will be given tools for information retrieval, processing, presentation, and communication. Therefore, the use of digital tools has become an important role in teaching that enables individuals and utilizes the opportunities offered for communication and publishing in teaching.

We found that implementation of IT requires the knowledge about how it will be used should thus be in every work situation where the students are activated into this. In this way, students can explain what they do and why they do it. The modern technology helped teachers to monitor the student’s activity at

the individual and group levels. This tool is used to capture where the students are, how they have understood the goals and purpose of the work. Initially, during and or at the end of a lesson, students may be given the opportunity to formulate questions to the teacher, as well as the teacher providing continuous and forward-looking feedback. Some examples that students are given the opportunity to show what they have been able to do with ICT; summary, exit ticket, review, and participation at the group level (google document) or individual level (google document). It can be pointed out and emphasized that didactics and formative assessment have never ever had such a significant role and use for the purpose of what is intended. This is an incredibly resultant combination with ICT.

Teachers experience about gaining a conceptual depth show that reproducing of information for the student is not the best way of learning. Furthermore, interest increasing was indicated when students tried to connect their structured meanings of mathematical concepts with their own concepts and reality. Students became aware that basic concepts are important in order to construct and understand more abstract concepts. Therefore, the complexity and abstraction of new concepts should be incorporated into the reality of a deeper understanding. However, teachers get improved that the teaching should extend slightly above the students' level for a challenge as well as the desire for learning in relation to new concepts. This creates greater meaning and context in relation to the content.

The other interesting result of our case-study is about the creating of “questions” which can stimulate and activate students learning. For a conceptual depth, it requires asking relevant questions based on a student’s prior knowledge. The most effective questions for students in grade 4 were teachers’ questions which were connected to the students' experiences (Knowledge increase was indicated as a max, 62%). The questions should form and balance between the concrete and the abstract in the teaching. Mastering this ability causes the student to create curiosity and see himself as a continuous seeker in the field and be able to move within conceptual hierarchies. As more teaching situations we invite students to the new concepts as more this results in the conceptual levels of the subjects. In this way, students are not left alone in their knowledge development.

How fourth-graders experience the Student-Centered facilitation? Students were enabled to find the connections between classroom contexts and reality outside the school. The reality that surrounds us today is so complex and abstract that, as a rule, students and teachers cannot understand it simply by the way being in it. Students experience this complex and abstract world mostly outside the school, but they miss it in the school world. The students choose another role - not to be passive and reproductive. They are interested in how the concepts meet the ideas, simply letting the students solve problems themselves and in collaborative ways. The development of conceptual knowledge requires such meanings and teaching should be organized around these meanings. Collaborative activity is very important to students and creates good conditions for the students' possible development zone. The possibility for the students to experience the concepts in activity is very important. Furthermore, students develop their ability to provide structures. In our case-study, 90% of students highlighted such activities as the main factor which affects their interest in mathematics. We believe that this approach should be a frequent feature of teaching. Therefore, the most obvious teaching problems should be encountered by the students and solved continuously as well.

4 CONCLUSIONS

In this case-study, we attempted to preliminary identify some aspects of the implementation of the HIIO-model in teaching mathematics in Swedish Middle school. We examined key problems of the implementation process which are related to the transition’s possibility for teachers. We found that students’ knowledge increase was 62% and 90% of them indicated an interest in this way to learn mathematics.

Finally, a number of other findings in this case-study deserve further investigation before more suggestions can be made and offered.

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