UNDERGRADUATE STUDENTS' PROJECTS WITH SPECIAL NEEDS PUPILS[1]

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ABSTRACT

The paper considers particular projects undertaken by undergraduate students' during the course of didactics of mathematics, which is part of the five year full time study for future teachers of special needs pupils. The projects involved the students doing experiments with special needs pupils in their schools. Following the work in school the students had to describe their experiments, then analyse them together with any work produced by the pupils to determine the pupil's abilities and/or thinking processes during the solving a mathematical problem. The student's own analysis of their experimental work with the pupils has subsequently been analysed by the tutor, who concentrated on the following aspects: how did the student work with the pupils?; how confident is the student in evaluating/analysing his/her pupils` work?. How can the student's own attitude towards mathematics and the understanding of mathematics be changed by having to prepare and present experiments, then work with pupils doing mathematics. Does evaluating/analysing his/her pupils' work also help this change? One project is considered from these points of view.

Keywords: student-teachers, student's project, pre-service of special needs pupils, experimental work, unconventional classroom mathematics, student's analysis of pupil's work, analysis of student's project

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1. Introduction

The projects of twenty-eight undergraduate students' were analysed, five of these became integral parts of broader research and have been/are to be submitted as diploma theses. As future special needs teachers the students undertake these projects when they are in year 3 of their study. The whole course of study lasts five years with mathematics being studied for two years, geometry and arithmetic in year 2 and mathematics education in year 3. These students have five weeks teaching practice in schools/other institutions for special needs. It sometimes happens that they do not teach mathematics during this practice because they are teaching other subjects or they are working in hospitals or penitentiaries where mathematics is not taught.

2. Theoretical framework

What do these students need in order to be able to teach mathematics? They are given lectures/seminars on theories of mathematics education and the tutor gives examples of the theory in practice from his/her own teaching experiences. However we believe that together with these lectures/seminars the students should have their own first-hand experiences of working with pupils whilst they are doing mathematics. Such experiences show the student-teacher that they need to have sufficient mathematical knowledge themselves to be able to satisfy the pupil's quest for knowledge, they need to be able to establish good teacher-pupil relationships, they also need a portfolio of teaching strategies which they can draw upon to meet the very different needs of a broad subject like mathematics. This belief is supported by writers such as Mason (1994), who writes "I see working on education not in terms of an edifice of knowledge, adding new theorems to old, but rather as a journey of self discovery and development in which what others have learned has to be re-experienced by each traveler, re-learned, re-integrated and re-expressed in each generation"; Sierpinska and Leman (1996) who state that "knowledge in relation to theory of instruction, should be regarded as 'potential of action developed through experience'"; whilst Tall (2001) states "In preparing students to be teachers of primary mathematics, I have advocated that they need to have a real insight into how mathematics develops cognitively. ...It means starting to reflect on one's own experiences to see why certain things were difficult, or even impossible, at the time."

3. The situation

A common reason why these students – future special needs teachers – wish to study at the university arises from their need to help children or people with special needs. From such a student's point of view, 'to help' means becoming a teacher so that they can improve the abilities of special needs pupils in all school subjects in order that these pupils can integrate into normal life. The majority of these students give this goal the highest priority. However one of the subjects they have to teach is significantly different from all other subjects for most of them and that is mathematics. Most of these students do not like mathematics because they have had bad experiences themselves whilst learning the subject. They are afraid of mathematics. They do not have the confidence to solve mathematical problems. They remember how they were taught and their template for teaching mathematics is to give pupils a set of instructions for solving a particular type of problem, to require the pupils to memorise algorithms and definitions and to apply these by rote. The students also feel that mathematics is not an appropriate subject for

special needs pupils because they think it is too difficult for these pupils, especially for mentally handicapped pupils. The students have not had experiences that show that mathematics can enrich the intellectual life of anyone. They come to the university with belief that the subject - mathematics is an institutional obstacle, which it is necessary to overcome in order to be able to help pupils.

4. The necessity of a change

The situation described above shows the absolute necessity to change the students' attitudes towards mathematics. This implies a complete change of teaching strategies from the traditional way in which students are taught at university. We want the students to experience that mathematics can enrich everyone and to understand that mathematics is as a part of our culture, and not just drill exercises to enable the teacher to see who can recall algorithms from memory. We try to achieve this goal in the following ways:

• To build up the student's belief in his/her own mathematical abilities. We individualize the mathematical needs of each student so that they can find appropriate tasks for themselves, which are not too difficult and not too trivial, otherwise the tasks do not help to build their self-confidence in their mathematical ability. In our experience we have found that the best way to do this is to give the students sets of graded tasks so that they can find the task that enables them to experience success in solving process as a result of their intellectual work.

• To use constructivistic approaches in mathematics teaching.

- We want the students to discover their own strategies as they solve mathematical tasks.

- We want the students to discuss with each other and the tutor, their strategies of how to solve the tasks; whether the tasks are solvable or not; whether all possible solutions have been found; the moment in a solving process when the students felt hopelessness. We want them to learn from their mistakes.

- The tutor initially leads/chairs discussions on mathematics in the student group. Eventually the students suggest their own ideas in the discussion which may or may not agree with the tutor's point of view. The more reticent students see their classmates contributing their ideas and this makes them willing to offer ideas into the discussion.

• To experience mathematics through observing pupils doing mathematics.

The mathematics, which these students are asked to do in school, is not conventional classroom mathematics but comprises non-traditional problems and environments, for instance making buildings from dice with the pupils having to sum the visible dots on them. Some tasks involve tetraminoes or pentominoes, orientation in the plane, making buildings from cubes and recording their characteristics, addition triangles, triads, patterns, combinatorial problems and so on. The students prepare their own formulation of the problems for the pupils of a certain grade (not necessarily with special needs pupils), and usually express some thoughts on how they think the pupils will solve them. The students then do the experiments with the pupils. We use non-traditional problems and environments so that the pupils cannot use nor rely on memory/skills used and already met in the classroom. The pupils often ask unexpected questions and use unusual strategies and the students in the role of teacher/researcher have to react to these. The students observe the pupils working and then write down their experiences from experiments. This write up and analysis of their work is the main part of their projects.

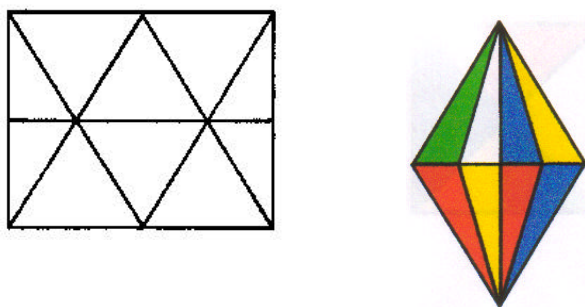# 5. The project: How many triangles are in the figure?

- **Characteristics of the student Peter**

Peter was a 2nd year student with average ability in mathematics. He was hard-working but sometimes he had difficulties with mathematics. His attitudes towards mathematics could be described as follows: He was afraid of doing mathematics individually. He was not sufficiently confident of his intellectual ability to believe he could solve problems on his own. He was very nervous when tests had to be written. But he liked discussing the problems or tasks in his student group. He usually offered some strategies how to solve it them. He often came to black board to describe the strategies.

- **Description of the project**

Peter made cards on which were geometrical figures (one figure on each card) consisting of white-black or colored triangles (16 cards with white-black triangles and 16 cards with coloured triangles, see Fig. 1). These cards (13x9 cm) were covered with film so that they would not be damaged when used. It is possible to wash the cards if a marker is used on them.

Figure 1

The aim of his project was to observe how pupils of different ages were able to distinguish triangles in figures. He asked pupils how many triangles there were in the figure and he measured the time taken for finding that number of triangles, which a particular pupil thought, was the total. Because he wanted to do a broader investigation, not only with pupils but also with students and adults he asked one classmate to help him.

Peter prepared tables for recording the given task and time needed for the pupil to discover the number of triangles.

He also prepared and used a computer program with the geometrical figures on the screen. The size and colors of figures were same as on the cards. The program was supported by sound-track instruction for the pupils and the tasks became more accessible for pupils with reading difficulties than when the tasks were on the cards only. It is worth noting that the pupils considered as game and not as task the computer version of the task.

The first investigation was carried out with white-black figures. He observed 34 pupils/students, aged 7-18. The second investigation was carried out with colored figures. He observed 59 people aged 6-41. The third investigation was carried out with figures on the computer. He observed 29 pupils/students aged 6-20.

All the results of his investigations were elaborated in four tables and eleven graphs (with the help of the computer). He then looked for correlations between age and success in the experiment

for all 'pupils' and then male and female separately followed by the correlation between the time taken to complete the experiment and age.

His analysis of his results showed some of the figures had caused more difficulties than others for the pupils/students/adults. The pupils were the most successful when they solved the tasks on the computer. Young males were considerably more successful than females, but from the age of fourteen upwards, these differences decrease. He was aware that he could not make general conclusion from such small sample.

- **Analysis of the project**

Peter created his own non-traditional mathematical environment for pupils. In order to help pupils with reading difficulties he decided to computerize his original cards and used the computer program Quarelldraw, which was new for him and he had to learn to work with it. He also learned how to provide the computer version with sound-track instructions. It told the pupils what they had to look for and if their answer was right or not. He learned to work with different age groups (from child to adult age). He learned to make graphs and evaluate them. He learned the necessary statistical theory that he had to use when analyzing his results. On the basis of these facts we can see that Peter's self-confidence in his mathematical ability rose. He was not afraid to work on his own. He used mathematics not only as a tool for investigating thinking processes (that is, how pupils/students solved the tasks) but as a tool for statistical analysis of his investigation. At the end of year 3 of his study he decided to continue with this work and to use these initial results as a base for his diploma thesis.

6. Conclusion

Peter's project is an example of the student who gained confidence in his own ability by carefully looking at the teaching strategy he was using and deciding to put his task into a computer program to help weak readers, choosing a task in which he was interested in, particularly the effect of age on the results and his need to analyse the data he gathered. All this gave him the incentive to go much deeper into his own mathematical thinking, to research the necessary computer techniques and mathematics needed to present his tasks, to analyse the data he had gathered and to communicate his results in his project. This work in turn made him realise that mathematics was not the subject to be feared and each small success which he achieved as he went through this process helped to build up his confidence in his own ability. This experience will encourage him to try things in future, which previously he would have thought beyond his intellectual capacity.

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