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Reality and Dream: An Analysis of Preschool Prospective-Teacher Students' Reports on Observation and Examination of Preschool Mathematical Environment

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ABSTRACT

This Action Research study is focused on the analysis of observational reports produced by preschool prospective-teacher students in a university course of Teaching and Learning preschool mathematics. The reports contain students' reflections about how Bishop's mathematical activities (*Measurement, Location, Counting, Design, Playing* and *Games, Explanations,* and *Reasoning*) can be used in preschool environment. The purpose of this study is to further develop our university practice in Teaching and Learning mathematics and to find out how well students are learning and applying the course's content. We present a scoring system to analyze how our students perceive mathematical environments in preschools and how conceivable mathematical development of preschool children is described in student's reports. The result indicate that students describe all Bishop's mathematical activities but not equally well since some of the students do not master the desirable knowledge and skills in preschool Teaching and Learning mathematics. Based on the analysis, we redesign the future course content to provide more in-depth knowledge of the subject. This is crucial for preschool prospective-teacher students' professional development in providing preschool children with a stable mathematical foundation.

Keywords: Bishop's activities, prospective-teacher students' education, Action Research, preschool

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Introduction

This study is dealing with education of preschool prospective-teacher students in the subject of Teaching and Learning preschool mathematics. One of the central areas in Teaching and Learning mathematics in preschool is dealing with how children receive their initial mathematical knowledge.

This work is based on Alan Bishop's study of geographically and culturally distinct groups of early childhood learners of mathematics. He has found that although learning of mathematics can develop differently in different cultures there are six universal mathematical activities that are used in early childhood in all cultures. He called these activities *Designing, Explaining, Playing and Games, Locating, Measuring,* and *Counting* (Bishop, 1988; Bishop 1991; Bishop, 2014, Helenius et al., 2014). The Curriculum for the Swedish preschool (Skolverket, 2019) has been developed in accordance to Bishop's activities as it is described by the Government's Education Department document *Preschool in Development* (Riksdag, 2015). The current goals of preschool education in mathematics in Sweden are to develop children's "ability to use mathematics to investigate, reflect on and try out different solutions to problems raised by themselves and others, an understanding of space, time and form, and the basic properties of sets, patterns, quantities, order, numbers, measurement and change, and to reason mathematically about this, an ability to discern, express, investigate and use mathematical concepts and their interrelationships" as they are formulated in the current curriculum (Skolverket, 2019). The curriculum also states that playing and investigating should permeate activities and environment in the preschool education. Thus, the Curriculum's goals are to teach through playing, as well as through everyday activities and they should be evaluated through the analysis of the preschools' activities and environments and not through analysis of children's knowledge. Therefore, this study is focusing on our preschool prospective-teacher students' ability to analyze preschool's mathematical environments during their practice in preschools. Do they have a sufficient knowledge in Teaching and Learning mathematics in preschool to perform such analysis? If not - how we can adapt our course in this subject to help the students to plan and implement opportunities for preschool children's mathematical learning via playing and everyday activities. We have therefore chosen to call our study *Reality and Dream*.

It has been shown before that preschool teachers have a key role in defining the object of learning in mathematics and choosing how to work on it with the children. Their choices and priorities determine the activities performed with the children, the quality of such activities and the quality of mathematics education in preschool (Lerkkanen et al., 2012). Sundberg and Ottander have studied an attitude toward mathematics and science in a cohort of students enrolled in prospective-teacher education in Sweden (Sundberg & Ottander, 2014). In this study it was shown that the analyzed students' cohort did not have any clear plans that would focus on developing preschool children's mathematical knowledge and skills through purposefully designed

mathematical activities. This result suggests an urgent need in developing the teacher education courses in Sweden in the areas of Teaching and Learning mathematics for prospective preschool teachers. To develop such educational practices, the university tutors like us can perform studies in which they can analyze and reflect on their own educational practice. In such studies the tutors themselves are doing an *Action Research* study, while in traditional research they usually are only the objects of a study by other researchers (Mills, 2000). An *Action Research* study may help tutors to plan and to reflect on educational practices, evaluating prospective-teacher students' knowledge, expressing ideas, building language, gaining perspective, and assessing quality of the acquired knowledge. An action research approach in this study serves to create preschool prospective-teacher students' awareness of their ability to understand mathematics, to build their confidence in Teaching and Learning mathematics as well as being able to teach mathematics in preschool. Therefore, to develop further this line of research we study our preschool prospective-teacher students' ability of observing and analyzing mathematical environments in preschools from the point of view of Bishop's activities.

Materials and Methods

There are two courses in Teaching and Learning Preschool Mathematics in our university's Preschool Prospective-Teacher education program. Our study is based on the first of these courses, called *Preschool Mathematics,* in which preschool prospective-teacher students are being taught about Bishop's activities through lectures, seminars and literature. This course is given during five weeks in the third semester out of the program's eight semesters in total. As part of an examination assignment, students visit preschools for field studies. Each student has a task to observe and give a description about the "real life situation" and also about what they think should be added to this preschool's environment for having a "dream-scenario" to successfully implicate Bishop's activities for children's mathematical development. Preschool prospective-teacher students write individual reports about one's observations from the Teaching and Learning preschool mathematics and Bishop's activities point of view. For the study presented here, after the course was completed, we asked the students to give us a permission to use their reports anonymously for our research. Of those students who gave their permission, 60 reports were chosen randomly with the help of a computer program *Microsoft Excel* (Microsoft 365 Apps for Enterprise).

We analyze student's written observations and their evaluations of how Bishop's activities are used or can be used in the observed preschool's mathematical environment. In the analysis we consider how broadly and deeply our students' reports describe the application of Bishop's activities. To be able to do that, we devised a system to analyze the reports both quantitatively and qualitatively. Quantitatively - in the sense that we analyze to which extend the content is mentioned. Qualitatively - in the sense that we

analyze whether a content is only mentioned or whether it is described with more depth and understanding. The system is built on a 5-point scale (points from 0 to 4), where 0 points are given if the student not even mentions the activity or its content, while 1 point is given if the student only mentions but shows no deeper knowledge. Finally, 2-4 points are given when the student shows deeper knowledge in relation to students' skills in–Teaching and Learning mathematics. Some aspects, such as if only the title of the activity is presented or not even that, are scored with 1 or 0 point respectively. By systematically labeling and codifying the content in the reports, we analyze the patterns of content applying qualitative and quantitative approaches to the content of students' reports.

To analyze qualities in students' reports, we further brake down Bishop's activities in subcategories to make visible and concretize the content of mathematics more nuanced. In our system the number of subcategories vary between the different activities. We reflect on whether all aspects are equally important for preschool teacher education and we feel that some aspects have higher relevance while others are not as central for children's early mathematical development. For example, we consider that for the activity *Measuring*, a subcategory *Length* (development of one-dimensional thinking) has higher relevance in preschool than, for example, a subcategory *Area (*two-dimensional thinking*).* Since the number of subcategories in our scoring system varies between different activities, total scores regarding the sums between the different activities cannot be directly compared with each other without an additional adaptation. We therefore make an overall assessment, using the same scale (0-4), of the students' demonstrated knowledge within each activity, as illustrated in Table 1.

For studying students' reports we are also employing a research method of *Content Analysis* (Stemler, 2000). We apply this method as an *Action Research* study instrument. One of the key advantages of using this method in educational research is its non-invasive ethical nature, in contrast to simulating educational experiences or collecting survey answers (Krippendorff, 2004). By applying the *Content Analysis* methodology, we comply with the Law (2003: 460) on ethic approval relating to research on humans (Riksdag, 2003). Our study analyzes the mathematical environment and does not process any sensitive personal data; therefore, our research is not an issue for approval of its ethical legality.

Table 1. *Mapping the Content in Activity Measuring Regarding Qualities, an Example of the Analysis of 10 student's Reports*

Student	Measuring	Size, comparison	Weight	Volume	Length	Time	Area	Temperature	Value, money	Total		Overall assessment
	Mentioned	Mentioned	Points	Points	Points	Points	Points	Points	Points	Total		Points
1	1	1	1	2	2	1			4	12		3
2		1								1		0
3	1		2	2	3	3				11		3
4	1	1	2	2	2	2				10		3
5	1		1	2	1	3				8		3
6	1	1			1					3		1
7	1	1		1	1	2				6		2
8	1		2	2	2	2				9		3
9	1	1	2	2	2		2			10		3
10				2		2				4		2

Notes: The subcategories marked in green considered by us more important for preschool mathematical education than categories marked in yellow, while categories considered least important are marked in white. The table shows individual points within each subcategory and the overall score within the activity (the column to the right).

Results and Analysis

An example of how we apply our presented here analytical system and how we come to the obtained result is shown in Table 1. The column to the left shows different Bishop's activities and the right one shows total scores within each activity. A compilation of all 60 analyzed reports is presented in Table 2. As it can be seen in Table 2 the students show relatively low scores in all Bishop's activities. The first two scores for *Measuring* and *Designing* in Table 2 are higher, 115 and 112 points respectively, than the scores in the remaining four activities, from 83 to 95 points only. It can tell that students show more profound knowledge just in *Measuring* and *Designing* compared to the other activities. Therefore, students' observations touch upon Bishop's activities *Measuring* and *Designing* more broadly and deeply, while other Bishop's activities namely *Locating, Counting, Playing* and *Games,* and *Explaining*, are described by students less pronounced or sometimes are even missing in the

analyzed reports. Based on these results we conclude that students can improved their scores by focusing more on the later four activities. They need to concentrate their attention on how they can interpret the possibilities of working with these four of Bishop's mathematical activities in preschool environment.

Table 2. *Overall Results for Bishop's Activities in Analyzed Students' Reports*

Activity	**Total score (max 240 points)**
Measuring	115
Designing	112
Locating	95
Counting	97
Playing and Games	99
Explaining	83

Notes: The table shows a total score for Bishop's six mathematical activities. In each activity students can receive maximum 240 points (the amount of 60 reports multiplied with 4 points).

Our analysis shows further a correlation between the results in the categories of *Playing* and *Games* as well as in *Explaining* as compared to other four activities. The students who have high scores in *Playing and Games* as well as in *Explaining* show also high scores in the other four categories, while those who do not show considerable knowledge in *Measuring, Locating, Counting* and *Designing* can also not see how children's mathematical knowledge and skills can be developed through *Playing* and *Games* or through *Reasoning*. This suggests that we can divide the work with Bishop's activities between our two courses so that the first course can concentrate on students gaining knowledge about activities *Counting, Designing, Locating* and *Measuring*. Then in the second course the students can more focus on Bishop's activities *Playing* and *Games* as well as on *Explaining.* This distribution of activities between the courses can be productive and useful for students' learning and being able to explore Teaching and Learning mathematics in preschool through playful forms where children are given an opportunity to use and develop their mathematical reasoning skills.

Table 2 shows also that the overall score in each mathematical category is lower than tutors can hope for. In other words, the *Reality* does not correspond to tutors *Dreams.* It can be an effect of our analyzed course dealing with all six Bishop's mathematical activities. It can be too much for students to learn about all six activities in a single five weeks course. As it is mentioned above, one effect of the study's findings is that we will change the course content of our two preschool Teaching and Learning mathematic courses so that the first one will focus more on Bishop's activities *Counting, Measuring, Locating* and *Designing*, which incorporate basic mathematical theory. In the second course we will focus on *Playing* and *Games*, and on *Explaining* where previous mathematic knowledge will be contextualized and exemplified in these two activities.

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