13th International Congress on Mathematical Education
Hamburg, 24-31 July 2016

A STUDY OF THE TEACHING OF PROBABILITY TO STUDENTS JUDGED OR NOT WITH LEARNING DIFFICULTIES IN MATHEMATICS IN REGULAR ELEMENTARY CLASSES IN QUEBEC

Vincent Martin and Laurent Theis

University of Sherbrooke

In Quebec, a majority of elementary students with difficulties are taught in regular classes, but few studies have specifically characterized mathematics education provided to these students in this context. By using the concept of didactic intervention (Vannier, 2006; Vannier & Eichner, 2011) and a conceptual analysis of probabilities, the teaching practices of two third cycle teachers were studied. These teachers worked with the same didactical resource in order to teach probability to elementary students of regular classes they judged or not with mathematics learning difficulties. The results[1] obtained show that the teachers had difficulties with the frequentist probabilistic perspective and with the institutionalization of mathematical knowledge included in this task. They point out that the didactical conditions offered to the students judged with mathematics difficulties were of the same nature as those offered to the other students, but were less frequent and were given at particular moments.

CONTEXT

The mathematics education offered to students with difficulties in special classes were the subject of a lot of researches. They made it possible to have an accurate overview of the didactical conditions given to these students in that context (Salin, 2006). It is possible to observe that the didactical conditions elaborated by the special mathematics class teachers are fundamentally different the ones used by regular class teachers. Hence, it appears that, compared to the regular classes, the special classes present a mathematics educational context in which the didactical time progresses slower. This is due to the nature of the knowledges introduced in these classes and to the importance it is given (Cherel, 2005; Favre, 1997; Rene de Cotret & Giroux, 2003).

Unlike the mathematics educational methods in special classes, a small number of researches exclusively concentrate their attention on the mathematics education offered to students with mathematical learning difficulties in regular classes. The didactical conditions given to this category of student in this context remain mostly unknown. Unfortunately, in Quebec, the majority of the elementary students with mathematics difficulties are taught in regular classes (Government of Quebec, 2010). This is why this research is focusing on the didactical conditions elaborated by regular class teachers for elementary students with difficulties in mathematics.

CONCEPTUAL FRAMEWORK

Two concepts were used to guide and structure our work. On one hand, the concept of didactic intervention from the work of Vannier (2006; Vannier & Eichner, 2011) made it possible to look at the didactical interventions of the teachers on four levels: the didactical project's definition, the

[1] The results reported in this paper were extracted from our doctoral work (Martin, 2014).

institutionalization of knowledge, the devolution of the situation and the support given to the students during the resolution. On the other hand, the teaching of probabilities was selected as context for this research. This choice was made because probabilities are an important part of society (Albert, 2006; Hacking & Dufour, 2004). They also have great conceptual value which can be noted in the characteristics of the non-deterministic aspect of probabilities (Savard, 2008; Scheaffer, 2006; Theis, 2011), of different probabilistic perspectives (Batanero, Henry & Parzysz, 2005; Savard, 2008), of probabilistic conceptions (Kahneman, Slovic & Tversky, 1982; Fischbein & Schnarch, 1997; Shaughnessy, 1992;) and of challenges associated with the teaching of probabilities (Jones & Thornton, 2005; Stohl, 2005).

Three objectives were set: (1) to describe and understand the didactical interventions of two teachers for the teaching of probabilities in regular elementary classes in Quebec, (2) to describe and understand the didactical interventions made specifically for the teaching of probabilities to students with difficulties in mathematics and (3) to compare the didactical interventions given to students with difficulties in mathematics and to students without difficulties in mathematics.

METHODOLOGY

In order to have a better understanding of the teaching of probabilities to students with difficulties in regular elementary classes, a case study investigated two third cycle elementary teachers. This choice is based on the idea of having a multiple case study (Yin, 2003) which gives the opportunity to analyze each case as an independent entity and compare them with each other to distinguish their particularities (Roy, 2008).

These teachers were asked to use the same didactical resource about probabilities to conceive and apply a didactical project adapted to their students. This resource contains three probabilistic tools. For each of these tools, the students had to figure out the probability of winning so they could compare them and identify the tool that gave them the biggest probability. The resource offered many possibilities so that teachers had the freedom to target knowledges and learning challenges that fit their environment's constraints. A preliminary meeting was set to present the resource to the teachers before the data collection. During this meeting, an overview of some conceptual challenges linked to the probabilities was done.

Collecting the data from each teacher was done in three ways: a pre-action interview, an in-class recording while executing the task and a post-action interview. Moreover, the teachers were asked to sort their students under three categories: strong in mathematics, average in mathematics or having difficulties in mathematics. The data collected was transcribed, treated and analyzed through qualitative and quantitative analysis. Finally, some important facts linked to the teaching of probabilities and to the didactical conditions given to the students judged with difficulties in mathematics were identified.

RESULTS

The main results of this research show that both teachers had difficulties with the frequentist probabilistic perspective and the conceptual challenges linked to it, specifically with regards to how the variability was managed in the trials and how the results were linked with the theoretical probabilities. The institutionalization of knowledge included in the task was another challenge for them. They had a propensity to indicate the expected solution without necessarily discussing the

underlying probabilistic issues. When they did, they stayed close to the task and the tools and did not connect the knowledge targeted in the task to a larger context.

In this context, the didactical conditions set in the regular classes observed here seemed consistent and alike in nature when aimed toward the students judged or not with difficulties in mathematics. They were strongly influenced by the posture adopted by the teacher in regards of the conceptual challenges and by his own level of mastery of the mathematics knowledge included in the task. The way the teacher intervened and the way he managed the exchanges (his global intervention methods) also had an impact on the didactical conditions offered to the students. Globally, only a few measures were specifically implemented for the students with difficulties in mathematics or seemed to have a specific impact for this category of students. However, quantitative differences were observed for the number of interventions toward students judged or not with difficulties in mathematics and the moment during which these interventions were made during the execution of the task. On one hand, the interventions toward the students judged with difficulties in mathematics were, in proportion, less numerous than the interventions toward students not judged with difficulties in mathematics. On the other hand, both teachers mostly intervened with the students judged with difficulties in mathematics before and during the execution of the task with the tools.

The results of this research show that from the same didactical resource, both selected teachers planned different didactical projects, specifically with regards to the modifications of the resource and to the moment the task was proposed in the students' learning process. Moreover, during this didactical project, it was noted that the two teachers made fairly different didactical interventions. This is true for the enrolment of the students and for the emergence of the problem, for the support offered during the resolution and for the institutionalization of knowledge included in this task.

CONCLUSION

The results obtained show that planning a task using a resource with high mathematical and didactical potential is not enough to teach probabilities and to offer favorable didactical conditions to learn probabilities for students judged or not with difficulties in mathematics in a regular elementary class.

A special attention must be given to the probabilistic challenges inherent to the task while taking into account the didactical consequences caused by the teacher's choices before the students' first contact with the task. The posture adopted by the teacher regarding the probabilistic content and his general intervention methods within the task can also have an impact on the didactical conditions offered to students to learn probabilities. In addition, how the plenary discussion and the conclusion of the task are managed in order to encourage the institutionalization of knowledge included in the task seem to be crucial aspects to take into account in this context. Finally, it seems essential for these thoughts on the didactical conditions offered to students judged or not with difficulties in mathematics to learn probabilities in a regular elementary class to be included in the teachers training, especially regarding the level of mastery of the probabilistic content, the didactic choices, the general intervention methods and the plenary discussion and the conclusion management.

References

Albert, J. (2006). Interpreting probabilities and teaching the subjective viewpoint. In G.F. Burrill, & P.C. Elliott (Eds.), *Thinking and reasoning with data and chance (*p. 417-433). Reston, VA: NCTM.

Batanero, C., Henry, M., & Parzysz, B. (2005). The nature of chance and probability. In G.A. Jones (Ed.), *Exploring probability in school: challenges for teaching and learning* (p. 15-37). New York: Springer.

Cherel, C. (2005). *Deux élèves en difficulté s'intègrent à une classe ordinaire le temps… des mathématiques*. Montreal, Éditions Bande didactique.

Favre, J.-M. (1997). *L'échec, le temps, la multiplication*. Master's thesis, University of Geneva.

Fischbein, E., & Schnarch, D. (1997). The evolution with age of probabilistic intuitively based misconceptions. *Journal for Research in Mathematics Education, 28*(1), 96-105.

Government of Quebec (2010). *Indicateurs nationaux des plans stratégiques*. Quebec: Ministry of Education, Recreation and Sports of Quebec.

Hacking, I., & Dufour, M. (2004). *L'ouverture au probable.* Paris: Armand Colin.

Jones, G.A., & Thornton, C.A (2005). An overview of research into the teaching and learning of probability. In G.A. Jones (Ed.), *Exploring probability in school: challenges for teaching and learning* (p. 65-92). New York : Springer.

Kahneman, D., Slovic, P., & Tversky, A. (Eds.) (1982). *Judgement under uncertainty: Heuristics and biases.* Cambridge, MA: Cambridge University Press.

Martin, V. (2014). *Étude des interventions didactiques dans l'enseignement des probabilités auprès d'élèves jugés ou non en difficulté en mathématiques en classes ordinaires du primaire.* Doctoral thesis, University of Sherbrooke, Quebec.

Rene de Cotret, S., & Giroux, J. (2003). Le temps didactique dans trois classes de secondaire I (doubleurs, ordinaires, forts). *Éducation et francophonie, 31*(2), 155-175.

Roy, S.N. (2008). L'étude de cas. In B. Gauthier (Ed.), *Recherche sociale. De la problématique à la collecte de données* (p. 199-225). Sainte-Foy: Presses de l'université du Quebec.

Salin, M.-H. (2006). À la recherche de milieux adaptés à l'enseignement des mathématiques. In J. Giroux; & D. Gauthier (Eds.), *Difficultés d'enseignement et d'apprentissage des mathématiques. Hommage à Gisèle Lemoyne* (p. 195-218). Montreal, Éditions Bande didactique.

Savard, A. (2008). *Le développement d'une pensée critique envers les jeux de hasard et d'argent par l'enseignement des probabilités à l'école primaire : vers une prise de décision*. Doctoral thesis, University Laval, Quebec.

Scheaffer, R.L. (2006). Statistics and Mathematics: On Making a Happy Marriage. In G.F. Burrill, & P.C. Elliott (Eds.), *Thinking and reasoning with data and chance* (p. 309-321). Reston, VA: NCTM.

Shaughnessy, J.M. (1992). Research in probability and statistics: reflections and direction. In D.A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (p. 465-494). New York, NY: NCTM.

Stohl, H. (2005). Probability in teacher education and development. In G.A. Jones (Ed.), *Exploring probability in school: challenges for teaching and learning* (p. 345-366). New York : Springer.

Theis, L. (2011). Quelle formation mathématique pour les futurs enseignants du primaire et du préscolaire? A la recherche des mathématiques dans une séquence sur l'enseignement des probabilités. In J. Proulx, H. Squalli, & C. Corriveau (Eds.), *La formation mathématique des enseignants* (p.181-204). Quebec : Presses Universitaires du Quebec.

Vannier, M.-P. (2006). Fonctions critiques de la tutelle auprès d'élèves en échec scolaire. *Nouveaux cahiers de la recherche en éducation, 9*(2), 169-186.

Vannier, M.-P., & Eichner, M. (2011). L'étayage de l'activité langagière en entretien de bilan. *Éducation permanente, 189*, 165-173.

Yin, R.K. (2003). *Case study research. Design and methods.* Thousand Oaks, CA: Sage Publications.