SHE WILL BE LOVED: COLLABORATIVE PROJECT WORK AND STATISTICS LEARNING

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In a knowledge-based society in which quantitative data play a major role, namely in the media, statistical literacy is becoming more and more essential in order to be a critical and active citizen. Although this is usually recognised in literature and in policy documents, statistics learning has not changed much and still needs further evolution in terms of daily practices. Research data underlines the role played by project work and by collaborative work as mediators and facilitators of transitions from students' previous knowledge and life experiences, and academic knowledge. Interaction and Knowledge is a research project aimed at studying and implementing peer interactions to promote students' academic achievement. Results illuminate that project work associated to collaborative work is a powerful tool for statistics learning. A critical analysis of some cases also show the challenges associated to this kind of work.

INTRODUCTION AND THEORETICAL BACKGROUND

Statistics is part of our daily life. Thus promoting statistical literacy is one of the ways of empowering students in order to become active and critical citizens (Lajoie, Jacobs, and Lavigne, 1993). Statistical literacy includes decision making, critical analysis of information, selecting the best criteria for studying a phenomenon, constructing data collection instruments (e.g., questionnaires), controlling variables, choosing the most adapted statistical treatment, or understanding statistical patterns in order to explain statistical findings (Cobb, 1999; Megid and Carvalho, 2005). This means statistical literacy is a complex competency, which must be developed through different learning experiences, like project work, statistical treatment and analysis of real data, problem solving, and statistical decision (Abrantes, Serrazina, and Oliveira, 1999; Batanero and Godino, 2001; Ponte and Fonseca, 2001).

Several authors stress the importance of relating statistics learning to real situations (Abrantes, 1994; Campos and Wodewotzki, 2005; Cobb and McClain, 2004), namely in order to promote community-based learning (Thorme and Root, 2002). When one aims at promoting learning communities, facilitating students' passage from peripheral participation to a legitimate participation as a way of empowering them (Lave and Wenger, 1991; César, in press), then working with real situations becomes a *must*. Real situations can be well explored and analyzed through project work, as it allows for studying real problems which are part of that community.

Project work is particularly recommended for the learning of statistical contents as it is suited to complex problems and themes, to studies that need to be accomplished over a long period of time, in which reflection during practice is vital for progress in that work (Abrantes, 1994; Boutinet, 2002; César, in press), and also in works that are shaped by participants' beliefs and attitudes as often happens in statistical analysis (Gal and Ginsburg, 1994; Gal, Ginsburg, and Shau, 1997). But as Mendes (2005) states, "unfortunately many teachers still believe that doing a project is the same as collecting data (...) namely because during their pre-service education many teachers' academic projects only consisted of data collection and their presentation in graphics and tables, without any kind of detailed analysis" (pp. 1-2). Teachers' pre- and in-service education is not the only element explaining why so many of them still feel unsafe, unable, or uncomfortable when they have to deal with uncertain events, students' questioning, or other characteristics of project work. But if project work was included in teachers' education they would probably feel more at ease to promote it in their own classes.

But in order to empower project work students need to be able to work collaboratively in an effective way. Several authors have stressed that collaborative work is an effective means of promoting knowledge appropriation as well as the mobilization and development of competencies (César, 2003, in press; Perret-Clermont, Pontecorvo, Resnick, Zittoun, and Burge, 2004; Vygotsky, 1978). When used in statistics learning collaborative work also proved to be effective in promoting students' argumentation, critical analysis of data and data treatment, or academic

contents appropriation (Carvalho and César, 2000, 2002). But in order to be effective, collaborative work associated to project work must be included in a coherent didactic contract, which creates an appropriate class culture (César, 2003).

METHOD

This work is from the *Interaction and Knowledge* research project whose main aim is to study and promote peer interactions as a way to mediate and facilitate knowledge appropriation as well as the development of students' competencies (socio-cognitive and affective). This work is included in level 2, an action-research level, in which teachers also act as researchers, implementing collaborative practices during at least a whole school year. Data were collected in 6 classes (10^{th} grade students, 15/16 years old), from 2 different schools, in 2 different Portuguese towns, through participant observation (registered in teachers' note books), some of them audio and/or video taped. There were different observers, including external observers and external evaluators. We also collected photos, questionnaires, school documents, students' protocols and project work. The project work was implemented every fortnight, during the 2^{nd} and 3^{rd} terms. This means that statistical contents were learnt during the same terms students were also learning functions contents. The decision making concerning project work was mostly done by students: the theme, questionnaire, data treatment, data presentation and discussion, general discussion, and presentation for the educational community were aspects decided by students. Group composition was the teachers' responsibility, according to the usual didactic contract implemented in these classes (César, 2003, in press). Research decisions were made by students, teachers/researchers and researchers altogether, including the ones related to data dissemination because this was also part of the collaborative work we aimed at implementing.

RESULTS

Deciding the theme of statistics project work allowed students to make connections between statistics and real life problems, as well as between statistics and other subjects. Like other teenagers, these students were concerned with current problems, such as drug and/or alcohol abuse, sexuality, money spent by teenagers, or music preferences. Thus, being allowed to study themes that were really in the top five of their usual conversations was a motivating starting point.

Another feature that interested them was to be able to know their educational community better but in a scientific way, not through mere opinions that are not supported in any kind of empirical evidence. Thus, studying a representative sample of their secondary school students was also an interesting point for them, above all because they felt they could have a chief role in the exhibition that would take place at the end of the school year. In fact, their statistical projects were one of the most important points, namely for parents, and other members from the educational community. And students felt so responsible and engaged in the work they had developed that they scheduled themselves in order to be there all the time and to explain and discuss with visitors the statistical work they had done.

Students worked in 4-element groups. They collected data through the questionnaires they elaborated. In order to construct them they discussed the different types of questions and numerical scales, as well as the information they would obtain. Then, after collecting the questionnaires' answers they had to decide about statistical treatment. Most of the groups began with the statistical treatment they already knew, like graphs, tables, means, and modes. But they also searched in textbooks about the new contents of the 10^{th} grade, like standard deviation, or quartiles. And even if these were completely unknown contents, they were able to process the textbooks' information, to discuss it within their group, and to appropriate it in order to apply it to their project work. This means students were not merely learning statistics contents, they were also developing social competencies like autonomy, sense of responsibility, decision making, respect for other people's opinions and arguments, search for scientific support, among others, which is also stated by other authors who promote project work associated to collaborative work (Martins, Santos, Ferreira, and César, 2003).

Participant observation (notes, videos, audio tapes, and photos) showed that students were really engaged in their work, and that they appreciated learning statistics through project work (César, in press). This is also stated in their accounts, namely in the questionnaires and

interviews. They particularly valued learning by themselves and being able to overcome difficulties, sharing knowledge and doubts, teachers' challenging questions and comments, and the process of evaluation that was implemented and which included their own participation. They also stressed the fact that for the first time they were doing a work from top to bottom, and that they also classified it as "a useful work not only for school but for their lives".

Although being very enthusiastically accepted by students, project work made teachers/researchers meet and discuss for a long time in order to plan it, decide how they would act, discuss the evaluation process, and feel secure enough to let students have as much autonomy as they needed. Teachers who already worked collaboratively did not feel so many difficulties implementing project work. But teachers from other classes and/or subjects, who did not work collaboratively in their classes, were not so successful, probably because students did not understand the sudden change in their didactic contract, and then they did not engage in the new practices they tried to implement in their classes. This is precisely why a coherent didactic contract, implemented since the beginning of the school year, is a decisive element in this process (Abrantes, 1994; César, 2003, in press).

Even those who were used to working collaboratively had to understand the differences between problem solving activities, investigative activities, and project work, namely as regards evaluation. In the beginning (António, Mesquita, Neves, Martins, and César, 2000) we tried to follow other authors' recommendations concerning project work and to grant a very secondary role to evaluation (Abrantes, 1994; Boutinet, 2002). But this proved to be inadequate to Portuguese class culture, as students seemed to be unable to really engage in very long project work if they did not receive any kind of evaluative feedback about their quality. Thus, we had to prepare evaluation instruments that allowed students and teachers to evaluate their own progress, and which also facilitated students' plans concerning future work. The collaborative work among teachers/researchers, as well as between them and students was a very important step to achieve this goal, and to be able to implement statistics project work in more effective ways.

After 7 years of project work implementation we feel that we have progressed a lot, but we still discuss what can be improved, and what needs to be changed in order to offer a quality education for each and all students. Meanwhile classes became more multicultural than they were before, and we know that we must pay special attention to cultural diversity in order to promote equity (César, 2003), and to be able to contribute to more inclusive learning settings. We believe that statistics learning can be a main contribution to more effective citizenship. But to achieve this we must find effective ways of learning statistics contents, like project work associated to collaborative work.

FINAL REMARKS

Project work associated to collaborative work is a powerful tool to use in statistics leaning, but it is also a method that needs further discussion. Considering learning as situated (Lave and Wenger, 1991), and then influenced by culture, namely school and class culture, teachers need to take cultural elements into account when they implement new practices.

Collaborative work was a major feature. Thus, teachers/researchers had a critical approach to learning and they shared, discussed, and co-constructed their conceptions, social representations, and practices. This means having an interventive goal that was only possible through questioning their practices and reflecting upon them, both with their colleagues and their students. Students' accounts through the questionnaires and interviews were very helpful in order to implement better adapted practices, and to achieve the evolution of project work through the school years. This is a never ending process that needs constant adaptation, and refinement. But it is also a promising way of promoting students' learning as well as teachers' development.

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REFERENCES

Abrantes, P. (1994). *O Trabalho de Projecto e a Relação dos Alunos com a Matemática*. Lisboa: APM.

Abrantes, P., Serrazina, L. and Oliveira, I. (1999). *A Matemática na Educação Básica*. Lisboa: Ministério da Educação.

António, C., Mesquita, S., Neves, S., Martins, M. and César, M. (2000). Estatística 10º ano: (H)isto gramas tu!. In E. Fernandes and J. F. Matos (Eds.), *Actas do ProfMat2000*, (pp. 181-188). Funchal: APM.

Batanero, C. and Godino, J. (2001). *Análisis de Datos y su Didáctica*. Granada: Departamento de Didáctica de la Matemática, Universidad de Granada.

Boutinet, J. P. (2002). *Antropologia do Projeto*. Porto Alegre: Artmed.

Campos, C. R. and Wodewotzki, M. L. (2005). A didáctica da estatística: Soluções para a sala de aula. In, *Actas do V CIBEM*. Porto: APM.

Carvalho, C. and César, M. (2000). Co-constructing statistical knowledge. In S. Starkings (Ed.), *Papers on Statistical Education*, presented at ICME9, (pp. 53-59). London: IASE and South Bank University.

Carvalho, C. and César, M. (2002). Sharing ideas and statistics leaning: The role of peer interaction in school context. In B. Phillips (Ed.), *Proceedings of the Sixth International Conference on Teaching of Statistics*, Cape Town. Voorburg, The Netherlands: International Statistical Institute.

César, M. (2003). A escola inclusiva enquanto espaço-tempo de diálogo de todos e para todos. In D. Rodrigues (Ed.), *Perspectivas Sobre a Inclusão: Da Educação à Sociedade*, (pp. 117 – 149). Porto: Porto Editora.

César, M. (in press). Come away with me: Statistics learning through collaborative work. In *ICME 10 Proceedings*. Copenhagen: Roskilde University.

Cobb, P. (1999). Individual and collective mathematical development: The case of statistical data analysis. *Mathematical Thinking and Learning*, 1(1), 5-43.

Cobb, P. and McClain, K. (2004). Proposed design principles for the teaching and learning of elementary Statistics. In D. Ben-Zvi and J. Garfield (Eds.), *The Challenge of Developing Statistical Literacy, Reasoning and Thinking*. Dordrecht: Kluwer Academic Publisher.

Gal, I. and Ginsburg, L. (1994). The role of believes and attitudes in learning statistics : Towards an assessment framework. *Journal of Statistics Education*, 2(2), 1-16.

Gal, I., Ginsburg, L. and Schau, C. (1997). Monitoring attitudes and believes in statistics education. In I. Gal, and J. B. Garfield (Eds.), *The Assessment Challenge in Statistics Education*, (pp. 37-51). Netherlands : IOS Press and the International Statistical Institute.

Lajoie, S., Jacobs, V. and Lavigne, N. (1993). Empowering children in the use of statistics. *Journal of Mathematical Behavior*, 14, 401-425.

Lave, J. and Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Martins, M., Santos, P., Ferreira, C. and César, M. (2003). A nossa amiga estatística. *Actas do ProfMat 2003*. Santarém: APM.

Megid, M. A., and Carvalho, D. L. (2005). Professores e alunos construindo saberes e significados em um projeto de estatística. In, *Actas do V CIBEM*. Porto: APM

Mendes, C. (2005). Estatística para futuros professores de matemática: Aplicando a pedagogia de projetos. In, *Actas do V CIBEM*. Porto: APM

Perret-Clermont, A. N., Pontecorvo, C., Resnick, L. B., Zittoun, T. and Burge, B. (2004). *Joining Society: Social Interaction and Learning in Adolescence and Youth*. Cambridge: Cambridge University Press.

Ponte, J. P. and Fonseca, H. (2001). Orientações curriculares para o ensino da estatística: Análise comparativa de três países. *Quadrante*, 10(1), 93-132.

Thorme, T. and Root, R. (2002). Community-based learning: Motivating encounters with real-world statistics. In B. Phillips (Ed.), *Proceedings of the Sixth International Conference on Teaching of Statistics*, Cape Town. Voorburg, The Netherlands: Inter. Statistical Institute.

Vygotsky, L. S. (1978). *Mind and Society: The Development of Higher Psychological Processes*. Cambridge MA: Harvard University Press.