

# Teaching for Entrepreneurial and Mathematical Competences: Teachers Stepping Out of Their Comfort Zone

Hanna Palmér, Maria Johansson, and Lena Karlsson

**Abstract** This paper reports on an educational design research study exploring the potential in combining the teaching of entrepreneurial and mathematical competences in Swedish primary schools. The focus in this paper, however, is not on the wholeness of this study but on changes in the teacher role when entrepreneurial and mathematical competences are to be combined in teaching – as expressed by the teachers themselves. Two of these expressed changes are “saying less” and “daring to let go of control”. In the paper, these two changes are explored in relation to how they seem to influence these teachers’ teaching of mathematics, and some implications are drawn regarding how their students’ possibilities to learn mathematics may have been influenced.

**Keywords** Teaching • Entrepreneurial competences • Mathematical competences • Comfort zone • Educational design research • Primary school • Teacher change • Reform mathematics • Problem solving • Entrepreneurship

## Introduction

Entrepreneurial and mathematical competences are two of the key competences the European Commission stresses as important in a society of lifelong learning. It is argued that entrepreneurial and mathematical competences will contribute to individuals’ future success in society, no matter what kind of work they will do (EU, 2007). Mathematics is (most often) an unquestioned subject in school, and entrepreneurship, which is now being stressed by the European Commission, is also attracting greater interest in educational settings around the world. Entrepreneurship in this sense is not necessarily about starting companies, but

---

H. Palmér (✉) • L. Karlsson  
Linnaeus University, Växjö, Sweden  
e-mail: [Hanna.palmer@lnu.se](mailto:Hanna.palmer@lnu.se)

M. Johansson  
Luleå University of Technology, Luleå, Sweden

rather it is viewed as an approach to education that gives children opportunities to develop abilities that characterize entrepreneurs. In Sweden, the government has a national strategy for entrepreneurship in the educational area (Regeringskansliet, 2009), and according to the Swedish primary school curriculum implemented in 2011, entrepreneurship is to permeate all teaching in primary school (National Agency for Education, 2011).

The school should stimulate pupils' creativity, curiosity and self-confidence, as well as their desire to explore their own ideas and solve problems. Pupils should have the opportunity to take initiatives and responsibility, and develop their ability to work both independently and together with others. The school in doing this should contribute to pupils developing attitudes that promote entrepreneurship. (National Agency for Education, 2011, p. 11)

This paper reports on an educational design research study exploring the potential in combining the teaching of entrepreneurial and mathematical competences in Swedish primary schools. The basis for the study is that entrepreneurship is often taken for granted as something positive, but there are very few studies on entrepreneurial competences in subjects in general and in primary school in particular (Leffler & Svedberg, 2010). In the study, instead of taking an unconsidered stance, we try to investigate both possibilities and reservations regarding combining the teaching of entrepreneurial and mathematical competences. If entrepreneurship is to permeate all teaching in primary school, what does that imply for mathematics teaching and learning?

At the time of writing, the study had not yet been completed, so the results presented in this paper do not reflect the study as a whole. Instead, the explicit focus of this paper is on how primary school teachers involved in the study express changes in their teacher role now that they are required to combine entrepreneurial and mathematical competences in their teaching. Two of these changes have been expressed as "saying less" and "daring to let go of control". Thus, the changes discussed in the paper are changes expressed by the teachers, not changes identified by the researchers. However, in the paper these two expressed changes are explored in relation to how they seem to influence these teachers' teaching of mathematics, and some implications will also be drawn regarding how these changes may have influenced their students' possibilities to learn mathematics.

## Entrepreneurial Competences

Entrepreneurial competences and entrepreneurship are stressed in both international and national educational contexts. The European Commission argues that entrepreneurship is important in a society of lifelong learning. Entrepreneurial competences are not only for older students but rather should be developed through continuous learning adapted to students' age (EU, 2007). One question to ask is which competences are considered to be entrepreneurial? Based on an overview, Holmgren and

From (2005) emphasize competences such as creativity, innovation, risk taking, opportunity spotting, self-motivation and ability to cope with uncertainty as entrepreneurial competences, which is similar to the definitions stated by the European Community.

Based on the European Community, on the Swedish national curriculum and on research literature on entrepreneurship (Jeffrey & Craft, 2004; Holmgren & From, 2005; Leffler & Svedberg, 2010; Sarasvathy & Venkataraman, 2011), the study presented in this paper has focused on the following six entrepreneurial competences: creativity, ability to take responsibility, ability to take initiative, tolerance for ambiguity, courage and ability to collaborate, and they are defined as follows:

*Creativity* is about finding new, for the individual, solutions to new and old problems and is well researched as positive in both entrepreneurial and mathematics education research. The *ability to take responsibility* regards both oneself and others. To be able to take responsibility, students must be given autonomy, which is about passing back control to the learner. The *ability to take initiative* is about being proactive, which, just like the ability to take responsibility, is dependent on autonomy. *Tolerance for ambiguity* is about acting in situations where a task is not fully understood or where the scope for action is not fixed in advance. *Courage* is about stepping into situations in which the individual is not fully comfortable; thus it is about leaving the comfort zone. Finally, the *ability to collaborate* involves both sharing and absorbing ideas and knowledge.

## Mathematical Competences

Mathematical competences are also stressed as important in a society of lifelong learning, especially with a focus on problem-solving in everyday situations (EU, 2007). In the Swedish national curriculum, mathematics is described as a “creative, reflective, problem-solving activity” (National Agency for Education, 2011, p. 62). Describing mathematics in terms of creativity, reflection and problem-solving can be seen in contrast to a national inspection of mathematics teaching undertaken in 2009, which showed that mathematics teaching was dominated by individual calculating, offering limited opportunities for students to develop their ability to solve problems (Swedish Schools Inspectorate, 2009). On the basis of those documents, problem-solving in mathematics has been especially – but not solely – emphasized in the study. In line with research (Cai, 2010; Lesh & Zawojewski, 2007), problem-solving is described in the national curriculum both as a purpose (an ability to formulate and solve problems) and a strategy (a way to acquire mathematical knowledge). In the study, both of these have been focused on; students have worked with problem-solving tasks they did not know in advance how to solve, and they therefore had to develop new (for them) strategies, methods and/or models to solve the tasks. In such an approach, students have to investigate

new ways of thinking where creativity and tolerance for ambiguity are often emphasized as important abilities (Lesh & Zawojewski, 2007). Thus, a problem-solving approach in mathematics teaching has similarities with education for entrepreneurship as presented above.

## Theoretical Perspective

In combining two different subjects – or rather two different sets of competences – and analysing what effect this combination has on the students' possibilities to learn (specifically the mathematical competences in this case), we need to analyse how the arrangement of the different mathematical activities change when the entrepreneurial competences are added in the lessons. According to Rogoff (2003) and Wertsch (1998), individuals' (e.g. teachers' and students') possibilities for learning depend on the activities they participate in, where learning implies changes in how they participate in these activities. Thus, learning is about becoming by participating in practices. This means that we have taken on a sociocultural perspective on learning. The changes expressed by primary school teachers regarding their teacher role now that they are required to combine entrepreneurial and mathematical competences in their teaching can be understood as their learning by participating in, what are for them, new activities. Similarly, these activities change what the students are invited to participate in, thereby also influencing their possibilities to learn. As mentioned, the focus of this paper is on the changes expressed by the primary school teachers regarding their teacher role now that they are required to combine entrepreneurial and mathematical competences in their teaching, with only some implications for the teachers' teaching of mathematics and students' possibilities to learn mathematics.

## The Study

Nine researchers from mathematics education and entrepreneurship as well as approximately 30 teachers from eight primary schools were involved in the study, which was conducted through educational design research. Primary school in Sweden implies students from 6 to 12 years of age. This paper will focus on the teachers at four of these schools, the schools where the authors of this paper were the participating researchers. The 21 participating teachers at these schools were educated as generalists, teaching several subjects, one of which is mathematics. Before becoming involved in the study, the teachers from these four schools had participated in a national professional development programme named *Boost for Mathematics*. The programme was initiated by the government in 2012 with the aim of improving mathematics teaching and thereby students' learning. The programme

has been developed by researchers and is organized around teacher collaboration, where teachers work in groups with experienced tutors. Within this programme the teachers at these schools had focused especially on problem solving.

The teachers were interviewed before and after the design research study. The interviews were open-ended, based on a template. All interviews were recorded. Design research is not a fixed method but a genre of inquiry within which solutions to practical and complex educational “problems” are developed through an iterative process of designing, implementing and evaluating lessons (McKenney & Reeves, 2012). The focus of the designed lessons was on combining the teaching of entrepreneurial and mathematical competences. Often, design research aims at finding solutions to educational problems and figuring out what teaching should look like to reach a desirable situation. This study, however, was more explorative since we did not know whether combining the teaching of entrepreneurial and mathematical competences was desirable or not.

The five mathematical competences emphasized in the national curriculum – with special emphasis on problem-solving – together with the six entrepreneurial competences presented earlier framed the design of the lessons. Each iterative design cycle included preparations for a mathematics lesson, implementation of this lesson and finally a retrospective analysis of the lesson. The researchers participated actively in the preparation and evaluation of the lessons and passively during the lessons taking notes. The joint evaluation was made using an evaluation form that focused on both entrepreneurial and mathematical competences as well as on possible connections between them. The focus of the evaluation was in line with the sociocultural perspective on what had been possible for the students to learn during the lesson and how the combination of entrepreneurial and mathematical competences may have contributed, positively or negatively. After the evaluation, the next lesson was planned, and the iterative process continued in this manner throughout one school year.

The result presented in this paper is based on empirical material from the follow-up interviews with the teachers together with observations and evaluations of two lessons. Two of the questions in the follow-up interview were “What characterizes a project lesson for you?” and “Has the project influenced your mathematics teaching, and if it has, how?” The analysis of the interviews was done using grounded theory methods, which implies building and connecting categories grounded in the empirical material by using codes (Charmaz, 2006). This way of coding does not involve the use of pre-constructed codes, but instead entails labelling the empirical material, line by line, with as many codes as possible (Kelle, 2007). When coding the follow-up interviews from one of the schools, two of the categories developed were “saying less” and “daring to let go of control”. Segments of similar kinds were then looked for in the interviews from the other three schools.

Then, lessons where the teachers, during or after, had talked about “saying less” and/or “daring to let go of control” were analysed as empirical examples illustrating what the teachers meant with these expressions. These lessons were also analysed based on students’ opportunities to learn mathematics. Since the students were not

tested regarding their mathematical knowledge before and after the intervention, we cannot analyse their learning but only opportunities for learning. The lessons were analysed based on the students' opportunities to learn the five mathematical competences emphasised in the national curriculum (formulating and solving problems; using and analysing mathematical concepts; choosing and using appropriate methods to perform calculations and solve routine tasks; applying and following mathematical reasoning; and using mathematical forms of expression to discuss, reason and give an account of questions, calculations and conclusions). (Analysis was also done with respect to the entrepreneurial competences, but those are not focused on in this paper).

## Results

Extracts from the interviews will first be presented, followed by an analysis of example lessons. Extracts and examples are not to be seen as the entire basis of the analysis but as examples of empirical instances labelled as "saying less" or "daring to let go of control".

### *Saying Less*

Several of the teachers talked about how the project made them, or forced them to, give less instruction to the students when introducing the lessons. They expressed this as "saying less" and handing over the acting space to the students. To make it possible for the students to take initiative and be creative, and to challenge students' tolerance for ambiguity, the teachers used more open questions and gave less instruction on how to solve tasks.

- Teacher, grade 4: More open questions. I let them discover more by themselves. [...] I have a clear mathematical idea. But don't give them too much because then the challenge disappears.
- Teacher, grade 3–4: My approach towards students and learning has changed. I have higher expectations but try not to steer too much, work more with open questions; you don't need to give them all the instructions at once.
- Teacher, grade 6: Open for several different ways to reach the goal.

### Example of a Lesson Illustrating "Saying Less"

In a grade 4 class, the students are working on a project on schoolyards. As part of this project, the teacher has an idea of the students comparing the sizes of different schoolyards in the municipality. She wants the students to explore how to calculate

area for figures with irregular sides. The students are divided into groups of three, and each group is handed a map of a schoolyard. In the previous lesson, the students had worked with scale, and when introducing the schoolyard task, the teacher starts to repeat yesterday's talk about scale. Then she suddenly stops, turns towards the researcher and says, "Now I'm saying too much, aren't I?" She then writes " $1\text{ cm} = 1\text{ m}$ " on the board and says to the students, "Now calculate and compare the size of the schoolyards". Thus, she does not say anything about how to calculate area for figures with irregular sides nor about how to compare the sizes. Different groups calculate the area in different ways. Some groups split their schoolyard into small pieces where each piece is a figure for which they know how to calculate the area. Some groups draw a large rectangle approximately around their schoolyard and then colour pieces of the schoolyard left on the outside of the rectangle. They then do the same with pieces that are inside the rectangle but are not part of the schoolyard. Finally, they compare to see if the coloured areas cancel each other out. When all groups have calculated the area of their schoolyard, they are to compare their results. The teacher makes a table on the board based on students' results. Each group explains how they solved the task, and the teacher highlights similarities and differences in their strategies. The different schoolyards vary greatly in size, and at first the students say this is unfair. Then one student says that "to be able to know if it is fair you must know how many students there are in each school". As homework, the groups are to find out the number of students enrolled in the school they are working with. The following day the whole-class discussions continue, and the table is extended to include a column headed "students" and another column headed "square metres/student".

### **Analysis Example of Lesson "Saying Less"**

An evaluation of the lesson in relation to students' opportunities for learning the five mathematical competences emphasized in the national curriculum indicates possibilities for students to develop their ability to solve a problem using mathematics and also to assess selected strategies and methods (how to figure out the area, whole-class discussion of strategies); use and analyse mathematical concepts and their interrelationships (peripheral, scale, area, square metre, square metres/student); choose and use appropriate mathematical methods (calculate area, scale, square metre); apply and follow mathematical reasoning (whole-class discussions based on students' ideas and calculations); and use mathematical forms of expression to discuss, reason and give an account of questions, calculations and conclusions (producing, presenting and evaluating calculations and tables). To summarize, the lesson where the teacher tries to adjust in line with the entrepreneurial competences by "saying less" becomes a lesson where the students have opportunities to learn all the mathematical competences emphasized in the national curriculum.

## ***Daring to Let Go of Control***

Several of the teachers also talked about how the project made them, or forced them, to let go of control in the classroom. To make it possible for the students to take their own initiatives, be creative and take responsibility, the teachers were forced to give the students increased influence. At the end of the project, they talked about this as something positive.

- Preschool class: It is about us daring to try. To give the students more influence. Dare to let go of the control and try.
- Grade 1: I dare to trust the students more. Release them. [...] I don't prepare in as much detail as before. [...] The students have more influence. [...] Before, I always needed to have all the answers, now we find them together.
- Grade 2: What is true for the students also applies to me. I have become more open to unplanned change. I dare to take in students' suggestions, I dare to go out in the quagmire and see where it carries us.
- Grade 5–6: I dare more; letting go of control is important! It doesn't matter if you fail, both we and our students learn from that.

### **Example of a Lesson “Daring to Let Go of Control”**

At one of the schools, all involved teachers from grades 1 to 6 choose to work with what they refer to as Fermi problems to promote tolerance for ambiguity. These tasks are open problems where exact answers are difficult or impossible to arrive at, so estimates must be made instead, based mainly on known facts or facts that can be easily found (Flognman, 2011). This lesson is also an example of “saying less” as the teachers in their joint preparation talk about giving the students very few instructions. The teachers themselves say that their students usually get very clear instructions and they want to see how the students handle the open problems together with few instructions. The teacher in grade 2 starts her lesson by showing the students a large bottle with small candies inside. The questions posed to the students are, “How many candies are there in the bottle? We are not allowed to open the bottle. How can we solve this?” The teacher splits the class into groups with three students in each. After a while, each group comes up with a suggestion for how to solve the task. One group suggests that they can go to the local shop and buy a bag of the same kind of candy as in the bottle, count the pieces of candy in the bag and then figure out the number of candies in the bottle by comparing with the number in the bag. The teacher gives them money, and the group goes to the local shop and buys a bag of the same kind of candy as in the bottle. Back in the classroom, the students weigh the candy even though the weight was written on the bag. They want to be sure. Then they count the pieces of candy. After that, they ask if the teacher has an empty bottle similar to the one she has shown with candy inside, and she tells them to look



in the teachers' office. The students find an empty bottle of similar size and they put the bought candy into this bottle, and then they estimate how many more bags of candy they would need to fill the bottle. After the lesson, the teacher says that she would never have let the students continue with their own initiative – to go to the local shop – before becoming involved in the projects on combining entrepreneurial and mathematical competences.

### **Analysis Example of Lesson “Daring to Let Go of Control”**

An evaluation of the lesson in relation to students' opportunities for learning the five mathematical competences emphasized in the national curriculum indicates possibilities for students to develop their ability to solve a problem using mathematics and also to assess selected strategies and methods (quantity of candy, discussion of strategies); use and analyse mathematical concepts and their interrelationships (estimation, weight versus quantity, volume versus quantity); choose and use appropriate mathematical methods (count, weigh); apply and follow mathematical reasoning (whole-class discussions based on students' ideas and calculations); and use mathematical forms of expression to discuss, reason and give an account of questions, calculations and conclusions (producing, presenting and evaluating calculations of the amount of candy). To summarize, the lesson where the teacher tries to adjust in line with the entrepreneurial competences by “daring to let go of control” becomes a lesson where the students have opportunities to learn all the mathematical competences emphasized in the national curriculum.

## **Discussion**

Several national and international studies report how curricular reforms in mathematics education seldom result in changes in the teaching of mathematics in schools. This is often explained with reference to teachers having difficulties with identifying the meaning of the messages of the different reforms (Boesen et al., 2014; Ross, McDougall & Hogaboam-Gray, 2002). The study presented in this paper does not focus on curricular reforms in mathematics education but on possibilities and reservations regarding combining the teaching of entrepreneurial and mathematical competences. The explicit focus of this paper has been on how primary school teachers involved in the research project express changes in their teacher role when entrepreneurial and mathematical competences are to be combined in their teaching.

Two of these expressed changes are “daring to let go of control” and “saying less”. These two changes entail the teachers stepping out of their comfort zone. This could be seen as the teachers changing the context of the mathematical activities and hence also changing the possibilities for the students to learn the mathematical competences. (As mentioned, based on the sociocultural perspective on learning in this study, students' possibilities for learning depend on the activities we invite them

to participate in.) They do this without changing how they talk about the mathematical context; rather, they add the entrepreneurial competences to the activities as seen in the analysed examples.

In the paper, these two expressed changes have been explored in relation to how they seem to influence the teaching of mathematics. It seems like “daring to let go of control” and “saying less”, which the teachers expressed as changes to fulfil the entrepreneurial part of the combination, actually direct their mathematics teaching in a reformatory direction. It can be argued that the designs of the lessons described above have been known and promoted in mathematics education for a long time. However, it was not until creativity, tolerance for ambiguity, courage, ability to take initiative, ability to collaborate and ability to take responsibility were introduced as important competences in themselves that these teachers planned these kinds of mathematics lessons. As mentioned, the teachers from these four schools had participated in the national professional development programme named *Boost for Mathematics*, and within this programme they focused especially on problem-solving. However, the kind of mathematics teaching that is exemplified in this paper is, according to the teachers, not a result of thinking about mathematics education but a result of trying to include entrepreneurial competences in the mathematics lessons. It seems that a focus on entrepreneurial competences in mathematics lessons has developed the lessons towards the creative, reflective, problem-solving activities described in the Swedish curriculum (National Agency for Education, 2011). Thus, changes that had been absent before and explained as teachers having difficulties identifying the meaning of the messages of different reforms are now being realized, but without the teachers having mathematics teaching in mind.

## References

- Boesen, J., Helenius, O., Bergqvist, E., Bergqvist, T., Lithner, J., Palm, T., et al. (2014). Developing mathematical competence: From the intended to the enacted curriculum. *The Journal of Mathematics Behavior*, 33, 72–87. <https://doi.org/10.1016/j.jmathb.2013.10.001>
- Cai, J. (2010). Commentary on problem solving heuristics, affect, and discrete mathematics: A representational discussion. In B. Sriraman & L. English (Eds.), *Theories of mathematics education: Seeking new frontiers* (pp. 251–258). London: Springer. [https://doi.org/10.1007/978-3-642-00742-2\\_25](https://doi.org/10.1007/978-3-642-00742-2_25)
- Charmaz, K. (2006). *Constructing grounded theory. A practical guide through qualitative analysis*. London: SAGE Publications Ltd. <https://doi.org/10.7748/nr.13.4.84.s4>
- EU. (2007). *Nyckelkompetenser för livslångt lärande. En europeisk Referensram*. Luxembourg, Europe: Europeiska gemenskaperna.
- Flognman, C. (2011). *Fermiproblem och klassrumskultur. Nämnaren Nr3*. Göteborg, Sweden: NCM.
- Holmgren, C., & From, J. (2005). Taylorism of the mind: Entrepreneurship education from a perspective of educational research. *European Educational Research Journal*, 4(4), 382–390. <https://doi.org/10.2304/eej.2005.4.4.4>
- Jeffrey, B., & Craft, A. (2004). Teaching creatively and teaching for creativity: Distinctions and relationships. *Educational Studies*, 30(1), 77–87. <https://doi.org/10.1080/0305569032000159750>

- Kelle, U. (2007). The development of categories: Different approaches in grounded theory. In A. Bryant & K. Charmaz (Eds.), *The SAGE handbook of grounded theory* (pp. 191–213). London: SAGE Publications. <https://doi.org/10.4135/9781848607941.n9>
- Leffler, E., & Svedberg, G. (2010). *Skapa och våga. Om entreprenörskap i skolan*. Stockholm: Skolverket.
- Lesh, R., & Zawojewski, J. (2007). Problem solving and modeling. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 763–799). Charlotte, NC: National Council of Teachers of Mathematics & Information Age Publishing.
- McKenney, S., & Reeves, T. (2012). *Conducting educational design research*. London: Routledge. <https://doi.org/10.4324/9780203818183>
- National Agency for Education. (2011). *Curriculum for the primary school, preschool class and leisure time center 2011*. Stockholm: National Agency for Education.
- Regeringskansliet. (2009). *Strategi för entreprenörskap inom utbildningsområdet*. Stockholm: Regeringskansliet.
- Rogoff, B. (2003). *The cultural nature of human development*. Oxford, England: Oxford University Press. <https://doi.org/10.1037/e612832007-002>
- Ross, J. A., McDougall, D., & Hogaboam-Gray, A. (2002). Research on reform in mathematics education, 1993–2000. *Alberta Journal of Educational Research*, 48(2), 122–138.
- Sarasvathy, S. D., & Venkataraman, S. (2011). Entrepreneurship as method: Open questions for an entrepreneurial future. *Entrepreneurship: Theory & Practice*, 34, 113–135. <https://doi.org/10.1111/j.1540-6520.2010.00425.x>
- Swedish Schools Inspectorate. (2009). *Undervisningen i matematik—utbildningens innehåll och ändamålsenlighet. Kvalitetsgranskning rapport 2009:5*. Stockholm: Skolinspektionen.
- Wertsch, J. V. (1998). *Mind as action*. New York: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195117530.001.0001>

Students' and Teachers' Values, Attitudes, Feelings  
and Beliefs in Mathematics Classrooms

Selected Papers from the 22nd MAVI Conference

Palmér, H.; Skott, J. (Eds.)

2018, XIV, 148 p. 9 illus., 3 illus. in color., Hardcover

ISBN: 978-3-319-70243-8