Using a journal to engage teachers in developmental work

Göran Emanuelsson, Bengt Johansson,

Barbara J. Reys, & Robert E. Reys

Professional journals provide a fresh and stimulating source of ideas and serve as both a lifeline and a conduit for professional growth for many teachers. Journals have the potential to address timely issues and reach teachers regularly. Furthermore, journals represent a significant resource to promote dialogue about teaching and learning as well as to chronicle historical developments within professional fields.

*This article details how a Swedish journal for mathematics teachers, Nämnaren, was used to focus on a timely issue and stimulate awareness and involvement of mathematics teachers throughout the country. Nämnaren was founded over 20 years ago and established with the stated purpose of helping Swedish teachers: keep informed of current issues and happenings in mathematics education; and learn more effective ways to learn and teach mathematics at all levels. Nämnaren is published four times a year and has a circulation that reaches nearly all elementary and secondary schools in Sweden. Several issues of Nämnaren were used recently to bring the mathematical theme of number sense to the attention of Swedish teachers *).*

Background

During the first decades of the Swedish compulsory school (1840-1880), primary education in mathematics was mainly directed at advancing skill with standard algorithms and applications on different types of problems (See Velander, 1884; Johansson, 1986; Johansson & Emanuelsson, 1994). At the end of the nineteenth century the value of understanding mathematical concepts and ideas was emphasized. In addition to the four basic operations, emphasis was placed on different ways of thinking, stressing the importance of

***Göran Emanuelsson** and **Bengt Johansson** are Senior Lecturers in mathematics education at the Department of Didactics, Göteborg University, Sweden. **Barbara J. Reys** and **Robert E. Reys** are Professors in mathematics education at University of Missouri, USA and visited Göteborg University as Fulbright Visiting Professors during the spring of 1995.*

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basic number sense and being able to understand and use the relations between numbers (See Nordlund 1890; Jonsson, 1919; Johansson & Wistedt, 1991). This trend continued and deepened through the first half of the 20th century. (See Johansson, 1984; Kilpatrick & Johansson, 1994; Lindström, 1933.)

Influenced by reform in the United States during the late 1950s and 1960s, Swedish educators engaged in discussions during this time about what standard algorithms should be taught and learned. These discussions resulted in a change in the standard algorithm for division. A secondary outcome of the focus on algorithms was that emphasis on number concepts, and the concept of division as a way of thinking almost disappeared and was replaced by a superficial discussion about regulations for calculation procedures. With the eventual entry of pocket calculators into Swedish society (and schools) during the middle of the 1970s a new discussion about non-algorithmic basic skills (and number sense) emerged. Ekenstam & Greger (1982) concluded that computation with the four rules of arithmetic

> did not seem to contribute to increasing the children's conceptual understanding to any great extent (p. 42).

What should be the content of primary mathematics education if the four computational algorithms are de-emphasized? What do our children know about arithmetic outside standard algorithms? (Emanuelsson, 1989; Mellin-Olsen, 1989; Unenge 1989.) These questions were the focus of a seminar during a five month period of Fulbright Visiting Professors Barbara and Robert Reys at Göteborg University during the spring of 1995. Together we reviewed and discussed the literature about number sense and connections of this knowledge to Swedish studies and the new national curriculum in mathematics (Emanuelsson & Johansson, 1996). During the seminars tests on number sense developed by McIntosh, Reys & Reys (1992) were revised and extended. The tests were given to a Swedish 4th and 8th grade student sample and the results were analyzed and discussed. This collaborative effort increased our consciousness about the importance of number sense and its relation to other parts of the Swedish national curriculum. We became convinced that there is much to be done to stimulate interest and engagement in the discussion of number sense among Swedish teachers.

In order to invite and involve teachers in the discussion and study of children's development of number sense we prepared a series of articles for Nämnaren (volume 22). The articles, published in Swedish, described different aspects of our work (Reys, Reys, Emanuelsson, Johansson et al., 1995a, 1995b; Reys, Reys & Emanuelsson, 1995). A summary of each article in the series is described here together with a report on it's early impact. (For a short description of the journal Nämnaren, see p. 73.)

Nämnaren series on number sense

The series of articles was developed to:

- provoke discussion and thinking about a topic stressed in the new Swedish curriculum and for which teachers seem to lack ideas and instruments for improving their instruction.
- promote collaboration between researchers and practitioners. More specifically, to learn if a series of articles in a professional journal can stimulate communication and exchange of knowledge and ideas between researchers and practitioners, and whether people who are reading the articles

  > ... influence on one another's thought and professional activities (Kilpatrick, 1991, p. 21).

The series consisted of three articles, all published within a year. The content of the articles included clarification of the character and importance of number sense, presentation of a series of number sense assessment items, encouragement to teachers to try the items in their classes and to compare and discuss the results with colleagues; and an invitation to share their experiences with Nämnaren readers. A brief description of the process and some comments on the content in the three articles follows.

What is number sense?

The first article in Nämnaren 22(2) announced the series and provided background information regarding number sense. A sample of test items (18 items for grade 4 and 18 items for grade 8) were included in the article (Reys, Reys, Emanuelsson, Johansson et al., 1995a, pp. 23-29). The items were chosen to provide a balance across the framework and identification of six strands of number sense (Reys et al., 1996):

- Understanding of the meaning and size of numbers.
- Understanding and use of equivalent representations of numbers.
- Understanding the meaning and effect of operations.
- Understanding and use of equivalent expressions.
- Computing and counting strategies.
- Measurement benchmarks.

The items were included in the journal as a 'pull-out' supplement, one section for grade 4 and another for grade 8. Guidelines and suggestions for using the test items were also provided.

In the narrative of the article we described the 'history' of the tests. More specifically, we described the background and the construction of the tests and discussed the six major strands around which the instrument was constructed. We also described the process used to collect data from about 300 Swedish pupils using the number sense items as well as our observations in giving the test.

From observations and discussions with the Swedish pupils and their teachers we knew that the students were stimulated and challenged by the items. The teachers found the character of the test items somewhat unusual and thought that many of their students had little experience with these types of test items. We pointed out that the items were designed to stimulate reflection and thinking rather than skill in performing long and tedious calculations. We also discussed how traditional tests often focus on arithmetic skills and related applications. We questioned if such tests assess children's understanding of number and operations (e.g. different representations of numbers and relations within and between such representations (Emanuelsson, 1995)). We pointed out that there is evidence that students with excellent results on traditional paper-and-pencil tests also show surprising weakness in number sense (Ekenstam & Greger, 1982; Sowder, 1992; Yang, 1995).

Within the article we invited readers to choose and try out items from the tests, to relate their own experiences of number sense to the strands and the items, to investigate the reactions of their pupils, and then compare their class results and analysis with the results and discussions we would present in the next issue of Nämnaren. We pointed out that the development of good assessment tools should be in harmony with the development of good instruction. We invited readers to collaborate with us, welcoming their reactions, suggestions, and questions.

Swedish student performance on number sense

In the second article in Nämnaren 22(3) we pointed out that almost every document describing improvement in mathematics education stresses the importance of children acquiring number sense (Reys, Reys, Emanuelsson, Johansson et al., 1995b). Even if the term number sense is relatively new in curriculum texts, similar calls for emphasizing understanding and meaningful learning are evident in the mathematics education literature in many countries (Reys, 1991).

Due to curricular emphasis and expectations, a focus on understanding and meaning has been often overshadowed by computation drill. This has happened despite the increasing attention to more efficient methods of calculation (for example, calculators) and the resulting re-examination of the mathematics curriculum and adjusting the emphasis toward establishing a better balance of computational alternatives (Shumway, 1994).

We admitted many questions remain to be answered regarding how to attain the goals we seem to agree on. There is need for better tools to implement curricula and educational efforts. We raised questions, such as, Do you consider the development of number sense an important goal for instruction? What are the thinking and learning strategies of children developing number sense? What type of curriculum and what types of learning activities give the best effect on the development of number sense?

By research and developmental work we suggested that answers to these important questions could be developed. As an example, we shared results of two aspects of the Swedish study – performance of Swedish 4th and 8th graders on the number sense test and beliefs regarding number sense of the teachers of the students tested. We also shared results from data collected using similar items in the United States and Australia.

Swedish performance on the number sense items

The study was carried out in three schools (one downtown, one suburban, and one rural) in a district near Göteborg. In this article, we presented a discussion of the test results, focusing attention on a few items. For example,

Gr. 8 Item: How many different numbers are there between 2/5 and 3/5?

A None. Why? ____________________

B One. Name it: ____

C A few. Give two examples: ____ and ____

D Lots. Give two examples: ____ and ____

A similar grade 8 item asked students "How many different numbers are there between 1.52 and 1.53?" There was a dramatic difference between these last two "betweenness" items. Fifty-one percent of the Swedish eighth graders indicated that there are "a lot of" numbers between 1.52 and 1.53 and also gave two correct examples. However, only 12 percent indicated there are "a lot of" numbers between 2/5 and 3/5 and gave correct examples (47 percent answered that there are no numbers between 2/5 and 3/5).

Results of a teacher survey on number sense

In connection with testing the fourth and eighth grade students, teachers of the participating classes answered a questionnaire after having studied the number sense items. From the analysis of the teacher responses it was clear that the concepts studied on the number sense test were rarely presented or discussed with students. The most important purpose of such activities according to the teachers answers was to develop estimation, mental arithmetic skills and reasonableness.

From the survey we found that number sense (as it was defined by the tests) was considered as very important but that teachers did not spend much time on activities of this kind. At the end of the survey the teachers were asked to rank the items in terms of the level of difficulty for the actual grade. Their judgment showed a very high correspondence with student performance, especially in grade 4.

Comparisons with data collected using similar items in other countries were also made. The article included a brief discussion of the common findings across countries related to the study including:

- Teachers in each country considered number sense important.
- Test items were regarded as new or different compared to current instruction and traditional curriculum.
- Agreement that much more attention to questions and problems of this type in mathematics classes (curricula and instruction) is needed.
- There was a wide range in responses of the tests in every country.
- Boys had better results than girls. However the differences are not always significant.
- Performance of Swedish students were typically between the performance of students in Australia (highest performance) and the USA.

Meaningful numbers

The purpose of the third article in Nämnaren 22(3) was to reflect on the results of the test and to give some response to promote reflection on the importance and the role of the teacher in developing number sense (Reys, Reys & Emanuelsson, 1995). We discussed possible reasons for the results which included:

- shortage of relevant activities on number sense,
- instruction is dominated in focus and time by paper/pencil algorithms,
- rote learning, the students practicing of mathematics in isolation or in situations devoid of conceptual understanding.

Once again we pointed out that number sense is not new but an important area for teaching and learning mathematics. In its simplest form good number sense means sense making of mathematics. One must combine new ways of thinking, facts, and informal knowledge with former understanding. It is a question of being able to look at phenomena from different perspectives and all the time search for connections, understanding and relevance in new contexts. A person with good number sense has a flexible and rich knowledge of mathematics in terms of being able to use what has already been learned about numbers and develop different ways of looking at representations, non-routine situations and problems.

We discussed the importance of the teacher's role in the development of number sense inlcuding:

• ***To promote the development of sense–making***
Students often look toward the teacher as "the one who knows all the answers". An important role in our work to support students' development is to help them understand that meaningful mathematical competence should be constructed in a continuous process. The mathematics must be individually internalized. To create meaning is to explore and invent associations, relations and pattern making and testing one's own statements. A teacher should share her/his own "mental dialogues" with her/his students and tell them about the meanings and patterns s/he knows in order to set aside the myth – to be good in mathematics is to immediately know the answer.

• ***To create classroom settings where why (the meaning) is as important as what (the answer) or how (the method)***
We wrote that reflection is a process which is closely connected to good number sense. This competence includes ability and insight to control the reasonableness of an answer considering requirement and context. Even if the problem is not integrated into a real situation the student should look for meaning. Every teacher in mathematics should aim for a classroom climate where reflection and evaluation are im-

portant elements in the work. The question "Is the answer reasonable?" ought to be used more frequently. It would be preferable to encourage the students to justify their answers by describing their ways of thinking.

- ***To present activities that challenge and engage students to reinvent conceptions from different perspectives***

One of the main reasons students do not develop number sense seems to be that they have not been invited to or engaged in mathematical sense making. There could be many reasons e.g., a shortage of activities and material that promote investigations in number sense; the first years of primary education in mathematics have been dominated by teaching facts and procedures; one believes that concepts are learned when algorithms are performed, yet fundamental relationships involving numbers and operations may remain mysterious for many children.

- ***To promote students' reflection on their own learning***

All over the world the curricula in mathematics emphasize that learning mathematics is about searching for meaning, relevance and ideas to create and to justify new ways of thinking in different contexts. We meet many children using formula and procedures with high accuracy in schools today. They are successful in school as long as they reproduce what they have learnt. This is what we mostly assess with written tests (Sowder, 1992).

To summarize, we emphasized that the development of number sense is an individual, lifelong, and complex process. The greater our knowledge of number sense and its importance, the more likely we will make a conscious effort to internalize number sense in our thinking and promote similar experience for our students. This was the primary purpose is we had in our mind in developing the series of articles in Nämnaren.

We ended with an open invitation to all our readers to give us feed-back and to contribute to the creation of activities, to collaborate and exchange ideas for the development of this important area.

Some results from the series of articles

The articles about number sense have been well received by the readers of Nämnaren. We got feedback and reactions from teachers, teacher educators, people responsible for local and national development and research in mathematics education. A few samples of the feedback follow:

- Teachers have requested copies of the entire test (we published selected items in the pullout) to use in their classes or in school, among other things as a part of the assessment and evaluation every teacher is bound to execute.
- One teacher reported that she had used the grade 8 test in group work in grade 6. She found that all tasks in the test could be solved by at least one group after discussions within the group.
- As part of an inservice teacher training program, teachers used the Nämnaren pull outs in all classes, and also made versions for use in other grades.
- One experienced teacher has written letters and an article, where he argues that number sense is a necessary basis for learning mathematics. If reflections of number sense affect teaching, the understanding of children's possibilities will increase for both teachers and students.

  Too often it happens that pupils mechanically reproduce problem solving and calculation strategies. They use their heads as simple computers, programmed with fixed "programs". Key words and key signs will then decide which of the already known patterns of behavior, should be used in the actual situation. These patterns inhibit fantasy and curiosity. The pupils don't experience the joy of discoveries and therefore they find school work in mathematics grey and boring. This is the biggest threat to their mathematical growth. Most of all girls are negatively affected (Askemur in Nämnaren 23(2), our translation).

- Teachers studying for a Master degree in mathematics education have asked for the articles and the tests to be used in projects in their own classes. Such studies will be reported in later issues of Nämnaren.
- The authors were invited to present and discuss the number sense study at conferences for teachers in mathematics.
- We have received reports that the number sense articles have been used in teacher training colleges throughout Sweden. One student group at our university has constructed a similar test for grade 10.
- The number sense articles have influenced the Non-statutory guidance to the new Swedish curriculum of mathematics (Emanuelsson & Johansson 1996) and supplementary material financed by the National Agency for Education (Emanuelsson, Johansson et al., 1996). Our study has influenced work on the recently published materials for formative assessment in grade 2 and 7, and on the national summative test in mathematics for grade 5.

- The positive experiences and reactions to the number sense articles have encouraged us to edit articles about a similar Norwegian study, focused on decimal number sense, in the same way inviting our readers to analyze test items and give feedback (Brekke & Støren, 1995; Brekke, 1995; Brekke, 1996).
- The number sense articles have also been noticed by other researchers at Göteborg university, working with individual differences in cognitive functions (Gustafsson & Undheim, 1996). During 1996, Swedish versions of number sense test have been given to 800 students in each of the grades 4, 6 and 8. The purpose is to test a model for hierarchical description of intelligence. Besides the number sense test the students will be given a test of mother tongue, a spatial test, an inductive test, and a traditional summative classroom test in mathematics. The design suggests interesting possibilities to compare the result of the number sense test with the outcome of the other instruments.

Summary and discussion

From the evidence we have gathered, the series of articles has influenced many teachers' reflections on what mathematical knowledge and skills children should develop. There are indications that the Nämnaren series has stimulated and engaged readers from different professions with interest in and responsibility for the field of mathematics education.

Curricula, syllabi, supplementary material, and research studies are often published as complete packages with no possibilities of participation or contribution in a dialogue with the authors. It is too often the exception that a scientific article has an enclosed concrete description of the activities and methods that have generated the empirical data. These shortcomings make it very hard for a teacher to value the scientific work, e.g., relevance and validity from the teacher's point of view. (Kilpatrick, 1995). In our opinion the kind of dialogue and openness characterizing the number sense articles is necessary if teachers should be given such possibilities. We have presented a project in progress and invited our readers to participate on their own terms. We hope that we have demonstrated respect for the teachers' ideas and concerns in order to create a dialogue between all those involved in influencing mathematics education (Firsov, 1995).

Our efforts have been to utilize a journal to both inform and involve Swedish teachers in a meaningful dialogue on an important mathematical topic. While the model we used was not perfect, this series was successful in engaging Swedish teachers in reflecting, reacting and becoming involved in classroom based action research by collecting data via tests as well as individual interviews.

Given our rapidly changing world, it is vital that students, teachers and schools not be left in the wake of change but become an integral factor. Professional journals provide a powerful source for communicating and facilitating change. Kilpatrick's comments on the role and value of professional journals provide a valuable perspective:

> A journal can put people from the world of practice in touch with people from the world of theory and research, or it can push these groups apart. It can help practitioners make their practice more reflective and researchers theories more useful, or it can evade that responsibility (Kilpatrick 1991, p. 22.).

We think that our effort has been a positive step forward in utilitizing a professional journal to bring research and practice a bit closer. This experience has already encouraged us to begin exploring additional ways of creating interaction and dialogue among mathematics teachers in Sweden with Nämnaren. Perhaps sharing our experience will encourage similar efforts in other countries.

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What is nämnaren?

Nämnaren is a Swedish journal for mathematics education. It is published from the Department of Didactics, Göteborg University. It is issued 4 times a year since 1974. Target groups are teachers, teacher educators, and researchers working with education and developmental work in mathematics from kindergarten to upper secondary school, K–12.

Objectives:

- to refine, publish, and comment on descriptions and results from teachers' approved experineces, from investigations and research studies in mathematics education,
- to follow the international growth and development of mathematics education,
- to make contributions to the development of professional language and professional approach in the field of mathematics education in Sweden.

Nämnaren is used in devlopmental work, in service education, teacher education, master education, in development of syllabi and text-books for teacher education in mathematics. To facilitate the use and also our planning, we are developing a database, where you can find information about volume, year, no., pages, title, author, abstract, references and key words. A short presentation of the content in the latest issue and a link to the database is given on the Internet:

http://didserv.did.gu.se/matemati/senaste.htm

Some remarks:
Sweden has 6 500 schools, with 100–120 000 students in each grade 1–12. Grade 1–9 are compulsory. Mathematics is studied by all students in grade 1–10, totally 1010 hours guaranteed. Nämnaren has 4–5 000 subscribers, mainly schools. Some of the issues have been printed in 10–15 000 ex.

Att använda en tidskrift för att engagera lärare i utvecklingsarbete

Facktidskrifter erbjuder nya och stimulerande idéer som kan användas både som tips för lektioner och för utveckling av den egna kompetensen. Tidskrifter har möjlighet att snabbt ta upp aktuella, viktiga frågeställningar och når lärare regelbundet. Dessutom ger de betydelsefulla möjligheter till dialog, kontakter och diskussion med kolleger om undervisning och lärande och en dokumentation som ger underlag för analys och uppföljning över tid.

I denna artikel beskrivs hur den svenska matematiktidskriften Nämnaren använts för att uppmärksamma ett aktuellt problemområde i matematik och inbjuda lärare i hela landet till utprövning av utvärderingsinstrument och utveckling av undervisning.

Nämnaren grundades för 22 år sedan i syfte att stödja och stimulera lärare och skolor att dokumentera och utveckla svensk matematikundervisning. Syftet är ge lärare möjlighet att följa utvecklingen av skolmatematiken och medverka i kompetensutveckling lokalt för alla stadier, från förskola till gymnasium.

Tidskriften utkommer fyra gånger per år och har en utgivning som göra att den når de flesta lärare som undervisar i matematik i Sverige. I ett antal nummer publicerades nyligen ett tema om vad som är karakteristiskt för god taluppfattning och hur man kan utveckla denna genom undervisningsaktiviteter. Här redogörs för syfte och innehåll i tre av artiklarna och de kontakter, reaktioner och utvecklingsarbeten detta ledde till.

Författare

Göran Emanuelsson och Bengt Johansson är universitetslektorer vid Institutionen för ämnesdidaktik, Göteborgs universitet.

Barbara J. Reys och Robert E. Reys är professorer vid University of Missouri, USA och arbetade vid Göteborgs universitet som besökande Fulbright-professorer våren 1995.

Adresser

Goran.Emanuelsson@ped.gu.se,
Bengt.Johansson@ped.gu.se
Nämnaren, Box 1010, 431 26 Mölndal, Sverige
cibr@showme.missouri.edu (Barbara Reys)
cirr@showme.missouri.edu (Robert Reys)
Townsend Hall, University of Missouri, Columbia, M0 65211, USA