Chapter 1 : SMP 1: Make Sense of Problems & Persevere in Solving Them - Achieve the Core Aligned Ma

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Share Does this sound familiar? You are given a challenging math problem during a workshop and, of course, not enough time to solve it. The facilitator is moving on and you look around the room to witness an amazing phenomenon: Presented with a problem, we first try to understand it. We figure out what the problem is asking and what information is given to us. We look for access points by considering multiple representations of the problem. We ask questions and develop ideas and strategies or we connect to prior knowledge, looking at special cases. Perseverance comes as we explore and test our strategies. We begin with the strategy we feel is most appropriate, continuously ask if our results make sense and modify our strategy as more information is revealed. So, what should be present in instructional materials to help achieve this goal? Looking at instructional materials, we want to see grade-level-appropriate opportunities for students to develop the skills to make sense of problems. We want to ensure that students have opportunities to be challenged, and not only make sense of problems but also persevere in solving those problems using strategies they learn and develop. The most challenging aspect of seeing this in instructional materials is understanding what this looks like for each grade level. In Kindergarten through grade 2, students might use pictures, counters, or some other type of concrete manipulative to show what is happening within a problem. For example, students could use base ten blocks to find different groups of tens and ones that will add up to a given number. Students should be encouraged to begin self-checking by asking if their results or steps make sense. In grades 3 through 5, students will build on the skills they have developed in grades K While students may still use pictures or concrete manipulatives to aid them in understanding the problem, they have opportunities to extend their skills by now considering different strategies to find the solution. As students become more confident, strategies can turn to the use of numerical equations. The development of multiple strategies should be encouraged and students should be considering which would be the most efficient or provide the desired results. Opportunities should be available for translating between different representations of problems, for example, taking the written or verbal description of a problem and writing an equation or mathematical expression. Drawings can still be used to make sense of the problem and help with visualization, and students can still use concrete examples to help solve abstract problems. In high school, students should be given opportunities to continue to build and fine tune their sense-making and perseverance skills. Opportunities to engage with real-life complex problems should be present. Students should still have opportunities to make sense of information given in different representations such as graphs, charts, verbal descriptions, and equations. Students should be considering multiple strategies including breaking the problem into smaller pieces and then combining the results to present a cohesive solution. Making sense of problems and persevering in solving them SMP 1 is a critical skill. This is one of the SMPs that should be present in the majority of lessons and activities found in the instructional materials. While scaffolding may be present to help students build their mathematical confidence and develop perseverance, instructional materials need to provide quality opportunities for students to be challenged and continue to grow. Leave a Reply Your email address will not be published. Sarah Galasso began her career teaching high school mathematics in Anaheim, CA. While still a classroom teacher, Sarah has been transitioning into her newest role as Co-Director of the Irvine Math Project. In this role, Sarah has been able to support multiple school districts in developing aligned curriculum and providing professional learning opportunities for teachers. Through her role within her school district and at the Irvine Math Project, Sarah has been able to work with many other organizations to better understand aligned instructional materials and assist teachers as they transition to a collaborative classroom. She is also a Master Scuba Diver Trainer and teaches a litany of scuba diving courses in her spare time.

Chapter 2 : Developing Studentsâ€™ Strategies for Problem Solving

problem solving strategies Get your students familiarized with these steps and strategies for problem solving. Since students learn in different way, some student may wish to use a strategy other than suggested in the math challenge.

These problem-solving skills are in a random order, although the first two, trial and improvement and working systematically, are key skills that will support children to become competent as problem solvers. The children will benefit from becoming proficient in each of these skills and working on one of them as a key focus in a lesson or series of lessons could be a useful strategy. Digging deeper usually happens when the problem has been explored and then it is possible to look for generalisations and proof. Concluding is the part of the problem-solving process where we support the children to learn to explain their findings both verbally and in writing. This all takes time, attention and practice. Written recording could be in the form of a photograph, diagram or written explanation. Children will need support to develop their proficiency with written recording. She has used a trial and improvement approach. You can read more about types of recording in this article. Also in the concluding part of the problem-solving adventure children will need to be supported to compare different strategies that were used to solve the problem in order to consider the efficiency of the method and the elegance of the solution. This will enable them to see how they might refine their own methods or adopt a different one next time they encounter a similar problem. The skills needed for a problem-solving task By this we mean the problem-solving skills listed above in Stage 2: It will help the children become fluent in these if you take every opportunity to explicitly talk about them and use the appropriate language when they occur in games or larger problem-solving activities. You may like to focus on developing one or two at a time. For example, is having sprinkles and sugar stars the same as having sugar stars and sprinkles on top of my iced biscuit? Children are often quite good at having a random guess as to how to solve a problem. To become fluent at trial and improvement they need to be able to think about how to adapt their first guess so that it is more likely to become a solution rather than throwing the first one out and starting again. When starting to explore Dice in a Corner children may well put the dice together at random and be surprised when they get the magic total of Those children who are becoming fluent at trial and improvement will then want to adjust the dice to see if they can make 18 in another way, rather than trying another random arrangement. There are lots of NRICH problems that will help you develop these skills with children in our collections. Being a competent and confident problem solver is central to the mathematical development of all our learners. It is also the major aim of our new national curriculum. This article has detailed the individual elements that teachers can focus on to support children to gain this level of proficiency. We trust you will find it useful and we are always interested in your feedback and experiences as you explore problem solving together with the children in your class. DfES Publications Here is a pdf version of this article:

Chapter 3 : Developing Excellence in Problem Solving with Young Learners : www.nxgvision.com

problem using mathematical solution. 4. You used mathematical solution? 1. Your strategies were not appropriate for the problem. 2. You didn't seem to know.

Email Maths problem solving KS2 is crucial to succeeding in national assessments. Reasoning and problem solving are widely understood to be one of the most important activities in school mathematics. Problems do not have to be set in real-life contexts, beware pseudo contexts. Providing a range of puzzles and other problems helps pupils to reason strategically to approach problems, sequence unfolding solutions, and use recording to help their thinking for next steps. It is particularly important that teachers and TAs stress reasoning, rather than just checking whether the final answer is correct. Pupils of all ability need to learn how to solve problems â€" not just the high attainers or fastest workers. Help your pupils gain confidence in approach new problems independently in KS2 Maths with our problem solving techniques guide Classroom resources free The Ultimate Guide to Problem Solving Techniques 9 ready-to-go problem solving techniques with accompanying tasks to get KS2 reasoning independently Download Now How to approach KS2 maths problems So what do we do? Well Ofsted advice is pretty clear on what to do when teaching problem solving. Jane Jones says we should: Set problems as part of learning in all topics for all pupils. Vary the ways in which you pose problems. Make sure you discuss alternative approaches with pupils to help develop their reasoning. Perhaps more than most topics in Maths, teaching problem solving to all pupils effectively requires a systematic approach. Pupils can face any number of problems throughout their SATs and they will face them without our help. Children need something to follow. They help establish a pattern within pupils so that, when they see a problem, they feel confident in taking the steps towards solving it. Find out how we train pupils to approach problem solving independently in our blog: The most commonly used model is that of George Polya , who proposed 4 stages in problem solving, namely: Understand the problem Devise a strategy for solving it Carry out the strategy Check the result Many models have followed the Polya model and use acronyms to make the stages stick. Which model you use can depend on the age of the children you are teaching and sometimes the types of problems they are trying to solve. Below are several examples of Polya model acronyms: S â€" Solve and check does my answer make sense and how can I double check? I â€" Identify the relevant information. D â€" Determine the operation and unit for expressing the answer.

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MTH Problem Solving Strategies. Lead Faculty: Dr. Igor Ya Subbotin Course Description. The aim in the course is not to impart any specific body of knowledge, but rather to foster the students' understanding that mathematics is a science of identifying, solving problems and generalizing.

Click to enlarge Download complete lesson as PDF In some lessons we decide that, rather than including errors, we invited students to complete unfinished responses. They were then asked to describe the advantages and disadvantages of each approach to the problem. Most students in a UK trial of the lesson were able to complete the work, they understood the processes, and were able to work out the correct answers. They did however encounter difficulties interpreting the resulting figures in the context of the real-world situation. This struggle prompted students to consider how far each approach is fit for purpose: Students were not given time to consider a sufficient range of sample student work 3 Initial feedback from observers indicated the lessons were taking longer than had been anticipated; teachers were giving out all pieces of sample student work, but there was often insufficient time for students to successfully evaluate and compare the different approaches. In response to this, designers included the following generic text to all lessons guides: There may not be time, and it is not essential, for all groups to look at all sample responses. If this is the case, be selective about what you hand out. For example, groups that have successfully completed the task using one method will benefit from looking at different approaches. These instructions encourage students to critique and reflect on unfamiliar approaches, to explicate a process and to compare their own work with a similar approach; this, in turn could serve as a catalyst to review and revise their own work. Differentiating the allocation of sample student work in this way may however create problems in the whole class discussion, as not all of the students will have worked on the piece of work under discussion. This instruction places pedagogical demands on teachers, however. They have to again make rapid decisions on which piece of work to allocate to each group. In US trials, however, the suggested approach was not followed: We have some teachers who give all the sample student work and let students choose the order and the amount they do. This might be less common. Others are very controlling and hand out certain pieces to each group. Others like a certain method to solve problems and like to use that one to model. Observer report It turned out that very few students were allowed sufficient time to work on all the pieces of sample student work or time to evaluate unfamiliar methods. These issues were also a concern for the UK teachers. At the start of the project some were reluctant to issue all of the sample student work at the same time, for fear that students would be overwhelmed. As one teacher commented: At the beginning of the project it was too much for pupils to take on all the different methods at once. I believed they became unsettled because the task felt too great. I felt they needed to get used to just looking at one piece first. I also picked out pieces of work that I felt within their ability they could access. Teacher report Students were not using the sample student work to improve their own solutions 4 Although the teachers clearly recognized that a prime purpose of sample student work was to serve as a catalyst for students to ultimately improve their own solutions, there was little evidence of students subsequently changing their work apart from when they noticed numerical errors. While most students acknowledged that their work needed improving, many did not take the next step and improve it. Only students that were stuck were likely to adapt or use a strategy from the sample student work. They attempted the task individually, before the lesson, then in groups, then considered the sample work and then again were urged to improve their work a third time. For teachers that were used to students working through a problem once, then moving on, this was a substantial new demand. It is clear that communicating complex pedagogic intentions is not easy. It is made easier by having some common framework with reference points. As such, all lessons include whole-class discussion instructions of the following kind: Ask students to compare the different methods: Which method did you like best? Which method did you find most difficult to understand? Did anyone come up with a method different from these? Feedback from both the US and UK classrooms indicate that teachers rarely encouraged students to make such comparisons. There appear to be multiple reasons for this. Time pressure was a frequently raised issue. Students need sufficient time to identify and reflect on the similarities and differences between methods and connect these to the constraints and affordances of each method in terms of the context of the problem. The whole class discussion was held towards the end of the lesson. These discussions were often brief or non-existent, possibly reflecting how teachers value the activity. A common assumption was that the important learning had already happened, in the collaborative activity. Another factor may be lack of adequate support in the guide. Teachers and students need criteria for comparison to frame the discussion Gentner, et al. Furthermore, these prompts should occur prior to the whole-class discussion. Students need time to develop their own ideas before sharing them with the class. Rather than compare the different pieces of sample student work, UK students were consistently given the opportunity to compare one piece with their own. Students often used the sample to figure out errors either in their own or in the sample itself. One UK teacher noted that when groups were given the sample student work that most closely reflected their own solution-method, their comments appeared to be more thoughtful, whereas with unfamiliar solution-methods students often focused on the correctness of the result or the neatness of the drawing and did not perceive it as a solution-method they would use. Discussion of the design issues raised xi Most of the teachers involved in the trials had never before attempted to ask students to critique work in the ways described above. I think it has taken most of the year to get the kids to actually be able to look at a piece of work and follow it through to see what that person has done â€¦.. One of the profound difficulties for designers is in trying to increase the possibilities for reflective activity in classrooms. The etymology of the word curriculum is from the Latin word for a race or a racecourse, which in turn is derived from the verb currere meaning to run. Perhaps unfortunately, that is precisely what it feels like for most students. We are encouraged, however to see that the new Common Core State Standards place explicit value on the development of problem solving, mathematical practices and, in particular, on students being able to critique reasoning. Most students, we suspect, are not aware of this new agenda. Some years ago, we conducted an experiment to see whether students could identify the purposes of a number of different kinds of mathematics lesson. The mismatch between teacher and student perceptions was more pronounced as lessons became progressively more practices-oriented Swan, et al. There was some empirical evidence, however, that by introducing metacognitive activities into the classroom that this mismatch could be reduced. These included such activities as discussing key conceptual obstacles and common errors, explaining errors in sample student work â€” and orally reviewing the purpose of each lesson. In this paper, we have seen that, left to themselves, students are unlikely to produce a wide range of qualitatively different solutions for comparison, and therefore it may be helpful to create samples of work to stimulate such reflective discussion. We have, however also noted that we have found it necessary to: We may thus have given the impression that the lessons have been unsuccessful in achieving their goals. This, however, is far from the truth. These lessons are proving extremely popular with teachers and are currently being used as professional development tools across the US. Teachers and observers have described on many occasions the learning they have gained from comparing student work in these lessons; teacher comments include: I now think pupils can learn more from working with many different solutions to one problem rather than solving many different problems, each in only one way. It moves away from students chasing the answer. To our knowledge, there are no major studies that focus on how teachers work with a range of pre-written solution-methods for a range of non-routine problems. This study raises many issues and in so doing acts as a launch pad for further more detailed studies. One might expect to see, for example, that students increase their repertoire of available methods when solving problems. So far, however, we have no evidence of this. We do, however, have some early indications that students are beginning to write clearer and fuller explanations as a result of critiquing sample student work. Acknowledgements xii We would like to acknowledge the support for the study, the Bill and Melinda Gates Foundation, our co-researchers at the University of Berkeley, California and the observer team. References xiii Barab, S. Putting a stake in the ground. The Journal of the Learning Sciences, 13 1 , Design research for

sustained innovation. Assessment in Classroom Learning. Principles Policy and Practice, 5 1 , Inside the black box: Theory of Didactical Situations in Mathematics N. Using worked examples as an instructional support in the algebra classroom. Journal of Educational Psychology, 83, Beyond being told not to tell. For the Learning of Mathematics, 19 2 , Design Experiments in Educational Research. Educational Researcher, 32 1. An emerging paradigm for educational inquiry. Educational researcher, 32 1 , The mechanisms of analogical learning. A General Role for Analogical Encoding. Journal of Educational Psychology, 95 2 , â€” The role of design in educational research. Educational Researcher, 32 1 ,

Chapter 5 : Art of Problem Solving

Olympiad Number Theory Through Challenging Problems Justin Stevens 5 Problem Solving Strategies 93 Solution. We begin by dividing the leading term of a(x) by.

Specific characteristics of a problem-solving approach include: Schoenfeld in Olkin and Schoenfeld, , p. My early problem-solving courses focused on problems amenable to solutions by Polya-type heuristics: Over the years the courses evolved to the point where they focused less on heuristics per se and more on introducing students to fundamental ideas: Schoenfeld also suggested that a good problem should be one which can be extended to lead to mathematical explorations and generalisations. He described three characteristics of mathematical thinking: As Cobb et al. Because it has become so predominant a requirement of teaching, it is important to consider the processes themselves in more detail. The Role of Problem Solving in Teaching Mathematics as a Process Problem solving is an important component of mathematics education because it is the single vehicle which seems to be able to achieve at school level all three of the values of mathematics listed at the outset of this article: Let us consider how problem solving is a useful medium for each of these. It has already been pointed out that mathematics is an essential discipline because of its practical role to the individual and society. Through a problem-solving approach, this aspect of mathematics can be developed. Presenting a problem and developing the skills needed to solve that problem is more motivational than teaching the skills without a context. Such motivation gives problem solving special value as a vehicle for learning new concepts and skills or the reinforcement of skills already acquired Stanic and Kilpatrick, , NCTM, Approaching mathematics through problem solving can create a context which simulates real life and therefore justifies the mathematics rather than treating it as an end in itself. The National Council of Teachers of Mathematics NCTM, recommended that problem solving be the focus of mathematics teaching because, they say, it encompasses skills and functions which are an important part of everyday life. Furthermore it can help people to adapt to changes and unexpected problems in their careers and other aspects of their lives. More recently the Council endorsed this recommendation NCTM, with the statement that problem solving should underly all aspects of mathematics teaching in order to give students experience of the power of mathematics in the world around them. They see problem solving as a vehicle for students to construct, evaluate and refine their own theories about mathematics and the theories of others. According to Resnick a problem-solving approach contributes to the practical use of mathematics by helping people to develop the facility to be adaptable when, for instance, technology breaks down. It can thus also help people to transfer into new work environments at this time when most are likely to be faced with several career changes during a working lifetime NCTM, Problem solving is, however, more than a vehicle for teaching and reinforcing mathematical knowledge and helping to meet everyday challenges. It is also a skill which can enhance logical reasoning. Individuals can no longer function optimally in society by just knowing the rules to follow to obtain a correct answer. They also need to be able to decide through a process of logical deduction what algorithm, if any, a situation requires, and sometimes need to be able to develop their own rules in a situation where an algorithm cannot be directly applied. For these reasons problem solving can be developed as a valuable skill in itself, a way of thinking NCTM, , rather than just as the means to an end of finding the correct answer. Many writers have emphasised the importance of problem solving as a means of developing the logical thinking aspect of mathematics. Yet intelligence is essentially the ability to solve problems: As was pointed out earlier, standard mathematics, with the emphasis on the acquisition of knowledge, does not necessarily cater for these needs. Training in problem-solving techniques equips people more readily with the ability to adapt to such situations. A further reason why a problem-solving approach is valuable is as an aesthetic form. Problem solving allows the student to experience a range of emotions associated with various stages in the solution process. However, although it is this engagement which initially motivates the solver to pursue a problem, it is still necessary for certain techniques to be available for the involvement to continue successfully. Hence more needs to be understood about what these techniques are and how they can best be made available. In the past decade it has been suggested that problem-solving techniques can be made available most effectively through making problem solving the focus of the mathematics curriculum. Although mathematical problems have traditionally been a part of the mathematics curriculum, it has been only comparatively recently that problem solving has come to be regarded as an important medium for teaching and learning mathematics Stanic and Kilpatrick, More recently, however, professional organisations such as the National Council of Teachers of Mathematics NCTM, and have recommended that the mathematics curriculum should be organized around problem solving, focusing on: One of the aims of teaching through problem solving is to encourage students to refine and build onto their own processes over a period of time as their experiences allow them to discard some ideas and become aware of further possibilities Carpenter, As well as developing knowledge, the students are also developing an understanding of when it is appropriate to use particular strategies. There is considerable importance placed on exploratory activities, observation and discovery, and trial and error. Students need to develop their own theories, test them, test the theories of others, discard them if they are not consistent, and try something else NCTM, Students can become even more involved in problem solving by formulating and solving their own problems, or by rewriting problems in their own words in order to facilitate understanding. It is of particular importance to note that they are encouraged to discuss the processes which they are undertaking, in order to improve understanding, gain new insights into the problem and communicate their ideas Thompson, , Stacey and Groves, Conclusion It has been suggested in this chapter that there are many reasons why a problem-solving approach can contribute significantly to the outcomes of a mathematics education. Not only is it a vehicle for developing logical thinking, it can provide students with a context for learning mathematical knowledge, it can enhance transfer of skills to unfamiliar situations and it is an aesthetic form in itself. A problem-solving approach can provide a vehicle for students to construct their own ideas about mathematics and to take responsibility for their own learning. There is little doubt that the mathematics program can be enhanced by the establishment of an environment in which students are exposed to teaching via problem solving, as opposed to more traditional models of teaching about problem solving. The challenge for teachers, at all levels, is to develop the process of mathematical thinking alongside the knowledge and to seek opportunities to present even routine mathematics tasks in problem-solving contexts. National Council of Teachers of Mathematics. In von Glaserfield, E. Professional Development for Teachers of Mathematics , pp. An Agenda for Action: Recommendations for School Mathematics of the s, Reston, Virginia: Mathematical Thinking and Problem Solving. Problem Solving in School Mathematics, pp. Classroom instruction that fosters mathematical thinking and problem solving: Reflections on doing and teaching mathematics. Strategies for Problem Solving, Melbourne, Victoria: Prospects for School Mathematics , pp. Multiple Research Perspectives, pp. Mathematics Education Research Journal.

Chapter 6 : Word Problems Grades | www.nxgvision.com

Mathematician George PÃ³lya's book, "How to Solve It: A New Aspect of Mathematical Method," written in , is a great guide to have on www.nxgvision.com ideas below, which provide you with general steps or strategies to solve math problems, are similar to those expressed in PÃ³lya's book and should help you untangle even the most complicated math problem.

Chapter 7 : Mathematics Through Problem Solving | Math Goodies

Challenging Problems stating that "mathematical problem solving in its broadest some of the problems and solution techniques considered in earlier.

Chapter 8 : High School Math: Problem Pages at The Problem Site

Mathematical tasks, exercises, and challenging problems In the mathematics and mathematics education literature, no universally accepted definition exists for the mathematical terms "task", "problem", or.

Chapter 9 : Get to Grips with Maths Problem Solving KS2 - Third Space Learning

Mathematical problems, or puzzles, are important to real mathematics (like solving real-life problems), just as fables, stories, and anecdotes are important to the young in understanding real life.