

AN INVESTIGATIVE APPROACH¹ TO TEACHING MATHEMATICS: EXCITEMENT AND CONCERNS OF K-8 PRESERVICE TEACHERS

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Following from the recommendations of the National Council of Teachers of Mathematics, an Investigative Approach (IA) to teaching mathematics encourages students to explore real-world problems through hands-on activities instead of focusing on rote memorization of facts, formulas, and procedures. This paper discusses thirty-two K-8 preservice teachers' responses to questions regarding excitements and concerns about using this method of teaching. Although most preservice teachers are excited about the prospects of using this approach in their future classrooms, some exhibit hesitations related to concerns about time constraints and their own math abilities. A mathematics methods course presently being taught that is centered around the ideas of IA is discussed, and recommendations for the use of IA in preservice math methods courses to help teachers overcome these concerns are made.

Following from the recommendations of the National Council of Teachers of Mathematics (NCTM) [1], an Investigative Approach (IA) to teaching mathematics [2] encourages students to explore real-world problems through hands-on activities instead of focusing on rote memorization of facts, formulas, and procedures. Many preservice teachers are excited about the prospects of using methods associated with IA in their future classrooms; however, some teachers have concerns and hesitations about using this approach. This paper discusses thirty-two K-8 preservice teachers' written responses to questions regarding their feelings toward using IA for teaching mathematics. Further, this paper discusses a mathematics methods course presently being taught that was developed around the ideas of IA [2] and how this course attempts to help teachers overcome some of their concerns.

The Investigative Approach

As described by Arthur Baroody [2], IA embodies three central ideas of the NCTM for teaching K-8 mathematics: 1) Math should be purposeful and made relevant to children's

¹ I would like to thank Arthur Baroody for his guidance and mentoring as he helped me develop my own investigative approach to teaching mathematics. The math methods course that I presently teach is based on my work with him at the University of Illinois at Urbana-Champaign and his mathematics teacher education curriculum [2].

everyday life; 2) Math should be problem-based and inquiry-based; and 3) Math should be understandable and meaningful. More specifically, the aim of IA is to foster in students a positive disposition toward mathematics and an ability to conduct mathematical inquiry and to promote mathematics as a way of thinking [2].

Teacher instruction within IA builds on the ideas of learning as a social process [3, 4] and on the belief that knowledge is best learned if constructed by students [5] and connected to their own informal ideas of mathematics [2, 6]. Instead of rote memorization, children are given opportunities to meaningfully memorize facts and procedures [7] which further promotes an ability to apply knowledge to novel situations [2]. For example, students investigate why 3×4 equals 12 and how this fact can be used to figure out $12 + 4$. By using IA in K-8 math methods courses, these ideas can be instilled in preservice teachers.

Survey of Teachers' Thoughts on Implementing an Investigative Approach

Thirty-two K-8 preservice teachers in two sections of a mathematics methods course were asked to respond to the following questions:

- 1) Thinking about the Investigative Approach to teaching mathematics, list at least 3 concerns or hesitations that you have about using this method in your future classrooms.
- 2) Thinking about the Investigative Approach to teaching mathematics, list at least 3 things that excite you about using this method in your future classrooms.

Responses to these questions were used as motivation for a class discussion centered around implementing IA and serves as the main source of information for considering preservice teachers' excitements and concerns.

Preservice Teachers' Excitements about Using an Investigative Approach

The excitements associated with using IA expressed by the 32 preservice teachers tended to fall into three categories: 1) Emphasis of hands-on activities; 2) Focus on understanding; and 3) Encouragement of inquiry-based learning. Teachers seem to be most excited about the hands-on nature of IA. As one teacher wrote, IA ". . . makes math fun and interesting. Kids love hands-on materials." Another teacher described IA as ". . . hands-on with a meaningful purpose," and yet another was excited about using IA because "hands-on activities (are)

remembered longer than math problem sheets." The following comment reflects the sentiment of most preservice teachers' excitements about IA's promotion of understanding: "It (IA) encourages students to discover principles and understand why things work not just how (emphasis added)." Most teachers were also excited about the encouragement of inquiry-based learning within IA. This was reflected in comments suggesting that the approach creates an "atmosphere of curiosity in the classroom," and provides "more opportunity for the children to explore." This approach, "engag(es) students in a more reflective style of learning, i.e. thinking through problems rather than rote spouting," wrote another teacher. Overall, teachers comments seemed to express enthusiasm about the possibilities of using IA in their classrooms.

Preservice Teachers Concerns about Using an Investigative Approach

The concerns and hesitations of the 32 preservice teachers tended to fall into two categories, time constraints and their own math ability. With the recently implemented Virginia Standards of Learning (SOL) [8] and corresponding Standards of Learning exams, many teachers expressed concerns about "having enough time to cover SOL material and still give them [students] plenty of time to explore the manipulatives." Based on student-teaching experiences, one preservice teacher wrote: "There have been days when I've been lucky to have 45 minutes of continuous math time. I don't think that is enough time to let the kids explore."

Some preservice teachers were also concerned about "having sufficient knowledge . . . to facilitate their [students'] learning." Another teacher questioned, "What will happen when one of my students poses a problem that I should know but can't come up with anything ?" Another teacher wrote, "I'm not sure I understand how to use all of the manipulatives, so how do I help my kids understand?" Although other concerns were expressed, time and ability tended to be the two most recurring concerns.

Overcoming Concerns Through the use of an Investigative Approach in Math Methods Courses

The K-8 math methods course taught by the author was developed to model IA for teaching mathematics. Preservice teachers investigate mathematical ideas, children's understanding of mathematics, and pedagogical content knowledge through hands-on, cooperative, inquiry-based activities. One goal of the class is to build on teachers' excitements

about IA and use this to help them overcome their concerns and hesitations.

As documented above, preservice teachers expressed concerns about having enough time to teach all of the prescribed curriculum (e.g., Virginia SOLs). In the methods course, lessons are integrated with literature, social studies, science, and writing which models for teachers ways of saving time by covering several topics in one lesson. For example, instead of discussing how math and literature can be integrated in their future mathematics lessons, teachers are involved in using Tangram puzzles to create animal character shapes and discuss geometric shapes as a children's story book, *Grandfather Tang's Story* [9] is being read to them. Preservice teachers also plan, present, and discuss integrated lessons. They are often amazed at the number of different concepts and ideas (e.g., SOLs) included in their lessons. Ultimately by using these techniques in their own classrooms time is saved and children are more likely to remember and understand [10]. As one teacher pointed out, "Kids come to understand the concepts and over the long run, time is saved because concepts won't need to be re-taught from grade to grade."

Preservice teachers also expressed concerns about their own math ability. In the methods course, questions and conflicts serve as situations for exploration. This is modeled by exploring students' questions that arise as part of the activities. Teachers are involved in activities that lead them to ask questions such as, "Is 0 odd or even?" or "How can I help children decide if $4/0$ is possible?" When questions are asked, the class works together to answer the question. By using these techniques in their own classrooms, teachers' short comings may serve as opportunities for exploration and in essence they can learn with their students.

Conclusions

It is important for teacher educators to be aware of concerns that many preservice teachers have, especially those related to time and ability, that may impede them from actually implementing IA in their classroom. By building on teachers' excitements, some of their concerns about using IA can be overcome. Teachers tend to teach as they have been taught. Through immersion in a methods course that embodies the philosophy of IA, preservice teachers witness teaching and learning that is inquiry-based. Consequently, they will be more prepared and confident with the methods and thus may be more willing to explore mathematics

with their own students through hands-on, inquiry-based activities. ■

References

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