How Much Curriculum Change Is Appropriate? Defining a Zone of Feasible Innovation

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ABSTRACT: The article grapples with the question of how much curriculum change is appropriate in a given context and in a given time frame. How can a balance be struck between stagnation, on the one hand, and the promotion of unrealistic innovation on the other? In answer to this dilemma, the concept of a zone of feasible innovation (ZFI) is proposed and explored, drawing on the literature of school development, teacher professional development, and of developmental psychology, the work of Vygotsky in particular. A series of procedures are suggested to help define the nature and scope of a ZFI in any given situation. Finally, vignettes from case studies of innovation in science education are evoked to provide real-life counterpoints to the theoretical constructs of the literature.
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INTRODUCTION

Curriculum development in science education in Africa, as viewed from the beginning of the 21st century, has a relatively long history. The decade of the 1960s saw many African countries attain independence from the colonial powers of Europe. It was also the decade of ambitious curriculum development projects in science education in Britain and the United States—the so-called "sputnik-inspired" initiatives. The Nuffield Foundation sponsored

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curricula in Britain and the National Science Foundation sponsored counterparts in the United States were seen to be at the cutting edge of the revitalized science curricula in these two countries. So what could be better for the newly emerging African countries than the transference of these cutting-edge curricula, perhaps in modified form? Today little remains of these early valiant, but naïve, efforts. Both donor and recipient countries have moved on and have learned, to some extent anyway, lessons from the past. One clear trend has emerged. The emphasis has shifted from the adaptation of curricula and curriculum materials to the building of local capacity and the development of partnerships (see, for example Ottevanger, de Feiter, O-Sake, & van den Akker, 2005). Some lessons, it would appear, have not been adequately learned. The words of Verspoor (1989, p. 133) seem as appropriate today as they were some 20 years ago: "Large-scale programs tend to emphasize adoption and neglect implementation. . . . in nearly all instances low outcomes resulted from poor implementation of what was essentially a good idea."

The purpose of this article is to grapple with the question of how much innovation in science education is feasible given the constraints of the context—to distinguish between the ideal and the possible. The word innovation covers a lot of ground, and so this article will focus on two aspects of innovation in science education that have received attention in policy documents (such as the National Science Education Standards; National Research Council, 1996), in both the developed and the developing world:

1. the performance of inquiry type hands-on practical work and
2. the linking of science education to societal issues.

The question of how much innovation is a dilemma which has been touched on frequently in the literature on innovation, school improvement, and teacher professional development, but which appears not to have been analyzed in any systematic way. Clune (1998), for example, in his analysis of National Science Foundation (NSF) funded systemic mathematics and science education reform in the United States stresses the desirability of deep, rather than shallow, change. But educational systems in developing countries may not have the capacity to introduce and sustain deep change. Boone and Kahle's (1997) work in Ohio shows that even in a comparatively resource-rich environment, the deep changes inherent in the implementation of the Standards cannot be realized easily. Hargreaves (1998) includes in his list of factors that make educational change difficult the determination of the degree of change expected or promoted—"the change is too broad and ambitious so that teachers have to work on too many fronts, or it is too limited and specific so that little real change occurs at all" (p. 281). Fullan (1998, 2001) too hints at this issue when he points out that a key feature of an implementation plan should be the presence of the next steps. But what should these steps look like, and how can be we sure that they are appropriate? This dilemma has been elaborated on by a number of writers, including an anecdote by Beeby (1966, pp. 74–75) about a "progressive" superintendent's efforts to implement a child-centered, activity-based curriculum in a developing country.

> It was understandable that the local superintendent's gallant attempt to introduce a modern philosophy of education and modern teaching methods should run into endless difficulties, for which no one was to blame. Teachers whose practice was already formless and fumbling were simply not ready for such things as activity methods and sophisticated devices for catering for individual differences—and it must be admitted, with classes of 60 to 90 children and practically no equipment even teachers better prepared might have been baffled.

After his departure,

> ..., his successor set about establishing first of all a tight, formal system of schooling, in the hopes that something approaching good modern education might be built on it later. The ... teachers took it up with enthusiasm; here at last was something clear and definite that appealed to the formal structure of their lives and of their thinking.

If, as Beeby claimed, the "modern-teaching methods" were too sophisticated, what guidelines exist for determining what might be appropriate in this type of context? Is there any reason to suppose that the "tight, formal system" of the second superintendent might lead to something better later on? How can a balance be struck between stagnation, on the one hand, and promoting unrealistic innovation on the other? It is these questions with which this article will attempt to grapple, particularly in the context of science education in developing countries.

A possible fruitful avenue for addressing some of the issues raised above was first mooted at in an earlier article by Rogan and Grayson (2003), in which we proposed the existence of what we called a zone of feasible innovation (ZFI)—a notion based largely on intuition at the time. However, since the main thrust of the previous article was on a framework for introducing and researching science curriculum innovation in developing countries, the notion of a ZFI was merely introduced with little explanation or rigorous analysis. In this article, I propose to return to this idea and treat it in more depth.

An Initial Definition

A ZFI consists of a collection of teaching strategies that go beyond current practice, but are feasible given the existing resources available to that teacher, or group of teachers, and the prevailing environment of the school in terms of its ability to foster and sustain innovation. The strategies in the ZFI are regarded as stepping-stones to some defined goal, which is not yet attainable given the prevailing context. For example, in a classroom where no practical work is done at all and few resources are available, teacher demonstrations and the performance of a few simple, cookbook type activities by the students might constitute an initial ZFI as the first step toward open-ended, student-designed inquiry.

This initial simplistic definition will be elaborated upon later in this article. First, the literature on school development, professional development, and developmental psychology, the work of Vygotsky in particular, will be explored to provide a theoretical underpinning for the concept of a ZFI. However, I will also draw on my own experiences of working to introduce innovative ideas in science classrooms in the Ciskei region of South Africa in the 1970s (Macdonald & Rogan, 1988, 1990), and more recently in the Mpumalanga Province of South Africa in the current decade (Rogan, 2004, 2006; Rogan & Aldous, 2005). Finally, the concept of a ZFI, and how it might be applied in practice, will be revisited. Although the focus will be on innovation in science education in developing countries, I suspect that the overall procedures proposed and conclusions arrived at are valid in a wide spectrum of educational systems.

THE CONTEXT

The discussion of "feasible innovation" might be made more accessible if placed within a specific context. The context in which I have been working is the implementation of South Africa's new Curriculum 2005 (C2005) (Department of Education, Republic of South Africa, 1997). It nails its colors to the mast in its opening section:

> The vision for South Africa encompasses a prosperous, truly united, democratic and internationally competitive country with literate, creative and critical citizens, leading productive, self-fulfilled lives in a country free of violence, discrimination and prejudice.

Curriculum 2005 unequivocally embraces outcomes-based education (OBE). The rationale is that for too long South African students have memorized content, which they then regurgitate in tests and examinations. With the introduction of OBE, the focus is intended to shift to what they can do with their knowledge, and in particular whether they can use what they know to meet the specified outcomes. The C2005 document makes the following assertion:

> The move towards an outcomes-based approach is due to the growing concern around the effectiveness of traditional methods of teaching and training, which were content-based. An outcomes-based approach to teaching and learning, however, differs quite drastically and presents a paradigm shift. According to Spady (1994) outcomes are high-quality, culminating demonstrations of significant learning in context.

The intention of the curriculum is to usher in a new era of prosperity based on better-educated citizens, who are literate, creative problem solvers, and critical thinkers.

Two major outcomes in the natural science curriculum are (Department of Education, Republic of South Africa, 2002, p. 6):

- The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and to solve problems in scientific, technological and environmental contexts.
- The learner will be able to demonstrate and understanding of the interrelationships between science and technology, society and the environment.

These two outcomes are further elaborated by means of grade-specific assessment standards. However, both the science standards, and the overall C2005 policy document, are without doubt ambitious (and unrealistic) undertakings, which most teachers, particularly those from disadvantaged schools, have struggled to attain (Jansen, 1998).

POINTERS FROM THE LITERATURE

School Development

The literature on school development is useful in building a more solid theoretical base for the concept of a ZFI, and in so doing possibly identify some of the gaps in this body of knowledge. As Hopkins (1998, p. 1049) puts it, "Most initiatives are poorly conceptualized in the precise ways in which they might impact upon the learning or classroom level, ..." There is still a need, it seems, to find realistic ways of determining which innovative classroom practices are appropriate at a given time and in a given situation.

In asking what innovation is appropriate, it seems sensible to recognize the diversity of schools and to plan accordingly. Writing about schools in the UK, Hopkins and MacGilchrist (1998) opt for a differentiated approach to implementation and professional development. In essence, they suggest a three-tier approach. Their so-called "type one" strategies are aimed at helping low-performing schools achieve some measure of success, in that they are put on the road to becoming functional. The goals that these schools set are within their reach, and achieving them instills a feeling of confidence. The "type two" strategies are designed for moderately successful schools and concentrate on helping schools improve

in areas where they are already competent. Finally, the "type three" strategies are for schools that have already achieved some level of excellence and are aimed at helping them to introduce sophisticated teaching and learning methods. In developing countries, most schools are likely to benefit from type one strategies. Even if this were not the case, where resources are in short supply it would seem appropriate to channel what is available toward the most disadvantaged, that is type one schools.

One implication for this differentiated type approach is the need to come to grips with the question of how much structure to provide as the innovations are being implemented. While freedom from curricular constraints might be viable as part of the type three strategies to help good schools become even better, type one strategies may well be more structured. As Beeby (1966, p. 74) observes:

> It would seem that the obvious thing to do . . . would be to give the maximum amount of freedom to all the teachers to teach in the way best suited to their ability, so that the best of them could sweep forward into stage IV [type three in Hopkins and MacGilchrist terms], leaving the others to do a competent job (in the lower stages). Unfortunately, complete freedom is just what the teachers at these lower levels neither need, nor, in general, want.

Paradoxically, the route to professional freedom may not be a direct one. It may even be necessary, in some instances, to first create more structure before being able to realize the desired goal of professional freedom. As Rogan and Macdonald (1985) observe:

> Curriculum developers . . . walk a tightrope on the issue of structure versus freedom. Initially, some structure is desirable, but unless relaxed as teachers grow professionally, it is likely to prove detrimental rather than beneficial. Beeby (1966, p. 110) warns that "the narrow, mechanical methods of a 'tramline' course, just because they are so successful with a limited objective, can clamp down on the schools and become a new orthodoxy, whose resistance to change can be singularly intense.

Any attempt to define the appropriate extent of curriculum innovation needs to be done collectively by all concerned, and specifically include those who will be implementing the changes. Curriculum planners at the school level should be allowed to take into account the context and capacity of their school, and be encouraged to select a route in working toward a meaningful implementation of the desired changes, phased in, if needs be, over a number of years. Thus, the implementation of an innovation will become a long-term, ongoing process in which teachers and other members of a school are given a say in where they begin and how fast they feel they are able to go. This approach is in line with the concept of "development planning" (Hargreaves & Hopkins, 1991), in which the various members of the school community participate in drawing up a plan to implement change in a way that is appropriate and feasible for that school's context and culture. As stated by Hargreaves and Hopkins (p. 8):

> . . . developmental planning increases the school's control over the content and pace of change. It provides a rationale either for saying "no" to certain demands, since not everything can be put into a single year's development plan, or for saying "not yet," since some changes are sensibly placed in the second, third, or even later years of the plan. In other words, a strategic approach to planning is adopted and the school ceases to be a target of demands for instant change.

Developmental planning implies making priorities. Hargreaves and Hopkins (1991) have suggested two criteria to assist in this process:

1. *Manageability*: How much can we realistically hope to achieve?
2. *Coherence*: Is there a sequence which will ease implementation?

Dalin (1998) stresses the first point with his advice to "keep the project as a holistic concept, but break it down in digestible pieces to avoid overload of single actors and of the organization" (p. 1069).

West (1998) adds a third.

3. *Consonance*: Do the priorities coincide with external pressures for reform?

West's point is echoed in the systemic reform literature, where researchers such as Smith and O'Day (1991) stress the importance of policy alignment—where changes to the curriculum at the classroom level are aligned with policy such as national standards. All these authors tend, however, to be somewhat vague on how these three criteria might be realized in practice. Nevertheless, these criteria will provide useful pointers in determining the nature and boundaries of a ZFI.

While the above authors tend to regard the school as the unit of analysis, ultimately it is the teachers, acting either as individuals or in groups, who are the arbiters of what innovation will occur in the classroom—who make the decisions on what is appropriate and feasible (Borko & Cadwell, 1982; Guskey, 1986). Hence, it is important to have some understanding of the nature of this decision-making process. Doyle and Ponder (1977) argue that teachers' decisions about whether an innovation is appropriate are based largely on what is deemed to be "practical." They go on to suggest that this "practicality ethic" has three dimensions:

- *Instrumentality*: The suggested innovation must be presented in terms of classroom examples rather than abstract principles.
- *Congruence*: The suggested innovation must be compatible with current practice and with the limitation imposed by prevailing conditions.
- *Cost*: The likely benefits of the innovation outweigh the perceived cost of the required effort to bring them to fruition.

The ZFI is an attempt to bring an element of direction and continuity to this decision-making process. Doyle and Ponder describe the process essentially as a question of acceptance or rejection of the proposed innovation. On the other hand, the ZFI assumes an acceptance of the final goal (in many countries this is not optional, since it is part of policy) and regards teachers' decision making as a series of graded steps toward this ultimate goal, phased in over a number of years if necessary. In other words, it is not a question of saying yes or no to an innovation, but of saying given our context, and where we are now in terms of practice, what can we realistically do this year to move closer to the final goal.

Vygotsky's Developmental Psychology and Social Interaction

When first proposed by Rogan and Grayson (2003) the idea of a ZFI was based somewhat playfully on Vygotsky's zone of proximal development (ZPD), defined by him as the

> distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

Wertsch and Stone (1985, p. 165) point out that Vygotsky developed the ZPD keeping in mind two "practical issues in educational psychology: the assessment of children's cognitive abilities and the evaluation of instructional practices." It is the latter that is of relevance to this article. He goes on to claim (quoted in Wertsch & Stone, 1985, p. 165) that "instruction is good only when it proceeds ahead of development, when it awakens and rouses to life those functions that are in the process of maturing or in the zone of proximal development."

The introduction of a new curriculum involves, amongst other factors, a certain degree of learning. As van den Akker (1994) observes, "Implementation implies a process of learning new roles (and often unlearning old ones) for teachers" (p. 1492). Hence possible overlaps between Vygotsky's ZPD and the ZFI will be explored. Others have already made this connection. For example, van den Akker, Ottevanger, and Plomp (1994) write, "Therefore, the combination of curriculum materials development and in-service education seems to be a potentially effective strategy for assisting teachers develop their teaching repertoire, thereby expanding their 'zone of proximal development' " (p. 5).

There are, of course, fundamental differences between these two zones. The ZPD is concerned with the appropriateness of learning strategies for the student. The ZFI, on the other hand, is concerned with the appropriateness of the innovation taking into account the context as a whole, including, but not limited to, the teacher. It is quite possible, for example, that a teacher might have no difficulty in implementing the expected innovation in one context (a well-resourced and functional school), but not in another.

Although the ZPD has certainly caught the imagination of educationalists around the world, it is by no means Vygotsky's only contribution to educational psychology. In fact, he wrote surprisingly little about the ZPD, and in the ultimate analysis does not offer very much guidance on how do determine the content of this zone. On the other hand, a thread that runs through all of Vygotsky's (1926/1997, 1978, 1998) writings is the role of the social environment in the learning process. He continually stresses, from his earliest to his most recent work, that learning occurs in a social setting. He "believed that higher psychological phenomena are stimulated and constituted by social relations" (Rather, 1998, p. xii). For example, he views the development of logical thinking in children as a process both initiated and mediated by group dynamics:

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (Vygotsky, 1978, p. 57)
> Thus, we see that the child's logical deliberation is as if an argument transferred to within the personality and, in the process of the child's cultural development, the group form of behavior becomes an internal form of behavior of the personality, the basic method of his thinking. (Vygotsky, 1998, p. 169)

In other words, the child first experiences learning in the presence of others, but gradually comes to function independently. In the formal educational setting, the role of the adult in the group is pivotal.

> The process of internalization is gradual; first the adult or knowledgeable peer controls and guides the child's activity, but gradually the adult and child come to share the problem-solving functions with the child taking initiative and the adult correcting and guiding when she falters.

> It is within this context of the gradual internalization of cognitive activities that were originally shared, interactive processes that Vygotsky introduced his zone of proximal development. (Brown & Ferrara, 1985, pp. 281–282)

If group dynamics are indeed factors that contribute to the nature of the ZFI, then we need to delve further into the players and their roles in the group. Vygotsky emphasizes potential learning being influenced by adults or more capable peers. As Cole (1985, p. 158) observes, "In the main, particularly where children are concerned, these activities are peopled by others, adults in particular." He goes on to describe the desirable characteristics of these adults. Cole also reminds us of the interplay between cognition and culture. The ZPD is strongly influenced by the context in which it operates. Individual differences determine the amount of scaffolding and support needed.

Bruner (1985) raises the issue of motivation and asks why would one want to embark on a journey into the ZPD, and once there, why one would stay the course: "It is very obscure how an adult gets a child to venture into the zone" (p. 29). Bruner does however offer a few suggestions, which include the quality of the scaffolding, which is designed to reduce risk, and the challenge factor, which circumvents boredom. The issue is a pertinent one, for both the ZPD and the ZFI. Why does one move into the learning or experimental phase (operating in the ZPD or ZFI) and then to the internalization of the concept or practice? Motivation to experiment with a change to one's teaching practice, and to consolidate the appropriate changes into one's teaching repertoire, will need to feature as part of the elaboration of any potential ZFI. It is likely that such motivation will comprise a combination of internal factors, such as professional satisfaction and adventure, and external ones, such as outside pressure to implement new policy. However, as Clune (1998, p. 13) observes, incentives for undertaking innovation are often not adequately considered at the outset and are, as he puts it, often "late bloomers."

A classroom teacher learning about the implementation of innovation in a classroom represents a different proposition from that of a child learning a specific cognitive skill in a formal learning setting. For example, learning about the innovation will most likely occur in a different setting, such as a workshop, from where implementation will take place. Furthermore, the roles of "teacher" and "learner" in these workshops differ markedly from the traditional classroom setting described by Vygotsky and Cole. The leadership of the workshop may rotate between "teacher" and "learners," since the latter often have more actual classroom experience than the outside "expert." Furthermore, the workshop "teacher" seldom has ongoing responsibility for the classroom implementation of the innovation beyond the initial workshop itself. Hence, the learning by a classroom teacher about an educational innovation and its implementation goes beyond the bounds of the traditional learning context typified by most of Vygotsky's writings.

Vygotsky's theories on the importance of social interaction as a vital component of learning have been extended by Lave and Wenger (1991) in their theory of situated learning. They argue that learning is a function of three factors: the activity, context, and culture in which it occurs (i.e., it is situated). Situated learning is in contrast to traditional classroom learning in which knowledge is often presented in an abstract form and out of context. Instead learning occurs, often incidentally rather than deliberately, as participants become part of a "community of practice." Wenger (1998) defines a community of practice as "members of a community informally bound by what they do together . . . and by what they have learned through their mutual engagement in these activities." They develop around issues or practices that are of mutual interest to a group of practitioners. According to Wenger, a community of practice defines itself along three dimensions:

- *What it is about*: Its *joint enterprise* as understood and continually renegotiated by its members.
- *How it functions*: Mutual engagement that bind members together into a social entity.
- *What capability it has produced*: The *shared repertoire* of communal resources (routines, sensibilities, artifacts, vocabulary, styles, etc.) that members have developed over time.

Experience suggests that teachers who are grappling with innovation are likely to do so more successfully if they are part of a community of practice (see, for example, Borko, 2002, 2004; Kahle, 1997). In his analysis of the NSF-funded systemic initiatives, Clune (1998, p. 1) points out "inservice professional development was seen as depending on active networks of teachers organized from the grassroots." In their book on designing professional development for science teachers, Loucks-Horsley, Hewson, Love, and Stiles (1998) continually stress the benefit of learning as part of a community. In an interesting case study of professional development, Jones, Rua, and Carter (1998) document how science teachers experienced growth within a ZPD, where more experienced colleagues were able to act as mentors to their younger colleagues. The implication is that the ZFI becomes less threatening and better defined for those participating in a community of practice. For this reason, the importance of a community of practice in negotiating a ZFI will be revisited later in the article.

Zone of Tolerance

While Vygotsky's ZPD provided the initial inspiration for conceiving a ZFI, other zones can also contribute to its development. One such zone, the so-called "zone of tolerance (ZT)," bears more resemblance to the ZFI than to the ZPD. This zone was first mooted by McGivney and Moynihan (1972) and defined as "the latitude or maneuverability granted (or yielded) to the leadership of the schools by the local community" (p. 221). Like the ZFI, this zone describes the extent of change that is feasible. However, it is concerned with the amount of change that the community of which the school is a component will accept or tolerate, and as such is based on external (sociological) factors rather than internal (capacity) ones. If the school leadership proposes or undertakes policy changes outside of this zone, the community will object, and the degree of opposition is likely to be in proportion to how far outside this zone the proposed change lies. Oakes, Welner, Yonezawa, and Allen, (1998) build on this "zone of tolerance" to propose a "zone of mediation," which essentially describes the space accorded to mediating institutions involved in reconciling the conflicting viewpoints of stakeholders in the change process. Three salient features of this zone are

1. Its boundaries are "shaped by forces originating at the societal and global levels as well as forces originating in the community."
2. Its "boundaries are not simply set by outside forces—they are largely created by people mediating among themselves and between themselves and those outside forces."
3. Its boundaries depend "on each person's perception or standpoint . . . the zone changes with time and with identity and place." (Oakes et al., 1998, p. 959)

Oakes et al. go on to illustrate these features by considering the attempts to detrack high school courses in 10 selected schools. One clear implication for the ZFI is that its boundaries will be determined by both internal and external forces, and not just the content of the subject.

Comparison of the Three Zones

The natures of these three zones are different, making it advisable that any possible transfer of parameters from one to the other can only be done with extreme caution. Differences and similarities between the three zones are summarized in Table 1.

The ZPD is at its most useful in gauging the appropriateness of new conceptual material, and perhaps ways in which it might be learned. It seeks to identify concepts that are new to the learners, but within their cognitive grasp. It would most usually be applied in a formal teaching/learning context such as a classroom, and normally any application would be confined to that setting. In this context, the roles of both the teacher and the learner are well defined, and progress is usually assessed. Motivation to learn may be either extrinsic, for

TABLE 1
Comparisons Between the ZPD and the ZFI

	Zone of Proximal Development	Zone of Tolerance	Zone of Feasible Innovation
Nature of the zone	It seeks to determine the appropriateness of new conceptual material—to identify concepts that are new to the learners, but within their cognitive grasp	It seeks to gauge the appropriateness of an innovative practice in a given situation—to identify those practices that are acceptable to the community	It seeks to gauge the appropriateness of an innovative practice in a given situation—to identify those practices that can be successfully implemented at a given point in time
What is learned	Learning focuses on cognitive development, with some possible application	Learning focuses on the understanding of community values and to some extent on the application of a new practice	Learning primarily focuses on the application of a new practice, but with an element of cognitive development
Learning context	Learning usually occurs and may be applied, in a formal setting	Learning may take place in a variety of settings	Learning may take place in a variety of settings, but rarely (although ideally) in the setting of application
Who is responsible	An adult teacher, or capable peer, is responsible for the learning to take place and possibly to be applied	Responsibility for determining what is appropriate may be distributed, but what is implemented is likely the responsibility of senior on-site management	Responsibility for determining what is appropriate may be distributed and may often be that of the learner (teacher). Responsibility for application is entirely on the learner
Motivation for learning	Rewards are clearly defined and may be extrinsic (e.g., grades) or intrinsic	Reward is in reduced likelihood of conflict with the community	Reward is in the satisfaction of successful, rather than frustrating, innovation

example, in the form of grades, or intrinsic in the sense that the learner derives satisfaction from the new conceptual knowledge.

The ZFI and ZT both seek to gauge the appropriateness of an innovative practice rather than a concept, in a given situation. However in order for the practice to be implemented, there must be some level of cognitive understanding of that practice and of the situation in which the innovation is to be attempted. The context in which the school community becomes aware of the new practice could be diverse: anywhere from a formal workshop, to informal interactions with other teachers, to exposure by way of a policy document. It is at this point that the ZT and ZFI diverge. In the case of the former, the decision on whether to proceed with implementation will rest mainly with the senior leadership of the school. In the case of the ZFI, it becomes the responsibility of individual classroom teachers, or groups of teachers, to implement the innovation. Motivation to apply the new practice in the classroom is often not well defined. In the case of strict external monitoring, there may be some level of extrinsic motivation. However, in most cases the motivation is likely to be intrinsic in the form of professional satisfaction.

FEATURES OF THE ZONE OF FEASIBLE INNOVATION

How then does this literature help develop the concept of a ZFI beyond its initial statement, and what does it have to contribute to how a ZFI might be applied? What are the features of a ZFI when it comes to the implementation of new curricular ideas? How can its boundaries be determined? What entices teachers into this zone in the first place, and keeps them in the zone as it boundaries expand?

Nature of the Zone of Feasible Innovation

In most countries, the curriculum is defined at the macrolevel—by some kind of central authority such as a Department of Education. Attempts are often made to set policy on implementation at the macrolevel as well. For example, in South Africa it was policy that all schools, regardless of capacity, would fully implement C2005 by the year 2005, although this date was later modified. The new curriculum was to be implemented at certain grade levels in the prescribed year. Schools were given no say as to when and to what extent they would comply with these requirements. The ZFI, on the other hand, is designed to operate at the microlevel. It is based on the assumption that those responsible for implementation at the classroom level should have the final say as to the pace and extent of the introduction of new practices and content.

Implicit in the concept of a ZFI is that there exists a continuum of practice on which the zone is located. This continuum may encompass a number of strands or dimensions. By way of example, two dimensions of innovation in the natural sciences in South Africa are provided in Table 2—science practical work and science in society. These two dimensions and their upper boundaries (as depicted in Table 2) are prescribed by the national curriculum standards (Department of Education, Republic of South Africa, 2002), while the lower boundaries are suggested by current practice. The continuum does not imply "progressing" from left to right; rather the higher levels are inclusive of the lower ones. For example, a teacher might be particularly adept at performing demonstrations. Should that teacher begin to offer guided discovery group activities, these are added to his or her repertoire rather than the one replacing the other. It is not a matter of only using higher level practices while discarding those lower on the continuum. Indeed, a curriculum designed only around high-level practices would be limited in its scope. Progression is seen as the judicious integration of the higher level practices.

TABLE 2
An Example of the Upper and Lower Bounds of a Continuum of Two Aspects of the Science Curriculum

Dimension	Continuum With Only Beginning and End Points Shown		
Science practical work	Simple, low-cognitive level demonstrations are performed by the teacher	←→ A series of intermediate steps	Learners investigate relationships and to solve problems in scientific, technological, and environmental contexts. Open-ended, genuine experiments are designed and performed by the learners
Science in society	Teacher mentions everyday applications of scientific concepts occasionally	←→ A series of intermediate steps	Learners are able to demonstrate an understanding of the interrelationships between science and technology, society, and the environment. Real-life problems guide the curriculum

The ZFI then is that area on the continuum beyond those practices that have already become a routine part of science lessons, which includes new practices that might be implemented with some kind of support. Its upper boundary is the interface between what is deemed to be feasible at the given point in time and context, and that which is only likely to be feasible at some later stage. The example given in Figure 1 pertains to the practical work continuum of Table 2.

The upper boundary is neither static nor impermeable. Over time, as new practices become routine, the boundary is likely to shift to the right. However, the upper boundary will also depend on the amount of scaffolding (support) that is available. With a high level of such support, teachers are able to push the boundary further and faster. However, pushing the boundary too far results in a situation of diminishing returns—more support effort with less to show for it. A second consequence of pushing the upper boundary too far is that when the support mechanisms are removed or diminished, practices are likely to regress to a lower level where implementation is more congruent with the capacity to support it.

The question of capacity received particular attention in the Rogan and Grayson (2003) article in which the concept of a ZFI was first mooted. In short, capacity to innovate was described by four dimensions: teacher factors, learner factors, physical factors, and school management/ethos factors. It is likely that there is a relationship between the width of the ZFI and the capacity of teachers to innovate, as shown in Figure 2.

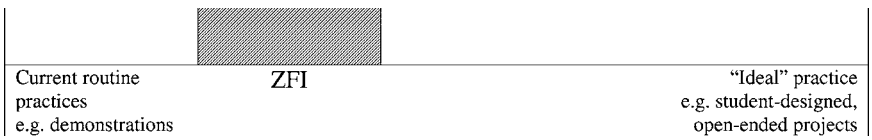

Figure 1. The location of a ZFI on a continuum.

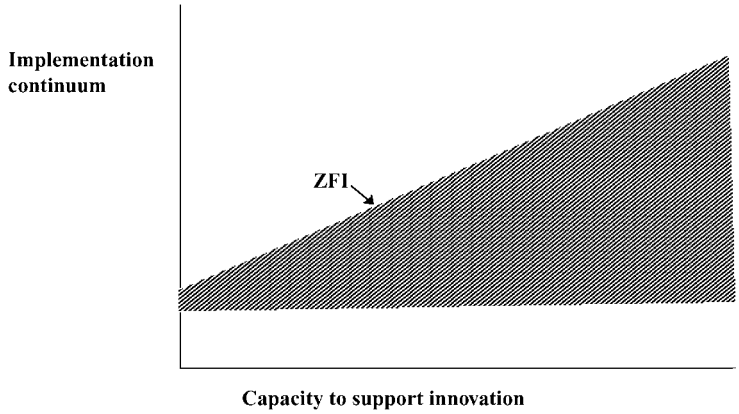

Figure 2. Possible relationship between the ZFI and capacity to support innovation.

In the hypothesized relationship, it is suggested that the ZFI will widen as the capacity is increased. In a school where capacity is limited for whatever reasons, the amount of innovation that might be attempted by teachers is likely to be small. However, a school with higher capacity, say in the form of good physical resources, well-qualified teachers, and a supportive administration, is likely to succeed with more ambitious changes. The figure also suggests that teachers in schools with a high capacity do not necessarily take advantage of their environment.

To summarize, the ZFI has two salient features:

- It encompasses a set of teaching and learning strategies that are feasible and appropriate in a given context, but which are stepping-stones toward a predefined goal.
- It provides a purpose and gives direction to a community of practice. Members of this community can support one another in the implementation of the strategies within the ZFI, and deliberate with one another on ways to extend the boundary of the zone over time toward the ultimate goal or outcome.

Implementing a Zone of Feasible Innovation

In this section, a series of proposed procedures will be suggested as one possible way of determining and implementing a ZFI. While they are presented here as linear steps, in reality their implementation will be much more "messy," spiral, and idiosyncratic in nature. For example, in one particular instance, step one might be revisited again after consideration of step three. Indeed, it is possible to envisage the entire undertaking as a whole by blurring all divisions between the steps. The undertakings described in this section might best be achieved by a community of practice—a group of teachers within a school or a cluster of neighboring schools—and constitute one powerful form of professional development. However, it should be realized that no single ZFI can be appropriate for all teachers even in the same school. While a generic school-level ZFI could be constructed, it would have to be modified and adapted by each individual teacher to suit his or her own unique circumstances.

Step One—Construction of a Continuum. A possible first step might be to construct one or more continuums—to fill in the intervening steps in a localized version of Table 2.

A number of considerations will need to be taken into account during such an undertaking. The first is to identify and accommodate all the forces, both internal and external, that are likely to shape the continuum. In many countries, and South Africa is no exception here, the continuum will be strongly shaped by national curriculum policies. For example, in South Africa the kind of practical work that should be attempted is spelled out in a number of grade-specific national assessment standards. In other countries, curriculum policies may be set at the state or district level.

Other forces that need to be considered are what the community will accept, and what the school can deliver. For example, members of some population groups in South Africa are uncomfortable if asked to do individual work. Also when considering the incorporation of societal issues, decisions will need to be made on how to deal with indigenous knowledge and culturally based beliefs (Onwu & Mosimege, 2004). Hence, the continuums may need to be adapted for specific communities. Likewise, current practice and capacity of individual schools need to be taken into account. The continuum needs to be rooted in reality—its beginning point should be consistent with current classroom practice and the capacity of the school. At this stage, content is not a factor. The focus is on the development of the continuum—for example, on the types of hands-on, minds-on practical work that exist and where they fall on the continuum.

Step Two—Create a Coherent Sequence Within the Continuum. A second step might be to interpret the continuum by means of concrete classroom strategies—"digestible pieces" to use Dalin's (1998) terminology—and then to sequence these strategies using the content of the subject matter as a guide so as to facilitate implementation within the local context. It is at this point that Hargreaves and Hopkins (1991) dictum comes into consideration: Is there a sequence which will ease implementation? The sequences will be determined by feasibility; what is manageable now, and what should be postponed until a later stage. Account will need to be taken of what resources are immediately available, and the level of outside scaffolding and support that can be expected.

Taking the practical work continuum (see Figure 1) as an example, current practice by the science teachers at a particular school may consist of no more than very elementary group work—perhaps using a comb to pick up small pieces of paper, thus illustrating static electric attraction. National assessment standards, on the other hand, might call for the collection and interpretation of data and for the planning of experiments, but the school in question has no science equipment whatsoever and the teachers are at a loss as what to do. An outside consultant may be aware of possible strategies that are feasible in such a situation, and which might constitute components of an envisaged ZFI appropriate for such situations. For example, science educators at Kings College, London, have developed a series of "translation activities" which are designed to enable students to engage, to some extent at any rate, in science processes using only pencil and paper (Johnson, Scholtz, Hodges, & Botha, 2003). A typical activity might provide the results of an experiment in table form, and the students' task is to "translate" the data into graphical form and come to some kind of a conclusion. Other possible solutions to the lack of science equipment might be the doing of "thought experiments"[1] and/or using the natural surroundings of the school as a source of data collection and experimentation. The role of the facilitator is to introduce multiple strategies consistent with the eventual goal of a particular continuum identified in step one, while that of the school-based personnel is to select strategies and to sequence them into those that are immediately viable and those that might be attempted later.

[1]In a thought experiment, students design an experiment in response to a question, but do not actually carry it out in practice.

The first two stages of the process might best be facilitated by persons both inside and outside the school. Outsiders need to bring to the process an understanding of the potential of the continuum—what the possibilities are and where the journey is leading. The school-based participants, on the other hand, will have a far better grasp of what is feasible—what is manageable in the immediate future in the light of their own and the school's capacity.

Step Three—Decide on a ZFI: The Degree of Innovation That Can Be Accomplished. The sequences of step two become operationalized in step three, with the process strongly driven by school-based curriculum managers. This step focuses on the Hargreaves and Hopkins (1991) dictum: How much can we realistically hope to achieve? Consultations at the school level need to occur, possibly facilitated by outside advisors, to determine where along the continuum current practice can be located, and what specific innovations will be attempted by whom in the immediate future. In other words, those most responsible for the implementation decide on the current boundaries of the ZFI for themselves, even if these differ from teacher to teacher within the same school. A balance needs to be found between what is feasible and what is meaningful.

The deliberations that accompany this step may also be used in the initial creation of communities of practice. Many schools are likely to have teachers who exhibit differing levels of experience in the implementation of innovation. Those with experience of some level of innovative practice could be part of the support system for others in the school or district. In other words, they become the "senior" members of a nascent community of practice. However, consistent with the notion of "legitimate peripheral participation" (Lave & Wenger, 1991), members of this community are all learners striving toward a common goal—the right-hand end of the continuum.

One way in which the innovations may be operationalized is through the selection or creation of curriculum materials, which are often powerful vehicles for the definition and conceptualization of the intended curriculum.

> Such materials are most effective when they stimulate teachers to a more elaborate and accurate "internal dialogue" about the what, when, how, and why of their own teaching role, and provide them with clear advice about the implications of these matters for classroom practice. (van den Akker, 1994, p. 1493)

Van den Akker goes on to argue that these materials play an important role in the scaffolding of teachers as they learn about and begin to take ownership of the innovation.

Crucial to the deliberations of this step will be an understating of the extent and nature of outside support (scaffolding) that is likely to be available during the initial phase of the implementation. The more support available, the more that can be attempted. Rogan (2006), in a case study of the implementation of C2005 in one rural school, describes the kinds of innovative practices attempted in situations where little or no outside support exists. (Vignettes from this case study are given later in this article.) The case study was located in Mpumalanga Province, where the changes required by C2005 were being introduced simultaneously in all schools, thus diluting the extent of support available. On the other hand, the evaluations of the Science Education Project (Macdonald, 1993) and the Primary Science Project (Harvey, 1999) provide descriptions of situations where extensive support was provided to a limited number of schools, and hence a larger degree of innovation was attempted.

Step Four—Implementation Within the ZFI. School-based curriculum managers continue to play a major role as implementation strategies are put into action. Optimal use of available outside resources needs to be made. However, outside service providers must be aware that their role is to support the teachers in realizing the goals set by the teachers themselves, rather than their determining the nature and extent of the innovation.

Particular attention needs to be played to Vygotsky's contention that learning is a social process and is context situated (Lave & Wenger, 1991). Learning and innovation are both more readily achieved with the support of peers than by individuals working in isolation. Structures could be developed, or supported if already underway, whereby teachers across different schools experiment with innovation together thus forming communities of practice, and in so doing support and encourage one another. In fact, the development of such peer-support groups has a fairly long history in South Africa (see, for example, Macdonald, 1993; Rogan & Macdonald, 1985) and elsewhere in the world, and is currently being encouraged as a matter of official policy in a number of countries.

The issue of motivating teachers to enter and remain in a ZFI is a complex one with many facets, both political and professional. As an initial prerequisite, on the political front the entity directing the innovation needs to have the respect of the stakeholders and be regarded as a legitimate authority. In the case of South Africa, there was no problem in this regard. C2005 was introduced by the country's first popularly elected, African National Congress (ANC)–led government, for which most of the teachers had voted. The new curriculum was seen as a positive replacement of the previous syllabus, which rightly or wrongly, was deemed to be inferior and discriminatory against the majority of the population. Hence, it came as no surprise that the majority of the teachers in South Africa fully supported the introduction of C2005. However, this support did not necessarily translate into effective implementation.

For effective implementation to occur, teachers need to be professionally motivated. As Bruner (1985) suggests, the quality of the scaffolding provided is likely to be a major factor that draws teachers into the ZFI initially. A well-designed and executed professional development program is vital. Enough has been written on factors that promote effective professional development (see, for example, De Feiter, Vonk, & van den Akker, 1995; Guskey, 1986; Loucks-Horsley et al., 1998) not to dwell on the topic here. Strategies need to be considered to sustain the motivation to continue with the innovation and expand the boundaries of the ZFI over time. Possibilities here include

- linking the implementation of innovation to the acquisition of additional qualifications, and hence salary increases and promotions;
- providing platforms where innovative programs can be shared and publicly recognized;
- granting official recognition and rewards for outstanding teachers and programs.

THE ZONE OF FEASIBLE INNOVATION IN PRACTICE

Having discussed the nature of a ZFI and how it might be applied, I conclude with a brief glimpse of what its content (or boundaries) might look like in classrooms in a rural province (Mpumalanga) of South Africa where conditions approximate those in many developing countries. From 2000 to 2006, the Japanese International Cooperation Agency (JICA) worked in collaboration with the Mpumalanga Department of Education and the Universities of Hiroshima, Naruto, and Pretoria to assist secondary school mathematics and science teachers to implement C2005 in a project known as the Mpumalanga Secondary Science Initiative (MSSI). One goal of the project was to vest its ownership with the teachers

and departmental officials of Mpumalanga, by means of what Nagao (2004) has described as an experience-sharing (as opposed to technology transfer) model of international cooperation. In parallel with this initiative, a large-scale research project, of which I was the director, was initiated at the beginning of 2001 to obtain data on the implementation of C2005 in grades 8 and 9. As part of this project, case studies of implementation of C2005 were conducted in 12 Mpumalanga schools during May and June 2002.

Selection and Conduction of the Case Study Sites

The Mpumalanga Department of Education provided the research team with a suggested list of 20 schools in which to undertake the case studies. The list contained rural and urban schools, some well resourced and some not. This list was used to select eight schools. A further four schools, not on the department's list, were selected by the researchers in such a way as to make the final selection as representative of the province as possible. All of the major types of schools found in the province were represented in the final selection, which also comprised schools in seven of the province's ten school districts.

Each case study was undertaken by a different person, who spent at least a full week at the school, but in most cases up to 2 weeks. I conducted one study, while many of the others were undertaken by departmental curriculum implementers, who are subject advisors attached to one of the districts. These persons took leave from their work to undertake the study and did not do the research in their own district. Because a different researcher conducted each case study, all involved met for a full day prior to the beginning of the case studies, in order to forge a common approach. Semistructured interview questions were designed for students, teachers, and the school principal. Common protocols were developed for the observation and videotaping of classrooms. A list of the kinds of documentation (mission statements, business plans, resources, and so on) to be collected was developed.

The case studies produced, amongst other tangibles, videotapes of 18 science lessons from 9 of the schools. The results have been published elsewhere (see, for example, Rogan, 2004, 2006; Rogan & Aldous, 2005). The intent here is not to reanalyze these findings, but to extract vignettes from them that illustrate what the content of a ZFI might look like in practice. The fundamental assumption is that those teachers who introduced innovation in their classrooms were operating in a self-defined ZFI. Orientation to C2005 had consisted mostly of one-shot workshops in which the new policies and terminology were explained. Very little was offered in terms of concrete examples, or any form of structure. Hence, implementation was largely a matter of sink or swim, and those who swam did so in self-defined zones.

The Content of a Zone of Feasible Innovation in Some Classrooms

In this section, data from the cases studies (18 videotaped lessons in particular) are used to suggest what might constitute a ZFI and where its boundaries might fall with respect to science practical work (labs) and the incorporation of science in societal issues.

Science Practical Work. In the observed case studies, a number of brave attempts were made to incorporate some form of practical work in the science lessons, only a couple of which apparently resulted in any kind of meaningful learning. One recipe for success was to keep the goals very simple. For example, in one of the lessons the purpose was to illustrate concepts associated with static electricity. Groups of learners were given instructions on how to rub a comb and test to see whether it had acquired an electric charge. There was

no exploration or experimentation. These activities typically lasted only a few minutes and were intended to reinforce the concepts in the photocopied sections of the textbook supplied by the teacher. In another classroom, the teacher successfully engaged the learners in a series of guided discovery activities on electric circuits. The keys to success in this case were thorough preparation, the availability of some equipment, and well-designed worksheets and tasks.

Other attempts at practical work floundered on the rocks of simple logistical considerations which derailed the goal of engaging the learners in a hands-on learning experience. For example, one of the lessons observed entailed getting groups of learners to measure their heights, to average the results, and to display them by age. However, the learners did not know how to measure their heights or to find an average. Once these shortcomings were dealt with, some learners measured themselves in inches and some in centimeters, and averages were calculated regardless of unit of measurement. Finally, the graph on which to plot the results, which was supplied by the teacher, had axes with inconsistent and incorrect scales.

Nevertheless, the enthusiasm for any kind of hands-on practical work displayed by the learners, and the willingness of teachers to go out on a limb to undertake new teaching strategies, suggests that simple, guided discovery activities could well be a fruitful area in which to develop a ZFI. It is likely that well-designed, structured worksheets requiring the minimum of apparatus could be key in defining the zone for most of the teachers observed in the case studies.

Science in Society. The notion of basing a curriculum on societal issues is very new to South Africa and does not really appear to have taken root yet (Rogan & Aldous, 2005). However, two of the observed teachers did attempt, but with little success, to base their lessons on "real-life" problems, thus addressing the issue of the relevance of the science curriculum. The one problem to solve was what to do if the ship you were supposed to sail on left without you. (Probably none of the children in the class, and perhaps even the teacher, had ever seen the sea.) The answer was to write a message, stuff it into a bottle, and throw it into the sea from the beach. The energy of the waves would then take the bottle from the beach to the ship, which would then turn around and pick you up. (The lesson was on kinetic energy.) A slightly less bizarre "problem" was on how to retrieve a ball from inside a vertical pipe filled with water. The answer was to pour salt into the pipe in order to change the density of the water thus making the ball float to the surface.

Given the emphasis on problem solving in the new curriculum, and the apparent willingness of some teachers to rise to the challenge, the ZFI might consist of ways to identify and grapple with *realistic* real-life problems in the communities in which the schools are located. The feasibility of such a practice was talked about by one of the teachers in the case study. During an interview, she mentioned her plan to have her learners analyze the water in a local pond used by the community, but which was reported to be brackish. However, she seemed rather uncertain as to how to go about putting this plan into action. The will was there, but considerable scaffolding would be required to help her achieve this intent.

Summary. In the absence of any concrete, practical guidance on how to implement the new curriculum, teachers took the opportunity to innovate by defining and appropriate extent of innovation for themselves, albeit in an unsystematic fashion. New practices that were deemed feasible given the context in which they were operating were instituted. These new practices suggest that innovations that are not too different from current practice and do not drastically challenge current perceptions of teaching and learning are indeed

feasible. While these practices were a far cry from the ideal, as expressed in the assessment standards of C2005, they were nevertheless steps in the right direction. However, as with the ZPD, teachers who venture into the ZFI need scaffolding and support, both of which were found to be lacking in the case studies. For example, attempts to introduce science practical work for the first time might result in more meaningful learning if the teacher were helped with the planning of the activity, and with simple logistical advice on issues such as how to distribute apparatus. Being part of a community of practice might assist teachers in the selection of appropriate local problems, and to help them design activities that engage learners in the solution, or at least understanding, of these problems. What was absent in the teachers' efforts to implement C2005 was a sense of what they were doing was just the beginning of a journey where the destination was in sight, that future steps needed to be defined, and that this journey might best be taken in collaboration with others.

DISCUSSION

If curriculum innovation is the goal, it is not enough to merely publish a new curriculum or assessment standards, particularly in the context of a developing country. This observation is particularly true of South Africa where a highly sophisticated curriculum was introduced into an educational system already under considerable stress (Rogan, 2006). Detailed attention needs to be given to how the curriculum ideals will be realized in practice. In most instances, particularly in developing countries, these ideas will not be realized overnight, no matter what policy pronouncements may dictate. The best chance of improvement lies with the definition of small, manageable steps determined at the school level, accompanied by the kind of outside support needed to make progress according to these steps. The ZFI is a way to facilitate the conceptualization and realization of these steps.

The ZFI is a direct challenge to the practice of mandating implementation policy at the macrolevel—a practice that is particularly prevalent in developing countries and typified by C2005. This practice, which bypasses teacher decision making, results in the Mikado effect[2]—where the policy comes to be seen more as an act of political symbolism rather than as something that actually can be achieved (Jansen, 2002), and where most of the players subscribe to a pact of pretence. Nevertheless, in a system where many teachers, through no fault of their own, are either un- or under-qualified, some form of structure, according to Beeby (1966), is necessary. However, providing this structure from the top down, as if one size fits all, has been a dismal failure in South Africa, and I suspect elsewhere too. The ZFI provides one way of developing capacity at the microlevel for making realistic decisions about how to go about the implementation phase of an innovation. It does require, however, that macrolevel policy makers be prepared to cede this function to schools, and also to find ways of developing this local capacity. Ceding authority might well result in implementing the innovation taking much longer than hoped for by the central authority. But in the long run, it is better that the intended curriculum be implemented at some more distant point in time, than to engage in the pretence that implementation has been achieved within a time frame prescribed from above.

Jansen (2003) has observed that almost all the current literature on educational change emanates from stable Western democracies. While much of what has been written may be applicable to developing countries, there is a need to rethink some of the issues in light of a different context—where the political landscape is still shaped by the emergence

[2]In Gilbert and Sullivan's The Mikado, Ko-Ko explains why, despite graphic details of his execution, the heir to the throne is in fact alive and well, as follows: When your Majesty says, "Let a thing be done," it's as good as done—practically it *is* done—because your Majesty's will is law (Gilbert, 1956).

from colonialism, civil strife, or in South Africa's case, apartheid. The notion of reform in moderation, as articulated in this article, may be one contribution to an emerging literature on educational change in developing countries. It may well be, however, that this growing body of literature will be able to make a global contribution by viewing familiar issues from a different perspective.

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