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From the Editors

Educational planning articles in this issue explore from national policies to classroom planning strategies. They also examine planning theories and how they are implemented in real world applications. Educational Planning is the journal serving as a unique platform for educational planners of all levels to share their planning ideas and experiences.

Emmanuel C. Ibara's article examines the Nigerian information technology policy and contends that the policy appears not to have sufficiently emphasized the integration of ICT in the nation's education system. It argues that the policy ignores critical elements of quality ICT application in education. The article advocates holistic policy considerations and strategies that reflect these critical elements.

Kenneth Tanner's article links measurements of the physical environment's physiognomies to human behavior and productivity. It is a rather new task in the fields of education, and social and natural sciences. The article approaches this issue through rules of consistent measurement and mapping practices. Three common measurement scales, nominal, ordinal, and interval scales are compared. Examples of the use of ordinal and interval scales are presented with respect to comparisons of student outcomes and measured environmental variables having magnitude and direction.

In Edward Duncanson's article, he shows that rooms with greater amounts of open floor space have higher test results. Four recent trends that have negatively impacted open space in classrooms are identified. His research also found that teachers react to the loss of classroom space with both active and reactive strategies. Dr. Duncanson emphasizes that the center for school improvement resides in the classroom.

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Editor

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Information and Communication Technology Integration in the Nigerian Education System: Policy Considerations and Strategies

Emmanuel C. Ibara

ABSTRACT

The paper examines the Nigerian information technology policy and contends that the policy appears not to have sufficiently emphasized the integration of ICT in the nation's education system. It argues that the policy ignores critical elements of quality ICT application in education such as the need for integration into curricular and pedagogical structures, the need for quality professional development programs for teachers and the development of local content software. The paper advocates holistic policy considerations and strategies that reflect these critical elements.

INTRODUCTION

The global interest for the advancement of education in developed and developing countries of the world has been challenged by information and communication technology (ICT). The pervasiveness of ICT has brought about rapid technological, social, political, and economic transformation that has resulted in a network of society organized around ICT (Castells, 1996). In concrete terms, ICT can enhance teaching and learning through its dynamic, interactive, engaging content and can provide real opportunities for individualized instruction. Information and communication technology has the potential to accelerate, enrich, deepen skills and motivate and engage students in learning. It helps to relate school experiences to work practices, contributes to radical changes in school, strengthens teaching and provides opportunities for connection between the school and the world (Davis & Tearle, 1999). Information and communication technology can make the school more efficient and productive thereby engendering a variety of tools to enhance and facilitate teachers' professional activities (Kirschner & Woperies, 2003). In research ICT provides opportunities for schools to communicate with one another through email, mailing lists, chat rooms, and so on. It also provides quicker and easier access to more extensive and current information and can be used to do complex mathematical and statistical calculations. Furthermore, it provides researchers with a steady avenue for the dissemination of research reports and findings (Yusuf & Onasanya, 2004). Accordingly, the Nigerian national policy on education places emphasis on the provision and utilization of ICT as it stipulates that considering the prominent role of ICT in advancing knowledge and skills necessary for effective functioning in the modern world, there is the urgent need to integrate ICT in education (FRN, 2004)

Based on a review of 28 major reports on technology integration in American Schools, Culp, Honey and Mandinach (2003) advanced three major reasons for ICT in education. They suggested that technology is usually (a) a tool for addressing challenges in teaching and learning, (b) a change agent and (c) a central force in economic competitiveness. As a tool for addressing challenges in teaching and learning, technology has capabilities for delivery, management, support of effective teaching and learning. It is equally good for geographically dispersed audiences and helps students to collect and make sense of complex data. It also supports diverse and process-oriented forms of writing and communication, and broadens the scope and timeliness of information resources available in the classroom. As a change agent it catalyses various changes in the content, methods, quality of teaching and learning, thereby ensuring effective operation of constructivist inquiry-oriented classrooms.

The school plays a major role in developing an ICT culture of a country. The school must provide effective leadership in ICT integration through research, modelling of effective integration of ICT and provision of opportunities for professional development. In order to husband the potentials of ICT, most nations have evolved national information and communication technology policies to serve as a framework for ICT integration in all facets of society. African countries, particularly Nigeria, are not exceptions to this practice.

The digital divide between advanced and developing countries particularly in Africa is well established. Like most African countries Nigeria as a nation came late and slowly in the use of ICT in all sectors of the nation's life. Although Africa has 12 per cent of the total world population the continent has two per cent presence in ICT use (Jensen, 2002). In Africa there is low access to basic ICT equipment, low Internet connectivity, low participation in the development of ICT equipment, and even low involvement in software development. The seeming backwardness of the African continent in ICT necessitated a continent-wide initiative, the African Information Society Initiative (AISI). The AISI action plan framework called for the formation of National Information and Communication Infrastructure (NICI) plans and strategies. This was to be an on-going process through planning, implementation, regular evaluation of programs and pilot projects developed according to the needs and priorities of each country (African Development Forum, 1999). It should be noted that Nigeria did not achieve much on the NICI plan and strategies at the beginning of 1999. A significant progress was made in October 1999 when the Nigerian government issued a document on telecommunications development strategy and investment opportunities. Similarly, in October 1999 the National Policy on Telecommunication was approved. The document contained policy statements on objectives, structure, competition policy, satellite communication, management structure, finance and funding, manpower development and training, Internet, research and development, safety and security, international perspectives, and policy implementation and review (FRN, 2000). The national policy on telecommunication was a key step in the development of infrastructural base for ICT. In 2001 the Federal Government approved the Nigerian national policy for information technology and the establishment of the National Information Technology Development Agency (NITDA).

This article examines the adequacy of the Nigerian national policy for information technology in respect to the integration of ICT in the educational system. The present educational needs of the country is taken into consideration. In addition, it advocates holistic policy considerations and strategies that emphasize the integration of ICT in the nation`s education system.

CONCEPTUAL FRAMEWORK

The national policy on information technology (FGN, 2001) defines ICT as any equipment or interconnected system of equipment used in the automatic acquisition, storage, manipulation, management, control, and transmission of information. In a related view ICT is conceptualized as communication in whatever form used, accessed, relayed and transmitted (Olorundare, 2006). ICT comprises a range of technologies and their applications, including all aspects of the use of computers, micro-electronic devices, satellite and communication technology (Commonwealth Secretariat, 1991). Thus, ICT are tools that comprise electronic devices that are utilized for the information needs of institutions, organizations, and individuals. The electronic devices include information machines (for example computer, hard and soft wares), networking, telephones, video, multimedia and the internet (Ibara, 2010). ICT covers products of communication technology that stores, retrieves, manipulates, transmits or receives information electronically in a digital form. Thus, ICT can be seen as the various technological devices that enhance the creation, storage, processing, communication and transfer of information. In relation to education, ICT provides teachers and students with practical and functional knowledge of the computer, the Internet and other associated areas. The application of ICT in education is a challenging process that involves three levels namely, macro, meso and micro levels (Onuma, 2007). Onuma (2007) notes that the macro level determines the national policy on information technology and outlines the various ICT in education needs of society as well as the implementation procedures. The meso level specifically deals with the educational institutions translating ICT policy into practice and involves the provision of personnel and facilities needed for the implementation process. The micro level is the implementation procedure using the curriculum. Thus, a good policy formulation for ICT integration in education is expected to address these levels.

THE PRESENT STATE OF ICT IN NIGERIA

Nigeria had a late start in the use of computers but the growth in usage has been remarkable. For instance, computer installations are widely distributed in universities, government departments and agencies, banks, and industries. Table 1 depicts some enabling, and constraining features in ICT deployment in Nigeria.

Table 1: Enabling and Constraining Features in ICT Deployment in Nigeria

Factors	Enabling Features	Constraining Features	Risk Factors
ICT deployment	• Launching of NIGCOMSAT-1 in May 2007 and connection to the SAT-3 submarine cable to reduce telecommunication and Internet connection rates • Investment of the private mobile telephone companies in fiber optic networks to enhance the deployment of Internet services and facilities especially in urban areas • Tertiary institutions and other schools involved in widening access to computer technology and knowledge • Nigeria will be a net supplier of electric energy by 2008 • Agreements with Microsoft, CISCO, and other stakeholders to spread the knowledge and usage of ICT including the production of Nigerian language versions of Microsoft products • Computers and blended learning being used in the distance learning programs of some teacher- training institutions as well as NOUN	• The low percentage of teachers who have ICT skills and the challenge of the massive ICT education drive needed to correct and develop the huge human resources base at national and institutional levels in the faculty and student populations • The lack of requisite telecommunications infrastructure capable of transporting multimedia messaging • The absence of electric power grids in most parts of the country even in cases where there is adequate telecommunications coverage • Uneasy access to computer equipment and other accessories at institutional and personal levels due to locations of cyber cafés in commercially profitable communities to the detriment of semi-urban or rural communities	• Inadequate motivation of government authorities and school administrators to implement the ICT policy in relevant education sectors • Lack of financial resources at government level • Inability of government to extend ICT infrastructure due to financial and budgetary constraints • High levels of illiteracy among women and the northern populations hamper programs even in the ethnic languages
Technical and Vocational education (TVET)	Government and UNESCO reviewed and re-oriented TVET and have equipped several institutions to train teacher-trainers in 28 disciplines in seven staff development centers. Already 527 staff are trained in 34 training workshops.	Government budgets do not permit meaningful provision for these initiatives,	Future absence of international donor technical assistance may stall progress in the programs and defeat the purpose since less than 1% of post-secondary education is in TVET.
Gender equity	Government and society are involved in the campaign and programs for girls' education, especially in the northern and eastern states.	Traditional daily household demands still take priority over girls' education especially in the northern states.	The bridging of girls and boys enrolment ratios is a daunting task in light of current enrolment statistics.
ICT policy and implementation	The university and some institutions establish computer laboratories with support from external sources.	The absence of policy at the ministerial level has not helped co-ordinate ICT projects and programs being carried out separately by various agencies operating in the education sector, and will lead to resource wastage and duplication.	

Source: Agyeman (2007) Survey of information and communication technology in Africa: Nigeria country report

THE PRESENT RANKING OF NIGERIA IN THE NETWORKED READINESS INDEX

The current ranking of Nigeria in the Networked Readiness Index is low. The Networked Readiness Index (NRI) published annually by the World Economic Forum measures the propensity for countries to exploit the opportunities provided by ICT. The NRI is composite of three elements; the environment for ICT offered by a given country or community; the readiness of the community`s stakeholders (individuals, business and governments) to use ICT, and the usage of ICT among these stakeholders. The table below shows the ranking of Nigeria among 133 and 138 countries that were included in the 2010/2011 and 2011/2012 of the index respectively.

Table 2: The Networked Readiness Index Rankings for Selected Countries

Country	2010/2011 Rankings	2011/2012 Rankings
Sweden	1	1
Singapore	2	2
Finland	3	3
United States	5	8
United Kingdom	15	9
South Africa	61	72
Ghana	99	97
Senegal	80	100
Nigeria	104	112
Uganda	107	110
Chad	133	138

Source: Adapted from World Economic Forum (2011& 2012) Global information Technology Report.

Table 2 indicates low position occupied by Nigeria among developed and developing nations (104th in 2011 and 112th in 2012). From the rankings in 2012, Nigeria drops a staggering eight places to 112th among 142 countries. The implication of the report is that the opportunities provided by ICT have not been fully exploited in Nigeria. According to the World Economic Forum Report (2012) Sub – Saharan Africa`s networked readiness continues to be disappointing, with the majority of the region lagging in the bottom half of the NRI rankings. It is obvious that many challenges need to be addressed in order to improve the state of ICT development in Nigeria. Corroborating this view Onuma (2007) notes this:

1. Telecommunication availability has improved in Nigeria, but communications quality is low and ICT penetration is still insufficient.
2. In Nigeria poverty is pervasive; hence ICT remains a stranger. Computing and telecommunication resources are unaffordable to the majority.
3. Software is at the heart of the global knowledge economy. Thus any nation that

values its sovereignty must take software development seriously. Software opportunities in Nigeria are not fully exploited.

4. Information security is an area of concern. Cybercrime, hacking, ATM fraud and general identity fraud theft are on the increase. Security of information is critical to building confidence in today`s network world.
(p. 517)

A REVIEW OF THE NATIONAL POLICY ON INFORMATION TECHNOLOGY

As Hafkin (2002) notes ICT policy can be categorized into vertical, infrastructural, and horizontal policies. Vertical ICT policy addresses sectorial needs, such as education, health and tourism. The infrastructural aspect deals with the development of national infrastructure and closely linked with telecommunication. The horizontal aspect deals with the impact on broader aspects of society such as freedom of information, tariff and pricing, privacy and security. These three aspects are adequately addressed in the Nigerian IT policy. It is now important to examine the document as it affects education. In making this analysis the author as a guide proposed two questions.

- How adequate is the policy for the integration of ICT in the Nigerian education system?
- How can the policy be redefined to address the need of the Nigerian education system?

Answers to these questions are intended to provide a basis for redefining the Nigerian national policy on information technology. First, the policy document recognizes the need 'to use IT for education'. It is important to note that in as much as the mission, general objectives, and strategies in the policy recognizing the importance of ICT in education, the document has no sectorial (vertical) application to education. Issues relating to education are subsumed under sectorial application for human resources development. In other words, the policy document has no specific policy for ICT in education. The policy document under sectorial application for human resources provides the following objectives:

- to develop a pool of IT engineers, scientists, technicians, and software developers;
- to increase the availability of trained personnel;
- to provide attractive career opportunities; and
- to develop requisite skills in various aspects of IT.

In order to achieve the objectives for human resources development, the policy outlines nine major strategies. These strategies are targeted at the building of knowledge and skills in information technology. These include

- making the use of ICT mandatory at all levels of educational institutions;
- development of ICT curricular for primary, secondary, and tertiary institutions;
- use of ICT in distance education;
- ICT companies investment in education;
- study grant and scholarship on ICT;
- training the trainer scheme for National Youth Service Corp members
- ICT capacity development at zonal, state, and local levels;
- growth of private and public sector dedicated ICT primary, secondary, and tertiary educational institutions; and
- working with international and domestic initiatives for transfer of ICT knowledge.

In spite of these objectives and strategies that are focused on education the document is inadequate in addressing the needs of the nation's education system. Some of the inadequacies observed in the document are enumerated as follows.

- The policy has no specific application to education. While there are sectorial applications for health, agriculture, art, culture, tourism; and governance, education is subsumed under human resource development. African Development Forum (ADF) (1999) recommendation explicitly notes the need for sectorial allocation dedicated specifically to education.

- The objectives and strategies related to education as reflected in the sectorial application for human resource development are market driven. Students are only being prepared to acquire knowledge and skills for future jobs. This philosophy limits the potential of ICT in education to a major force in economic competitiveness. Its potentials as a tool for addressing challenges in teaching and learning and as change agent are ignored. Students need not learn about computers only, rather ICT should be integrated for the development, management of teaching and learning in Nigerian schools.

- Teachers are indispensable for successful learning of ICT. Computer education introduced into the Nigerian secondary school since 1988 has largely been unsuccessful as a result of teachers' incompetence (Yusuf, 1998). Empirical studies have established that teachers' ability and willingness to use ICT and integrate it into their teaching is largely dependent on the professional development they receive (Davis, 2003; Pearson, 2003). The Nigerian national IT policy is silent on teacher education and teachers' ICT professional development.

- Learning through ICT entails the development of nationally relevant content software for school use. The national policy does not recognize the need to create quality software. The available software in Nigerian schools is imported with no local content. The policy document does not address this issue.

- In addition the document has no specific direction on ICT or technology plan at institutional levels. Advanced countries have specific plans for ICT. For instance, in Britain the National Grid for learning initiatives and the strategy for Education Technology, specifically address ICT issues in United Kingdom and Northern Ireland respectively (Selinger & Austin, 2003). The Nigerian national policy does not give any guideline on school technology plans.

The implication of the above review is that the national policy appears not to address the need of the Nigerian education system. Its educational focus is limited to the market driven goal. The need for integration in teaching and learning, the need for quality professional development programs for pre-service and serving teachers, research, evaluation and development, and the development of local content software are ignored. These are major components of quality ICT application in education.

ICT POLICY DEVELOPMENT AREAS

Policies are usually seen as the strategic statements that provide a broader context for change and articulates a vision that motivates people to change and coordinate otherwise disparate efforts within the system and across sectors (Kozma, 2005). Policies involve action plans that provide the instrument in which the vision is to be realized. In 2003, UNESCO Bangkok conducted a survey of the state of ICT use in education across Asia and the Pacific. Not surprisingly, the survey found a great deal of variation in the nature and extent of technology integration in the more than two-dozen countries surveyed. Specifically, countries were at different stages of both development and implementation in the areas of policy formulation, ICT infrastructure development and access to it, content development, program initiatives and the training provided for education personnel (Farrell & Wachholz, 2003). The differences stemmed not only from differences in the countries' financial and human resources, but also from differences in policymaking with regard to ICT in education. Farrell and Wachholz (2003) sum up these policy-related differences as follows:

> The countries are arrayed along a continuum of stages with regard to policies pertaining to the integration of ICT into their education systems. While all of them have stated that the development of ICT capacity is important to the future of their countries, fewer have grappled with the policy questions as they relate to ICT applications in education – and many of those countries lack the resources to implement their strategies.. This 'lack of resources' reflects, however weaknesses of existing policies and the need to improve them. (p. 267)

Indeed, weaknesses in policymaking often lead to the misallocation of resources, which in turn exacerbates the existing lack of resources. For example, there is a tendency to emphasize the installation of ICT over the seamless integration of ICT in teaching and learning – i.e. making ICT a part of the educational milieu and ensuring that it results in improved learning outcomes. This results in an incredible influx of financial support for equipment but only a meager trickle for network support or staff training (Monahan, 2004). In the Nigerian context the key areas proposed for policy development include:

1. The key considerations in selecting infrastructure and hardware are appropriateness, cost-effectiveness, and sustainability (Guttman 2003). Appropriateness refers to fitness for purpose and context, which implies that policymakers must resist the pressure to adopt the newest technologies simply because they are 'high-tech' and other countries are adopting them. As Guttman (2003) notes, some of the greatest educational problems are in the most remote areas, where electricity supplies may be irregular or non-existent, telephones scarce and lines difficult to maintain.

2. At the same time, in ensuring universal access to technologies, governments must keep in mind the need to ensure sustainability, which has technological, political, and social dimensions aside from the economic or financial dimensions. Techno-

logical sustainability has to do with choosing technology that will be effective over the long term, taking into account the rapid evolution of technologies and the availability of technical support. Political sustainability has to do with the policy environment and management of the change processes involved in technology integration in schools. Social sustainability comes from the involvement of all stakeholders, including those who will use the technology (teachers, learners), those who will be affected by its use, and others with a legitimate interest in education processes (such as parents, political leaders, and business and industry leaders (Tinio, 2003).

3. The financial cost of ICT acquisition in schools is usually a major focus of attention in policymaking and project planning. But the cost of acquisition is only one aspect, and policymakers and administrators need to budget for the recurring costs that form part of the Total Cost of Ownership (TCO). Maintenance and support account for about a third to half of the initial investment in computer hardware and software (Haddad, 2007). Thus, even if computers may be acquired for free, as in the case of donated computers, they require a substantial financial investment for maintenance and support.

4. The development of content for ICT-supported teaching and learning is another key policy area. According to Haddad (2007), introducing TVs, radios, computers, and connectivity into schools without sufficient curriculum-related ICT-enhanced content is like building roads but not making cars available, or having a CD player at home when you have no CDs. Development of content software that is integral to the teaching/learning process is a must. Policymakers will need to make a choice between acquiring or creating new ICT-enhanced educational content and software. Suitability (including curriculum relevance), availability, and cost are key considerations in making this choice. The selections of appropriate content and software have to be made not once but many times, since different learning contexts will have different requirements, for example in terms of age and learning abilities, subject-specific demands, culture and language.

5. The need for trained personnel who will implement technology integration in schools is also a key area that policymakers need to pay attention to, and they must do so from the outset. Technology by itself is not enough to transform education processes and improve educational outcomes. As Haddad (2007) notes appropriate and effective use of technologies involves competent and committed interventions by people. The required competence and commitment cannot be inserted into a project as an afterthought, but must be built into conception and designed with the participation of those concerned.

6. Access to the Internet and local networking resources deserves attention in ICT in education policies. This should address issues related to bandwidth and areas to be networked. Budget decisions should address not only the costs of the initial installation of networks but also the recurring costs of network services.

7. Technical support is another important component of ICT in education policies. It requires the provision of regular technical assistance. Teachers need this support not only in the early phases of ICT use, but also as educational applications become complex. Technical assistance is needed in order to integrate the use of ICT in curricular subjects.

The key components of ICT integration in education discussed will need to be integrated into a coherent plan with clearly specified targets, timelines, and costs. Moreover, the plan should first be implemented in pilot mode rather than full scale in order to determine whether the various elements work singly or in combination.

STRATEGIES FOR ICT INTEGRATION

The author proposes the following strategies for ICT integration in the Nigerian education system.

1. In planning for ICT integration in education policymakers in Nigeria would do well to begin by determining the educational purposes that technologies are to serve before they are brought on board. This means clarifying overall education policy as this should serve as the rationale and road map for technology integration. It is important to note that technology is only a tool and as such it cannot compensate for weaknesses in education policy (Haddad, 2007).

2. Once national education goals have been clarified, policy makers need to decide on what ICT integration approach to adopt. Farrell and Wachholz (2003) found three different strategies being used in Asia Pacific countries which can be beneficial to the Nigerian education system.

   (i) teaching ICT as a subject in its own right, usually beginning at the upper secondary level, to develop a labor force with ICT skills;
   (ii) integrating ICTs across the curriculum to improve teaching and learning; and
   (iii) using ICTs to foster learning anywhere and anytime as part of the development of a knowledge society in which all citizens are ICT savvy. Each of these has different infrastructural, personnel, and management requirements among others.

3. Private sector-Public sector partnerships to either pilot or fast *track* ICT- based projects is a strategy that has gained currency among ministries of education in developing countries. These partnerships take many forms, including private sector grants with government counterpart contributions, donations of equipment by corporations to schools, and provision of technical support assistance for planning, management, and strengthening human resources at the grassroots level. However, the financial litmus test of ICT- based programs is survival after donor funds has run out. Many ICT–based education programs funded by aid agencies could not sustain because government failed to step in with the necessary funding. Thus, a two–fold strategy is imperative; government support and local community mobilization.

4. One of the greatest challenges in ICT use in education is balancing educational goals with economic realities. ICTs in education program require large capital investments; hence caution is required in making decisions about what models of ICT use will be introduced and the need to maintain economies of scale. Consequently, it is an issue of whether the value added ICT use offsets the cost relative to the cost of alternatives. In other words, is ICT–based learning the most effective strategy for achieving the desired goals, and if so what is the modality and scales of implementation that can be supported given existing financial, human and other resources. Tino (2003) suggests the following possible sources of funds and resources for ICT use programs: (1) grants, (2) public subsidies, (3) private donations and fund raising events, and (4) community support.

5. Teachers are critical to ICT-based learning and a good strategy for ICT integration in education should involve their professional development in five areas: (1) skills with particular application, (2) integration into existing curriculum, (3) curricular changes related to the use of IT (including changes in instructional design), (4) changes in teachers' role, and (5) underpinning educational theories (Tino, 2003). ICTs are rapidly evolving technologies and even the most proficient teacher need to continuously upgrade his or her skills in line with international best practices.

CHALLENGES TO EFFECTIVE INTEGRATION OF ICT IN EDUCATION

Some of the challenges to effective integration of ICT in the Nigerian education system include:

1. In Nigeria a good number of teachers and support staff in the school system are far from being computer literate. As Akubuilo and Ndubuizu (2007) rightly notes a high percentage of teachers and lecturers in science subjects in Nigeria are computer illiterate. From this standpoint, it is obvious such teaching staff will find it extremely difficult to deliver ICT compliant education and training.
2. Low teledensity constitutes a major challenge to ICT integration. For instance, access to telecommunication tools such as computer, Internet and telephones are still low. Adeyeye (2006) notes that Nigeria has the second largest telecommunication sector in Africa (second to South Africa) with a subscriber base of 20 million, but has a teledensity of less than 15% while Canada with a much smaller population has teledensity of l07%.
3. Power supply in Nigeria is epileptic. ICT facilities are power driven. In urban cities where there is power supply it is irregular and therefore interrupts the effective use of ICT facilities.
4. Low level funding has resulted in low level provision of ICT facilities in schools. Gbadamosi
(2006) observes that education is grossly underfunded in Nigeria and has affected many areas such as the funding of ICT project, training and retraining of teachers, and development of software packages. The current level of funding education in Nigeria with decreasing budgetary allocation to the education sector is a major constraint to provision of ICT facilities in schools. For instance, the federal budgetary allocation to education in Nigeria for years running are far below the 26% education sector funding benchmark stipulated by the United Nations Educational

Scientific and Cultural Organization (UNESCO). The effect of poor funding is more pronounced in tertiary institutions where computers are needed for instruction and global information.

5. On a serious note, ICT has not been fully integrated into the curriculum of primary and secondary education in Nigeria. Not until the national policy on education is revised to fully integrate ICT in the curriculum the problem will still linger.

CONCLUSION AND RECOMMENDATIONS

Different countries will formulate different policies regarding how best to harness the power of ICTs to further their economic and social development goals through education. Even the process of developing policy could be different among countries. However, ICT in education policy considerations discussed comprise a basic set of elements that can guide the policy making process. As the Nigerian government embarks on large-scale adoption of ICTs in education, it is important to move away from techno centric planning and implementation approaches to models that focus on establishing sound policy and support strategies leading to integration of ICT in education. For this to happen, policymakers themselves need to develop systematic policy formulation and strategic planning for ICT integration. While they do not need to know the nuts and bolts of technology policy makers need to understand how technologies and education systems interact. They need to have a good grasp of the conditions necessary for ICTS to be effective in educational contexts. In the light of the discussion it is recommended that:

1. In view of the observed inadequacies in the present policy document there is the need to revise the document. Such revision should be undertaken to involve stakeholders in the area of education so that they can ensure that the policy cover issues related to learning about ICT and learning through ICT.
2. Furthermore, the objectives in sectorial application areas should address education specifically in order to broaden the market driven objectives. The integration of ICT into every aspect of teaching and learning should also be the key focus.
3. Although the issue of infrastructure is implicit in the present policy it should be reviewed in such a way that access policy is addressed in concrete terms, since this is important in ICT integration.
4. Given that teachers are important in ICT integration in education, the national policy on IT should address the issue of teachers' professional development. This should incorporate issues relating to teacher training institutions and ICT, pre-service teacher education, in–service teacher education, and standards for teacher competence and certification in ICT.
5. Also, research, evaluation, and assessment are critical for ICT usage in education. In this context, the national policy should identify a frame of reference in order to gauge success of ICT application in education, such a frame of reference will encourage refinement of school practices relating to ICT integration.

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The Interface Among Educational Outcomes and School Environment

C. Kenneth Tanner

ABSTRACT

Linking measurements of the physical environment's physiognomies to human behavior and productivity is a rather new task in the fields of education, and social and natural sciences. In education; for example, how can a schoolhouse and its surroundings be measured such that valid and reliable comparisons can be made among student outcomes? For example, how do school environments influence student behavior and other outcomes? How do we quantify specific features of the physical environment of the school? Obviously, we already accept the quantification of student testing and other measurable outcomes based on our continual dependence on standardized tests for making decisions. The article approaches this issue through rules of consistent measurement and mapping practices. Three common measurement scales, nominal, ordinal, and interval scales are compared. The nominal scale is shown to be of unequivocally no value in making quantitative comparisons, beyond classifying and categorizing assigned values. The ordinal and interval scales may be considered as vectors having magnitude and direction, while the nominal scale does not fit into correlations, regression, and prediction equations because the nominal classification cannot show direction or specify magnitude. Examples of the use of ordinal and interval scales are presented with respect to comparisons of student outcomes and measured environmental variables having magnitude and direction.

INTRODUCTION

Almost 50 years ago Sommer wrote that, "… *The interface between education and design has remained relatively unexplored – educators being mainly concerned with student behavior and designers with aspects of the physical environment* (Sommer, 1969, p. 101). Only during the past 15 years has the complex endeavor of relating school environments to students' learning and behavioral patterns shown increased attention in the media and in research institutions.

This new prominence still finds measurement of school layout for the purpose of comparing it with student outcomes plagued by the view of skeptics who argue, "*you can't claim student outcomes have any causal relationship to a physical structure because measurement of a physical environment is not isomorphic to measurement of student achievement and behavior*." This disagreement has its basic foundation in issues of interface or boundaries, which include educational measures of achievement, psychological measures of behavior, aesthetic measures of physical structures and designs, and natural science measures of spaces, places and distances.

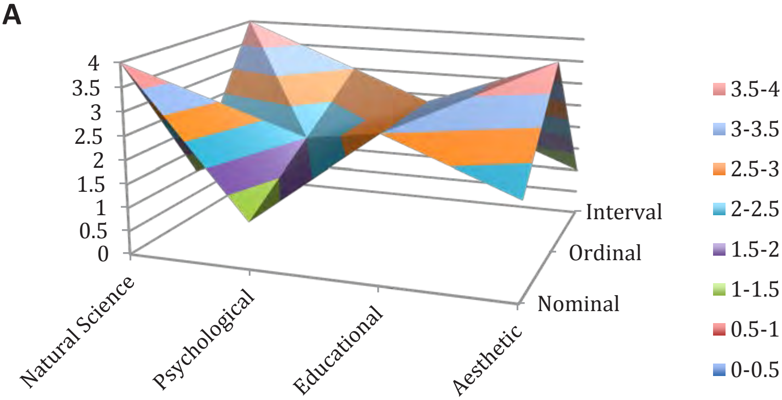
CONCEPTUALIZING THE CONSISTENCY OF MEASUREMENT

Before getting into the published research, it is important for us to consider the measurement issue noted in the introduction. Included in the science of measurement, where phenomena relate to quantities and objects relate to numbers, there exist rules for measurement, which are often presented in instrumentation such as standardized tests and questionnaires. This science is developing rapidly as a result of the push of advancing technology and the pull of changing requirements (Finkelstein, 2009). *The nature, scope,* *and organization of measurement as discussed in this article includes the identification of a common denominator among various forms of measurement, with and illustration and application pertaining to how the physical environment influences student achievement and behavior.* The concern here is can measurement in the natural sciences such as length width and volume and aesthetic preferences (Salkind & Salkind, 1974) be linked to educational and psychological measurements? To gain a better view of this idea three categories of measurement relevant to this discussion are depicted in Figure 1.

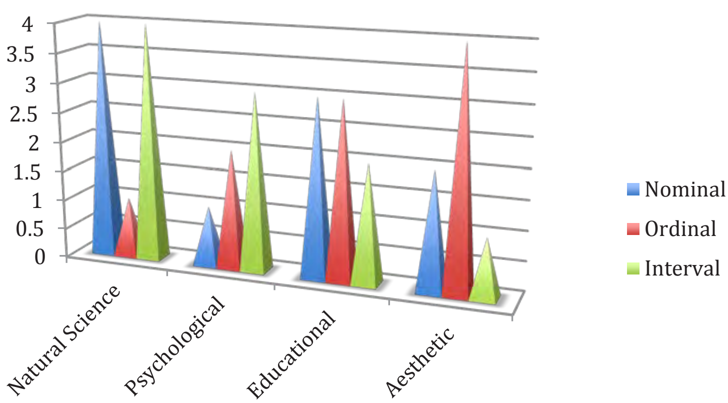
Figure 1. Scales and Measures

Measures	Nominal Classification	Ordinal Scale	Interval Scale (%)
Natural Science	4	1	4
Psychological	1	2	3
Educational	3	3	2
Aesthetic	2	4	1

Graph A



Graph B



In Figure 1 each of the four identified measures was assigned symbols or numerals (1 to 4) on the nominal classification. There is no difference in the value between the symbol 4 for natural science measures and the symbol 1 assigned to psychological measures on the nominal scale. The nominal classification is not a vector, since nominal classifications or identifiers have neither direction nor magnitude. These are just identifiers (identifier or descriptive symbols). When the ordinal scale is considered, for example, a subjective value was attached to each type of measurement by the author, thereby indicating direction and magnitude.

Moving to the other two scales, and in order of importance (one rater's viewpoint as seen on the ordinal scale), we have natural science (1), psychological (2), educational (3), and aesthetic measures (4). The reverse subjective values are applied to the interval scale so that we may see how these rules of measurement apply. By holding the nominal scale constant (since we have no other choice because it lacks magnitude and directional qualities) where measurement is concerned, we may plot the interval and ordinal values on Cartesian coordinates and show an isomorphism as seen in graphs A and B.

Although the concern about comparing the physical environment to educational and behavioral outcomes exists, there is some agreement that the conversion of subjective information about a school facility to an objective descriptor is possible. Even the most complex measurement system morphed from subjective items to objective criteria. Sophisticated standardized tests have their beginning in the subjective arena. Test items are identified subjectively before any numerical value is placed on them.

Measurement of anything begins with the identification and classification of items under consideration. Objects or phenomena as candidates for evaluation or measurement may be represented by symbols or numerals as noted in the nominal scale in Figure 1. Measurement is the assignment of numerals to physical objects or human performance according to rules (Kerlinger, 1967). Thus, in Figure 1, we have natural science measures representing objects such as school buildings, educational and psychological measures tied to standardized tests, behavior, and human performance, and aesthetic measures linked to the physical environment.

To assess a school's physical environment for the purpose of comparing it to educational outcomes in clusters (see for example, Tanner & Lackney, 2006, pp. 295 – 306) we ask a person (or persons) trained in school facility planning and design to tour a school's physical environment and rate various design characteristics on a validated questionnaire. Based on work by Likert (1932) the questionnaire containing Likert items describes various school design characteristics. Then, with numerals, the individual specifies where, in their judgment, the design characteristic falls on a set of Likert items that are later converted to a Likert scale (which may also be a percentage or interval level data – see discussion below).

As an example of linking the measurement scale to objects of interest we will consider attributes such as *space for movement, fenestration, and architectural design. Movement* is defined as easy to find relations among spaces, pathways with goals, and ample room to move about freely. *Fenestration* may be described as windows for daylight and views overlooking green areas. *Architectural design,* which might also include some aspects of movement patterns and fenestration, is expressed as the school building's point of reference, friendly entrance, intimacy gradients, variation of ceiling heights, and scale.

Professional educational facility planners, using a numerical format and a list of objects to look for, give the estimates in terms of numerals or symbols on various Likert items that correspond to school design characteristics. For example, a specific school may receive a numerical score on a Likert scale of 9 on space for movement, an 8 on fenestration, and 7 on architectural design.

The assessment is first tabulated on Likert items having a ranking scheme of 1 (a low degree of a specific characteristic is present) to 10 (a high degree of a specific characteristic is present) and converted to percentages on a Likert scale, indicating the degree that the characteristics are present. The estimates may be given by several people and then aggregated to establish a per item score leading to total Likert scale scores across categories. *The key to measurement in this example is that the planners, serving as judges, assign numerals to objects according to rules.* The list of objects is presented in questionnaire form, where close attention was paid to reliability and validity constraints (Tanner & Lackney, 2006, p. 278).

According to Flygt (2009), a measurement should include objective-subjective assessments representative of both the functional/technical and the ethical/aesthetical dimensions of a facility. The objects, numerals, and rules are specified as illustrated in Table 1. The numerals, based on the Likert items, are placed next to each descriptor, the objects are the school design items identified in the questionnaire, and the rules are contained in the instructions given in the questionnaire. For example, the instructions might read as follows: *Please score the design patterns below on a numerical scale from 1 to 10, where the numeral 1 indicates dysfunctional and the numeral 10 denotes functional. Design includes the way the schoolhouse is made, how it is arranged, and how the outside areas near the school complement the curriculum.* Here we have given meaning to numerals thus allowing them to become numbers such as percentages.

Table 1. Objects and Rules of Assignment

(Likert Scale: 24/3 = 8) Movement Patterns

The school's design may be judged regarding its ability to enable students and teachers to enter and move freely within and around a facility.

1- ____7___ **Promenade** – Outside walkways linking main areas; ideally placing major activity centers at the extremes.

Ambiguous *Likert Item* Distinct

< -- >

0 1 2 3 4 5 6 7 8 9 10

2-___8___ **Pathways** - Clear and comfortable pathways that allow freedom of movement and orientation among structures. These play a vital role in the way people interact with buildings. This pattern defines the overall philosophy of the layout.

Ambiguous *Likert Item* Clear

< -- >

0 1 2 3 4 5 6 7 8 9 10

Circulation Patterns - Indoors spaces for circulation. The passages should be broad and well-lit allowing for freedom of movement.

3- ____9____ Within learning environments .

Poor *Likert Item* Excellent

< -- >

0 1 2 3 4 5 6 7 8 9 10

According to Brown (2011), When considering Likert items … "we must think about individual Likert items and Likert scales (made up of multiple items) in different ways. Likert items represent an item format not a scale. Whether Likert *items* are interval or ordinal is irrelevant in using Likert *scale* data, which can be taken to be interval. If a researcher presents the means and standard deviations (interval scale statistics) for individual Likert items, he/she should also present the percent or frequency of people who selected each option (a nominal scale statistic) and let the reader decide how to interpret the results at the Likert-item level. In any case, we should not rely too heavily on interpreting single items because single items are relatively unreliable." (p. 13)

Brown (2011) concluded, "Likert scales are totals or averages of answers to multiple Likert items." Likert scales contain multiple items and are therefore likely to be more reliable than single items. Naturally, the reliability of Likert scales should be checked using Cronbach's alpha or another appropriate reliability estimator. Likert scales contain multiple items and can be taken to be interval scales so descriptive statistics can be applied, as well as correlational analyses, factor analyses, analysis of variance procedures, etc. (if all other design conditions and assumptions are met). (p.13)

Since we are relating characteristics of a school layout to student outcomes, the last aspect of measurement is defined. At this point the item describing a certain characteristic of school layout with an assigned rank on the questionnaire is converted to a Likert scale or percentage. In measurement terminology this is known as *mapping*. In summary, a number is a numeral that has been assigned a quantitative meaning (Likert scale) and implicitly includes magnitude and direction. The percentages representing school design characteristics are now ready for comparison to test scores and behavioral measures that are also presented as percentages. Hence, we have a rule of correspondence that assigns or maps aesthetic measurements, and natural science measurements onto educational and psychological measurements. The mapping functions, assumed to be one-to-one, are isomorphic since they are represented as percentages and have special rules of assignment and correspondence. Now that the issue of measurement has been addressed, we may apply our instrumentation to the evaluation of a physical structure.

HOW THE SCHOOL LAYOUT MIGHT CONTRIBUTE TO STUDENT OUTCOMES

The research documented here conducted at the School Design and Planning Laboratory (SDPL) attempts to tie aspects of the interplay of knowledge, beliefs, behaviors, and actions in reference to a place (the school environment) to cognition or acquisition of knowledge (measured by standardized scores on tests for cognition). Other researchers independent of the SDPL have linked these two areas, simultaneously. For example, Rollero and De Piccoli (2010) report that affective and cognitive dimensions, defined as place attachment and identification, characterize *the relationship between people and places*. Their timely study shows that the affective and the cognitive dimensions (1) are directly predicted by different demographical and psychosocial variables and (2) are strictly associated with the perception of the place and its inhabitants. Furthermore they contend that cognitive and affective dimensions are two distinct but correlated components.

Beginning in 1997, the SDPL associates discovered that no valid and reliable measurements existed that would indicate if or how much the school's physical environment contributes to or influences the student's cognitive learning and behavior. Hence, we set out, tolerating colleagues' pointed skepticism as presented in the introduction, to explore a way to link place and cognitive learning and behavior. Up until then, we discovered that school environments were usually built on whims, standardized codes, and unsupported "best practices," or hearsay evidence among educational planners and decision-makers. To strengthen our argument, we encouraged educators to examine the issue of "best practices in building schools," which often goes unchallenged regarding whose best practices and what, when, where, and how they might influence various educational and cultural settings (Tanner & Lackney 2006, pp. 263 - 322). Our conclusion was to avoid, or at least beware, of using best practices as a basis for planning and designing schoolhouses and educational environments.

Early studies at SDPL began with identifying aspects of places where students learn (these are called 'design patterns,' after Alexander, Ishikawa, and Silverstein (1977), from their masterwork entitled *A Pattern Language*.) Table 1 shows an example of design patterns used in our instruments. Our primary assumption was that design patterns in the school's physical environment influence student achievement; therefore, "Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice" (Alexander et. al. 1997, p. x). That is, *we assumed that place and cognitive dimensions are related in various ways.* Readers interested in more detail on the physical environment, as we have defined it may refer to additional works such as Sommer (1969), Tanner and Lackney (2006, pp. 263 -322), and Tanner (2009).

More than 100 characteristics of design patterns were identified and debated among educational leaders attending graduate level classes offered in the SDPL, beginning as early as 1997. The purpose of these discussions was to validate each "education related design pattern" based on need and relevance to teaching and learning. Representing a very small fraction of our findings, three broad areas are identified below (Tanner, 2012).

1. Movement Classifications

Research on movement classifications, described as links to main entrances, pathways with goals, circulation pattern, density or freedom of movement, personal space, and social distance has been of interest to researchers in the field of environmental psychology for many years. In our validation process we always asked questions about too much or too little space and then referred to issues of social and personal distance to develop a stem for a measurement scale to be used in assessing existing places and spaces for learning.

Regarding personal and social distance, Wohlwill and Van Vliet (1985) summarized the effects of high student density as a hindrance to movement. "It appears as though the consequences of high-density conditions that involve either too many children or too little space are: excess levels of stimulation; stress and arousal; a drain on resources available; considerable interference; reductions in desired privacy levels; and loss of control" (pp. 108-109). Works such as this have led to the assertion that a high-density school influences achievement negatively (Weinstein & David, 1987). Our decision about freedom of movement has been consistent: An overcrowded school is not conducive to teaching and learning. *It is not the size of the school that plays the positive or negative role in student achievement as much as it is the density - number of students per square and cubic unit of measurement.*

Some other major conclusions from our research at the SDPL are summarized as follows: The issue of density may be viewed through psychological implications implied in "territoriality of place." Since the school is a social system within the cultural environment, social distance (as defined by Hall, 1966) relates to crowding and density, which are functions of school design. This course of reasoning should be made for school size and the size of classrooms. Special attention should be given to circulation classifications that permit student traffic to flow quickly from one part of the building to another. Movement within the school should be a conscious and perceptible environmental exchange; and complex structures that cause crowding should be avoided. School design should include pathways both inside and outside of the building. Pathways may link structures together and lead into the natural environment.

2. Architectural Design

Fiske (1995) indicated the organization of space has a profound effect on learning, and students feel better connected to a building that anticipates their needs and respects them as individuals. When children attend a school obviously designed with their needs in mind, they notice it and demonstrate a more natural disposition toward respectful behavior and a willingness to contribute to the classroom community (Hebert, 1998). Collaboration among stakeholders in planning and designing a school is a significant step in achieving the right design. Both the planner and the stakeholders (including parents and students) learn from each other. Participation can lead to the ultimate agreement about what the future should look like and includes awareness and perception. Awareness involves persuading participants to speak the same language, perception takes awareness a milestone forward – it facilitates an understanding of the physical, social, cultural, and economic ramifications for the project outcomes (Sanoff, 1994).

The need exists for the development of spaces that engage, challenge, and arouse a student's imagination. Brain-compatible learning requires much more interaction with the environment than current facilities allow. Taylor and Vlastos (1975) suggested that educational architecture is a "three-dimensional textbook." This means that the learning environment is a functional art form, a place of beauty, and a motivational center for learning. School buildings are visual objects, and as such they can be stimulating both in terms of their intrinsic design and their use.

Architectural design should include a friendly entrance that is age appropriate and highly visible. Huge, overpowering entrances are intimidating to young children, for example. The entrance should evoke a welcome feeling (Alexander et al, 1977), not instill fear. To stakeholders, the school administrative offices should be centralized for convenience and connection. Main buildings have an obvious reference point, a feature that heightens the sense of community. *Variation of ceiling heights and intimacy gradients help blend public and private places in schools and give the effect of drawing people into an area.*

The issue of scale must be emphasized in planning the school layout. Meek (1995) contributed to the understanding of scale when she wrote about Crow Island School: " Then you are at the front door, and what you notice is that the door handler is too low. Too low for you, just right for children." (p. 53)

3. Fenestration, Daylight, and Views

The presence of natural light in classrooms improves student learning. An extensive research effort, including a controlled study of over 21,000 students in California, Washington, and Colorado found that students with the most "day lighting" in their classrooms progressed 20 percent faster on mathematics and 26 percent faster on reading tests over a period of one year than students having less daylight in their classrooms (Heschong Mahone Group, 1999). "We also identified another window-related effect, in that students in classrooms where windows could be opened were found to progress 7-8% faster than those with fixed windows. This occurred regardless of whether the classroom also had air conditioning." (p. 62). Rather than being a distraction, an argument often used from the "conventional wisdom" side, which disrupts the learning process, windows provide a necessary relief for students (Kuller & Lindstern, 1992). As a general rule, being able to see at least 50 feet or more allows students to rest their eyes by changing focal length.

According to Wurtman (1975) light is the most important environmental input, after food and water, in controlling bodily functions. Different colors of lights affect blood pressure, pulse, respiration rates, brain activity, and biorhythms. Full-spectrum light, required to influence the pineal gland's synthesis of melatonin, which in turn helps determine the body's output of the neurotransmitter serotonin, is critical to a child's health and development (Ott, 1973). To help reduce the imbalances caused by inadequate exposure to the near ultra-violet and infrared ends of the spectrum, full-spectrum bulbs that approximate the wavelengths provided by sunshine should replace standard bulbs. Ample evidence exists indicating that people need daylight to regulate "circadian rhythms" (Alexander et al 1977, p. 527). Poorly lit and windowless classrooms can cause students to experience a daily form of "jet lag," while forms of florescent lighting may affect some students and teachers by causing mild seizures.

CONCLUSIONS

Following the logic presented in this article, we may hypothesize that measurement of educational and psychological outcomes can be compared with measures of the physical environment. That is, given isomorphic measures including magnitude and directional vectors, school layout can be compared to student outcomes. From the literature and SDPL research we can conclude that ample space for learning where overcrowding is avoided improves student outcomes. Likewise ample circulation patterns, appropriate scale, and plenty of natural light in the classroom improve student performance. The relationship between people and places is a significant and sound topic for further research.

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Lasting Effects of Creating Classroom Space: A Study of Teacher Behavior

Edward Duncanson

ABSTRACT

Research has shown that rooms with greater amounts of open floor space have higher test results. Four recent trends that have negatively impacted open space in classrooms: (1) storage of CCSS materials in the classroom, (2) storage of science kits in the classroom, (3) inability to remove unwanted material, and (4) inability to remove unneeded furniture from the classroom. Teachers have reacted to the loss of classroom space: (1) desks are rearranged frequently to create specific spaces needed for an activity; (2) daily planning considers the use of space; (3) hallways and the library are used to increase student space; (4) the amount of materials readily available for student use have been reduced. (5) tall book cases have replaced horizontal models; (6) the size of interest/exploration centers had decreased. Administrators need to create a system to dispose of unwanted materials. The center for school improvement resides in the classroom.

The ability to simplify means to eliminate the unnecessary so that the necessary can speak.
David Henry Thoreau, 1817 – 1862

INTRODUCTION

Classroom spaces may not be meeting the needs of small children (Tanner, 2000). Adults look at rooms vertically while 'rug-rats' look at and use floor space horizontally. Planning classrooms for use by children tends to be ignored even while new curricula, testing, and accountability are being put in place (Jarman, 2008; NRC, 2000; Sommer, 1977). But that is changing. Researchers are beginning to focus on classroom environment as an important component of the education system. As Achilles (1999) stated, "One place to start observing classrooms is to consider space, space use, and the environment or context of the teaching-learning process" (p. 38).

A greater amount of attention must to be paid to the arrangement of a classroom and how it evolves (Lowe, 1990; Sargent, 1991; Weinstein, 1992). Lacking adequate instruction in teacher preparation programs, teachers copy the structural mistakes they see in other classrooms (Tanner, 2000).

Open space changes classroom dynamics. Teachers who have reduced the amount of material and furniture in their classroom to open floor space have recognized the benefits. Adding just 80 square feet of open space provides benefits for students: extra books permit students to read for fun; students find materials on their own; organizational improvement by the teacher is copied by students; students find a space to read by themselves or with a partner; and distractions lessen when distance between students increases (Duncanson, Volpe, & Achilles, 2009). Researchers are beginning to understand: **"**The center for school improvement resides in the classroom."

Research reported in 2012 by the author offered the position that elementary classrooms typically are used as a branch of the school library. Therefore it makes sense to design classrooms after considering the space recommendations for libraries. Using that criteria, a standard 850 square foot classroom would need to be 300 square feet larger to address the education needs of young children (Connecticut State Library, 2002; Duncanson, Tanner, & Achilles, 2012).

While bigger classrooms are needed, teachers are faced with a growing storage problem. Boxes of materials and bookcases full of instructions connected to new programs are being stored in classrooms. This situation makes it more difficult for teachers to maintain space they know is important to students. William McInerney commented, “But the classrooms are already there. Teachers can’t make them bigger. What can they do?” (personal communication, October 10, 2012). That query became a focus for this investigation.

Classroom Architecture

Classrooms start out as empty spaces but soon change. Each room is the total of the fixed architecture and the moveable furniture. Fixed items can include: windows, doors, electrical outlets, shelves and cabinets attached to the walls, computer outlets, overhead projection screens, and projectors mounted on the ceiling. Fixed architecture influences classroom arrangement. Specifically, the position of the classroom door, placement of an emergency exit window, HVAC system, permanent storage cabinets, a sink, computer outlets, wall-mounted smart board, and a ceiling mounted projector reduce the flexibility of furniture arrangements.

Moveable furniture can include: teacher’s desk, student desks, reading table, display/work table, map storage, book cases, soft furniture, easels, storage bins, and plant stands (Duncanson & Achilles, 2006). While moveable furniture can be arranged in a variety of patterns to accommodate different learning activities, furniture arrangement is always influenced by the position of fixed aspects of the room. Arranging desks in clusters rather than rows naturally creates wide pathways that invite students to explore.

Because every classroom is different, planning space cannot follow a cookie cutter design. Classrooms have different sizes, shapes, and include fixed structures in different locations. As part of their job, teachers become the architects of interior space to serve the needs of children.

Student-Selected Learning Space

When given the opportunity students use classroom space to their best advantage. Space is important to teachers who employ a Daily Five teaching format enabling students to use their discretion in selecting a suitable work environment (Boushey & Moser, 2006). A variation of the Daily Five format uses 60 to 80 minute blocks of time with three to five stations each with a different purpose. Students may be asked to work on (for example): a remedial assignment, extended projects, writing skills, silent reading, or group reading with the teacher. Students rotate through each station in12 to 20 minute blocks of time.

Students select their own space to work based on three criteria: (1) need for a solid work surface: a desk, the floor, or a clipboard; (2) physical comfort to match their personal need; and (3) autonomy – the need for privacy. Students select areas in the classroom in a manner that is highly predictable: corners of the room are a prime work location; tables are used for projects; desks, clipboards and the floor may be used for writing assignments; children reading will go as far away as possible from the small group reading with the teacher; small groups will move to the largest space available; and children working alone will find a space that is equidistant from other groups.

Teachers can know ahead of time where students will select to work based on the activity and a personal knowledge of the student. That information can be used to effectively plan the activities offered to students so all available space is used. Moveable furniture may be rearranged to create needed spaces. In general, more than one-half the students will select a work space on the floor (Duncanson & Achilles, 2010).

Teachers can set a high priority on having an appropriate amount of space to rearrange student furniture to match spaces needed for student activities (Lang, 2002). Flexible environments are normally good ones for students: flexibility allows for different kinds of learning activities (Casson, 2013).

Space, Time, Teaching and Learning: M-time vs. P-time

Space is a crucial factor determining how teaching time is used. Hall (1976) focused his attention on how people interacted with space and used time. Both factors impact teaching and are within the control of teachers: school days are planned around time and space. The lack of large spaces for student work forces the teacher to schedule all events in a one-size fits all modality: activities are scheduled into fixed slots of time using specific spaces. Hall termed this use of time and space as 'monochronic' (M-time): each activity is scheduled for a specific time. In M-time classrooms teachers devote a great deal of time to highly structured activities. These classrooms are arranged so students have little space or opportunity to move around: four rows of student desks face the teacher for whole-group instruction. Therefore an M-time teacher-centered model is falling by the wayside.

Student involvement in active learning, individualized teacher interactions, and a release from monochronic time settings is possible only if the classroom structure is changed. "Structure must change before culture can change" (Ouchi, 2004, p. 18). Classrooms have to change before student achievement will improve. Meier (2008) noted that people will change their behavior if you change the environment.

When teachers have spacious classrooms they shift to a polychronic time system (P-time) and students direct their own activities (Hall, 1976; Hall & Hall, 1975; Manke, 1994). P-time functions in a fluid context in classrooms where space is abundant. P-time systems stress participation in social interactions and completion of projects rather than adherence to a preset deadline. Released from confining structures of time and space, students become curious, independent, open-minded, and questioning individuals. Having ample space in a classroom makes a switch in pedagogy possible. Teachers are able to react with students individually or in small groups while several activities may occur at the same time. In classrooms with ample space, there is a connection between hands-on activities and creativity (Lasky & Yoon, 2011). P-time teaching addresses the needs of students who possess different talents and enables the teacher to become a mentor – coach.

Opportunity to Learn

Today's youngsters are visually oriented and prefer active learning in a welcoming space. School and classroom environments that accommodate the needs of all students while promoting student thinking and individualization are necessary for opportunity to learn (OTL) (MAEC, 2008). Six factors that contribute to quality schools can be observed in classrooms: safe and orderly environment; high expectations for student learning; adequate physical space; access to books, technology, and support materials; uninterrupted periods of instruction; and the use of appropriate and varied teaching strategies (Banicky, 2000; Frank, 2007; Schwartz, 1995). Rows of student desks arranged for whole-group-single-size-fits-all instruction is not compatible with brain-based learning (Jensen, 2000; McNeil, 2008). If better results are expected on high-stakes tests, then classrooms with greater amounts of space need to be created (Higgins, et al., 2005). Different size work spaces appropriate to their purposes are required for students: individuals, small groups of 3-5, teams of 5-10, and full class-size groups (Espey, 2008).

OTL is associated with teacher use of time and space (Banicky, 2000; Frank, 2007; Schwartz, 1995). OTL guidelines call for classes in spacious rooms where students are free to use space and can learn well; this open environment promotes active learning (Higgins, et al., 2005; UCLA, 2003). Space invites students to move around: it gives them a break (Jensen, 2000). These conditions are a match for teaching and learning in a P-time system. Easy passage around the room allows students to receive help from their peers in an effort to make their work better: 8 and 9 year old students enjoy the opportunity to work on projects away from their desks (McNeil, 2008; Wood, 2007). When teachers increased the amount of open space in their classroom, they found that several positive changes occurred naturally: organization improved, student behavior improved, the classroom was cleaner, and students managed their own activities (Duncanson, Volpe, & Achilles, 2009; Rourke & Hartzman, 2009).

Proof in the Pudding

Open space on the floor of elementary classrooms contributes to positive outcomes for teachers and students (Tanner, 2000). Research by the author has shown there is a high positive correlation between open floor space and grade 4 student achievement in science skills, and New York State (NYS) English Language Arts (ELA). The science skills of classifying, manipulating materials, measuring, making non-standard measurements, recording data, and questioning are positively correlated to student density (sq. ft./pupil). When student scores are compared to the square feet of space per student in each classroom, there was a Pearson correlation coefficient of +.881 that was significant at the .048 level (2-tailed) ($\underline{r}$ = +.881, $\underline{p}$ = .048). This is a high positive correlation (Hinkle, Wiersma & Jurs, 1998). This means that students have higher scores on tests of science skills in classrooms with greater amounts of empty floor space (Duncanson, 2003a).

After a classroom was redesigned, students showed substantial improvement in test results for NYS ELA Standard #3 (Language for critical analysis and evaluation). A t-test yielded positive results: t = -2.303; df = 38; Sig (2-tailed) = .027 (Duncanson, 2009). Collectively this means that student test scores are higher in classrooms that have greater amounts of open floor space.

These findings are in line with class size research (e.g. Tennessee's Student Teacher Achievement Ratio [STAR]) which showed that increasing classroom space by having fewer students improves student achievement (Achilles & Boyd-Zaharias, 2008).

Guidelines for Creating Space

Reorganizing a classroom is most easily achieved by first removing everything from the room. Having teachers change classrooms from time to time is a convenient way for administrators to facilitate this important opportunity. Starting with an empty room makes planning a functional layout easier (Zike, 2005).

Step #1: Identify classroom material that will be used in that school year.

Classrooms should contain only materials that are needed for instructional purposes that year: they should not be storage rooms for unused materials. Shelves of old texts, materials for another grade level, and stuff not used in the previous year should be discarded. Bookcases and shelves that held unneeded materials can be placed in storage. One teacher who emptied her room found boxes holding seven broken staplers, five pencil sharpeners, tests from 15 years ago, old curriculum guides in their original shrink-wrap, and dry ditto masters. Those dusty boxes were not helping the health of young students.

Computer access has changed teaching. The need to hang onto teaching tools has been reduced by the internet: new materials are readily available. It can be easier to find new ideas than to dig old ones out of storage. The internet can replace a file cabinet. Teachers in some classrooms have been able to discard 90% of their holdings when they examined everything before it was placed back in a classroom (Duncanson, Volpe, & Achilles, 2009).

Step #2: Map out the areas needed for instruction and activities.

Harlan (2000) pointed out that space needs to serve different size groups and meet different needs: direct instruction, class meeting area, small meeting areas, and space for individuals. The curriculum likely requires specialist areas: study bays, work centers, large group work area, displays and interest/discovery/learning centers (BCSE, 2007; Higgins, et. al., 2005; Locker, 2007; Nielson, 2004). Having space leads teachers to increase the number of teaching methods they use. Hands-on experiments, collaboration, student performances, and increased student-teacher communication begin to happen when space is available.

After careful thought, spaces that match the teacher's style for teaching and learning need to be preserved. Teachers can delineate these areas for preservation by marking the floor with masking tape or chalk.

Step #3: Plan pathways

Classroom pathways create a pattern that reminds people of a roadmap. While meeting with a civil engineer, the author spoke about roadways in a classroom and how there must be a science behind patterns of highways. The civil engineer suggested that a parking lot was a better model for a classroom: after all teachers park students at a desk (Duncanson, 2003b).

If classrooms are treated like parking lots, then a main avenue should start at the classroom door and run across the room parallel to one wall. Secondary paths should lead to special areas of the room (Federal Sign and Signal Corporation, 1974). Pathways, wide enough to allow two students to pass without touching each other, can be outlined on the floor (Colbert, 1997). A reasonable goal is for one-half of the classroom to be open space: space already outlined on the floor. Tanner (2000) recommends that each student have 49 square feet of empty space. Thus a classroom of 850 square feet should hold 17 students.

Step #4: Arrange the furniture.

Furniture that will be used on a daily basis can now be moved into the room in space not reserved for teaching or pathways. Student seating will probably occupy one-fourth of the classroom space. A maximum of 15 additional pieces of moveable furniture can occupy the remaining one-fourth of the classroom. The open space and furniture placement should address a variety of teaching situations: group instruction to teach skills, laboratory learning for exploration and discovery, project work, practice space, and individual and group work and study. "When teachers choose only furniture that contributes to educational success, more space is available for student use" (Duncanson & Achilles, 2005, p. 31).

Adding additional pieces of furniture takes space away from students. When the number of boxes, bins, and furniture totals 30 or more, rooms become overcrowded and safety is compromised (Clayton, 2001). A target of 15 pieces of furniture reserves space for the students while providing easy access to materials student's use. If materials are not readily available students spend a lot of time waiting in line, waiting for help, waiting for materials so they can get to work (Shalaway, 2013). Care should be taken to not employ unused student desks as a place to pile paper – a clear example of Flat Surface Syndrome (FSS). FSS is the habit of laying 'stuff' on any flat surface until the pile earns the title of clutter (Funny the World, 2009). Extra student desks should be sent to storage.

Teachers who generally only use their desk before and after regular school hours, or as a place to stack papers, should consider getting rid of their desk and using a large table as their work area. When materials teachers use are the same ones students use, storing them in the center of a worktable serves everyone's needs (Duncanson & Volpe, 2009). The presence of a teacher's desk also creates a 'teacher's space' that students do not enter. Removing the desk can open 80 square feet of space that benefits the students. If the teacher needs a desk, it should be positioned against a wall to minimize the teacher space. A teacher who got rid of his desk commented, "I don't have a place to lay things down. I have to deal with everything immediately: toss it or put it away. There is no more clutter. It is wonderful" (J. Tobin, personal communication, November 6, 2008).

As a final task, teachers should sit in different parts of the room to see the arrangement as students will see it (Chan, et al, 2009; Design Council, 2005; Loughlin & Suina, 1982; Lushington, 2008). Otherwise students get stuck with the teacher's environment. Be careful that students do not have a place to hide.

RESEARCH QUESTION

How do teachers maintain classroom space while being asked to store an increasing amount of material?

METHODOLOGY

Research Design

A descriptive, cross-sectional, non-experimental research design was used (Johnson, 2001).

Research Participants

Five teachers in two rural, elementary schools 70 miles north of New York City volunteered to participate in the following study. They had previously worked with the researcher in studies of classroom space. Studies in their classrooms resulted in the collection of student achievement data in Science and ELA, the identification of tessellation patterns when students self-selected their learning space, and the study of 20th century classrooms. Teachers received a final copy of all the studies in which they participated.

While the teachers received assistance with classroom management in years past (see Steps 1-4 above), they were involved in no professional development activities related to room arrangement in the preceding two years. Five teachers participated in the study. (Eleven teachers made up the original pool of possible participants. Six were not available for the study: two had retired, one was deceased, two moved out of the area, and one elected not to participate.)

Data Collection

Data were collected through classroom visits, survey, interview, and a follow-up interview to review findings. The narrative is presented in a conversational manner.

FINDINGS

It was clear in the interviews that open floor space was constantly on the teacher's minds: all five participants mentioned space as a primary concern. They recognized that the development of independent learners requires spaces of different sizes to meet the individual needs of students (Casson, 2013; Harlan, 2000).

Teachers identified four recent trends that have negatively impacted open space in classrooms.

(1) New York State Education Department officials have mandated the use of curriculum plans and materials to support Common Core State Standards (CCSS). The materials are stored in each classroom and commonly fill two sets of horizontal shelves.

*Impact***:** The sheer volume of paper to read has been overwhelming. A sample set of teacher directions (six pages in length) contained 31 bullets of instructions for the teacher to relay to the students, 120 bullets of suggestions for how the teacher could meet student needs, instructions for the creation of a T-chart to record student answers, and instructions for a student homework assignment to analyze five quotes from a reading passage. A four-page lesson plan outlined teacher/student behavior for a 55 minute class (NYE Dept. of Education, 2012). Teachers reported that a 55-minute lesson plan normally consumed five 55-minute blocks of time. Science, Social Studies, project based learning, extended presentations, and special events were eliminated to create additional time for Common Core based instruction. The loss of space and increased pressure on time reduced space/student and forced teachers to work in an M-time system.

(2) The school district science supply center was dismantled. Staff at the science center previously delivered a single science kit to a teacher when it was requested and retrieved the kit upon completion of the unit. Four units of a new kit-based science program are now stored in each classroom.

Impact: While the science program is designed to promote inquiry, the volume of the stored materials has reduced the work space available to perform inquiry science experiments. Teachers have resorted to lecture and fewer hands-on activities (M-time): both products of less space and time.

(3) The ability to remove unwanted material has been restricted by administrators. A convoluted process developed by the Board of Education (BOE) discouraged teachers from trying to rid themselves of outdated instructional

materials. Teachers avoided the extra paper work and stored old materials.
Impact: Teachers have shelves, boxes, and bins of unwanted material they cannot dispose of. The amount of material in four of the five classrooms has increased in the past two years: space has been reduced.

(4) Four teachers saw their class count for 2011-2012 increase by one student and then reduced by one student in 2012-13. It was noted in classroom observations that the desk for the lost student remained in the classroom taking up space and enabling the teacher to display a manifestation of flat surface syndrome by covering the desk with papers.
Impact: Open space was lost.

Positive Steps

Teachers have reacted to the loss of classroom space by changing aspects of the classroom that are within their control.

- Large tables have been removed.
- Buckets or bins have been substituted for large cabinet interest centers.
- Tall bookcases and cabinets have replaced horizontal models. High shelves are used for teacher materials and lower shelves for student supplies.
- The amount of materials readily available to students has been decreased.
- Desks are rearranged frequently to create specific spaces needed for an activity.
- Tessellation pattern spaces are planned to match the needs of the Daily Five.
- Hallways and the library are used by students to access privacy.
- Teachers created private nooks in the classroom for silent reading.
- An interest center cabinet is removed when an additional student and a desk are added to the class.
- Teachers continue to operate in P-time.

Implications for Planning

- Administrators need to be aware that decisions they make impact classroom space and teaching pedagogy (Banicky, 2000).
- Administrators need to give teachers permission to throw things away and give space back to the students (Zike, 2005).
- The availability of storage space outside the classroom for bins of science materials needs to be explored (Clayton, 2001).
- Teachers should revisit annually and follow recommendations found in Steps #1-4 for how to create greater amounts of classroom space (Duncanson, Volpe & Achilles, 2009).
- Teachers need to plan the physical layout of classroom furniture carefully due to its influence on space and student preference when choosing a place to learn (Duncanson & Achilles, 2010).
- Teachers can consider replacing horizontal storage shelf units with vertical units to gain storage space without decreasing open floor space.
- Teachers need to be aware of the impact on students that Common Core Curriculum

instruction based on M-time alters the classroom dynamic that functioned in P-time (Hall, 1976).

- Students need to have a voice in the design of classroom space to reflect their needs (Design Council, 2005; Sommer, 1977).
- Model classrooms can be established with carefully designed arrangements to promote the benefits of ample space (Achilles, 1999).

CLOSING THOUGHTS AND OBSERVATIONS

There is a need to plan the physical layout of classroom furniture due to its influence on space and time. Teachers understand classrooms with maximum open space, clear pathways, and a variety of teaching spaces provide students with ample opportunities to self-select learning spaces that meet their needs. They know planning space before placing the furniture is a crucial step needed to preserve space and requires careful consideration.

Only materials needed for the current school year should be in the classroom: in this study, that was not always the case. Equipping rooms with a minimum amount of furniture is required to meet the goal of not covering more than one-half the floor space: student's desks plus 15 other pieces of furniture should be a maximum. Organizing a classroom to promote P-time teaching strategies can be achieved with proper planning and at no cost.

Decisions about classroom organization made by individual teachers and their students in the context of pedagogy, task demands, and furniture, are being over-ridden by decisions that are outside their control. Using classrooms as store rooms for large amounts of CCSS curricula, science kits, extra furniture and unwanted materials decreases space per student, limits instructional strategies teachers may use, and limits work-spaces for students.

Teachers have tried to counteract the loss of space by: reducing the amount of furniture students use; only using interest center materials that occupy a small amount of space; reducing the amount of materials readily available to students; using non-traditional classroom spaces; and frequent rearrangement of student desks to create needed work spaces. The mandated addition of material to classrooms has outstripped teachers' ability to rid classrooms of an equal amount: the result is a net loss of empty space.

When teachers understand how to plan classrooms, the ideas stay with them even when faced with obstacles. Constructive steps that restructure classrooms and remove obstacles to learning can be implemented. These observations are consistent with identified needs of P-time classrooms and the theory for OTL. Educators can change what happens in school.

POST SCRIPT

Armed with knowledge of the barriers classroom teachers faced in their effort to maintain recommended amounts of empty floor space, the researcher wrote a letter to the Superintendent of Schools requesting consideration for the plight of teachers. The importance of spacious classrooms was summarized and supported with statistical results using state tests. Recent trends that hindered teacher's efforts to maintain classroom space were then listed. It was noted that the course of action required to dispose of outdated texts, non-working electronic equipment, and broken furniture was cumbersome. The Superintendent was urged to simplify the required paperwork. She immediately shortened that process.

Staff members took advantage of the change in procedure. Teachers quickly earmarked unwanted materials for disposal: 15 year old sets of texts for language arts and mathematics, computers and overhead projectors that did not work, and pieces of broken furniture. This action resulted in benefits for teaching and learning: there was an increase of space/student, organization of teacher materials improved, a greater number of books were exposed for student use, and an inviting classroom environment emerged. Custodians cleaned out storage closets creating space so science kits and unneeded furniture could be removed from classrooms.

Teachers have been energized and continue to downsize with custodial assistance. Bookcases that held old texts and extra student desks have been moved to storage. Instructional materials used in conjunction with disposed texts are being discarded. Teachers continue to cull files of outdated material. One teacher reduced her holdings by 50% enabling her to remove two book cases and a file cabinet from her classroom. The floor space was given back to the rug-rats.

Once again classrooms look open and inviting. The participants in this study were able to simplify: they eliminated the unnecessary so the necessary could speak. They understood that the center for school improvement resides in the classroom.

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Collaborative Planning and Teacher Efficacy Of High School Mathematics Co-teachers

Raquel C. Rimpola

ABSTRACT

Current educational policies such as NCLB and IDEA have led to the adoption of inclusive classrooms in schools. This presents challenges to teachers because they are held accountable for the learning experiences of both general and special education students. The situation is especially challenging in high school mathematics inclusion classes where the special education co-teachers may not necessarily possess the content expertise to teach advanced levels of mathematics. Collaboration between co-teachers is necessary in order to successfully plan effective lessons that address the needs of all students. A quantitative research design was used, with follow up interviews for further explanation of the findings. This study provides information about the teacher efficacy of high school mathematics co-teachers when various collaborative planning times were considered. Implications for future studies and school practice were presented, while considering the efficacy of co-teachers in inclusive contexts.

INTRODUCTION

All students should have access to the highest quality mathematics instruction. According to NCTM (2000), excellence in mathematics education requires equity. This means that mathematics educators should have high expectations and provide strong support for all learners. Students who are passionate about mathematics and have a deep interest in pursuing careers in science, engineering, technology, and mathematics should have their talents and interests nurtured. Likewise, students with special needs must have access to support services that can allow them to gain a concrete understanding of mathematics. Youth, who struggle in mathematics, may require additional resources, such as after-school tutoring, extended time on tests, and peer mentoring. Teachers of mathematics should accommodate the unique and range of needs of these students without inhibiting the learning of other students (NCTM, 2000). This is especially true when teaching inclusion mathematics classes.

Co-teaching is an effective means for providing the supplementary aid and services to students, with or without disabilities, who are taught in the general education classrooms (Jennings, 2007; Murawski, 2009; Villa, Thousand, & Nevin, 2008). In an effective co-teaching partnership, both the general and special education teachers are responsible for the delivery of instruction in the inclusion classes (Alper & Ryndak, 1992; Bauwens, Hourcade, & Friend, 1989; Murawski, 2009). In particular, teaching mathematics inclusion classes requires both co-teachers to plan a variety of ways to support all students as they learn advanced mathematical concepts. While this endeavor would seem to be a natural progression in addressing the needs of both general and special education students, it is important to consider certain pre-existing conditions (e.g. teacher perception about teaching inclusion classes, teacher preparation for teaching inclusion classes) that may derail plans for delivering quality instruction in inclusion mathematics classes. Without adequate training, high school teachers can hold a limited perception about their ability to address the needs of the special education students in their class (Van Reusen, Shoho, & Barker, 2001). On the other hand, even a highly qualified special education teacher may feel overwhelmed by the requirement of providing effective instruction to his or her students with mathematical challenges (Humphrey & Hourcade, 2010). One possible way to address these concerns is to engage general and special education teachers of inclusion classes in collaboration efforts. This collaboration may lead to an increase in teacher efficacy of both collaborating teachers (Shidler, 2009).

CONCEPTUAL FRAMEWORK

Vygotsky's sociocultural theory (1997) posits that learning is determined by a person's social environment. It stresses the interaction of the interpersonal, cultural-historical, and individual factors. Interactions with persons in the environment stimulate development processes and promote cognitive growth (Vygotsky, 1997). Learning is perceived as an act that is embedded in social and cultural contexts. It is best understood when regarded as a form of participation within those contexts. This learning may result in the simultaneous transformation of social practices and the individuals who participate in them, making the social and individual aspects of learning mutually constitutive (Boreham & Morgan, 2004). The interactions of persons, which are conducted through collaboration, stimulate the developmental processes and foster cognitive growth.

Collaborative planning

Studies show that teachers who engage in collaborative work are able to learn from one another (Clark, Moss, Goering, Herter, Lamar, Leonard et al., 1996; Tschannen-Moran, Uline, Hoy, & Mackley, 2000). Members of the leadership team may learn about other's strategies when they collaborate to solve school issues like attendance problems. Teachers learn how to adopt new instructional technology tools when they are provided access to their peers who are expert users of specific programs. Collaborative networks create the momentum for creating action plans geared toward school improvement (DuFour, DuFour, Eacker, & Karhanek, 2004). As teachers learn, they become better with their craft. They learn to reconceptualize their roles as they work together with others. Teacher collaboration may improve school's ability to foster student achievement (Goddard, Goddard, & Tschannen-Moran, 2007).

Collaboration is the foundation of successful inclusive education when two or more teachers are involved (Hourcade & Bauwens, 2001). During collaboration, teachers can share their knowledge about teaching strategies that they have found to be successful in the past, enrich their thinking processes on an ongoing basis, and transform their knowledge for the future (Putnam & Borko, 2000). As collaborating peers, they can review each other's work and share immediate feedback after conducting classroom observations. These educators can also assist one another in solving problems that arise from day to day instruction (Murawski, 2009).

Collaborative planning is a potential source of teacher learning (Clark et al., 1996; Eisenman, Pleet, Wandry, & McGinley, 2011; Hargreaves, 1996; Lalik & Niles, 1990). It opens up the discussions around pedagogical knowledge and provides opportunities for reflection and shared critique of practice (Clarke et al., 1996). Learning content-specific material from the general education teacher, sharing accountability, developing shared instructional practices through professional learning meetings, being physically accessible to the co-teacher and students in the co-taught classroom, and anticipating service needs and priorities with the co-teacher also help improve co-teaching (Eisenman et al., 2011). Maccini and Gagno (2000) shared their recommendations on designing and implementing lessons for students with disabilities in a mathematics classroom. They proposed that teachers incorporate elements of effective instruction, such as use of manipulatives, real world connections, teacher modeling, guided and independent practice, monitoring of student performance, use of pro-active classroom management strategies, and group work. They also recommended that co-teachers create individualized mathematics instruction plans based on students' numeracy and literacy skill levels.

Collaborative planning does not occur simply by forming a group of two or more teachers and allowing them to spend some time to communicate. It requires the professional commitment of both co-teachers to the process and a consistent focus on students' needs, curriculum decisions, and planning teaching strategies. It is during the collaborative planning phase when most of the learning agenda is established and this is why it is important to ensure that all participants establish a level of ownership in the collaboration process. The same benefits of collaboration are realized in this phase. In the current study, the mathematics and special education co-teachers may benefit from the collaborative planning phase in two ways: gaining knowledge as a result of the professional learning experience, and developing a better understanding of the content of mathematics. First, collaborative planning is a potential source of teacher learning (Clark et al., 1996; Hargreaves, 1996; Lalik & Niles, 1990). The special education teacher can share strategies for teaching students with learning disabilities while the mathematics teacher can share techniques for teaching certain mathematical concepts. Through collaboration, both teachers can raise issues that team members may not have thought of independently (Kotelawala, 2010). Collaborative planning opens up the discussions around pedagogical knowledge and provides opportunities for reflection and shared critique of practice (Clarke et al., 1996). Second, both teachers learn specialized content knowledge for teaching mathematics (Hill & Ball, 2004). Teachers use the teaming as an opportunity for professional development by working together on tasks and discussing possible treatments of the mathematical idea that is about to be taught. While differences in the background knowledge and preparation that special and general education teachers possess may cause some arguments about who is best equipped to teach the students, the main focus should be the promotion of a collaborative partnership between co-teachers to ensure that they can provide all students in their class the opportunity to master the standards (Maccini & Gagnon, 2000).

Teacher efficacy

Researchers claim that teacher efficacy relates to student achievement as it results in teachers' efforts to adapt instructional practices that support student learning (Allinder, 1995; Almog & Shecktman, 2007; Ashton & Webb, 1986; Caprara, Barbaranelli, Steca, & Malone, 2006; Dembo & Gibson, 1985; Goddard, Hoy, & Hoy, 2004; Ross, 1994). Teachers with higher efficacy levels are more apt to plan engaging lessons and interact with students to encourage their participation in the lesson (Schunk, 2008). They are also more likely to use varied strategies to meet the needs of their students (Goddard et al., 2004). These educators work longer with struggling students (Almog & Shecktman, 2007; Dembo

& Gibson, 1985) and are less likely to refer a difficult student to special education (Poddell & Soodak, 1993). When assigned to teach special education students who were placed in the mainstream classes, teachers with high levels of efficacy are willing to involve special education students in class discussions and persist in educating them (Brownell & Pajares, 1996; Nunn, Jantz, & Butikofer, 2009), while maintaining better control of an inclusion class (Woolfson & Brady, 2009).

Teacher efficacy can determine the likelihood that a teacher will provide the desired level of expected outcomes such as incorporating appropriate response interventions strategies to help support struggling students (Raudenbush, Rowan, & Cheong, 1992; Wertheim & Leyser, 2002; Wolters & Daugherty, 2007). It should be noted that because conditions in the school setting continually change, a teacher's level of efficacy may vary from one class to another, much like a student's efficacy (Raudenbush et al., 1992; Ross, 1994). Bandura's social cognition theory provides the primary support for the study of teacher efficacy. However, Vygotsky's sociocultural theory provides a framework for the development of teacher efficacy in the context of the collaborative partnership between co-teachers of secondary mathematics inclusion classes. Interactions with persons in the environment stimulate development processes and promote cognitive growth (Vygotsky, 1997). Co-teachers are able to share and work together to accomplish desired goals (Dettmer, Thurston, & Dyke, 2005). Bandura (1986) uses the triadic reciprocity model of causality to explain how learning can occur through the use of models within social environments, such as co-teaching. Learning is a process whereby information about the structure of behavior and environmental events are transformed into symbols that serve as guide for future actions (Bandura, 1986). Learning occurs either inactively when people perform actions or vicariously when they observe models of behavior (Bandura, 1986, 1997; Schunk, 2008).

CONTRIBUTION OF THE STUDY

There are limited studies available that present information about co-teaching at the secondary level. This study begins to fill this gap in research as it specifically utilized a sample group of mathematics and special education co-teachers at the high school level. Most of the studies on co-teaching utilized a qualitative approach in collecting data. This is an attempt to contribute to the field by using a quantitative research design in studying teacher efficacy of high school mathematics co-teachers utilizing valid and reliable scales. Because of the special focus on teaching mathematics, this study also is unique as it discusses findings about the teacher efficacy of co-teachers as they teach high school level mathematics such as algebra and geometry. The following questions will be addressed.

1. Is there a significant difference in teacher efficacy of mathematics teachers among the varied lengths of collaborative planning time?

2. Is there a significant difference in teacher efficacy of special education co-teachers among the varied lengths of collaborative planning time?

3. Is there a significant difference in mathematics teaching efficacy of mathematics teachers among the varied lengths of collaborative planning time?

4. Is there a significant difference in mathematics teaching efficacy of special education co-teachers among the varied lengths of collaborative planning time?

METHODOLOGY

The study utilizes a quantitative research design with follow-up interviews. The quantitative data were collected from a sample of 77 secondary mathematics teachers and 15 special education teachers from a large, urban school district. At the time of the study, these teachers co-taught mathematics inclusion classes in 9th, 10th, or 11th grades. This was a sample of convenience derived from a pool of participants from specific school locations. Table 1 shows additional information about the participants in this study.

Table 1

Survey Participants' Teacher Demographic Information

	General Education Teacher	Special Education Teacher	Gender		Educational Attainment			
			Male	Female	Bachelors	Masters	Masters+	Doctorate
n	77	15	25	67	24	30	34	4
%	84	16	27	73	26	33	37	4

There were two instruments utilized in this study. The first was *Teachers' Sense of Efficacy Scale* (TSES) by Tschannen-Moran & Hoy (2001) and the second was *Mathematics Teaching Efficacy Belief Instrument* (MTEBI) by Enochs, Smith, and Huinker (2000). Without a valid single instrument available that could measure the teacher efficacy of collaborating teachers involved in a particular setting of co-teaching secondary mathematics inclusion classes, both instruments were utilized to capture the participants' beliefs about the subject. The *Teachers' Sense of Efficacy Scale* (TSES) is also called the Ohio State Teacher Efficacy Scale (OSTES). Two researchers and eight graduate students, who were participants in the seminar on self-efficacy in teaching and learning at the College of Education in Ohio State University, created it. The Likert scale format from the Gibson and Dembo (1984) instrument and the expanded scale advocated by Bandura (1997) were referenced in the early stages of the creating the instrument. The TSES has three scales. They are efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management (Tschannen-Moran & Hoy, 2001). The *Mathematics Teaching Efficacy Belief Instrument (*MTEBI) for pre-service teachers resulted from a small modification of the Science Teaching Efficacy Belief Instrument (STEBI-B). Essentially, the word "science" was replaced with "mathematics" with everything else remaining the same. This MTEBI instrument consists of 21 items with 13 items comprising the Personal Mathematics Teaching Efficacy (PMTE) subscale and eight items on the Mathematics Teaching Outcome Expectancy (MTOE) subscale. In this survey, participants choose one rating from a 5-point scale. The scales are labeled using the descriptors "strongly agree," "agree," "uncertain," "disagree," and "strongly disagree." Item analysis was conducted for the original 23-item scale and it was found that two items had item-total item correlations that were less than 0.30. These items were removed from the survey. Reliability analysis produced an alpha coefficient (Cronbach's alpha) of .88 for the PMTE subscale and .77

for the MTOE subscale. The MTEBI has two scales – personal mathematics teaching efficacy (SE) and outcome expectancy (OE). The survey also included questions about the collaborative teaching practices of the teachers such as gender, years of teaching, educational level, co-teaching experiences, and mathematics teaching experiences. Data were collected using a commercial online tool and was analyzed using SPSS, a common statistical software package. Analysis of variance (ANOVA) was utilized to assist in the data analysis process.

Independent semi-structured interviews were conducted with members of three pairs of high school mathematics co-teachers who were selected using a purposeful sampling method. Table 2 shows some demographic information on the interview participants. Pseudonyms were used to maintain confidentiality. They were provided a set of guide questions ahead of time.

Table 2

Follow -Up Interview Teacher Demographic and Instructional Information

Teacher	Certificate Area	Years of Teaching Inclusion Class	Years of Collaboration with Current Co-Teacher	Common Planning Time Provided
Team A				
Ms. Allen	Mathematics	9	3	No
Ms. Bennett	Special Education	7	3	No
Team B				
Ms. Carter	Mathematics	4	< 1	No
Mr. Dalton	Special Education	1.5	< 1	No
Team C				
Mr. Elbert	Mathematics	10	2	No
Mr. Ferguson	Special Education	2	2	No

The researcher had the flexibility to adjust the order of the questions and may not necessarily use exact wording during the interview (Merriam, 2009). The researcher used follow-up questions to clarify the meaning of shared statements between members of the same co-teaching team. This method was also used to determine the accuracy of the collected data. Permission to conduct the interviews at the school site was provided by each co-teaching team's principal. Interviews were audio recorded with the consent of each participating co-teacher. The purpose of the follow-up interviews was to gather information that can provide further explanations of significant results (Creswell, 2009). It was also intended to provide further exploration and clarification of unusual findings (Morse, 1991). The survey data were considered the primary source of data with the data from the interviews providing a supportive role in this study (Creswell, 2009).

RESULTS

Participants were asked to provide information about the amount of time they spend in collaboration with their co-teacher and the instructional practices that they perform while engaged in collaborative planning. The analyses of the responses of mathematics and special education co-teachers were treated separately.

Analysis of Variance (ANOVA) tests were used to analyze if significant differences in teacher efficacy and mathematics teaching efficacy of the mathematics and special education co-teachers exist among the varied weekly collaborative planning times. Results revealed that there is no significant difference in the average TSES subscale scores of the mathematics teachers across the varied collaborative planning times ($F(6,70) = 1.031$, $p > .05$). Similarly, there was no significant difference in Student Engagement ($F(6,70) = 1.307$, $p > .05$), Instructional Strategies ($F(6,70) = .883$, $p > .05$), and Classroom Management ($F(6,70) = .465$, $p > .05$) scores of mathematics teachers across the varied collaborative planning times. These were also true for special education teachers. The results from follow up interviews showed that the co-teachers' were committed to setting aside some time for collaborative planning. This tremendously minimizes the range of planning time differences to begin with. That is why significant difference in teacher efficacy across various collaborative planning times was not detected.

Results of the ANOVA showed that there was no significant difference in the MTEBI subscale scores of the mathematics teachers across the varied collaborative planning times ($F(6,70) = .417$, $p > .05$). Similarly, there were no significant differences in personal mathematics teaching efficacy ($F(6,70) = .937$, $p > .05$) and outcome expectancy ($F(6,70) = .250$, $p > .05$) scores of mathematics teachers across the varied collaborative planning times. There were no significant differences in the average MTEBI subscale scores of the special education teachers across the varied collaborative planning times ($F(5,9) = .993$, $p > .05$). Similarly, there were no significant differences in personal math teaching efficacy2 ($F(5,9) = 1.482$, $p > .05$) and outcome expectancy ($F(5,9) = .924$, $p > .05$) scores of mathematics teachers across the varied collaborative planning times.

Descriptive statistics indicated that participating co-teachers planned between 30 to 60 minutes per week. An item on the survey provided the participants the opportunity to indicate if they are given a scheduled planning time within a week. A defined scheduled co-planning time is necessary as a time frame that is built into the school's master schedule where both co-teachers are provided a common planning time to collaborate and plan their lessons for the shared class or classes.

Table 3

Analysis of Data on Scheduled Collaborative Planning Time for Co-Teachers					
Collaborative planning time provided	*n*	%	Performs instructional practices with co-teacher	n_S	%
Yes	37	40 %	No	6	16 %
			Yes	31	84 %
No	55	60 %	No	22	40 %
			Yes	33	60 %
Total *n*	92		Total Yes	64	70%

The results found in Table 3 indicate that fewer than 50% of the participants were provided a scheduled collaborative planning time during the week. Participants were asked to select instructional practices which they perform during their collaborative planning time. The results showed that of the participants who indicated that they were given a weekly collaborative planning time about 83.78% indicated some of the activities that they perform during this scheduled time. Approximately 16.22% did not respond to this question. On the other hand, of those who indicated that they were not provided the scheduled weekly collaborative planning time about 60% indicated that they collaborate with their co-teacher and that they perform instructional practices related to co-teaching. Approximately 70% of the participants indicated that they perform instructional practices with their collaborating teacher regardless of whether they were provided with a scheduled planning time or not. This showed that most of the participating co-teachers set aside some time to plan together even if a collaborative planning was not built into the school's master schedule. Results from the interviews showed evidence that supports this finding. Participants shared some of the creative strategies they used to be able to plan lessons with their co-teachers. Ms. Bennett, who was the special education teacher, shared:

> Unfortunately, we do not have the same planning. But because we have such a great relationship whenever she's on planning she'll come by and see me or whenever I have planning I'll go by and see her. And we discuss a couple of students at a time. Because we work so well together there have been times… she has called me at home to discuss some strategies we could possibly implement for some students or for the entire class. So we don't necessarily have a common planning time but we do make sure that we do get some time to discuss (Interview 1, 2/7/11).

This was consistent with Ms. Allen's testimony that they "get together in the hallway or discuss [lessons] on the phone" (Allen, personal communication, February 16, 2011). Similarly, Ms. Carter shared that they "plan after school, in between classes, via email. By in between classes [she] meant advisement [or homeroom time] as giving them a little bit more room for talking about things and getting things done before class" (Carter, personal communication, February 10, 2011). This was also supported by the testimony of Mr. Dalton, who was her special education co-teacher. He shared that "he would go in during advisement to look at the Powerpoints for the day" (Dalton, personal communication, February 23, 2011). Mr. Elbert, who was the mathematics co-teacher, shared that they "sometimes meet before class [or] sometimes after class" (Elbert, personal communication, February 14, 2011). While co-teachers in each team stated that they were willing to meet with their co-teachers for planning, it did not alleviate the challenges in not having a scheduled collaborative planning time. Mr. Dalton shared that "he had to choose between doing [his IEP] paperwork or co-teach" (Dalton, personal communication, February 23, 2011). Even with challenges such as this, the participants were willing to find the time to co-plan with their collaborating teacher. Ms. Carter further explained that they "usually plan about once, maybe twice a week" (Carter, personal communication, February 10, 2011). Ms. Allen confirmed that "planning time is definitely important" (Allen, personal communication, February 16, 2011).

DISCUSSION

Co-teachers of secondary mathematics inclusion classes may be able to address the needs of all students by implementing these effective strategies while delivering rigorous instruction of a highly technical subject. A national study conducted by Maccini and Gagnon (2000) reported that special education teachers use more instructional strategies than general education teachers when it comes to teaching computational and problem solving tasks. Their familiarity with the mathematics topic significantly contributed to the number of instructional practices they provided. The strategy implementation rate of general education teachers are affected by the number of methods courses they took on teaching students with learning disabilities. While these differences in the background knowledge and preparation that special and general education teachers possess may cause some arguments about who is best equipped to teach the students, the main focus should be the promotion of a collaborative partnership between co-teachers to ensure that they can provide all students in their class the opportunity to master the standards (Maccini & Gagnon, 2000). Special education teachers take a variety of roles in varied content areas at the high school level; lowest levels of lead teaching were observed in high school mathematics classrooms (Zigmond & Matta, 2004). They are challenged to possess some level of specialized content background especially when co-teaching courses such as science and mathematics. Studies have shown that teacher efficacy influences the amount of effort and duration that a teacher is willing to invest in addressing challenges in teaching inclusion classes (Almog & Shecktman, 2007).

Comprehensive planning that focuses on content, assessment, and specific issues like classroom management can lead to a successful co-teaching partnership (Hang & Rabren, 2008). Scheduled planning time, agreement on shared duties, goals, and academic tasks, and open communication between these co-teachers also enable them to develop lessons that better address student needs (Hines, 2008). While there are benefits in scheduling collaborative planning times between the general education and special education co-teachers (Villa et al., 2008), in reality this may not always be the priority, especially at the high school level.

The findings show that the effect of scheduled collaborative planning time on mathematics teaching efficacy is not enough to cause a difference in teacher efficacy between the mathematics and special education co-teachers when the amount of scheduled collaborative planning time per week was considered. The data from the interviews and survey support this finding. Having scheduled planning times may not be a major concern for co-teachers such that it impacts their teacher efficacy. The reason for this may be that co-teachers find time to plan together regardless of whether they have a scheduled planning time built into the master schedule or not. They set aside time to collaborate with one another outside of their regular teaching periods. Some of the creative ways to find time to plan include meeting during advisory period, before school starts, or after the dismissal bell rings. Others may briefly visit their co-teacher's room during their own planning time to present ideas about an upcoming lesson. Still some co-teachers who are comfortable with each other may plan lessons together via email or by calling each other on their cell phones at times that fall outside of the regular workday. Mastropieri, Scruggs, Graetz, Norland, Gardizi, and McDuffie (2005) stated that a lack of scheduled co-planning time is not a barrier for actually co-planning with co-teachers as they set aside time to collaborate outside of their regular teaching periods. The findings of this study support this as 70% of the mathematics and special education co-teachers scheduled meeting times outside of the scheduled planning times, or lack thereof.

IMPLICATIONS FOR SCHOOL PRACTICE

Most schools have adopted an inclusion model for providing support to their students with disabilities in general education classes. This approach to educating general and special education students in inclusion classes presents benefits as well as challenges. One challenge is additional demand for collaborating teachers of these inclusion classes to collaborate together in order to provide rich educational experiences that meet the needs of all students. The results of this study present some implications for supporting co-teachers of high school mathematics inclusion classes.

It should be noted that while co-teachers may find creative ways to craft some time to plan together as a result of their dedication to teaching, the research shows that teachers consider the scheduling of collaborative planning time as necessary to a successful co-teaching partnership (Mastropieri, Scruggs, Graetz, Norland, Gardizi, & McDuffie, 2005). Administrators should schedule collaborative planning times so that teachers are able to design lessons, learn from each other through their collaborative work, and determine strategies for teaching mathematical concepts to a diverse group of students. Friend (2008) recommended scheduling weekly planning time. This supports the finding that collaborative planning times for participating co-teachers were held between 30 to 60 minutes per week. All social support can improve teacher efficacy (Huang & Liu, 2007). There is an opportunity for district leaders and professional developers to look at providing adequate support to co-teachers so that they are provided information about research based practices that lead to effective co-planning and co-teaching.

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BOOK REVIEW

An Excursion into the Labyrinth of School Change: Lessons Learned

Riva Bartell and Marv Bartell

Smith, L. (2008). *Schools That Change. Evidence-Based Improvement and Effective Change Leadership. Thousand Oaks, CA: Corwin, a Sage Company.*

In this book, Lew Smith selected from four hundred and eighty nationally nominated, for National School Change Awards, schools for detailed portrait-narratives eight underperforming schools that transformed themselves into thriving schools. The process of change occurred during the period 2000-2007.

The portraits were composed utilizing descriptive, qualitative methodology and employing portraiture techniques. No two schools were and are alike and their paths to effective functioning are varied as well. No one approach to success that fits all is neither offered nor attempted. What then, the apt reader may ask, is unique about this book? Let us count the ways:

- Each of the eight schools started the process of change from *within*, rather than having been imposed upon from outside or above.
- The change was substantial and systemic, focused on teaching and learning outcomes and actively involving all stakeholders.
- The portrait methodology aimed to combine systematic, detailed observational data with interpretive and nuanced layers of the dynamic interaction of the human experience. Thus, the reader is likely to experience each of the individual school portraits as live and present.
- The theoretical model consisting of 3 essential elements and 3 catalytic variables was essentially inductively developed "bottom up" from the analysis of the empirical data, using a wide range of eclectic sources and supports.
- School, generically, is viewed by Lew Smith as an organization and as such, he broadens the scope of his discussion of organizations, and leadership of organizations, to include examples and references from across and far afield – such as business, history, physics, spirituality, and geographical realms.
- The author views schools in the broader, rapidly-changing societal context as having to catch up with the changing times and uncertain destinations.
- Eight of the eighteen chapters in the book are dedicated to a lively, firsthand description of an insightful and sensitive active-participant observer, that is, the author himself and his team of researchers, who repeatedly visited all the school sites, built trust and had extensive conversations with the lengthy, arduous, challenging and exhilarating processes that their "subjects" were experiencing and undergoing. No

wonder that his and his research team's contacts with members of the school communities were likely "infected" favorably by the author's observant eye and wisdom. How much influence? We could only imagine.

- The selection process of the finalist eight schools for the award resulted from a step-wide process from the pool of four hundred and eighty that were initially identified and nominated. Each school, with its own idiosyncratic context and characteristics, centered its change process in the person of the principal who also served as a hub for the many and varied activities and actions.

In one elementary school, for example, the vision of the principal for his school was inspired powerfully by a feature-length film called M*iracle* that described a sport team in his state that was transformed from losing to winning over the Soviet Union team. This was his starting point in leading the change. Another elementary school principal, in another context, chose to upgrade the physical environment of the school – recruiting her own family, friends and community volunteers, to fresh-paint the common areas of the school during her summer break, as a "Message, Milestone and Metaphor`` (Smith, 2008, p. 68), to kick start her change agenda.

A strong-willed and determined high school principal challenged the staff that she expected them to like kids and not to be clock-watchers. Many teachers resigned and she newly hired two-thirds of the teachers willing to accept and practice her challenge. In another high school, in a different state, the principal revitalized a school leadership team and thus created a climate for change with the message that succinctly asked the message: "Why are we here?"

Other chapters in the book discussed the nature of change, generally and school change, specifically, and measurement of change. Four criteria, or dimensions, for assessing school change were:

(i) Is the change substantial or superficial?
(ii) Is the change systemic or isolated?
(iii) What is the focus of the change?
(iv) Is the change outcome-oriented? (Smith, 2008, p. 44).

The author, wisely, in our view, avoided any attractive, broad formulaic solutions, and instead, identified two sets of a 3x3 model of six interacting components as a lens through which the common variables - which undergird the richness and the diversity of the change process of the eight schools - are revealed and account for their significant change, in (a) the three essential elements and (b) the three catalytic variables:.

(a) The essential elements are: s*chool context*, including culture, climate, messages and physical environment; s*chool capacity* which comprises what individuals and organizations are capable of doing, specifically, to teach, assess and plan coupled with the capacity to work and learn in teams; c*onversations* about and with the students about teaching and learning, about vision and about progress. These three elements are interrelated and all three are essential elements, according to Smith, if there is to be substantive change in any failing school.

(b) The *catalytic variables* are: *internal dissonance* referring to concerns within the school about professionalism, support for moving forward, pride, order and security; *external forces* which include governmental authorities and the community-at-large, the push-in forces, and reach-out forces, such as, grants, awards, partners and charter schools; *leadership*, in particular, change agent leadership that enables the school to move from failure to success.

Not to be missed are the whimsical and wise TEN TRAPS TO AVOID (Smith, 2008, pp. 273-276). The book ends with a note of caution: “If you’ve plugged a breach in the levee, get ready for the flood” (p. 275). The author points out that “we may require a complete structural overhaul of what now exists”. “It may be necessary to dramatically change how we view levees (and schools). What purpose do they have? How well do they function? “Are there better structures and systems?” “What do we do when they break and do not do the job they are expected to do?” “We must see the larger picture.”

In conclusion, this book is a refreshing read for anyone interested in schools and the process and prospect of change. It provides a refreshing perspective on school change, using holistic observational-interpretive methodology and a useful conceptual model for accounting for the successful change of these schools. It provides a fascinating reminiscence of the vivid depiction of the social realities of the school in Phil W. Jackson’s 1968 *Life in Classrooms,* and as such it is very delightful and instructive reading. The additional bonus is the author’s thoughtful conceptual formulation that could serve as an empirically-based guide, a checklist for considering, or planning school change, or as an audit, following a change process. About six years have passed since the conclusion of this massive study. A follow-up would be interesting and instructive in terms of the sustainability of the change over the passage of time. The author invites the reader to contemplate and consider the foregoing questions in terms of substantial change of schools and schooling in a dynamically changing society that is highly impacted by rapid technological change.

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