

# 40 Inventive Principles with Applications in Education

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## **Introduction**

Recent TRIZ research has resulted in extending TRIZ applications into non-technical areas. The Contradiction Matrix and corresponding 40 Principles have found applications in several areas, for example business (Mann & Domb, 1999) and (Mann, 1999), service operations management (Zhang, J. *et al.*, 2003), quality management (Retseptor, 2003), and education (Marsh, Waters, & Mann, 2002).

Marsh, *et al.*, discussed potential solution concepts generated by doctoral students in education using the Contradiction Matrix for Business and Management developed by Mann. The Contradiction Matrix was first modified for use in resolving education related technical conflicts. The 31 business features of the Business Matrix were redefined and equivalents for higher education, and K through 12 grades developed.

These redefinitions enabled educators and education students to interpret the business features in educational concepts and terms with which they are familiar.

This paper provides educational examples of the 40 inventive principles. The examples address both administration (A) and classroom teaching (C), or both (A/C). These examples are intended to act as concept triggers for users who wish to use the Educational Contradiction Matrix and Educational 40 Principles to resolve conflicts and contradictions in the educational field.

# Educational 40 Principles

## 1 - SEGMENTATION

- a. Divide an object or event into independent persons or parts.**
- Conduct site-based management. (A)
  - Offer separate programs to meet the diverse needs of students. (A)
  - Utilize task analyses when planning instruction. (C)
- b. Make an object or event easy to assemble or disassemble. Make an object sectional.**
- Create flexible class scheduling that supports student choice of classes. (A)
  - Create project teams. (A)
  - Create review boards. (A)
  - Use partitions to create sectional classrooms. (A)
  - Utilize flexible grouping. (A)
  - Use block scheduling. (A) (See also Principle 30)
  - Create homogeneous (track) or heterogeneous (un-track) grouping. (A)
  - Use curricular modules/units. (C)
- c. Increase the degree of fragmentation or segmentation.**
- Identify key areas of concern in conducting teacher contract negotiations. (A)
  - Set short-term and long-term goals for successful reform efforts. (A)
  - Employ mass customization - each student is a market. (A)
  - Break down teaching goals (objectives) into sub-goals. (A)
  - Condense a full year course into one semester or quarter. (A)
  - Create individual standards-based modules. (A)

## 2- TAKING OUT

- a. Separate an interfering component or property from an object or event, or single out the only necessary component (or property) of an object or event.**
- Create needs-based professional development plans / programs that meets staff needs accordingly. (A)
  - Create virtual educational programs. (A) (Take out the classroom) (See also Principle 26)
  - Offer clinical supervision to teachers requiring remediation. (A)
  - Create or single out remedial programs. (A)
  - Create or single out alternative programs. (A)
  - Utilize online searches for books, periodicals, etc., in libraries. (A)
  - Eliminate non-purposeful physical and psychological barriers. (A/C)
  - Utilize data to make decisions. (Take out the emotion) (A/C)
  - Enable auditing or testing out for students who believe they have met course requirements. (A/C)
  - Make use of time-outs. (C)
- b. Extract the only necessary part (or property) of an object.**
- Set up a mentoring / peer coaching program for teachers. (A)
  - Use data-driven budgeting process. (A)
  - Match new programming and curricula to AYP (Adequate Yearly Progress). (A)
  - Separate 'troubled' students from the general student population. (A)
  - Match curricula and instruction to 'high stakes' tests. (A)
  - Use matrices to identify key skills to be taught. (A/C)
  - Teach to the curricula or test. (C)
  - Use College Outline Series books. (C)

### 3- LOCAL QUALITY

**a. Change an object's structure from uniform to non-uniform. (Homogeneous to Heterogeneous)**

- Set up class scheduling to avoid student tracking. (A)
- Provide handicapped entry to schools and classrooms. (A)
- Create differentiated professional development programs. (A)
- Use differentiated supervision models. (A)
- Provide choices and options in curricula, schedule, and auxiliary services. (A)

**b. Change an external environment (or external influence) from uniform to non-uniform.**

- Create multiple ways that parents can interact with the school. (A)
- Lobby for flexibility in funding streams. (A)
- Establish strong, ongoing, wide-ranging relationships with the community. (A)
- Organize the classroom with worktables, movable seats, and resource centers versus podiums, lecterns, and raised platforms at the front of the room. (A/C)

**c. Make each part of an object or system function in conditions most suitably for its operation.**

- Utilize flexible grouping to meet individual student needs. (A)
- Employ schools without walls. (A)
- Locate schools in heavily populated areas to maximize tax revenues. (A)
- Locate continuing education centers in locations near to customers. (A)
- Use multiple times for parent training programs. (A)
- Utilize summer school, weekend, and evenings. (Year-round schooling) (A)
- Create varying time schedules for classes and school. (A)
- Create educational modules different in content and duration for different organizational levels. (A/C)

**d. Make each part of an object or system fulfill a different and useful function.**

- Allocate time, money, materials, space, and staff to achieve desired ends. (A)
- Create a comprehensive program to provide community members opportunities to foster learning. (A)
- Create differentiated staffing programs. (A)
- Use individual accountability in instructional methodology. (C)

### 4- ASYMMETRY

**a. Change the shape of an object, system, or event from symmetrical to asymmetrical form.**

- Utilize portfolio assessment to represent a running record of students' intellectual progress versus a standardized report card. (A)
- Offer asynchronous opportunities to learn. (A) (See also Principles 19 and 35)
- Utilize flexible seating in classrooms. (C)
- Use differentiated instruction. (C)
- Create interest in learning through unexpected events. (C) Asymmetrical with respect to the normal schedule.
- Use cognitive dissonance strategies to create student interest and higher level thinking. (C)

**b. Change the shape of an object, system, or event to suit external asymmetries (e.g. ergonomics)**

- Start classes for secondary education later in the day. (A)
- Create incentives and support for non-traditional stakeholders. (A)
- Create an engaging and welcoming environment. (A/C)
- Create a warm atmosphere in classroom and school. (Colors, design, furniture) (A)

**c. If an object, system, or event is asymmetrical, increase its degree of asymmetry.**

- Provide student differentiation by offering advanced placement classes. (A)
- Use asymmetrical body language when dealing with classroom management problems. (C)

- Increase the randomness of student response. (C)
- For disaffected students increase emphasis of student-based relevance. (C)

## 5- MERGING (COMBINING)

### a. Bring closer together (or merge) identical or similar objects, or assemble identical or similar parts to perform parallel operations.

- Hire paraprofessionals to assist classroom teachers in meeting the diverse needs of students. (A)
- Structure staffing assignments to support team teaching initiatives. (A)
- Engage in instructional team planning and teaching. (A)
- Employ multi-purpose classrooms. (A)
- Create a cafeteria /auditorium (A)
- In universities and private schools locate the Registrar and Bursar offices close together. (A)
- Encourage collaboration between teachers and parents. (A)
- Organize action research groups to study influences, practices, and results of curriculum design. (A/C)
- Combine skill based experiences within fundraiser activities. (A/C) (See also Principle 7)

### b. Make objects or operations contiguous or parallel; bring them together in time.

- Use team teaching to capitalize on teacher expertise. (A)
- Create inclusive classrooms with a co-teaching structure. (A)
- Coordinate library and media centers. (A)
- Incorporate interdisciplinary curricula and instruction. (A)
- Offer internships, shadowing, and cooperative education opportunities. (A)
- Locate computers in classrooms. (A/C)

## 6- UNIVERSALITY

### a. Make a person/system/event perform multiple functions; eliminate the need for other persons.

- Recruit and employ teachers with dual/multiple areas of certification. (A)
- Break down barriers between departments. (W. E. Deming) (A)
- Create multidisciplinary teams. (A)
- Use data collected for accreditation purposes for continuous school improvement. (A)
- Merge and standardize accreditation processes. (A)
- Employ "Lunch and Learn" events. (A/C)
- Utilize test scores for regulatory statistics as well as student grading. (Program evaluation as well as individual student evaluation) (See also Principle 23) (A/C)

### b. Use standardized features.

- Use multidisciplinary teams to develop standardized tests. (A)
- Create computerized templates. (A)
- Consider using department and grade level examinations. (A/C)
- Use state testing standards and curricula as district standards and lesson plan objectives. (C)
- Use rubrics, checklists, and other scoring tools to standardize expectations. (C)
- Use parallel tasks and experiences to match state standards and examinations. (C)
- Use common lesson elements. (C)

## 7- "NESTED DOLL" (MATRESHKA)

### a. Place one event inside another; place each event, in turn, inside the other.

- Write curriculum with K-12 faculty versus by grade or school level ensuring a seamless set of teaching and learning experiences. (A)
- Include CD's inside textbooks. (A)
- Align national, state, and local educational standards. (A/C)

- Combine skill based experiences within fundraiser activities. (A/C) (See also Principle 5)
- Use practice, homework, and assessment techniques to make students accountable. (C)
- Create purpose for learning through communicating authentic real world experiences. (C)
- Provide cognitive dissonance during classroom teaching. (C)

**b. Make one person/system pass (dynamically) through a cavity in the other.**

- Operations in the Main (Principal's) Office should not be isolated from the classrooms. School receptionists should know the operational status of classrooms. (A)
- Create channels that allow direct communication throughout the line and staff organization. (A)
- Create professional development schools and internships. (A)
- Consider differentiated staffing including apprenticeship periods. (A)
- Create meaningful parent-teacher organizations. (A)
- Articulate the desired ends of the School Board through the Superintendent and building principal to the classroom teacher for implementation. (A/C)

## 8- ANTI-WEIGHT (COUNTERWEIGHT)

**a. To compensate for the weight (downward tendency) of an event, merge it with other events that provide lift.**

- Group students with mixed abilities. (A)
- Invite consulting firms to identify and enable development activities. (A)
- Merge classes and curricula to combine unique strengths. (A)
- Create special events to reward student effort. (A)
- Adopt inclusion to integrate special education with regular education. (A)
- Create flex professional development programs that allow for individual choice. (A)
- Support learning experiences that incorporate peer tutoring. (A/C)
- Use special events to showcase student talents. (A/C)

**b. To compensate for the weight (downward tendency) of an event, make it interact with the environment (e.g. use global lift forces).**

- Group students to learn academic content. (A)
- Encourage cooperation between traditional and charter schools. (A)
- Use technology to create interest and to minimize non-essential tasks. (A/C)
- Create interesting homework assignments. (C)

## 9- PRELIMINARY ANTI-ACTION (PRIOR COUNTER-ACTION)

**a. If it will be necessary to do an action with both harmful and useful effects, this action should be replaced with anti-actions to control harmful effects.**

- Conduct random drug searches to ensure safety and commitment to laws and regulations. (A)
- Use innovative instructional media to satisfy both academic and safety requirements. (A)
- Use virtual modules to test out of annual professional development requirements. (A) (See also Principle 27)

**b. Create beforehand stresses in an object that will oppose known undesirable workingstresses later on.**

- Identify focus areas for teacher observations/evaluations. (A)
- Engage in open, active communication to avoid future misunderstanding. (A)
- Understand, respond to, and influence the political, social, economic, legal, and cultural contexts of the larger community. (A)
- Maintain student records. (A/C)
- Build/present a rubric to be used to assess student work prior to creation/submission of product. (A/C)
- Separate and pre-locate challenging students. (C)

- Use quizzes before major examinations. (C)
- Share scoring rubric when assigning projects, papers, etc. (C)
- Use parallel tasks to prepare for 'high stakes' testing. (C)
- Create needs-based learning. (C)
- Use diagnostic assessment. (C)
- Use best practice theory to determine developmentally appropriate times and ways to teach content. (C)

## 10- PRELIMINARY ACTION

### a. Perform, before it is needed, the required change of an object or event (either fully or partially).

- Model desired behaviors throughout the building/organization. (A)
- Create and utilize emergency preparedness plans. (A)
- Create long-range as well as annual plans (NCLB – No Child Left Behind) (A)
- Establish a proactive rather than reactive process for decision-making. (Strategic planning) (A/C)
- Prepare lesson plans for substitute teachers. (C)

### b. Pre -arrange objects such that they can come into action from the most convenient place and without losing time for their delivery.

- Provide sign posters and route maps as directions for students and parents. (A)
- Ensure that there is sufficient lead-time for demands made on families and the community. (A)
- Create a common calendar. (A)
- Create a climate for learning that is collaborative, supportive, challenging, and fair. (C)
- Have students express concerns/ pose questions/offer potential solutions prior to learning. (C)

## 11- BEFOREHAND CUSHIONING (CUSHION IN ADVANCE)

### a. Prepare emergency means beforehand to compensate for the relatively low reliability of an event.

- Develop an emergency management plan. (A)
- Create ongoing communication tools to allow for continuous update. (A)
- Train faculty and staff in use of emergency equipment. (Automatic External Defibrillator) (A)
- Identify emergency resources needed and method of accessibility. (A)
- Create a safe drop-off and pickup plan for students at beginning and end of day. (A)
- Use metal detectors and guards to maintain safe learning environment. (A)
- Have students conduct peer assessments prior to submission of work for grading. (C)
- Identify areas of assessment at the onset of learning. (C)

## 12- EQUIPOTENTIALITY

### a. In a potential field, limit position changes (e.g. change operating conditions to eliminate the need to raise or lower object or events to match requirements).

- Utilize flexible bleacher seating for assemblies. (A)
- Utilize satellite campuses for "Lifelong Learning". (A)
- Structure so students stay put, teachers move between classrooms. (A)
- Purchase equipment that can be adapted to meet varying student needs. (A)

## 13- THE OTHER WAY ROUND (INVERSION)

### a. Invert the action(s) used to solve the problem (e.g., instead of cooling an event, heat it).

- Provide for student feedback for course and teacher evaluations. (A)
- Blame the process rather than the teacher. (A)
- Students assess their own and other student's examinations and homework assignments. (C)
- Allow students to choose preferred learning experiences within course requirements. (C)
- Let the students teach and the teachers learn. (C)

**b. Make movable persons /systems (or the external environment) fixed, and fixed persons / systems/ movable.**

- Try teachers moving between classes vs. students moving between classes. (A)
- Implement home visits to provide teaching for homebound students. (A)
- Incorporate Management by Walking Around. (A)
- Conduct PTA and PTO meetings in the community rather than in the school. (A)

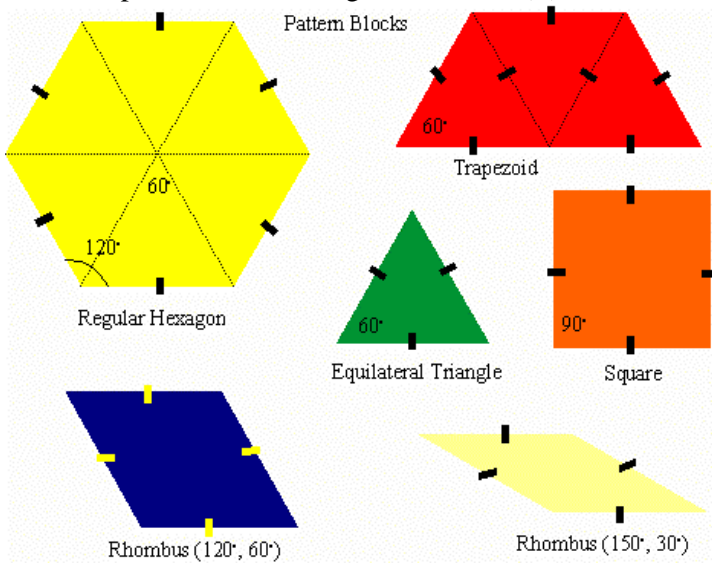
**c. Turn the event (or process) "upside down."**

- Develop outcome-based rather than education-based structure. (A)
- Have students teach classes. (C)
- Incorporate independent learning experiences and contract learning. (C)
- Have students assess themselves. (C)
- Have students help develop classroom rules. (C)
- Create cognitive dissonance with classroom instruction. (C)

**14- SPHEROIDALITY - CURVATURE**

**a. Instead of using rectilinear parts, surfaces, or forms, use curvilinear ones; move from flat surfaces to spherical ones; from parts shaped as a cube (parallelepiped) to ball-shaped structures.**

- Use rounded personalities as interface to parents. (A/C)
- Use smoothing techniques for conflict resolution - encourage joint problem solving opportunities. (A/C)
- Establish deviation request protocols as a formal method for circumventing the rules. (A/C)
- Use educational globes rather than maps for instruction. (C)
- Use 3D virtual computer models rather than 2D equations. (C)
- Use 'manipulatives' in teaching mathematics. (C)



- Use 'hands-on' activities. (C)

**b. Use rollers, balls, spirals, and domes.**

- Employ quality circles. (A)
- Build the curriculum in a spiral manner that enables students to continually build on what they have already learned. (A/C)
- Use biosphere environmental enclosures rather than terrariums. (A/C)
- Use Bloom's taxonomy to emphasize creative and reflective thinking. (C) Adapted from: Bloom, B.S. (Ed.) (1956) Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. New York ; Toronto: Longmans, Green.



**c. Go from linear to rotary motion, use centrifugal forces.**

- Use site-based management. (A)
- Encourage lateral or pattern (Out of the Box) thinking rather than linear thinking. (A/C)
- Build a collaborative context for learning that stimulates the construction of knowledge, reflection, and social awareness to shape individual and collective growth. (C)
- Use constructivism as an instructional approach. (C)

**15- DYNAMICS**

**a. Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition.**

- Make creative use of all resources - people, time, and money - to support school improvement. (A)
- Create alternative programs. (A)
- Adopt a participatory change process. (A)
- Use self-paced learning. (C)

**b. Divide an event into persons / systems capable of movement relative to each other.**

- Utilize site-based management teams for decision-making. (A)
- Use cross-functional and cross-department teaching, and offer interdisciplinary degree programs. (A)
- Employ team-teaching and co-teaching models and methodologies. (A)

**c. If an object (or process) is rigid or inflexible, make it movable or adaptive.**

- Provide learning opportunities for teacher and students via technology-based, asynchronous systems designed to deliver education and training programs. (A)
- Create flexible curricula (Chaocracy). (A)
- Employ permanent substitute teachers. (A)
- Utilize flex and comp time as well as stipends to compensate teachers. (A)
- Provide inter, intra, and interscholastic co-curricular programs. (A)
- Modify written curriculum to accommodate learners with special needs. (A/C)

**d. Increase the degree of free motion.**

- Offer Advanced Placement or Regents programs. (A)
- Enable asynchronous distance learning. (A)
- Have students only attend school during class time. (A)
- Create an open campus. (A)
- Create an individualized education plan for each student. (A/C)
- Use interactive teleconferencing to distant museums, classrooms, etc. (C)

**16- PARTIAL OR EXCESSIVE ACTIONS**

**a. If 100 percent of an event is hard to achieve using a given solution method then, by using "slightly less" or "slightly more" of the same method, the problem may be considerably easier to solve.**

- Use retirement incentives to complement anticipated teacher attrition. (A)
- Create study halls. (A)
- Utilize teacher aides. (A)
- Recruit ten (10) volunteers, then use only the five (5) best. (A/C)
- Offer enrichment and remedial opportunities to meet individual learning needs. (C)
- Grade all questions then average the top scores on examinations. (C)
- Teach to the test. (C)
- Work to contract. (C)
- Give no homework assignments. (C)
- Re-teach students who do not achieve mastery. (C)



- Schedule extra practice sessions. (C)
- Inspect every head in classroom for head lice. (C)
- Provide extra test time for students who need it. (C)

## 17- ANOTHER DIMENSION

### a. To move an event into two - or three-dimensional space.

- Offer instructional programming that is delivered via the Internet or computer linkages to students receiving instruction in locations outside a classroom supervised by physically present teachers. (A)
- Celebrate special events in other cultures (e.g., Cinco de Mayo, Hannuhka) (C)
- Use experiential learning rather than theoretical learning. (C)
- Incorporate field trips. (C)
- Utilize guest speakers. (C)

### b. If an object continues to moves in a plane, consider use of dimensions or movement outside the current plane.

- Use multi-dimensional parent satisfaction surveys. (A)
- Open facilities during evenings and weekends. (A)
- Create homework hotlines and virtual support beyond school day. (A/C)
- Vary teaching for different learning styles. (C)

### c. Use a multi-story arrangement of events instead of a single -story arrangement.

- Differentiate and segment students on the basis of their needs, behaviors, ages, etc. (A/C)
- Use cooperative learning and constructivism. (C)
- Use multiple examples and practice opportunities. (C)

### d. Tilt or re-orient the event, lay it on its side.

- Create grade level or interdisciplinary teams. (A)
- Assign classroom instructional responsibilities to the building principal. (A/C)
- Encourage horizontal communication among teachers. (A/C)
- Use "Library on a Cart" concept. (C)

### e. Use "another side" of a given area.

- Work with parents, school board members, and other interested groups to share and interpret achievement results about what students are learning, areas that need improvement, and plans for improvement efforts. (A)
- View school from other side by use of external consultants for school or program assessment. (A)
- Establish two-way communication among teachers, parents, doctors, etc. (A)
- Coordinate use of facilities between school and community needs. (A)
- Use peer tutoring among buildings and grade levels. (C)

## 18- MECHANICAL VIBRATION

### a. Cause an object or event to oscillate or vibrate. (Shake things up)

- Utilize mid-term interim report cards. (A)
- Re-assign teachers to different grade levels. (A)
- Re-organize classroom seating assignments. (C)
- Utilize 'anticipatory set' in instruction. (C)
- Use cooperative learning, hands-on activities, stations, and centers for classroom instruction. (C)

### b. Increase its frequency (even to the ultrasonic).

- Communicate frequently in multiple modes - newsletters, telephone, report cards, etc. (A/C)
- Reorganize classroom-seating assignments periodically. (C)

- c. **Use an event's resonant frequency.**
  - Have outside consultants work in harmony with school administrators. (A)
  - Coordinate scheduling to avoid conflicts and overload. (A)
  - Instruct to different learning styles. (C)
- d. **Use piezoelectric vibrators instead of mechanical ones.**
  - Use a variety of motivational techniques. (C)
- e. **Use external elements to create oscillation / vibration.**
  - Utilize third party external assessments. (A)
  - Utilize data-driven decision-making. (A)
  - Embrace accountability models. (A/C)

## 19 - PERIODIC ACTION

- a. **Instead of continuous action, use periodic or pulsating actions.**
  - Monitor periodically the impact of the curriculum on teaching and learning. (A)
  - Offer evening or weekend classes for continuing education students. (A)
  - Monitor and evaluate the daily processes of teaching and learning. (A)
  - Offer asynchronous opportunities to learn. (A) (See also Principles 4 and 35)
  - Use randomized questioning techniques. (C)
- b. **If an action is already periodic, change the periodic magnitude or frequency.**
  - Conduct quarterly teacher assessment reviews instead of annually. (A)
  - Use adjustable reporting, IEP, requisitions, inventories, and other paperwork frequencies. (A)
- c. **Uses pauses between actions to perform a different action.**
  - Offer teacher training during pauses in teaching. (A)
  - Offer enrichment/remediation activities during vacations or off-periods in year-round scheduling. (A)
  - Conduct preventative maintenance on school facilities during vacations. (A)
  - Conduct quick reviews of basic skills while waiting in line. (C)
  - Employ reflective thinking strategies. (C)

## 20 - CONTINUITY OF USEFUL ACTION

- a. **Carry on work continuously, make all persons / systems of an event work at full load or optimum efficiency, all the time.**
  - Maintain class size. (A)
  - Bring the services for special education students to the classroom rather than have students go elsewhere for services. (A)
  - Utilize retired teachers and staff for student teacher evaluations. (A)
  - Reduce paperwork load. (A)
- b. **Eliminate all idle or intermittent actions or work.**
  - Use mobile phones. (A)
  - Use intercoms. (A)
  - Create life-long learning opportunities. (A)
  - Institute 12-month school schedules or varied year-round models. (A)
  - Increase length of teacher workday to allow time to do extra tasks that take away from student time. (A)

## 21 - SKIPPING (RUSHING THROUGH)

- a. **Conduct a process, or certain stages (e.g. destructive, harmful or hazardous operations) at high speed.**

- Create efficient procedures for routine activities, e.g., (avoid diesel fuel vapors, fire drills, etc.) (A/C)
- Listen to intuitive sense when making decisions. (A/C)
- Utilize formative assessment e.g., fail fast - learn fast. (C)
- Use brainstorming as an instructional technique. (C)
- 'Cram' (conduct intense review) for exams. (C)
- Answer questions quickly to avoid psychological inertia. (C)

## 22 - "BLESSING IN DISGUISE" (TURN LEMONS INTO LEMONADE)

### a. Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect.

- Use parents' complaints to improve the quality of educational delivery. (Parents whose complaints are handled properly are more loyal than parents without complaints.) (A)
- Employ rapid re-grading of faulty, inaccurate 'high stakes' examinations. (A)
- Establish policies that allow students to revise work to improve grades. (A/C)

### b. Eliminate the primary harmful action by adding it to another harmful action to resolve the problem.

- Eliminate fear of change by substituting fear of competition. (A/C)
- Recognize that the accountability demands of State and Federal mandates have led to acceptance of district policies. (A/C)

### c. Amplify a harmful factor to such a degree that it is no longer harmful.

- Realize that the greater the cost for consultants, the greater the perception of value. (A)

## 23 - FEEDBACK

### a. Introduce feedback (referring back, cross-checking) to improve a process or action.

- Provide opportunities for educators to work together on issues of teaching and learning, enabling colleagues to give and receive feedback on teaching performances. (A)
- Collect and use data from a variety of sources to inform school improvement decisions. (A)
- Use RFID technology in school bookstores. (A)
- Use comprehensive assessment – diagnostic, formative, and summative. (C)
- Study student work samples and reflect on how improvements might occur. (C)
- Utilize test scores for regulatory statistics as well as student grading. (Program evaluation as well as individual student evaluation) (A/C) (See also Principle 6)

### b. If feedback is already used, change its magnitude or influence.

- Anticipate potential obstacles to school reform efforts by including stakeholders from various positions in the planning / implementation process. (A)
- Increase frequency of report cards. (A)
- Utilize five-week interim notices. (A)
- Vary length of report card periods. (A)
- Move from letter and number grades to standards-based reporting. (A)
- Create a sense of urgency about improving learning for students and teachers. (C)

## 24 - "INTERMEDIARY"

### a. Use an intermediary carrier article or intermediary process.

- Encourage satisfied parents to be emissaries of educational programs. (A)
- Recruit and nurture parents to be active members of Parent-Teacher Associations. (A)
- Use arbitrators for sensitive discussions. (A)
- Accept advocates as part of the IEP process. (A)
- Use facilitators at group, brainstorming, and problem solving sessions. (A/C)

**b. Merge one object temporarily with another (which can be easily removed).**

- Utilize temporary aides. (A)
- Utilize support staff. (A)
- Hire consultants. (A)
- Train substitute teachers. (A)
- Create interdisciplinary teams. (A)
- Create a core group of volunteers. (A)

**25 - SELF-SERVICE**

**a. Make an event serve itself by performing auxiliary helpful functions.**

- Conduct self-assessment of teaching practices by previewing videotapes of classroom activities. (A)
- Employ faculty self-evaluations. (A)
- Utilize self-directed work teams. (A)
- Combine classroom and program assessment. (A/C)
- Utilize rubrics quantifiable scoring systems. Heidi Goodrich, a rubrics expert, defines a rubric as "a scoring tool that lists the criteria for a piece of work or 'what counts.'" (A/C)
- Build in reflective experiences for students. (C)

**b. Use waste (or lost) resources, energy, or substances.**

- Analyze poor teacher evaluations to improve performance. (A)
- Evaluate recurrence of negative behaviors by expelled students to measure "waste" remediation efforts. (A)
- Conduct exit interviews with teachers leaving the profession. (A)
- Conduct exit interviews of students who drop out. (A)
- Recycle books. (A)

**26 - COPYING**

**a. Instead of an unavailable, expensive, fragile object, use simpler and inexpensive copies.**

- Benchmark competitors, e.g. charter schools. (A)
- Benchmark similar projects/proposals to identify improvement opportunities. (A)
- Create virtual educational programs. (A) (See also Principle 2)
- Borrow images or 3D simulations of items from local museums, corporations, etc. (A/C)
- Use local resources (e.g., town historians, government officials as speakers). (A/C)
- Utilize teacher-made worksheets. (C)

**b. Replace an event or process with optical copies.**

- Offer professional coursework on-line. (A)
- Use an electronic database rather than paper records. (A/C)
- Provide learning syllabi in CD format. (A/C)
- Use electronic course management software. (A/C)
- Use projectors and transparency copies in lecturing. (C)
- Use visuals to support lectures. (C)

**c. If visible optical copies are already used, move to IR or UV copies. (Use an appropriate out-of-the-ordinary illumination and viewing situation).**

- Evaluate student and parent satisfaction using multiple techniques. (A)
- Use black lights for demonstrating fluorescent and phosphorescent phenomena. (C)
- Use simulations, case studies and games instead of lecture-style training. (C)
- Import graphical and visual representations in information-giving segments. (C)

## 27 - CHEAP SHORT-LIVING OBJECTS

### a. Replace an expensive event / object with a multiple of inexpensive objects / events, compromising certain qualities, such as service life.

- Develop early retirement incentives to replace expensive staff with less expensive staff. (A)
- Hire back retired staff at lower salaries. (A)
- Use disposable cutlery and plates during influenza outbreaks. (A)
- Consider differentiated staffing models. (A)
- Use virtual modules to test out of annual professional development requirements. (A) (See also Principle 9)
- Use trial software for the trial period or limited times for free. (A/C)
- Use volunteers in place of paid staff. (A/C)
- Use the Internet for virtual field trips. (C)

## 28 - MECHANICS SUBSTITUTION

### a. Replace a mechanical means with a sensory (optical, acoustic, taste or smell) means.

- Use distance learning. (A)
- Videotape lectures and CD recordings as a substitute for physical attendance. (A)
- Use electronic communication. (A/C)
- Develop multi-sensory experiences in science. (C)
- Use learning style responsive activities rather than lectures. (C)
- Attach a sensory response to an educational concept or practice. (C)

### b. Use electric, magnetic and electromagnetic fields to interact with the object.

- Create problem-solving teams for site-based management. (A)
- Substitute electronic communication for physical travel (e.g., learning through online classes, or video conferences). (A/C)
- Use online physical education courses. (A/C)
- Use cooperative learning groups. (C)

### c. Change from static to movable fields, from unstructured fields to those having structure.

- Enable real-time communication with visual images through Internet technologies. (A/C)
- Create opportunities for older students to teach /tutor younger ones. (High school students teach/tutor elementary students.) (C)

### d. Use fields in conjunction with field activated (e.g. ferromagnetic) particles.

- Utilize new teacher mentoring programs. The new teacher is activated by the aura of the mentor. (A)

## 29 - PNEUMATICS AND HYDRAULICS (INTANGIBILITY)

### a. Use gas and liquid parts of an event / system instead of solid parts (e.g. inflatable, filled with liquids, air cushion, hydrostatic, hydro-reactive). Use intangible parts of an object / system instead of tangible parts.

- Utilize flexible (fluid) organizational structures vs. fixed hierarchical structures. (A)
- View competitors as collaborators (Charter Schools / Traditional Schools). (A)
- Introduce binding arbitration into contracts. (A)
- Share teachers between schools and school districts. (A)
- Consider benefits of traditional vs. virtual education. (A)
- Introduce breathing spaces into contracts. (Buyer's remorse clauses) (A)
- Encourage peripheral stakeholders' positive perception of schools. (A)
- Encourage high school students to take college courses. (A/C)

### 30 - FLEXIBLE SHELLS AND THIN FILMS

- a. Use flexible shells and thin films instead of three-dimensional structures.**
- Have students mentor other students. (A)
  - Have administrators make themselves available to students during non-instructional periods. (A)
  - Have principals develop open door policy. (A)
  - Allow parents direct access to teachers to deal with educator most directly involved. (A/C)
  - Have teachers participate in after-school clubs and activities. (C)
- b. Isolate the object from the external environment using flexible shells and thin films.**
- Employ block scheduling. (A) (See also principle 1)
  - Use breakout areas for students. (A)
  - Facilitate home schooling. (A)
  - Use multiple locations and structures for study hall. (A)
  - Use one-on-one teaching (teaching aides). (C)

### 31 - POROUS MATERIALS

- a. Make an object porous or add porous elements (insets, coatings, etc.).**
- Improve communications by providing for Internet and intranet accessibility. (A)
  - Set up and maintain web site. (A)
- b. If an event is already porous, use the pores to introduce a useful substance or function.**
- Set up faculty profiles on school web site. (A/C)
  - Create community and business partnerships to enhance classroom instruction. (A/C)
  - Create advanced assignments for students who already understand the basic concepts. (C)
  - Create online tutorials to support classroom instruction. (C)
  - Use high school students as technology resource people in elementary school classes. (C)

### 32 - COLOR CHANGES

- a. Change the color of an event or its external environment.**
- Increase student diversity in the classroom. (A)
  - Use school colors to increase student spirit or solidarity. (A)
  - Foster employee diversity. (A)
  - Develop community and business partnerships to enhance diversity. (A)
  - Utilize lighting effects to change the mood in the classroom. (A/C)
- b. Change the transparency of an event or its external environment.**
- Provide clear and concise vision and mission statements for parents. (A)
  - Provide visibility to school cafeterias, auto shops, etc. (A)
  - Pre-group students to work in activity centers. (C)
- c. In order to improve observability of things that are difficult to see, use colored additives or luminescent elements.**
- Use desktop or graphic presentations. (C)
  - Use temporarily colored glue that dries clear. (C)
  - Match color in materials to desired effect. (C)
- d. Change the emissivity properties of an object subject to radiant heating.**
- Develop behavioral and environmental modifications to meet the needs of challenged students. (C)

### 33 - HOMOGENEITY

**a. Make events interact with a given event of the same material (or material with identical properties).**

- Provide for common planning time for teachers. (A)
- Use students to talk with visiting students and parents to improve enrollment and retention rates. (A)
- Treat teachers and staff as external parents (customers). (A)
- Create different center activities leading to common unit goals. (A)
- Use external guidance/professional standards to direct curriculum design. (A/C)
- Develop peer-tutoring opportunities. (C)
- Use cooperative learning strategies. (C)

### 34 - DISCARDING AND RECOVERING (REJECTING AND REGENERATING PARTS)

**a. Make portions of an event that have fulfilled their functions go away (discard by dissolving, evaporating, etc.) or modify them directly during operation.**

- Conduct clinical supervisory practices and/or counsel ineffective teachers out of the profession. (A)
- Eliminate redundant, duplicated, and non-value added activities, programs, and classes. (A/C)
- Change instructional activities to maintain student interest. (C)
- Develop activities and assessments congruent with standards. (C)

**b. Restore consumable parts / events of a system during operation.**

- Introduce periodic re-training. (A)
- Periodically re-energize and refocus continuous improvement initiatives. (A)
- Implement cyclical development programs. (A)
- Encourage revising and sharing lesson plans. (A/C)

### 35 - PARAMETER CHANGES (TRANSFORMATION OF PROPERTIES)

**a. Change an event's physical state (e.g., to a gas, liquid, or solid).**

- Create an organizational culture that embraces and supports change. (A)
- Turn brick-and-mortar schools into virtual schools. (A)
- Convert paper tasks to online systems. (A/C)

**b. Change the concentration or consistency.**

- Focus on specialties to be more efficient and competitive. (e.g., Schools of music, technology, culinary institutes, etc.) (A)
- Change team structures. (A)
- Encourage charter schools. (A)
- Change length of day, week, course, and school year to meet student needs. (A)

**c. Change the degree of flexibility.**

- Engage staff in shaping the content and conditions of personal learning needs. (A)
- Provide flexible variable-sized teams. (A)
- Periodically review standard practices to determine relevance. (A/C)
- Provide multiple remediation structures. (C)
- Provide (individual) teaching approach for different student sectors. (C)

**d. Change the atmosphere to an optimal setting (e.g., temperature, pressure, other parameters).**

- Offer asynchronous opportunities to learn. (A) (See also Principles 4 and 19)
- Motivate students by providing them honors degrees and certificates. (A/C)
- Provide alternative classroom designs. (A/C)
- Encourage student excitement by providing ownership of change. (C)



### 36 - PHASE TRANSITIONS

- a. Use phenomena occurring during phase transitions (Awareness of macro -scale business phenomena).**
- Use hall monitors for supervision of students going from homeroom to other subject classrooms. (A)
  - Develop transitional support programs between attendance unit levels. (A)
  - Develop effective procedures that allow adequate time for moving between classrooms. (A)
  - Develop protocol for field trips. (A/C)
  - Employ "Stages of learning - unconscious incompetence, conscious incompetence, conscious competence, unconscious competence" (W. E. Deming) (A/C)
  - Provide transition events for students moving from elementary to secondary education. (A/C)
  - Attempt to convert empty minds to open minds. (C)

### 37 - THERMAL EXPANSION (EXPANSION OF EVENTS OR PROCESSES)

- a. Use thermal expansion, or contraction, of materials.**
- Consider year-round schooling. (A)
  - Offer summer programs. (A)
  - Employ self-paced studies. (A/C)
  - Provide academic enrichment for students. (A/C)
  - Provide differentiated instruction. (A/C)
  - Utilize methods to encourage students to be excited about their subjects. (C)
- b. If thermal expansion is being used, use multiple materials with different coefficients of thermal expansion.**
- Encourage empowerment - share authority and responsibility with students, teachers, and parents. (A)
  - Expand or contract curricula depending on the student's interest and academic ability. (A/C)
  - Develop differentiated materials. (C)
  - Get synergy by mixing motivated students (mentors) with less motivated students. (C)

### 38 - STRONG OXIDANTS (BOOSTED INTERACTIONS)

- a. Replace common air with oxygen-enriched air (enrich value added for students).**
- Create and articulate a vision of high standards for learning for all to share and support. (A)
  - Continually address and improve customer (student and parent) perceived quality of schools. (A)
  - Create an interactive learning environment. (C)
- b. Replace enriched air with pure oxygen (increase customer participation in education delivery).**
- Delegate responsibility and develop leadership in others to monitor strategic planning processes. (A)
  - Ensure total commitment to vision and mission statements. (A)
  - Implement site-based management. (A)
  - Allow students to become teachers. (C)
- c. Expose air or oxygen to ionizing radiation (employ external influences).**
- Encourage and support the attendance of staff members at professional conferences and meetings.
  - Revise vision based on effective research. (A)
- d. Use ionized oxygen**
- e. Replace ozonized (or ionized) oxygen with ozone (extreme or radical activities).**
- Consider radical reorganization. (A)
  - Support charter school development. (A)
  - Facilitate home schooling. (A)

## 39 - INERT ATMOSPHERE

### a. Replace a normal environment with an inert one.

- Develop an emergency management plan. (A)
- Encourage alternative passive systems for educating disaffected students. (A)
- Maintain atmosphere free of judgment and criticism at brainstorming sessions. (A/C)
- Encourage multi-cultural acceptance. (A/C)

### b. Add neutral parts, or inert additives to an object.

- Use neutral third parties during difficult negotiations. (A)
- Introduce 'quiet areas' into the school environment. (A/C)
- Use time-out during negotiations. (A/C)
- Encourage reflection on the part of all stakeholders. (A/C)

## 40 - COMPOSITE MATERIALS

### a. Change from uniform to composite (multiple) structures. (Awareness and utilization of combinations of different skills and capabilities).

- Develop interdisciplinary teams for teaching and learning. (A)
- Consider differentiated staffing. (A)
- Send follow-up notes as physical reminders of telephone conversations, etc. (A)
- Utilize multiple modes (newsletter, intranet, staff meetings, etc.) for effective communications. (A)
- Use multi-disciplinary, cross-functional teams. (A)
- Introduce training/teaching with a combination of lecture, simulations, on-line learning, etc. (A/C)
- Use multi-media for instruction - lecture with music and video. (C)
- Combine high risk and low risk teaching methodologies and strategies. (C)

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