SenSel

CREATIVITY

Sensitization- and Self-Questionnaire

for Educators & Teachers

by Klaus K. Urban

klausur-verlag

Component 1: Divergent Thinking and Acting	1*	2*	3*	4*
Do I try to offer a problem-oriented learning and teaching?				
Do I allow and expect questions by students?				
Am I open and sensible for questions and problems of/by students?				
Do I put students' attention to open questions?				
Do I try to get them sensitive for their environment (under material, social, cultural, political, societal aspects)?				
Do I address as much senses as possible?				
Do I introduce problems at all (not just presenting ready, correct answers)?				
Do I provide for opportunities to find problems (individually and collectively)?				
Do I encourage students to look at objects and situations from different perspectives?				
Do I give opportunities/possibilities to deal with objects or situations "experimentally", to explore them and try to treat them differently than usual?				
Do I give excitations to think in different directions and to find more solutions or different pathways towards a solution?				
How about my response to a "wrong" answer? Do I interpret it as a (sometimes important) possible step to find a solution?				
Do I accept "deviant" work or solutions?				
Do I show appreciation for original answers / solutions / questions?				
In my classes, are there also held open or openly designed phases and processes and/or outcomes / products?				
Do I encourage the learners not to be satisfied always with the first solution?				
Do time/organization of work and teaching allow for extensive idea-finding and more than just one attempt at a solution?				
More generally, does something happen in my classes that can be called divergent thinking? (That is, learning does not consist merely of the accumulation and repetition of given knowledge that is mediated via text books or teachers?)				
Sum:				

1* = never; 2*= sometimes; 3*= often; 4*= mostly, always

Component 2: General Knowledge & Thinking Base	1*	2*	3*	4*
Do the learning tasks require and promote broad and differentiated perception (areas), i.e. do they not limit the focus?				
Do I give way/opportunities for self-regulated learning?				
Do I give ways for students to discuss, bring in, and to prepare their own experiences?				
Am I aware of different sensory channels for teaching and learning?				
Do I use different/various ways and methods of teaching and learning?				
Do I value interdisciplinary projects / tasks? Transfer between subjects?				
Do I give suggestions/stimulation for (different kinds of) "memory training"?				
Do I give suggestions and proposals for analyzing (the structure of) learning objects and situations?				
Do I put a focus on the learning process, not only on the result?				
Are solutions questioned, scrutinized, optimized?				
Do I give suggestions and create opportunities for social and cooperative work, thinking, and problem-solving?				
Is my teaching also dealing with systematic analysis and synthesis of problems, objects, facts, situations?				

Do I provide for challenges for logical, inductive and deductive reasoning?				
Do I wish and urge for evaluation and criticism? Can I stand and tolerate it?				
Do I observe learning processes and I reflect them with students, so that metacognitive thinking is encouraged and supported?				
1* = never; 2*= sometimes; 3*= often; 4*= mostly, always Sum:				

Component 3: (Area-)Specific Knowledge Base & Specific Skills	1*	2*	3*	4*
Can individual interests and abilities of the students be incorporated into the school and integrated into the classroom?				
Is there sufficient choice and transparency?				
Do I allow and support self-regulated, independent learning of students?				
Is the development of specific interests of students promoted and supported? (Eg. additives and extra-curricular activities, mentoring systems, competitions, etc.)				
Is therea diversity of methods for acquiring specific knowledge?				
Are there (also temporal) possibilities and opportunities for students to work with items and problems so intensively and in depth as possible?				
Is there time and space for individual counseling?				
Is attention paid to the possibility of the connection between theory and practice?				
Is (students')expertise valued by me?				
1* = never; 2*= sometimes; 3*= often; 4*= mostly, always Sum:				

Component 4: Focussing & Task Committment	1*	2*	3*	4*
Is a particular committment in an activity appreciated?				
Is task committment rewarded by me?				
Are the students instigated and encouraged to recognize distractions and to avoid those?				
Is there the obvious expectation that tasks taken over will become fulfilled and completed by the end?				
Do I help the students through constructive criticism?				
Do I urge students to evaluate themselves and others, fair but critically?				
Are the problem-solving strategies evaluated for their effectiveness and optimized, if necessary?				
Do I use support systems / methods, when the students' work does not make progress? Is there something like "work(ing) counseling"?				
Is a long-term employment in/with a special field of interest permitted, enabled and promoted (eg. accompanying research, joint projects, competitions)?				
~~Ermöglichen Schulorganisation, Stundenpläne und Zeitfenster grundsätzlich oder fakultativ solche Aktivitäten?~~ Do school organization, class schedules and time windows allow for such activities, principally or optionally ?				
Are there environmental structures in space and surroundings condicive/beneficial for working intensively on a problem/project?				
1* = never; 2*= sometimes; 3*= often; 4*= mostly, always Sum:				

Component 5: Motives & Motivation	1*	2*	3*	4*
Are students' questions addressed, taken up and utilized for learning work?				
Is the natural curiosity of students aroused, encouraged and supported?				
Do I give opportunities for self-directed and discovery learning so that intrinsic motivation can be developed?				
Do I appreciate and support individual interests?				
Dovl try to avoid unnecessary repetition?				
Do I try always to motivate learners, to sustain or enhance their motivation?				
Do I strive for an open, positive communication?				
Can students identify themselves with the teaching subjects and activities?				
Am I a model for a behavior interested and engaged in subjects, questioning, and problem-solving?				
1* = never; 2*= sometimes; 3*= often; 4*= mostly, always Sum:				

Component 6: Openness & Tolerance of Ambiguity	1*	2*	3*	4*
Do I make school not only a placeof traditional teaching, but also a place of living togther, of the joy of the (mental) adventure, open to surprises?				
Do I get/bring reality and real live problems into school?				
Does my teaching go into outside-school reality?				
Do I involve the students in terms of content and didactic-methodical planning?				
Do I design school as a place for open learning?				
Is there a balance of free and guided learning appropriate to students (needs)?				
Can I stand and accept an open teaching/learning result?				
Do I value self-paced/-regulated learning and action?				
Are there any learning and working stages without time pressure?				
Is school a place for fantasy and imagination?				
Do I give opportunities for students to explore and examine subjects in a playful and experimental way, and to learn?				
Is school a place for Eu(= wellness) -stress and relaxation,too?				
May students/teacher laugh (not about others), is humor valued?				
Do I allow also mistakes and errors or just fast and accurate answers and results?				
Do I encourage students to take „thinking risks" also?				
Am I willing to depart from prefabricated (thinking) paths?				
Do I tolerate unusual behaviors or solutions?				
Can I endure a temporary or open result ? Do I expect not only final results?				
Do I appreciate individuality and uniqueness of each person?				
Do I not expect conformist behavior at any time?				
Am I myself humorous and tolerant?				
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Total:

The most important aspects (at least three) that I want to consider in the self-observation and my teaching behavior, especially in the near future:

_____

_____

_____

_____

_____

_____

_____

Furthur remarks:

_____

_____

_____

_____

_____

_____

_____

Your Challenge: make a DT Challenge for your students

Preparation

Step 1: Make a group of teachers that work with the same age group. Discuss and decide on a collective theme for your DT Challenge. (workbook 0-1 Define a Challenge)

Step 2: Create a project plan describing the end goals, the indicators of success and constraints you might encounter. (workbook 0-2 Create a Project Plan)

Step 3: Share what you know by discussing your experience with Teaching Creativity. Also establish what information / inspiration you are missing. (workbook 1-1 Understand the Challenge, right part of the page).

Step 4: Build your team, by really getting to know each other. Play the quality game to establish everyone's qualities. Then decide on the roles and goals every member will focus on. (workbook 1-1 Build your Team)

Empathizing

Step 5: Define your audience! Who are your users and what are their needs? In other words: what group of students are you going to develop this DT Challenge for? (workbook 1-1 Define your Audience) How are you going to define their needs? Anticipate on your students' needs by talking about various types of students. Describe them. (workbook 1-2 Select Research Participants). Decide on what you can do to check if you have described their needs well!

Defining

Step 6: Formulate your students' needs.

How might we ....

Here are some examples:
How might I redesign my lessons on English grammar to improve student engagement?
How might we redesign our school playground to make it safer, more exciting....?
How might we redesign our classroom to make it easier to differentiate?
How might we design a series of lessons on the theme of 'systems' that differentiates on students' abilities?
How might we redesign the park in our town to make it safer for children?
How might we ....

Ideating

Step 7: think of as many ideas as you can! Start this session by brainstorming on your own for 10 minutes. After that come together and share everyone's ideas in your team. Add to each other's ideas, combine ideas that are similar or that can go together well. Take at least 30 minutes to discuss all options.

NB: check the brainstorm rules in your workbook before starting (3-1 Generate Ideas, right page)

NB: feeling stuck? Check the tips in your workbook (3-1 right page)

Step 8: select promising ideas. Cluster any related ideas and as a team pick your three favourite ones. Collect the post-its of these favourites. If necessary vote to get the three best ideas.

Step 9: divide the three best ideas among your team members and work these out to a concept. (workbook 3-2 Refine Ideas).

Step 10: discuss all three ideas and decide on the one you are going to work out. Then describe your idea more thoroughly (workbook 3-2 Describe your Idea).

Prototyping

Step 11: create a prototype of your DT Challenge. You can do this by making a poster, a mindmap, do an activity, act a play, make a storyboard or script, make photos, make a clip or a podcast, …..

NB: You only have 15 minutes.

Testing

Step 12: present your prototype and collect as much feedback as possible. Make a grid to do this.

+ good point

Δ improvement point

? question

new idea

Prototyping & Testing

Step 13: improve your prototype and test it again.

Step 14: try this at home! Make a list of what you need to do this DT Challenge at school. Use your workbook 4-2 (Identify What's Needed). Discuss solutions for any difficulties you might encounter.

Step 15: agree on what, when, who, where and how! Make sure all agreements are clear to every team member. Hand in your project plan with the description of your DT Challenge and the agreements you made.

What are you going to do?

Who is your target group?

When are you going to do the DT Challenge in class?

Where are you going to do it?

How are you going to do it -> your project plan.

What do you need to do this DT Challenge?

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When are you going to do the DT Challenge in class?

Where are you going to do it?

How are you going to do it -> your project plan.

What do you need to do this DT Challenge?

Destination, Imagination and the Fires Within: Design Thinking in a Middle School Classroom

Maureen Carroll, Shelley Goldman, Leticia Britos, Jaime Koh, Adam Royalty and Michael Hornstein

Abstract

The purpose of the Taking Design Thinking to Schools Research Project was to extend the knowledge base that contributes to an improved understanding of the role of design thinking in K-12 classrooms. The ethnographic qualitative study focused on the implementation of an inter-disciplinary design curriculum by a team of university instructors in a public charter school. Three questions framed the study. How did students express their understanding of design thinking classroom activities? How did affective elements impact design thinking in the class-room environment? How is design thinking connected to academic standards and content learning in the classroom?

Maureen Carroll,
Shelley Goldman,
Leticia Britos,
Jaime Koh,
Adam Royalty and
Michael Hornstein

Introduction

A young seventh-grade student slung his backpack over his shoulder and headed for the narrow doorway of his corrugated metal portable classroom. The school day was over, and he had just finished an exuberant design thinking class where students brainstormed, sketched, and giggled as they designed eyeglass prototypes for each other.

As he left he said, 'I really liked using my imagination. I haven't used it for a long time.'

As children move from kindergarten, to middle school, and to high school, instruction shifts from stories to facts, from speculation to specifics, and imagination fades from focus. Design Thinking is an approach to learning that focuses on developing children's creative confidence. Students engage in hands-on projects that focus on building empathy, promoting a bias toward action, encouraging ideation, and fostering active problem solving. Using one's imagination is central. This article focuses on the journey of one urban middle school as design thinking became part of classroom instructional practices.

Need

According to The Partnership for 21st Century Skills, the central economic competitiveness issue for the Obama administration is to create an aligned, twenty-first century public education system that prepares students, workers and citizens to triumph in the global skills race. A focus on innovation, creativity, critical thinking, problem solving, communication and collaboration is essential to prepare students for the future. Passig (2007) describes the skill of melioration, which he considers essential to successfully functioning in the twenty-first century, as choosing the appropriate chunks of information, and applying them to the solution of problems in different time and space-dependent situations. Advanced economies, innovative industries and firms, and high-growth jobs require more educated workers with the ability to respond flexibly to complex problems, communicate effectively, manage information, work in teams and produce new knowledge. Diversity of perspectives and ideas is essential for innovation (Staw

2006). Much of today's education system guides students toward finding the correct answers to fill-in-the blanks on standardised tests, as this kind of instruction facilitates streamlined assessments to measure success or failure. Van Dam (2003) states

Many districts are so overwhelmed and concerned about the No Child Left Behind requirements and potential financial repercussions of not complying, that for lots of them the safest route is the 'back-to-basics' approach-focusing entirely on 20th century skills at the expense of 21st century ones.

It is critical that, particularly in under-served schools, this model of learning does not continue to prevail. Students need both the skills and the tools to participate actively in a society where problems are increasingly complex and nuanced understandings are vital. Design Thinking provides a powerful alternative to this model by challenging students to find answers to complex and difficult problems that have multiple viable solutions and by fostering students' ability to act as change agents.

Overview

The purpose of the Taking Design Thinking to Schools Research Project was to extend the knowledge base that contributes to an improved understanding of the role of design thinking in K-12 classrooms. The qualitative study focused on the implementation of a design curriculum by a team of university instructors and graduate students during a middle school geography class in a public charter school serving grades K-3 and 7-8. Three key questions framed the study:

- How did students express their understanding of design thinking in classroom activities?
- How did affective elements impact design thinking in the classroom environment?
- How is design thinking connected to academic standards and content learning in the classroom?

Three key themes emerged from the research:

* Design as Exploring: Understanding Design
* Design as Connecting: Affect & Design
* Design as Intersecting: Design Thinking
  & Content Learning

The first theme, Design as Exploring, highlighted the ways in which students participated in the classroom design activities. Students embraced diverse aspects of the design thinking process, adopted the discourse of design in varied ways, and were able to reflect on the nature of the process as they created a series of prototype-driven projects. Giving students the opportunity to explore as they problem solve is an essential component of learning. Design thinking does not encourage students to jump to immediate solutions; instead, the focus is on exploring all aspects of problems through multiple sources and iterations.

The second theme, Design as Connecting, forefronted the powerful role that design thinking plays in developing students' creative confidence. Students were engaged in personally meaningful work, had opportunities to express their voices, and saw the power of risk-taking as they engaged design challenges. Collaboration experiences are a key foundation of design thinking and students had many opportunities to problem solve with each other. They became more empathetic, learned how to work in a group setting with a focused goal, and struggled to figure out how to participate as a seventh-grade student in a collaborative task. Design thinking activities provided tools that helped illuminate the complex nature of collaborative efforts, and the multiple ways to develop as a successful collaborator.

The third theme, Design as Intersecting, highlighted the relationship between design thinking and academic content learning. The integration of design thinking into the classroom learning environment was both challenging and problematic. Instructors, classroom teachers and students faced many obstacles. The instructors struggled to find an effective means to teach design thinking within the constraints of academic content standards in geography. The teacher struggled with integrating new knowledge about design

thinking with her instructional goals, as she questioned the value of this new way of thinking and its place in her classroom culture. The students had to learn both design thinking concepts and geography content, both of which were new to them, and they also had to make connections between them. This struggle highlights the constant tension between new learning approaches and established classroom practices.

Theoretical perspective

The project was guided by a theoretical rationale that is based on a sociocognitive view of learning. As Vygotsky (1976 [1934]) described, opportunities to interact verbally with others in a social environment become crucial to cognitive development. Language is central to this view, as we communicate and engage in dialogue with others (Bakhtin 1986). The key components of design process are that it is (1) human-centred (2) action-oriented and (3) mindful of process (Hasso Plattner Institute of Design at Stanford 2007). Through meaningful, hands-on projects, students develop deep understanding of a domain while developing skills in building empathy with users collaboration, and prototyping.

Promise for this work has been shown in several projects (Goldman 2002; Hmelo et al. 2000). Work in mathematics (Goldman et al. 1998), science (Kolodner et al. 2003), and technology (Kafai & Resnick 2002; Todd 1999) suggest that design thinking skills are not merely extras, but can in fact aide students in core subject areas as well as building cognitive and social skills. Early work in this domain has indicated the potential for design in K-12 to contribute to young people's meta-cognitive (Kolodner et al. 2000) and social learning (Cognition and Technology Group at Vanderbilt 1999) as well as in specific subject areas (Goldman et al. 1998; Middleton & Corbett 1998). Vande Zande (2007) characterises design thinking as a means of creative problem-solving, that relates thought and action directly and dynamically. Design has the potential to impact learning to learn skills such as working in groups, following a process, defining problems and creating solutions (Barron 2006). In peer collaborative efforts in the classroom, students negotiate meaning (Ruddell

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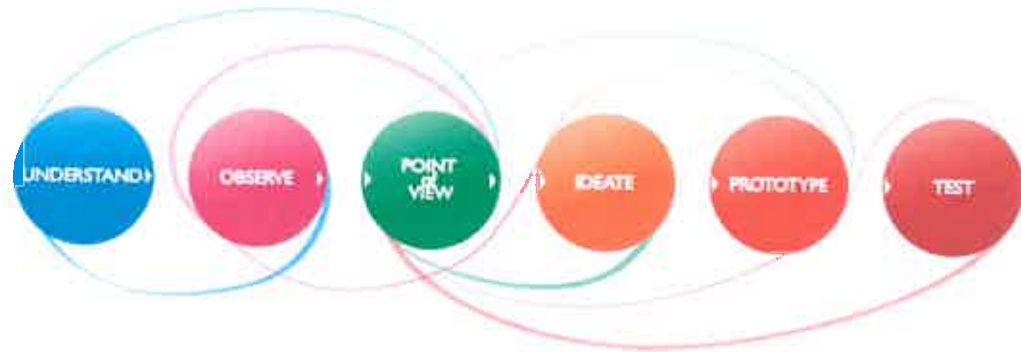
& Unrau 1994). Molinelli (2000) suggests that the type and quality of group interactions ultimately determine the nature and degree of any cognitive and social benefit for students.

The design thinking process

The conceptual framework for the research project curriculum was a series of design challenges through which students learn the six key components of the design thinking process and the design thinking mindsets that underlie this approach to learning [1]. Design challenges are created around an issue that has many potential solutions. The focus of the process is for students to be able to define interesting problems and deal with varying levels of ambiguity.

The components of the design thinking process include the following:

- Understand
- Observe
- Point of View
- Ideate
- Prototype
- Test

Understand

The first phase of the design thinking process is understanding. During this phase, students immerse themselves in learning about issues related to the design challenge. They access a wide array of resources that include conversations with experts, viewing multimedia and conducting research.

Observe

Students become keen people watchers in the observation phase of the design thinking process. They watch how people behave and interact. They talk to people about what they are doing, ask questions and reflect on what they see. The understanding and observation phases of design thinking help students develop a sense of empathy.

Point of View

In the design thinking process, one must develop a point of view that is based on a specific user. Statements are framed as 'How might we. ..?' questions. Students must synthesise what they learned in the understanding and observation phases. A Point of View statement takes into account information about user needs and insights. The formula for Point of View formula is: User + Need + Insight = Point of View Statement.

Ideation

In the ideation phase, quantity is encouraged. Brainstorming ideas is the foundation of this phase, and students may be asked to generate a hundred ideas in a single session. Students are asked to defer judgement of others' ideas. Every idea that is suggested is recorded. A supportive classroom climate is essential. Students are challenged to become silly, savvy, risk takers, wishful thinkers and dreamers of the impossible ... and the possible. They work on their design challenges with an openness to unexpected ideas and new possibilities as a team where everyone contributes and builds on other's ideas.

Prototyping

A prototype can be a sketch or a two- or three-dimensional low resolution model made out of diverse materials such as cardboard, pipe cleaners or paper.

It is a way to convey an idea quickly; the more one produces the more one can learn. A diverse assortment of materials is provided to use when creating prototypes, and every prototype is created with the purpose to learn something specific by testing it. It is better to fail early and often as one creates prototypes.

Testing

Testing is part of an iterative process that provides feedback. The purpose of testing is to learn what works and what doesn't, and then iterate. This means going back to one's prototype and modifying it based on user feedback. Testing ensures that one learns what works and what doesn't work for specific users.

Design Thinking Mindsets

Design thinking is built upon fundamental mindsets or orientations to learning. These include the following: Human-centredness; Empathy; Mindfulness of Process; Culture of Prototyping; Show Don't Tell; Bias Toward Action; Radical Collaboration.

Human-centredness

Design thinking is a human-centred process, and the best innovations arise out of a thoughtful response to stimuli that designers are exposed to in the world. The focus is on making people the source of inspiration and direction for solving design challenges.

Empathy

Empathy is the intellectual identification with or vicarious experiencing of the feelings, thoughts or attitudes of others. The empathy that comes from observing users enables design thinkers to uncover deep and meaningful needs (both overt and latent). Empathy develops through a process of 'needfinding' in which one focuses on discovering peoples' explicit and implicit needs.

Mindfulness of Process

The third important mindset in design thinking is Mindfulness of Process or metacognitive awareness. Flavell (1976) defines this as the ability to 'know what you know'. As people engage in design thinking they develop the ability to always know where they are in the process and the goal they are moving toward. Being mindful of process requires being thoughtful not only about the work that one does, but about how one does that work and about how one will improve the methods used.

Culture of Prototyping

The mindset of creating and maintaining a Culture of Prototyping focuses on being highly experimental, building to think and engaging people with artifacts. This mindset relies on eliciting and receiving feedback in a ways that will help one arrive at a better solution. Flexibility of stance allows one to make rapid changes, learn along the way and build increasingly higher resolution models.

Show Don't Tell

Visual literacy has three components: learning, thinking and communicating (Randhawa & Coffman 1978). Expressing ideas in a non-verbal way makes ideas more compelling, helps one see problems and opportunities that discussion may not reveal and often leads to fruitful misunderstandings.

Bias Toward Action

Bias Toward Action is a focus on action-oriented behaviour rather than discussion-based work. This mindset becomes evident through engaging users and by prototyping and testing to inspire new thinking and foster group consensus. A Bias Toward Action mindset utilises all modalities of learning.

Radical Collaboration

The mindset of Radical Collaboration is built upon the idea that radically diverse multidisciplinary teams will lead to greater innovations than teams that come from the same discipline. This also fosters the ability to focus on the elements of successful collaboration. Examining and

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Figure 1
Overview of the
design thinking
process

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confronting team dynamics is an essential component of radical collaboration. In sum, Design Thinking is a powerful model for learning, and the research project focused on how to effectively harness this power in the classroom.

Project description

Site and participants
The school site for the research project was located in a semi-urban setting in the San Francisco Bay area. There were approximately 215 students in the public charter school, which has classes in grades K-3 and 6 and 7 and adds new grade levels each year. The population consists of approximately 60% Latino students, 30% African American students, 9% Pacific Islander students and 1% White students. Some 85% of the students receive free lunch. The school's mission is to prepare students with the knowledge, intellectual strategies, skills and habits of mind for lifelong success by monitoring the academic, social and emotional needs of all students and providing support services as necessary. The study participants included a seventh grade class of 24 students, their teacher, two university design school staff members, two graduate student instructors, and graduate students who were small-group coaches. Two post-project interviews of classroom teachers who had previously completed a design unit were also interviewed to better depict teachers' views of design in the school curriculum.

Instructional goals
The instructional goal of the project was to use design thinking to teach students about systems, an important element of geography. Students, who worked in collaborative teams, were guided through the design process to identify and redesign systems that existed at the school. The teaching team, which included four 'instructors' and five 'coaches', had a meeting at the start of each week to plan the lessons. Once the lesson plan was complete, the entire teaching team reviewed it, adding changes where necessary. Students groups consisted of four to five students. Every class session included two

instructors and three coaches; therefore, each group had a design coach to assist them. The sessions alternated between direct instruction by members of the teaching team and group work on the design projects.

Methodology
The project was a qualitative research study. The goal was to gain a multilayered understanding of the perspectives of the students, the teacher, the instructors and the graduate students, as they engaged for the first time in design activities in the classroom (Bogdan & Biklin 1992). It was, as Geertz (1973) described, 'not an experimental science in search of law, but an interpretive one is search of meaning'. The project spanned a three-week period. Sessions occurred twice a week during a two-hour period for a total of 12 hours of classroom time. A team of two researchers acted as participant/observers in the classroom and collected descriptive data through notes, audio recordings and video recordings. Each researcher observed three of the six sessions.

Data sources
Data sources included field notes, audio tapes, text and drawings produced by students, audio-taped transcriptions, 16 student interviews, a pre-project and post-project teacher interview, two post-project interviews from teachers who had recently participated in design thinking projects at the school site, two instructor interviews and project coaches' blog postings. The researchers inductively analysed the data to gain further understandings of the perspectives of the participants. Coding categories were developed based on salient aspects of the data. These categories provided tools to answer the research questions.

Instructional tasks
The instructional tasks for the design units focused on introducing students both to the design process and to systems in geography. The instructors used a variety of strategies. These included whole-class instruction, class discussions, modelling, hands-on activities, small group work, brainstorming and individual instruction.

Category	Evidence
Students' Understanding of Design	Students' use of design discourse
Students' Understanding of Design	Students' descriptions of design projects
Connection to Academics/Outside World	Students' descriptions of geography
Connection to Academics/Outside World	Students' descriptions of geography and design
Connection to Academics/Outside World	Students' descriptions of how design is used outside of the school setting
Social/Emotional Aspects	Affective elements
Social/Emotional Aspects	Collaboration
Students' Evaluation of Project	Students' description of favourite part of project
Students' Evaluation of Project	Students' description of least favourite part of project
Students' Evaluation of Project	Students' description of potential project improvements
Students' Output & Creations	Students' description of projects

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They sketched on chart paper, took photographs with the students, showed movie clips, used the Internet and utilised iMovie and iPhoto.

The first session introduced two critical concepts to the students. The first emphasised the fact that design is a human-centred activity and that everyone has the potential to be a designer. The second concept was systems. Students, who were divided into groups that stayed the same throughout the project, were asked to search for examples of systems in and around the school site. The students took photographs and notes about what they observed about needs. The systems they identified included the cafeteria/food system, traffic and parking lots, fields for play and leisure, lavatories, and the administration and office spaces. The session also featured a guest speaker who worked as a designer. He shared his experiences with the students.

The second session focused on visual representation. Students were asked to use the systems they identified the previous class and describe the needs of those systems. After a few quick sketching exercises, each group drew a map of the school, complete with the system the students identified as one that was in need of change. This session featured a guest who shared his experiences as he travelled from Japan to California. He highlighted his journey using a series of maps of differing scales and views.

In session three, the concept of brainstorming solutions to problems was introduced. The class practised this skill by generating ideas about the varied systems that exist in their city. The groups then brainstormed solutions for the problems they found in the previous class.

The fourth session focused on prototypes. Students were provided with examples of prototypes and discussed the purpose of prototyping. Each group built prototypes of the solutions they generated in the previous session.

In the fifth session, each group completed its prototypes and created a movie demonstrating how the prototypes worked.

During the final session the students showed their movies and received feedback from the class and teaching team. During the final portion of the class, the students shared their reflections on the design thinking project.

Table 1

Summary of Coding Categories for Students

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Category	Evidence
Teachers' Needs & Expectations	Teachers' descriptions of project objectives, desires, wishes and goals
Design Thinking Outcomes	Teachers' descriptions of his/her perspective on the project classroom outcomes
Teachers' Understanding of Design	Teachers' description of his/her learning, understanding of design, and use of design thinking in other classroom activities
Teachers' Perspective of Students' Understanding of Design	Teachers' descriptions of his/her perspective on how students came to develop diverse understandings of design
Conflict Between Instructor Perspective & Teacher Perspective	Teachers' descriptions of differences between instructor perspective and teacher perspective with regard to instructional goals and instructional decision-making
Standards, Content Learning & Design Thinking	Teachers' descriptions of the relationship between education standards, geography learning and design thinking principles
Design Challenges in the Classroom	Teachers' descriptions of the challenges of integrating design into the classroom learning context

Data analysis

Phase One: Student Data

The qualitative analysis began with a review of the data collected from 16 student interviews. After the first collaborative coding session, 24 initial categories emerged. In the second collaborative coding session, further in-depth analysis ensued, and after reviewing the initial list of 24 coding categories and their relationships, connections and similarities and differences, five major coding categories emerged. Table 1 contains a summary of the categories.

Phase Two: Teacher Data

Teacher data consisted of a series of interviews: one with the project's primary teacher prior to beginning the design project, one after the project was completed, and two post-project interviews of teachers who had participated in two previous iterations of the project. After the first coding session, which consisted of analysing the pre-project interview, a variety of categories emerged. These included the teacher's concerns about time commitment, the importance of connecting to standards-based topics, the reasons for wanting to use geography as the content subject in the project, a description of the standards, and how the project would be developed. Analysis continued using the post-interview data. A more fine-grained analysis ensued, and a concise set of categories emerged. These are illustrated in Table 2.

Phase Three: Instructor Data

The third phase of analysis focused on interview data collected from two design school instructors. After the first coding session, a variety of categories emerged. These included the instructor purpose, integration of design thinking and content learning, disconnection between teacher and instructor goals, lack of communication, development of curriculum, standards, instructional decision making, defining learning through design, congruence between teacher purpose

Category	Evidence
Instructor Process & Purpose	Instructors' descriptions of the purpose of the design thinking project and the processes they used to develop the project
Instructor/Teacher Relationship	Instructors' descriptions of the relationship between the instructor and the teacher and how that influenced the design project
Standards, Content Learning & Design Thinking	Instructors' description of the interrelationships between educational standards, content area learning and design thinking principles
Impact on Students	Instructors' description of the impact that the programme had on students
Design Challenges in the Classroom	Instructors' descriptions of the challenges of implementing a design thinking project in the classroom

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and instructor purpose, student empowerment, engagement, instructor vision, focus on being user-centred and human needs, instructor process, instructor learning and instructor vision. After a more fine-grained analysis, six categories emerged. Table 3 summarises the categories.

Findings

This section describes the major findings from the research study. The research questions that framed the study included the following:

How did students express their understanding of design thinking in classroom activities?

How did affective elements impact design thinking in the classroom environment?

How is design thinking connected to academic standards and content learning in the classroom?

Three major themes emerged:

- Design as Exploring
- Design as Connecting
- Design as Intersecting

Design as Exploring: Understanding Design

The first theme, Design as Exploring, highlights the ways that students participated in the classroom design activities. Students explored design in a myriad of ways that were shaped by their social interactions, purposes, and understanding of the design process. Students explored questions about design thinking that included 'What is design thinking?', 'How can I use it?', 'What do designers do?' and 'Who can be a designer?' They explored what design thinking was and what they could do with it. The two most important aspects of this theme were that students saw themselves as active change agents and that students exhibited empathy in relation to understanding human needs, both of which are essential components of design thinking. This was particularly important as they were in their school environment, and had intimate in-depth knowledge of their surroundings. The instructors taught the students about systems in the world from a geographical perspective, and then the students left the classroom to explore different aspects of the systems around them. The students discussed systems at their school, such as how packages were delivered, how students were dropped off in the school parking lot, how the school office worked, and how the cafeteria functioned. They looked at the human needs of those people participating in these systems. The design projects they created reflected this notion of the power to change one's environment in response to understanding human needs. This awareness came about through their developing sense of empathy for others. This is

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critically important for students of this age, and sometimes difficult, but it can be a tremendously powerful learning experience that extends beyond the design thinking project. When students see that they can have an impact, they often begin to look at the world differently and may see new opportunities and new possibilities around them. As Ryan & Deci (2000) describe, 'The fullest representations of humanity show people to be curious, vital, and self-motivated. At their best, they are agentic and inspired, striving to learn; extend themselves; master new skills; and apply their talents responsibly.' The educational significance of the theme 'Design as Exploring' is that the students' learning in relation to design thinking was both situated and impactful. The following section contains a sampling of responses from the data that highlight the theme.

Students displayed diverse understandings of the design process.

Over the course of the project, students showed evidence of their understanding of the design process in many different ways.

Some students grasped the concepts of human needs. This was evident in the following explanation when a student was asked what he learned about design:

… that when a designer wants to design something he or she will go, for example, to a school and ask what do you like and what do you not like and how would you like it to be and then he will take that and think about it and try to design that way.

Another student described her group's decision to make a stage in the school cafeteria that reflected the needs of her classmates:

We decided on the way we always heard people that they wanted a stage in our cafeteria, and they wanted it bigger. They wanted something to hang out in, to not be squished.

Perhaps the most comprehensive description of human needs and design came from a student who described his reaction to the design project:

I think it was really interesting because every design is meant for a human need, so for every need that a human has, a design is made for it; like a chair, the need is for us to sit down or we could sit down or sleep. There is a lot of reasons for a chair … I also thought that we got to figure out a human need by looking at our own school. We found a lot of stuff like the parking lot, the cafeteria, the playground, and the bathrooms. We figured out that we need more space and it needs to be cleaner because we are really cramped onto each other and it's very dirty.

Other students embraced the idea that design is empowering and that the role that change plays in the design process:

I really understood what you guys were talking about. You guys wanted to make a difference for our school because you told us to make a poster about what we needed to change.

If you don't like one way of how to make it, you could change that way and make different designs.

### Students appropriated design discourse in varied ways.

This became evident as they described their projects and what they learned. They used specific vocabulary and described the kinds of work that designers do:

They helped us make prototypes of how we wanted our cafeteria to be.

I think I learned that you have to take a lot of steps before you're starting any other design because normally you want to start it and just do anything the way you want to do it in the room. But you also have to sketch out the design and all of that.

Students created projects that expressed their understanding of design thinking principles.

An important element of design thinking is understanding human needs, and the students' projects reflected this understanding in different ways.

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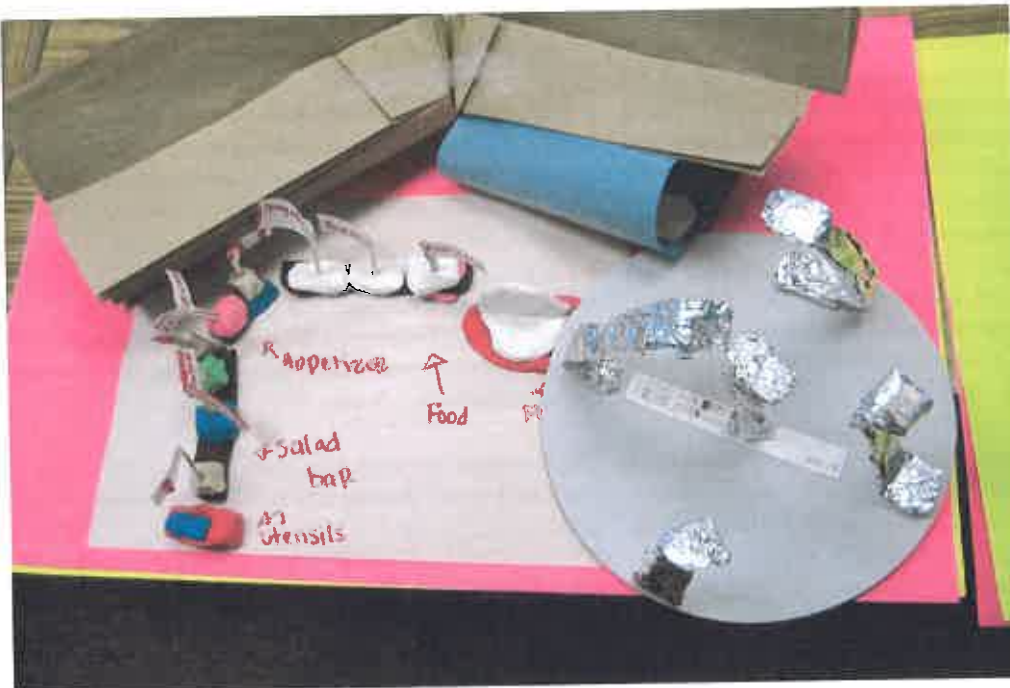
Two groups concerned themselves with safety and one considered how design might meet the needs of the young children in the school:

What we did was the parking lot. We wanted to make it safer for us to be for us to hang out in the parking lot. Well, we made it the same way how it is but we made an umbrella so people could sit down there. You could go talk to your friends. There's stairs so cars won't go on top, won't go past that. We didn't change anything else.

The project was about as a community, how we needed help in our school; how to improve it, and my team actually did it on the parking lot because it's small and it needs to be bigger because kids pass there and they could crash ... We made a video about it. We took pictures outside and then we had a video like they did with the cars, how we improved it, how they move, and how it all worked out.

Design thinking can be a tool that fosters metacognition.
The teacher described how design thinking is connected to metacognitive skills.

She focused on how this is an important area in her classroom:

One of the philosophies that I have with my students is it's not so much what you know; it's how you know how to learn. I don't care if you memorize everything in the textbook. But if you know how to refer back to that textbook to get the answer you need, you're a heck of a lot smarter than if you just memorize a bunch of facts. So getting them to think that way is huge. So any kinds of projects that come in and talk about, 'We're not just going to think about a problem, but we're going to think about how to think about a problem,' is huge. And I think that this group of students needs it, even on a greater level than most. To tie that in with this age group, working with middle school students, getting them conscious of their thought because they are so reactionary right now. They are so from the gut right now, which is really cool. And it's one of the things that I love about working with these kids. They're so raw and they're so genuine in terms of the way that they interact and deal with everything that's going on around them.'

Figure 2
Student team prototype

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Design as Connecting: Affect & Design

The second theme, Design as Connecting, highlights the role affective elements played in classroom design activities. The three most educationally significant aspects of this theme were risk-taking, expressing creative confidence in one's voice and collaboration among the students. These notions are critical parts of the social world of middle school students' lives and greatly influence cognitive thinking and academic goals. Middle school students are at a vulnerable age and often have a strong desire to conform. The notion that one can take risks in a supportive environment is fundamental to design thinking. When ideas are suggested, none are rejected. One of the goals for design in schools is to create a classroom climate where student voices are listened to so that they might they become more and more confident in their own ideas. In the design unit, students brainstormed multiple ideas as they worked in collaborative teams. When they created their prototypes, they were able to take risks because they worked with their friends and within a supportive learning context created by the classroom instructors.

Students showed positive affect while engaging in design thinking activities.

Affective elements were an important part of the design thinking project, which was characterised by a high level of social interactions. Students moved around the classroom, investigated their school site, moulded clay, sketched maps, shared ideas, bent pipe cleaners and, most importantly, they did this as they talked, argued and laughed with their friends. Their level of enjoyment appeared to be enhanced by the chance to work with each other. Social interactions were an integral part of the fun of participating in the design activities. The students gave a wide range of feedback on what they liked about the project:

I liked to use the equipment that we got to use … like the clay, the foil and the popsicle sticks.

It's cool, it's fun, and it takes a lot of time.

Students engaged in collaborative learning while participating in design thinking activities.

Collaboration is essential to design thinking and students had much to say that reflected the social nature of the design process:

I thought that the project was really fun. I enjoyed it. It was fun because I was working with my friends and we were chatting and messaging. It was really fun. I liked it.

The students showed an awareness that collaboration can also be a challenging process. When asked about what was difficult about brainstorming in a group setting, the students had varied responses:

Little communication.

One person tries to do it all.

Not participating.

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explain what they would do to fix it, I really saw a high level of engagement that we don't get all the time, even with some of the stuff that I have to do with them, trying to figure out creative and exciting ways to get them involved. And this was definitely one of those experiences.

Students preferred active learning activities to passive listening activities.

Part of teaching a new topic, such as design thinking, involves some initial whole-class instruction. This came in the form of a lecture given by graduate student instructors and/or small-group coaches. When asked, students expressed a clear preference for the times when they were actively engaged in doing, rather than sitting and listening:

It's kind of boring listening to everybody talk and stuff ... it would have been better if it was just mostly project instead of talking.

When they just kept talking, we just wanted to get to the work so that we could just have fun.

Design thinking projects facilitated engagement by providing an opportunity for students to express their voices and opinions.

The teacher felt that one of the greatest strengths of design thinking is that it gave students a change to express themselves. She felt that this was an important thing for her middle school students to be able to do:

And I really felt like they were able to connect with the experience because they are so much about giving their opinion ... And I did say they are a very opinionated group. They have a lot to share. That's this group of kids and this age group in general. And the fact that they were able to express what they thought were the major areas of need here on campus and then, given the opportunity to

Prototyping can be a powerful classroom tool to engage students quickly and does not focus on perfection.

One part of the design process that was used to engage students was prototyping. The instructors created an activity where students paired up and designed eyeglasses for their partners that were made from pipe cleaners and an assortment of decorative materials. They focused on helping students see that they had to work quickly and that they could always make changes. When students created their small-group design projects in subsequent sessions, they used prototyping. The students seemed to understand this idea, and realised that the focus was on rapid development and not trying to be perfect:

If you don't like one way of how to make it, you could change that way and make different designs.

The project was to take a part of our school and design it how we want it to be designed. And you have to do a prototype. And you have to draw it. And you can use clay ... you can use all this different stuff and build it how you want it.

Design as Intersecting: Design Thinking & Content Learning

The third theme, Design as Intersecting, highlights the relationship between design thinking and academic content learning. This was an important element of the project, as one goal was to integrate design thinking and classroom learning. The evidence suggested that this integration was not very successful. Students learned about design thinking principles and about geography, but most made few connections between the two. The evidence also highlighted the important role that the teacher plays in the integration process. Findings around this theme were a source of

Opposite page:

Figure 3
Students planning
a redesign of the
school cafeteria

This page:

Figure 4
Demonstrating
prototypes using
student-created
movies

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great learning for the research team. Initially, it was believed that design thinking would best be taught within the context of specific subject areas. Instead, what occurred was that the students did not have a strong foundation in design thinking or in geography (which was a supplemental content area that the teacher requested be used in the project) and, as a result, little content learning occurred. A question that emerged for the research team was whether or not design thinking skills should be taught as separate from content learning.

Creating a classroom design project that integrates academic standards, content learning and design thinking is a challenging process.

In a pre-project conference, the classroom teacher expressed a desire to use geography as the main academic area. How to integrate design thinking with academic content is an area of critical importance, and therefore, this was a key focus for the instructors.

The integration was complicated by the fact that the project team had little knowledge of classroom standards in geography and an abundance of experience in teaching the design thinking process. The classroom teacher had geography experience, but no experience with design. The project team questioned whether they had presented students with a 'split' notion of design goals and geography goals:

I think the goals are still sort of split by design versus geography. I think the goal was to give them – to empower them to see that they can effect change, but also to have them come up with some idea about geography, like something … I think it was to get a tighter curriculum, and to really try to nail or get at teaching geography and design at the same time, and I think there is a lot more richness in how we did that.

Students made tenuous connections between design thinking and academic learning.

Although the design thinking project focused on integrating design thinking and geography, students seemed unable to make clear connections between design and geography, and there

appeared to be confusion about connecting geography, mapping and design thinking as well. Their responses to what they learned about geography were diverse:

Geography? Nothing really.

Geography? That's the study of the earth, right?… mmm. I don't know.

Geography? I forgot.

I didn't really learn that much.

A few students seemed to have ideas about how geography and design thinking might connect:

Yeah. I learned some things because before you start designing something, you don't know where it is exactly and how much space you have. And in geography you needed to know where places are, how big they are and what do they have in them, and what is the most special thing about that place.

I learned where all the places are and also how to find stuff, how to find where I'm located or where something is located, like Nick's project he showed us.

It is essential to have teachers see the value of design thinking in their classrooms, and the connection between design and the academic goals of the classroom needed to be obvious to them.

The teacher talked about how she made choices to support what she felt were gaps in students' content knowledge, and the role that design thinking might play in filling these gaps, especially in school communities that have been traditionally underserved. She thought giving her students 'voice' in their content learning was especially important to helping them develop agency:

I think it's part of being in this community. You have to have a voice. You have to be able to fight. You have to have that fire or you're not going to get anything done.

Harnessing the voice and power of students was important to the teacher and she saw design work as a process for doing that in the classroom.

Implications for practice

Design thinking is a tool that is embedded within existing classroom cultures. The constraints, values and possibilities inherent in the culture shape the way the students and teachers use this tool for learning. An awareness of the classroom culture greatly impacts the effective implementation of design thinking activities and frames the implications for practice.

First, and foremost, the function of design thinking should be to enhance classroom instruction. This must be done by learning what the teachers' instructional goals are and using design thinking to support student learning. A supportive relationship between the teacher and the classroom instructor with clear communication of goals is essential. Teachers need to see the value of the design thinking process and how it can help them with their students.

Second, design thinking must be integrated into academic content. While it may stand alone, its power as a tool for learning comes in the ways it can support a diverse range of interdisciplinary academic content. Design curriculum requires strategic integration of education standards, design principles and content information. This means it is critical to focus on creating activities that teach the fundamental mindsets and processes of design thinking and are entwined with content learning. Classroom experiences need to provide spaces where students to have 'what if', 'what could be' and 'what might happen' experiences (Wong 2007). Teachers face a struggle to teach students all they need to learn, and if they are asked to integrate design thinking into their classrooms it needs to be done in a way that synergizes instruction that is already in place.

Third, design thinking has an impact on the ways that students engage in the learning process. It challenges them to think in new ways and take risks. Design tasks must focus on harnessing that engagement, and supporting students as they prototype, fail, and prototype again. Failure,

as it is traditionally defined in the classroom, must be reconceptualised.

Fourth, design thinking and collaboration are intricately linked. The collaborative process in the classroom is impacted by students' willingness to listen to other's ideas, to take risks and to share their ideas with others. Carroll (2004) describes how collaboration involves creating a classroom climate where others' knowledge is valued and is both modelled by the instructor and becomes an essential part of the classroom culture. Design thinking projects thrive in a climate where collaboration is an explicitly valued part of the classroom culture.

Fifth, design thinking provides a means for students to be cognizant of where they are in the process, and encourages metacognitive awareness. Design thinking activities should focus on how to best foster this awareness through both the design cycle and in assessment of academic content learning.

Sixth, design projects and design discourse practices can provide new ways of thinking that can be incorporated both into teachers' classroom instructional strategies and students' approaches to learning.

In sum, the implications for practice from this research study focus on the nature of fundamental beliefs about design thinking pedagogy, enhancing the connections between academic content learning and design thinking, and discovering the most effective ways to teach design thinking in classroom settings.

Limitations of study

This study featured a small teacher/coach/student ratio that does not reflect what exists in most schools. This impacted the instruction in design thinking skills by providing more small group instruction and support for the students. In addition, the content area of geography is a subject that is not always taught at middle schools and may have impacted the learning about integration of content and design thinking.

Implications for research

As design thinking comes to play a more important part of educational communities, further

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research is needed on its role in learning. The following research questions arose from this study:

- How can we develop classroom cultures that invite risk taking, openness collaboration and innovation?
- What are the most effective ways to integrate design thinking processes, educational standards and academic content information?
- How does design thinking function as a tool to foster metacognitive abilities?
- What are the best practices for integrating design thinking into classroom settings?
- How can we more effectively assess what students are learning about design thinking?
- How can we more effectively assess what students are learning about design thinking and about content area subject matter?

Conclusions

In this study design thinking became part of the classroom learning environment in diverse ways. Students explored different aspects of design as they created prototypes, sketches, and projects. They were energised, excited and challenged by their design tasks as they brainstormed with their peers. Instructors aimed to create design curriculum that was nested within classroom expectations. Much was learned. The most important learning, perhaps, was that design thinking fosters the ability to imagine without boundaries and constraints. This is critical, as the development of creative confidence is an essential part of learning. Design thinking may help students become empowered agents in their own learning who possess both the tools and the confidence to change the world. As we move into the increasingly complex world of the twenty-first century, this ability becomes essential. As one student in this study stated, 'If I set my mind to it I can do it.' Let's celebrate the benefits of design thinking as we move towards further integration of this innovative process in classroom learning environments.

Note

1. The six key components are those developed by the Hasso Plattner Institute for Design. Other design processes have similar key points that may be described slightly differently.

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