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Why Are Schools Reluctant to Bring Higher-order Thinking Games to Classrooms?

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Abstract: In this conceptual paper, we analyze why schools are reluctant to bring higher-order thinking games to the classrooms. We use a role-playing mobile game designed for scientific argumentation—*Mad City Mystery*—to illuminate the complexity of the issue. We argue that the complexity arises at the design level, at the enactment level, and at an education system level as schools evaluate bringing a higher-order thinking game to a classroom. We maintain that these factors, as synthesized in Table 1, can be utilized as an essential check list for researchers, teachers, school leaders and policy makers when they consider designing and introducing higher-order thinking games to the classrooms.

Keywords: game-based learning, scientific argumentation, school innovation, ICT integration, 21st century competency

1. Games for learning: Promise and reality

Game-based learning surfaces as a promising solution to educational reform, especially for developing 21st century competencies (Shaffer, Halverson, Squire, & Gee, 2005). Indeed, game scholars in the 20th century did not miss the connection between games and learning. MIT researcher Malone (1980) was one of the pioneers to theorize the motivation aspects of game play and learning. Using games, or the concept of games, as learning approaches, however, did not gain momentum until Prensky and Gee. Prensky (2001) maintains that games motivate learners to learn deeper with its player-centered design. Gee (2003, 2007), arguing from a sociocultural perspective, maintains that "good" games can help people learn because they incorporate learning theories and cultural models. With the promotion and theorization from heavyweight scholars, game-based learning has become a popular research theme in the past decade.

Researchers are not the only ones intrigued by the mysterious power of games. While researchers are designing and theorizing games for learning, school practitioners in many parts of the world have already used games for learning in classrooms. In a 2011 survey by the Joan Ganz Cooney Center (Barseghian, 2012), 18% of the 505 K-8 United States teachers (mostly K-5th grade) use games in their classroom on a daily bases while half of them use digital games with their students two or more days a week. Nearly 70% of the participant teachers said that "lower-performing students engage more with subject content with use of digital games."

In Asian countries such as Singapore, games emerge as an attractive approach for teaching and learning. In the Ministry of Education, a special task force is dedicated to game-based learning. Schools not only work with researchers to develop learning games (e.g., Jan, Chee, & Tan, 2010), but also utilize commercial off-the-shelf game engines and editors to design their own games for learning (e.g., "3DHive - Canberra Primary School," 2014)

Given the zeal in game-based learning across international boundaries and stakeholder communities, there are few reported cases in Asian schools that utilize games for historical thinking (e.g., Squire & Barab, 2004), place-based inquiry (e.g., Klopfer, 2008), scientific habit of mind (e.g., Steinkuehler & Duncan, 2008) or scientific argumentation (Squire & Jan, 2007)—all of them are higher-order thinking skills that can be viewed as 21st century competencies. While game scholars are urging schools to utilize games for deep learning (e.g., Gee, 2003), identity formation (e.g., Thomas & Brown, 2009), and even changes of discourse patterns in the classroom (e.g., Jan, 2010), schools are mostly using games for motivation, drilling and practices (Jan, 2013). Even when they use games for learning, it is rarely a sustainable practice (e.g., Chee, Tan, Tan, & Jan, 2012).

2.Why Are Schools Reluctant to Bring Higher-order Thinking Games to Classrooms?

Since games are a popular medium for learning and game-based learning is a proven approach for developing higher order thinking skills such as historic thinking and argumentation, why are schools reluctant to bring higher-order thinking games to classrooms?

This conceptual paper provides an analytic account for the above phenomenon. In particular, we tease out the major reasons that keep researcher-developed higher-order thinking games out of schools. To illustrate the case, we use *Mad City Mystery* (will be referred to as MCM hereafter), a scientific argumentation game designed by researchers (Squire & Jan, 2007), as an example to delineate pertinent issues that inhibit using games for higher order thinking skills in classrooms.

As a conceptual paper, this paper does not employ a standardized research paper structure commonly found in empirical studies. Instead, we describe the problem and build the argument with an authentic example—*MCM*. As the game designer and co-researcher of this game, I describe the game design and critical elements that enable the game a success in engaging students to practice scientific argumentation. After that, we re-situate the enablers in the classrooms in order to illuminate why schools may not utilize the game *as it is*. A similar writing approach is commonly adapted by education researchers such as the conceptual paper by diSessa and Cobb (2004) at the Journal of the Learning Sciences.

3. Case Selection Criteria

Why do we choose MCM to illuminate the issues pertaining to bringing higher-order thinking games to schools? Mad City Mystery (Squire & Jan, 2007), a role-playing mobile game designed to foster scientific argumentation skills by designing an authentic argumentation context, is an early proof of concept in game-based learning. It exemplifies how game-based learning may engage players in making scientific argumentation—a higher order thinking skill. The following reasons justify the case selection.

1) MCM is designed for a higher-order skill that is relatively common in the school syllabus. The curricular alignment makes it a plausible choice for schools to take up. The alignment with the science curriculum enables us to scrutinize reasons for not taking up the game.
2) A robust proof of concept is an important factor for schools to take up a learning game. MCM has clearly demonstrated the potential of game-based learning for a higher-order thinking skill.
3) The technology that enables MCM was novel when it was developed, but has become mature and readily available in the past few years.

The above criteria make MCM a plausible choice when schools consider using a learning game to foster scientific argumentation. In using MCM to make a case, we are able to exclude three major reasons that often prevent teachers from using a new technology in their classroom: curricular alignment, proof of concept, and technology integration (e.g., Cuban, 1986; Earle, 2002). In other words, the choice of the case enables us to highlight other factors that are equally critical, but often inconspicuous when it comes to bringing higher-order thinking games to classrooms.

4. *MCM*: A game-based learning model for scientific argumentation

MCM is a mobile game designed by researchers for scientific argumentation. With a location-sensitive technology developed by MIT (Klopfer, Squire, & Jenkins, 2004), Squire and Jan turned the physical space into an enormous game board. They employed game design principles such as role-playing, open-ended challenges, rich just-in-time contents delivery, to design a location-based game. Players role-play as teams of Environmental Specialist, Medical Doctor and Government Official. In uncovering the mysterious death of Ivan, they interview non-player characters (NPCs) to collect qualitative and quantitative data. The data is designed based on argumentation theory such as Toulmin's (1958) argumentation pattern. The ultimate goal is to design an authentic context in the game so that it is essential for players to coordinate theory and evidence (Kuhn, 2005) while they investigate the mystery. The coordination of theory and evidence, based on Kuhn, is the core skill of scientific argumentation.

4.1 Briefing Session

The entire learning activity is composed of three activities that can be completed in 2~3 hours: pre-game briefing, gameplay, and post-game debriefing. The pre-game debriefing familiarizes players with the game narrative, game interface and technology. Game play was initiated after the briefing when a team of three players (as a Medical Doctor, a Government Official and an Environmental Scientist) read about Ivan's death from their GPS-enabled mobile device.

4.2 Game Session

> *Ivan Ilyich is dead.*
> *Police claimed that he drowned while fishing by the south shore of Lake Mendota.*
> *Between January and the time of his death, Ivan put on 25 pounds and started drinking heavily. His health condition had deteriorated considerably.*
> *As one of his friends, your task is to investigate the case with two of your best friends. It is your duty to present a clear picture about the causes and effects of these to the public.*

The investigation of Ivan's mysterious death brought the team (composed of three players) into a complex system involving ecological, social, and cultural issues in Ivan's case. The success of the investigation relies on the players' ability to (1) critically filter the data they receive from the non-player characters (NPCs) in the game, (2) formulate hypotheses based on the collected data, and (3) revise/abandon hypotheses or construct new hypotheses when new data emerge. Through the entire game, players are immersed in (1) data collection at different physical locations and (2) the practices of coordinating theories and evidence. Figure 1 demonstrates how the non-player characters are designed to foster the argumentation among the players.

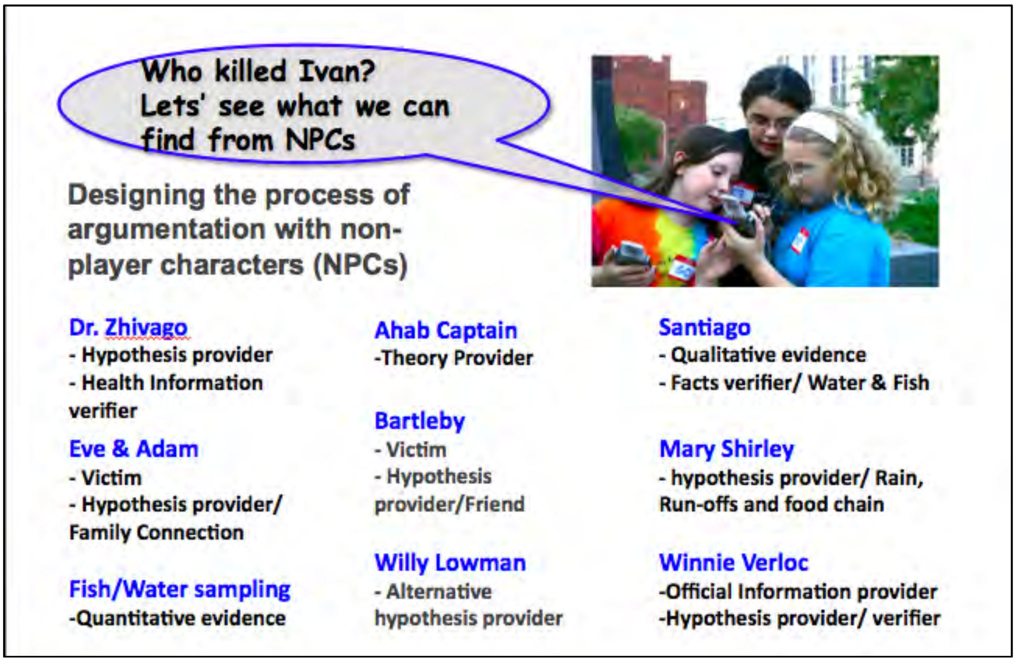

Figure 1: Designing non-player characters to foster the coordination of theory and evidence

Furthermore, the coordination of theories and evidence is a collaborative effort by design. Each player, depending on the role they play, only receives a subset of data. Unless they work with each other closely, each player can only develop a partial view of Ivan's case. In this process, team building is as critical as theory building if they want to solve the mystery.

During the game play, player teams often play at different paces due to various factors—collaboration skills, computer literacy, reading capabilities, observation of the physical space, to name just a few. Therefore, almost no teams finish the game at the same time.

At the end of the data collection, players need to ask more questions because the game never gives students sufficient data to come up with an absolute answer. The design goal is for them to develop multiple hypotheses and tell people which ones are more plausible. This is similar to multiple interpretations and debates about the extinction of dinosaurs in the science community.

4.3 Debriefing Session

In the debriefing session, players are first given thirty minutes to examine collected data and develop hypotheses as teams. After that, each team present their case to the Chief Investigator played by a researcher. What happened to Ivan Ilyich? How did he die and why should it be a concern to the public?

MCM was designed to with open-ended challenges—there are no "absolutely correct" answers that student players can identify in a content mastery paradigm. Players' performance is evaluated based on how well they are able to piece together relevant data and formulate evidence-based and plausible theories. The debriefing to the Chief Investigator is the assessment on the players. After the assessment, players are encouraged by the Chief Investigator to reconsider how they may come up with more robust theories or hypotheses about the above questions based on the collected data.

In a nutshell, *MCM* provides a *designed experience* (Squire, 2006) that is informed by theories about learning argumentation. The play experience is similar to the discourse practice commonly found in scientists' communities (c.f., Lemke, 1990; Gee, 2004)—debating the validity of data, making hypotheses, revising theories, and reporting findings.

4.4. Designing Argumentation Experience in Out-of-school and School Settings

MCM successfully create a *designed experience* where players develop argumentation skills via authentic discourse practices (e.g., Lemke, 1990) in an out-of-school setting. *What does it take to bring MCM to schools so that a similar designed experience can be achieved?* This is a question that we ask in the beginning of this paper. This is also a question that policy makers, school leaders, and teachers are most concerned about when they consider introducing learning games to the classrooms.

To unpack the question, we examine the *critical design elements* that enable the designed experience mediated by MCM in an out-of-school context. We then ask if the critical design elements can be replicated regularly in schools so that a similar designed experience can be achieved. Examining the efforts that it takes to bring MCM to the classroom enables us to pinpoint a set of *critical design constraints* that researchers, teachers, school leaders and policy makers should consider if the ultimate goal of designing a learning game and activities is to generate sustainable impacts to student learning in a school setting.

5. Critical Design Elements that enable *MCM* as a game for scientific argumentation

In the following, we enlist the **critical design elements** for MCM and re-situate them in a classroom setting. Doing so allow us to identify and examine the enablers for both contexts. Specifically, we will unpack these critical design elements from the (1) *game design stage* to the (2) *game enactment stage* in order to develop a systematic understanding.

5.1 Critical Design Elements in the Game Design Stage

In the *game design stage*, the critical design elements that enable the success of *MCM are*:

1) **Designing a learning experience that is informed by learning theories.** Integrating learning theories that inform how people develop argumentation in situ and game design principles are the most challenging design components in MCM. The designers of MCM not only design the game, but also the theory-informed play experience. To ensure a similar designed experience for scientific argumentation in the classroom, there is a need for teachers to be able to play a similar role that the researchers played—understanding the affordances of MCM and how to leverage its affordances for argumentation skills (Jan, 2009). Unfortunately, teachers are mostly trained as *content experts* rather than an *experience designers or facilitators*. Besides, the role change will have a deep effect on classroom management, discourse participation (e.g., O'Connor, & Michaels, 1996; Jan, 2009), teacher-student relationship (e.g., Frymier, & Houser, 2000) and other unexpected outcomes that teachers must be prepared for.
2) **The availability and affordability of technology.** The design of *MCM* was enabled by MIT's mobile augmented reality game engine/editor (Klopfer & Squire, 2008). The software technology and the digital device are critical enablers for a game like *MCM*. Though the technologies were not commonly seen in schools at the time *MCM* study was carried out, it has become mature and the infrastructure is in place for most schools in developed and some developing countries. In Singapore, many schools are currently using similar technology to develop learning trails for history, science and other subjects (e.g., So, Kim, & Looi, 2008). Even without the game engine/editor provided by MIT, there is a great chance that *MCM* can be reproduced using game engines available today. The real challenge, however, may not lie in the price tag. Whether the devices are easy to maintain and if the devices are used for multiple purposes are all practical issues that schools and policy makers must put into consideration.
3) **Flexibility in designing learning objectives and curricular structure.** *MCM* was designed for students to develop scientific argumentation skills—important 21st century literacy. As MCM was designed, the researchers were more concerned about the proof of concept. Designing a learning program not bounded by the formal school curriculum is a more feasible choice at a proof-of-concept stage. To bring *MCM* to the classroom, we must at least consider the following schooling-related constraints. The first and foremost is if developing scientific argumentation skill is a requirement in the curriculum. Even with scientific argumentation listed as an important learning objective, there is the issue of teaching approach and time allocated for developing argumentation skills. Fostering students' scientific argumentation skills require substantially more time than teaching what a scientific argumentation is using a direct instruction approach. In a content mastery learning paradigm, taking more time for the practices of scientific argumentation means less time for other content areas and therefore unexpected consequences if not planned well.
4) **Flexibility in choosing the learning sites.** To make *MCM* an authentic life experience game, the researchers utilize GPS-enabled technology to develop scientific argumentation skills. In *MCM*, the choice of game site is not a random choice because the problems players encounter in the game are also authentic problems commonly identified in the same physical space. Learning in the mainstream classrooms often assumes that learning in contexts (e.g., place experience) can be traded for convenience and efficiency (i.e., content mastery). To create a similar experience in schools, there is a need to "localize the game" based on the schools' location and the authentic problems to be solved near that location. This may post a tremendous challenge to schools if the goal is to recreate a similar authentic learning experience.
5) **Flexibility in designing alternative assessment.** In *MCM*, assessment is designed as students' team performance in the debriefing session. The goal is to identify the failure or mistakes that players make so that appropriate scaffolding can be provided. Players' performance is evaluated based on how they defend their hypotheses about Ivan's death. From there, the researchers could understand players' needs in

developing scientific argumentation skills. In other words, the assessment is designed to improve learning. In schools, assessments are often designed for multiple purposes. Unfortunately, many assessments, especially high-stake exams, are designed for *streaming* and *ranking*. Ranking students are so important that there is often a demand for new learning programs to have a quantifiable assessment before schools adapt them.

5.2 Game Enactment Stage

In the enactment stage, the critical design elements that enable the success of *MCM are*:

1) **Administrative and logistic support.** Before running the MCM game, there is a need to install software to all mobile devices, manage their updates, and make sure that they are all charged for game play. This is not a trivial task when there are 30~40 mobile devices to manage. When students play the game in an outdoor space, players' safety is always a concern especially for young kids who are concentrated on the mobile device. For a classroom with 40 students, there is a need to deploy 4~6 well-trained teachers to help manage game play during its enactment.
2) **Roles and social model.** MCM is a role-playing game with a unique social model designed into the practices of scientific argumentation. To play the game is to enact the embedded social model. It requires students and researchers to play roles that are quite different from their everyday identities. To enact the social model in a classroom, there is a need for the students to view themselves as professionals and inquirers. Shifting their identity from a student to a professional ensures the learning process to be more authentic. The identity shift can not be achieved without the researchers playing a counterpart. Creating a social model and fostering such an identity shift is perhaps more challenging in the classroom than in an outdoor space due to the established cultural model (e.g., Wegerif, Mercer, & Dawes, 1999) in the mainstream classrooms.
3) **Diverse learning pace.** To make MCM a successful learning experience, the research team allows the players to play at their own comfortable pace based on their needs and capabilities. Players interested in knowing more about water quality may spend more time observing water by the lake. Players who like to share may raise more questions when they collect new evidence. It is often not the case in a mainstream classroom, especially when developing cognitive abilities are placed on top of the learning hierarchy. Most classrooms have troubles accommodating students with diverse learning paces, not to mention diverse learning needs. This phenomenon has not changed much since Dewey (1956) comments on the compartmentation of subjects and grades in schools.

Table 1 summarizes the critical design elements for *MCM* and what it takes to enable them in schools.

Table 1 Aspects for considerations when we bring MCM from an out-of-school context to schools

	Critical Design Elements	**Challenges in bringing MCM to schools**
1.	Designing a game that is informed by learning theories.	Teachers are often trained as content experts and they mostly utilize direct instruction as a major pedagogical approach. To enact *MCM*, teachers need to understand how scientific argumentation skills are developed and play a mentor/facilitator role in guiding students. There is a need for professional development in the above areas.
2.	The availability and affordability of technology	Although the technology that enables *MCM* is mature and affordable today, there is a need to consider if the technology is useful for other purposes and is easy to maintain.

3.	Flexibility in designing learning objectives and curricular structure.	Developing higher order thinking skills requires guided participation through authentic practices. It takes significantly more time to develop. This creates a tension for a curriculum designed for *teaching* scientific argumentation instead of *practicing* argumentation.
4.	Flexibility in choosing the learning sites.	*MCM* is designed based on problems authentic to the place where it is played. There is a need to localize the game at a different site in order to recreate similar authentic learning experience.
5.	Flexibility in designing alternative assessment.	In *MCM*, the assessment is designed to help the researcher address issues of learning. In schools, assessments are often designed with ranking as the top priority. To design an assessment for learning and ranking at the same time is complex, and is often not achievable.
6.	Administrative and logistic support.	Using digital technologies to support learning demands tremendous amount of administrative and logistic support. Given that resources are always limited, there is a risk of enabling *MCM* in schools at the price of other learning activities.
7.	Roles and social model.	The researchers design a new social model to foster scientific argumentation. It can be a daunting challenge to promote this new social model in a classroom when there is already an established social model.
8.	Diverse learning pace.	Schools demand students to learn with similar speed/pace, and the mainstream curriculum is designed with this assumption. Therefore, catering the needs of learners with diverse learning styles will be a critical concern for the game to be used in schools.

6. Why are schools reluctant to bring higher-order thinking games to the classrooms?

Based on the above analysis, we can further delineate the issues of brining a game like *MCM* to the classroom in three areas—*curricular*, *teaching* and *managerial*. Curricular issues refer to structural issues such as what to teach and how much time is allocated for teaching a topic. It is within the same category that the purposes of assessment are defined. Teaching issues refer to what teachers learn when they learn to teach and how they actually teach in the classrooms. Managerial issues refer to how resources are allocated to keep the system effective, such as teacher/student ratio, and the support given to teachers for teaching a subject. We find that in enabling *MCM* as a sustainable practice, all of the above practices face significant challenges. In a nutshell, there is misalignment lying at the system level if we wish to promote higher order thinking skills with games like *MCM*.

6.1 How should the analysis be interpreted?

In presenting these design challenges or design constraints, we do not maintain that higher order thinking games can be introduced in the classrooms because it requires substantial changes at a curricular, teaching and managerial level to sustain the MCM learning practices. We do not argue that we should keep the current education system intact because the price to pay is too great to be practical. *We ask readers not to view the condition as a dualistic choice.* Rather, the case presents a comprehensive view of the issues and complexities in introducing a higher order thinking game to the classroom. The complexity arises at the design level, at the enactment level and at a system level because the issue is not as simple as bringing a higher-order thinking game to a classroom. If fostering higher-order thinking skills is essential for a flat new world (Friedman, 2006; Shaffer & Gee, 2005), then there is a need to reconsider the major design assumptions underlying the current education system and why it is resilient to changes (Sarason, 1996).

6.2 How may the analysis inform practitioners and researchers when they bring/design higher order thinking games for sustainable changes?

We argue that the analysis above can also be viewed as an essential checklist for, teachers, school leaders, and policy makers when they consider bringing higher-order thinking games or other learning technologies to the classrooms. For researchers, this list will inform them to better define the *design constraints* if the ultimate goal is to bring their learning design to the classroom on a regular basis. For instance, the researchers may design card games informed by the *MCM* design principles as a way to minimize the pushbacks from the established learning system. It is useful for teachers to interrogate the changes they might have to make and the professional development they must go over before they take on this journey. School leaders and policy makers have more authority to redefine the constraints at different levels. Without fundamentally changing the education system, they could create alternative spaces within the system to slowly, but firmly and steadily, roll in new learning initiatives.

7. Contribution

This paper explicates the challenges and constraints of bringing higher order thinking games to schools from a design perspective. We scrutinize eight design constraints arising due to the change of design contexts—from an out-of-school setting to the mainstream schools—and the change of design objectives—from a proof of concept to everyday practices. By doing so, our contribution to the research community and stakeholders can be summarized as:

1) Presenting a holistic and comprehensive picture about the design constraints that game-based learning researchers must identify before they embark on designing learning games. There are researches that zoom into certain design constraints from different perspectives such as technology integration (e.g., Chai, Koh, & Tsai, 2010). Viewing from a design perspective enables the researchers and practitioners to consider the design constraints simultaneously from multiple levels—cognitive processes, tools, social models and systems. We argue that viewing these design constraints as a holistic and interwoven mechanism is a major contribution of this paper.
2) We explicate how “context” plays a critical role in designing games for learning. Our analysis highlights the design of a small “g” game and big “G” game at the same time. Drawing from Gee (2008), good game designers not only design the small “g” game—the software—but also the big G game—the social interaction taking place when the small “g” game is played. To play *MCM* in an out-of-school setting and schools, the same “g” game is identical while the big “G” game is different. This paper spells out some major factors that define the big “G game in the mainstream schools.

8. Limitation

In crafting this conceptual paper with a case—*MCM*, we do not argue that all higher order thinking games will face identical design constraints when they are used in schools. Undeniably, a card game designed based on the same design principles may encounter different constraints. Nonetheless, there are system level constraints—such as teachers’ capacity—that are shared regardless the choice of media. We hope that there will be more studies about design constraints at different school systems. The better we are able to clarify the design constraints, the better we can pinpoint key design features at the early development stage.

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