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Playful Assessment: A Game-Based Approach to Assessing Teachers' Competency for the Wise Integration of Technology in the Classroom

Beomkyu Choi
beomkyu.choi@uconn.edu

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Beomkyu Choi, Ph.D.

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The goal of this dissertation was to document and analyze ways in which a game can be a valid and useful assessment of teachers' competency for the wise integration of technology in the classroom. Using concepts from ecological psychology and situated cognition, this study analyzed card and board games as measures of the situative and interactive aspect of teachers' pedagogical design thinking in relation to technology integration. To achieve this goal, this dissertation project was comprised of three studies, featuring a theoretical framework whitepaper, a design experiment report, and an omnibus research study.

Chapter 1 describes teachers' on-the-fly pedagogical reasoning in relation to technology integration and proposes an expanded framework for teacher competency with technology called TPACK-L framework. Chapter 2 proposes an alternative game-based assessment framework called Playful Assessment. Drawing from the proposed framework, Chapter 2 presents a game-based assessment practice as an alternative and useful way to assess the situative and interactive aspect of teachers' cognition and action in relation to technology integration. Lastly, Chapter 3 utilizes a newly developed board game, *EXPERTISE*, as an assessment environment and examines to what extent the designed game can serve as a valid and useful assessment tool for assessing teachers' competencies with technology integration into their classrooms. Particularly, Chapter 3 provides empirical evidence showing that gameplay outcomes can be used to estimate teachers' competencies with technology integration in an ecologically valid way.

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for the Wise Integration of Technology in the Classroom

Beomkyu Choi

B.A., Chuncheon National University of Education, Republic of Korea, 2004

M.A., Korea National University of Education, Republic of Korea, 2011

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Playful Assessment: A Game-Based Approach to Assessing Teachers' Competency

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Presented by

Beomkyu Choi, B.A., M.A.

Major Advisor____

Michael F. Young

Associate Advisor____

Suzanne M. Wilson

Associate Advisor____

Ronald A. Beghetto

University of Connecticut

2017

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PROLOGUE

A game-based approach to playful learning and teaching has long been studied using various perspectives and methods, including behavioral, cognitivist, socio-cultural, and even situated perspectives. Many researchers found interesting results using games as instructional tools. However, Young et al. (2012)'s meta-review on gaming for education reported that their impact on student achievement is still variable, and a deep understanding of game-based learning is still missing. Drawing on the playful context of Mario Brothers games, they suggested that game-based research should look in another castle, move away from a traditional cognitivist and individual psychology toward a more situated and social approach, on the grounds that games are often multiplayer and cooperative in a rich social context. This in turn guided me to shape the general theme for this dissertation study, seeking to find a way to utilize a game as an assessment environment drawing from the perspective of situated cognition and sociocultural theory.

In particular, this dissertation study looked for ways and possibilities to use game outcomes as valid estimates of one's capability in a particular context given that, like tests, games always provide explicit outcomes and scores (i.e., estimates) to be able to feasibly predict and assess a player's performance while adding a rich social game context. This line of thinking guided me to start this scholarly journey, a game-based approach to assessment, that aimed at finding an answer to the question of how game results can be used as a useful and meaningful estimate of one's academic performance.

In order to investigate how game results can be used as useful and meaningful estimates of achievement, this dissertation study was particularly concerned with the issues of validity. The general theme of this dissertation study—i.e., finding another castle to move away from a traditional approach toward a more situated and social approach—also guided me to expand the

focus of validity beyond a context-free approach—individual as the unit of analysis (psychometrically meaningful)— toward a context-laden approach—social interaction within context as the unit of analysis (ecologically meaningful). That is, this dissertation study attempted to provide evidence showing that game results could be used to estimate one's capability in an ecologically valid manner.

Meanwhile, this dissertation study focuses on teachers' competencies for the wise integration of technology in the classroom. Teachers' wise technology integration is widely considered as "design thinking" that represents pedagogical reasoning used to critically examine the affordances of instructional technologies and strategically utilize them as suited to particular subject matter ideas in a specific classroom context. Mishra and Koehler (2006) introduced the Technology, Pedagogy, and Content Knowledge (TPACK) framework to better define the dynamic and transactional aspects of teachers' technology integration cognition. Yet, I suggest that their existing TPACK framework was still missing a very important aspect of wise technology integration in the classroom, namely a sound understanding of foundational theories of individual and social learning. This dissertation study thus addressed the importance of understanding theories of learning in technology integration practice and introduced an expanded framework for the wise integration of technology in the classroom called Technology, Pedagogy, Content Knowledge, and Learning Theory (TPACK-L).

Lastly, this dissertation study describes "design research" that aims to test and refine the design of playful assessment context (i.e., game-based assessment environment) that can help externalize and assess teachers' pedagogical design thinking in relation to technology integration in the classroom. This dissertation describes three attempts at creating a playful assessment

context that can test what we want to teach in UConn's Two Summers Program (i.e., the wise integration of technology in the classroom instruction).

A Narrative Sketch: Connecting the Three Attempts

My scholarly journey started in 2013 when I joined a research team at UConn's Two Summers Master's Program. We needed a creative way to playfully assess Master's students' level of achievement with the ISTE[1] technology coach standards, and their ability to apply the TPACK framework approach to selecting classroom technology wisely. Our first attempt (i.e., Chapter 1) was to develop and implement CARD-*tamen*™ TPACK-L card game, that was able to externalize players' pedagogical reasoning in a game context. In this first implementation, we were able to detect some evidence of how they went through their pedagogical reasoning in relation to technology integration within the game context. Yet, CARD-*tamen*™ TPACK-L was limited in that the context provided by the cards lacked much of the richness of an authentic school/district setting, where needs of various stakeholders, organizational challenges, and even conflicting goals among the stakeholders influenced teachers' and technology coordinators' decision making with regard to technology integration. We also found that players tended to build off of one others' ideas to generate their own technology integration strategy, meaning the gameplay really appeared to be authentic social activities. We really missed a social aspect of gameplay and assessment. These two emergent findings guided our second attempt that revised the context and developed a collaborative board game, *INFLUENCE*.

The second attempt (i.e., Chapter 2) was to develop and implement *INFLUENCE* board game, that was able to show how the work of technology coordinators must involve setting priorities and matching effort to the changing goals of various fractions in the district. In this

[1] International Society for Technology in Education

implementation, we found that the system thinking involved in setting priorities could be shown through gameplay, as well as that collaborative gameplay could capture the situative and interactive cognition. However, we concluded that playing *INFLUENCE* had little at all to do with thinking with the TPACK-L Framework; instead, it was more a game of setting broad priorities. Since our *INFLUENCE* game lacked the content that we needed with regard to applying the TPACK-L reasoning strategy, we needed to revise the context once again. In addition, *INFLUENCE* gameplay failed to clearly detect which game actions could be used to estimate each game player's interactive and situative cognition. These findings guided us to our third attempt that revised the context and developed another collaborative board game, *EXPERTISE.*

The third attempt (i.e., Chapter 3) was to design and implement *EXPERTISE* board game, that was able to externalize TPACK-L reasoning in a playful way, as well as provide game results that could be used to estimate individual players' pedagogical design thinking in relation to technology integration (i.e., TPACK-L). In this implementation, we found that the game design worked well to be able to playfully assess players' ability to apply the TPACK-L framework approach to designing their instruction with classroom technologies. However, *when* and *why* this design works has yet to be clearly shown.

References

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017.

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., ... & Yukhymenko, M. (2012). Our princess is in another castle a review of trends in serious gaming for education. *Review of educational research*, *82*(1), 61-89.

INTRODUCTION

The overarching purpose of this study was to document and analyze ways in which a game can be a valid and useful assessment of teachers' competency for the wise integration of technology in the classroom. Using concepts from ecological psychology and situated cognition, I analyzed card games as measures of the situative and interactive nature of teacher competency with technology—unlike many design and development studies from the objectivist tradition, this study did not simply examine the effectiveness of the intervention (i.e., product-selling approach).

This study presented a series of related journal-ready manuscripts (i.e., multi-manuscript dissertation format), featuring a theoretical framework whitepaper, design experiment report, and omnibus research study. It centered around 1) illustrating TPACK-L as a framework for teacher competency for wise technology integration in the classroom; 2) providing the framework and principles of assessment from the situated cognition perspective; and, 3) presenting an ecologically valid game-based assessment practice.

Logical Flow of the Study

This study centrally focused on assessing teachers' on-the-fly pedagogical reasoning and/or competencies for the wise integration of technology in the classroom. Specifically, an omnibus study was conducted to analyze and document how a card game could be used as an assessment tool for the situative and interactive nature of teachers' professional competencies with technology integration into the classroom. To answer this overarching research question, I first describe teachers' on-the-fly pedagogical reasoning in relation to technology integration and propose an expanded framework for teacher competency in technology integration. Second, I

propose an alternative measurement approach/practice to assessing situative and interactive teachers' cognition and action. To this end, this study describes a new assessment model using a situated cognition perspective. Drawing from the proposed framework, this study presented a game-based assessment practice as an alternative and useful way to assess situative teacher cognition and action. Lastly, this study used a new card game as an assessment tool and examined to what extent this game can serve as a valid and useful assessment tool for assessing teachers' competencies with technology integration into the classroom. Particularly, this study provided empirical evidence showing that a game could be used as an ecologically valid assessment tool for teachers' situative and interactive cognition and action.

The logic model and scope of the study is depicted as follows (Figure 1).

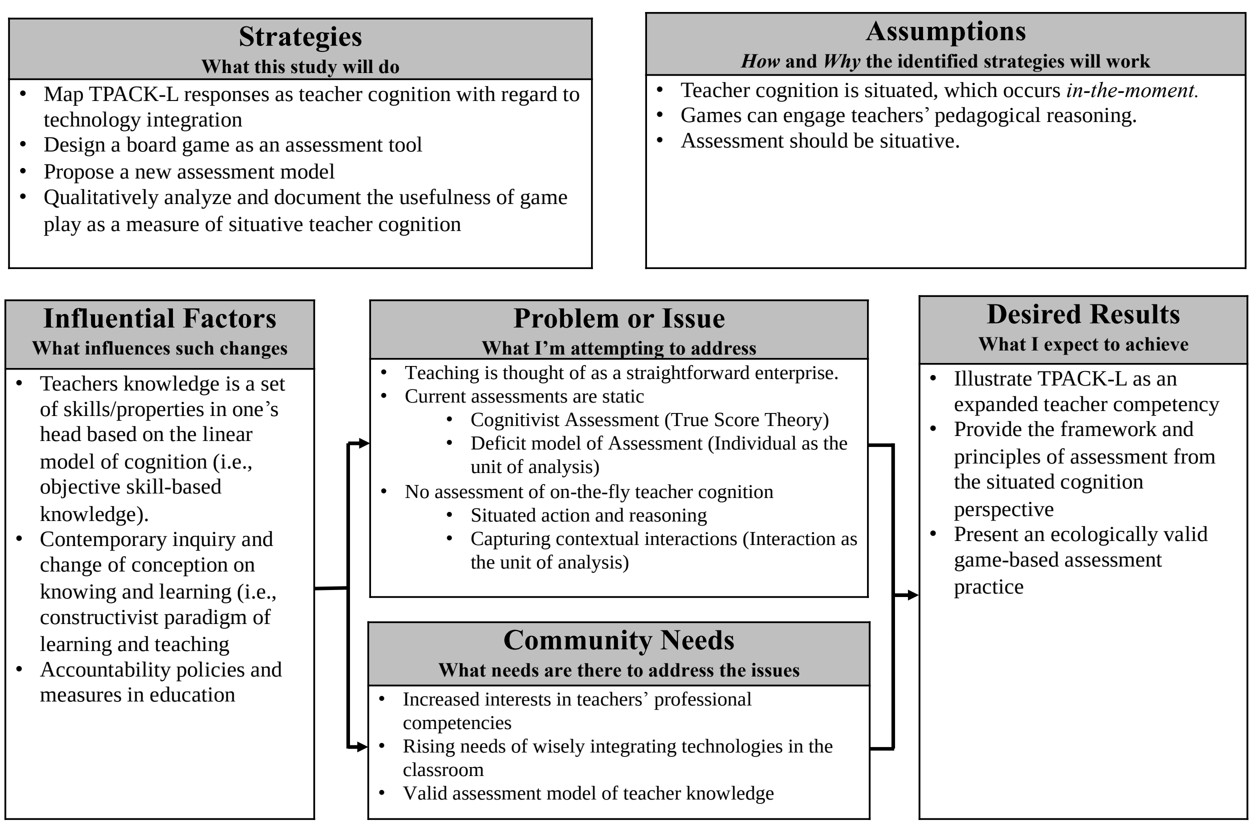


Figure 1. Study Logic and Scope

Significance of Study

This dissertation presents practical cases of how a card game could be used as an assessment tool to measure teachers' competencies for technology integration, and provides some empirical evidence as to the extent to which such games might become valid assessment tools for the teachers' in-context competency with technology. In so doing, this work was intended to provide much-needed guidance for the theory, research, and practice of game-based assessment from the situated cognition perspective.

This dissertation was also intended to contribute to the development of assessment theory and practice, moving from the deficit model of assessment (i.e., the individualistic and finding-a-right-answer tradition) to a developmental model of assessment (i.e., situative nature and competency-growth-oriented tradition). Adding to this, by addressing issues of teacher knowledge with technology, this study has the potential to contribute to teacher education communities in terms of teachers' competencies for wise technology integration. Finally, the practical cases I present provide a detailed description of an iterative game design process, in particular documenting how emerging theories from interactive game design and play testing can be incorporated into such iterative design processes. This provides the instructional design community with a concrete case and guidance for the design and development of a game–based assessment.

CHAPTER I

TPACK-L: EXPANDING THE FRAMEWORK FOR TEACHER COMPETENCY WITH TECHNOLOGY INTEGRATION

Introduction

With increased access to various learning technologies as well as the current press for increased STEM education, computational thinking in education, 21^{st} century skills, digital classrooms, and one-to-one computing initiatives, teachers increasingly feel a need to integrate technology into their instruction. In response, many teacher preparation programs and professional development activities for technology integration have given particular attention to helping teachers expand their teaching competencies for using technology effectively. Mishra and Koehler (2006) introduced a widely adopted theoretical framework for teacher knowledge in relation to technology integration—Technological Pedagogical Content Knowledge (TPACK)—describing how teachers need to develop integrated competencies in each key knowledge domains (i.e., Technology, Pedagogy, and Content Knowledge). Yet, despite the widespread awareness that teachers' competencies with technology are a holistic body of knowledge, the current state of teacher technology instruction has still mainly taken a tool-centric approach or technocentric approach (Papert, 1990). That is, the focus has been on how to make use of educational technologies such as iPads, Chromebooks, Google classroom/apps, Web 2.0 applications, etc. rather than strategy-centric approach focused on design thinking or deep understanding that emphasizes making sound instructional decisions based on an understanding of the intersection of content, pedagogy, and the associated learning technologies (see Harris, Mishra, & Koehler, 2009; Koehler, Shin, & Mishra, 2012; Mishra, Hershey, & Cavanaugh, 2007).

Such a tool-centric approach to technology integration instruction often relies on the preconception that technology integration is merely a skill-based knowledge and practice that goes hand in hand with the prevailing notion that teaching is a straightforward performance of

effective instruction. However, researchers have long claimed that teaching is complex intellectual work and/or an in-the-moment decision-making process in context (Darling-Hammond & Bransford, 2007; Koehler & Mishra, 2009; Shulman, 1987; Wilson & Berne, 1999). It is thus claimed that, “an approach to successful technology integration is needed that treats teaching as an interaction between what teachers know and how they apply what they know in the unique circumstances or contexts within their classrooms” (Koehler & Mishra, 2009, p. 61).

Researchers have pointed out that teaching practice should be guided by explicit theories about how students learn, what they should learn, and how teachers can enhance student learning for the sake of better instruction (Bransford, Derry, Berliner, & Hammerness, 2005; Wilson & Peterson, 2006). It is also argued that without a strong understanding of theories of learning, teaching practice involving technology is more likely to subvert, rather than support curriculum and innovation that has been designed (Web & Cox, 2004) and to create a mismatch with a teacher’s plan or beliefs related to wise technology integration (Chen, 2008). In regard to the importance of understanding theories of learning for technology integration practice, an analysis of implementation problems associated with technology-integrated interventions across many years concludes that teachers’ deficits in understanding of learning theories has often led to fatal mutations to innovative technology designs, resulting in assimilation of such innovations into traditional teaching practice (e.g., Slota, Young, & Travis, 2013).

The wise integration of technology may require more than sound knowledge of content, pedagogy, and technology. It may also require a working understanding of learning theory for classroom teachers to implement an effective and innovative instruction with technology within the complex dynamics of classrooms. The question then is how does learning theory fit into the framework of teacher knowledge in relation to technology integration and by extension, how we

can support teachers to develop a working understanding of several contemporary learning theories, and how best to evaluate whether or not teachers are armed with such holistic pedagogical design thinking.

Accordingly, this study aimed to propose an expanded framework for teacher knowledge of technology integration called TPACK-L by broadening Mishra and Koehler's vision (systematic design thinking around technology integration practice), and to delineate what this pedagogical design thinking looks like. In addition, this study aimed to address the issue concerning how to measure such in-the-moment pedagogical reasoning. Specifically, this study introduced a card game, *CARD-tamen*™ TPACK-L, as a measure of teacher's TPACK-L competencies, describing the potential of games as assessment environments. Lastly, this study examined the differences in the quality of TPACK-L reasoning among three levels of expertise (i.e., 1st-year master's students, 2nd-year master's students, and faculty members) using the game, in an attempt to catalogue various TPACK-L reasoning strategies. Doing so may help to show the expertise-nature of teacher competencies with technology, as well as unveil the potential of games as assessment contexts. Hence, this study addressed the following two research questions:

1. What does teachers' pedagogical reasoning in relation to technology integration look like in *CARD-tamen*™ TPACK-L card gameplay?
2. How does the game capture different levels of expertise in light of TPACK-L reasoning?

Teachers' Pedagogical Cognition related to Technology Integration

Mishra and Koehler (2006) introduced the Technological, Pedagogical, and Content Knowledge (TPACK) framework to better define and catalogue the complex dimensions of technology integration associated with innovative instruction and domain expertise. At its heart, technology integration is not simply a matter of what to use, but how to use it in each unique circumstance or context within the curriculum (Koehler & Mishra, 2009; Mishra & Koehler, 2005). That is, technology integration cognition should be thought of as "design thinking," a form of pedagogical reasoning (i.e., decision-making) that involves critically examining the affordances of learning technologies and strategically using them as suited to particular subject matter ideas in a specific classroom context. In this respect, Koehler, Mishra, and Yahya (2007) elaborated TPACK as a situated form of knowledge:

> At the heart of TPCK is the dynamic, transactional relationship between content, pedagogy, and technology. Good teaching with technology requires understanding the mutually reinforcing relationships between all three elements taken together to develop appropriate, context-specific, strategies and representations (Koehler et al., 2007, p. 741).

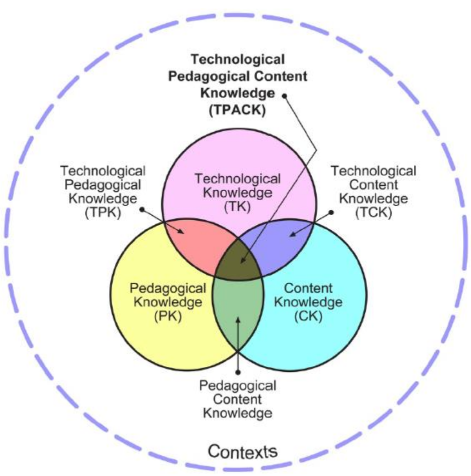


Figure 1. Transactional Relationship between Technology, Pedagogy, and Content Knowledge

Since the TPACK framework was introduced, several researchers have attempted to expand Mishra and Koehler's vision by adding other important components in service of applying the TPACK vision in various ways (see Table 1).

Table 1.

Frameworks for Technology Integration Cognition

Expanded Framework	A brief description of the framework
ICT-TPCK (Angeli & Valanides, 2009)	• Teacher competence to design technology-enhanced learning exclusively related to information and communication technologies • Knowledge of learner and context included
TPACK-deep (Yurdakul et al., 2012)	• Focus on the way to evaluate preservice teachers' TPACK • Delineate TPACK around four factors extracted, including design, exertion, ethics, and proficiency as competencies
TPACK-XL (Saad, Barbar, & Abourjelli, 2012)	• Integrate Context and Learner into the TPACK model • Elaboration of ICT-TPCK tailored toward pre-service teachers and teacher education programs designers
TPACK-practical (Yeh et al., 2013)	• Consider both the related knowledge and teachers' experiences as an indicator of teacher proficiency of TPACK • TPACK model that is knowledge and experience based, considering learners, subject content, curriculum deign, practical teaching, and assessments
TPACK-in-Action (Koh, Chai, & Tay, 2014)	• Focus on contextual variables teachers need to manage as they enact their TPACK during the design of ICT lessons • Include four contextual factors, such as Physical/Technological, Cultural/Institutional, Interpersonal, and Intrapersonal, that influence teachers' design of ICT lessons
TPACK-in-Practice (Jaipal-Jamani & Figg, 2015)	• Derived from and situated in the practice of teaching • Identify the characteristics and actions demonstrating TPACK knowledge that teachers use in practice associated with the knowledge intersection

Together, what these extensions of TPACK have attempted to do is to specify TPACK in various contexts, moving from TPACK as a broad conceptual lens to TPACK as applied practical knowledge. Also, many of these efforts have focused on how technology integration is

supposed to be learned and used. Interestingly enough, all of these expanded frameworks are consistent in viewing technology integration cognition as a process—not a static knowledge representation—necessary to soundly reason in varying classroom contexts (i.e., a situated form of cognition and action).

The Importance of Learning Theory in Technology Integration Cognition and Action

When defining teacher knowledge of pedagogy, it is often considered that theories of learning are part of teachers' tacit knowledge. Shulman (1987) took theories of learning into consideration as one of the sources for the teaching knowledge base; yet, in his Pedagogical Content Knowledge (PCK) framework, Shulman did not explicitly include theories of learning (e.g., how teachers can design their instruction based on sound understanding of implicit theories of learning) other than as one of the sources for the knowledge base. It appears that in the PCK framework, pedagogical knowledge is emphasized in such a manner that involves "broad principles and strategies of classroom management and organization that appear to transcend subject matter" (Shulman, 1987, p. 8). As such, it seems that to a degree, teacher knowledge is widely understood as teachers' repertoires of teaching knowledge concerning how best to teach the subject matter. Since TPACK, as one of the widespread conceptual lenses for technology integration cognition and action, has expanded Shulman's original PCK framework by adding technological knowledge, the technology integration practice underrepresents the importance of learning theory as vital teacher practical knowledge. Instead, it highlights the interactive and transformative nature of knowledge relating pedagogy, subject matter and technology in the sense of wise technology integration practice.

Meanwhile, a great deal of research has shown that there is often a mismatch between teachers' pedagogical beliefs and their technology integration practices (Chen, 2008; Ertmer,

2005; Heitink, Voogt, Verplanken, Braak, & Fisser, 2016; Kim, Kim, Spector, & DeMeester, 2013; Liu, 2011). For example, teachers often report that their use of technology is in line with the constructivist perspective, but observations of practice reveal instruction guided by the behaviorist approach to uses of technology. Chen (2008) asserted several reasons for this, including the fact that teachers do not fully understand the role of theories of learning in their instruction.

Researchers have also discussed the role of theories of learning in technology integration practice (e.g., Ertmer, 2005; Papert, 1980; Webb & Cox, 2004). Webb and Cox (2004), in particular, claimed that teachers need to understand the relationship between the affordances of instructional technologies and their professional knowledge (e.g., subject matter, knowledge of learners, etc.), as underlying theories influencing their instructional with technology. Ertmer (2005) also indicated that teachers who have a strong understanding of theories of learning are more likely to wisely integrate technology in the classroom. As such, there is a reason to believe that a sound understanding of learning theories plays a critical role in the wise integration of technology in the classroom. And yet, little research has been devoted to examining the role of theories of learning in teachers' technology integration practice.

Arguably, there is a huge difference between using technology guided by a sound understanding of theory of learning and not. Consider the history of technology-related classroom innovations. Many large-scale attempts to introduce new technology-based approaches to instruction (e.g., Logo, The Adventures of Jasper Woodbury, Quest Atlantis, etc.) have entailed researchers using contemporary learning science research and theory to design innovative, technology-based curricula that show substantial benefits to important instructional variables (Slota, Young, & Travis, 2013). Crucially, however, positive results arise only when

the project investigators have close and direct involvement with teacher education and implementation. Also, once researchers are no longer directly involved, the innovation is either watered down or disappears. One possible explanation might be that simply knowing about a technology and having the pedagogical skills to implement it are not enough when faced with the dynamics of schooling. Without understanding a learning theory that spawned a particular innovation, teachers' on-the-fly decisions during implementation can cause fatal mutations to the intended design and result in assimilation of the innovation into a more traditional approach to teaching.

TPACK-L: Technological Pedagogical Content Knowledge and Learning Theory

TPACK-L is a UConn expansion on an existing framework for teachers' competency with technology that responds to perceived challenges of the technology integration practice, specifically the lack of explicit attention to learning theory (see e.g., Choi, Slota, Lai, & Young, 2015; Slota, 2014). As discussed, the TPACK framework on which it is based proposed that the ability to integrate technology in the classroom involves a unique body of knowledge. Because learning theory was not an explicit part of the original teacher competency framework, TPACK-L argues that effective instruction involves four components: technology, pedagogy, content and learning theory. Choi, Slota, Lai, and Young (2015) propose the incorporation of learning theory as an independent structure within the framework (Figure 2). This adds intersections between the original model's Technology, Pedagogy and Content Knowledge with a learning theory component that underlies design and innovation associated with technology.

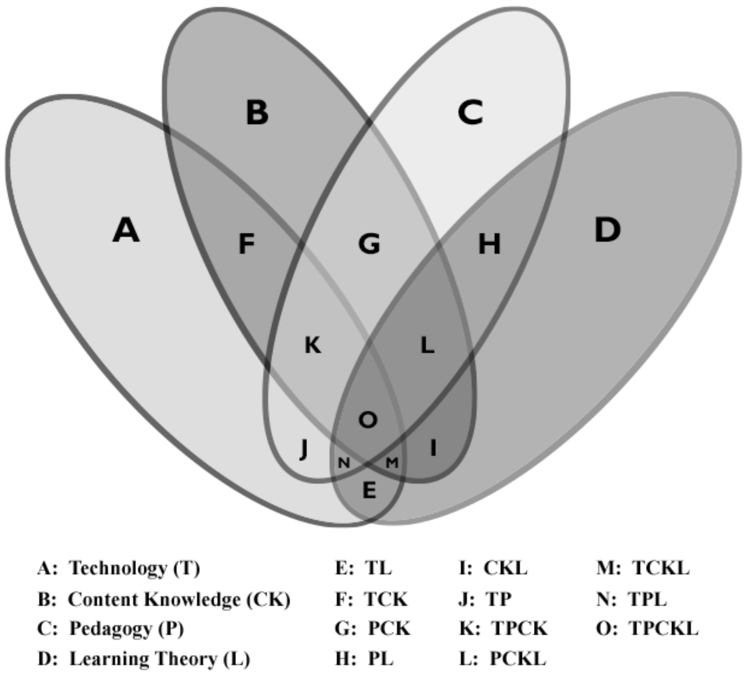


Figure 2. Transactional Relationship between Technology, Pedagogy, Content Knowledge, and Learning Theory (NOTE: size of overlap does not correspond with relative importance).

Examples of the TPACK-L-specific interaction loci include:

> **L:** Demonstrating an understanding of the tenets, goals, strengths, and weaknesses of contemporary theories of human thinking and learning (e.g., behaviorism, cognitivism, constructivism, constructionism, social learning theory, situated cognition, etc.)
>
> **TL:** Identifying tool affordances that exemplify the tenets of a particular learning theory (e.g., virtual reality simulations and situated cognition theory)
>
> **PL:** Classifying instructional techniques that are supported by a particular learning theory (e.g., anchored instruction and situated cognition theory)

CKL: Cataloguing overlap between a specific content area and the particular learning theories that best fit traditional content area goals (e.g., history and information processing theory)

PCKL: Using specific instructional techniques that fulfill the specific goals of a learning theory within a particular content area (e.g., using exploratory experiments in a chemistry course)

TCKL: Pinpointing tool affordances that target the needs of a particular content area through the lens of a particular learning theory (e.g., database search engines for use within a history course curriculum driven by information processing theory)

TPL: Isolating tool affordances that exemplify the tenets of a particular learning theory and can be matched with an efficient and/or effective related instructional practice (e.g., a massively multiplayer online roleplaying game in which learners work together to solve complex logic problems justified using the underlying tenets of situated cognition theory)

TPCKL: Isolating tool affordances that instantiate a particular learning theory and can be matched with sound instructional practice(s) within a particular content area (e.g., student-constructed video presentations created using audio-visual equipment, shared via YouTube, and commented on by peers for the purpose of demonstrating shading techniques in an art class justified using the underlying tenets of social learning theory)

It is important to note that creating a conceptual lens/framework is not enough to elucidate the nature of the proposed knowledge. Thus, there need to be further refining works that apply this conceptual lens to practical knowledge, with the intent of explicitly addressing *what* this pedagogical cognition and action looks like and *how* to teach and assess it. In this respect, in what follows, I discuss how I have tried to capture and measure TPACK-L cognition.

CARD-*tamen*™ TPACK-L:

A Card Game to Assess Teachers' Competencies of Wise Technology Integration

To creatively assess teachers' ability to wisely integrate technology, this study used an existing card game, CARD-*tamen*™ TPACK-L[2], as a potential assessment of teacher's technology integration skills and knowledge. This card game was designed for players to articulate their technology integration strategies by elaborating on situations in which they role-play as technology coordinators, tasked with offering a solution to a given instructional situation drawn randomly through card play. Winning relies on a player's reasoning to integrate pedagogy, learning theory, policy, and technology, externalizing their thinking about TPACK-L issues.

There are four suits in this card game: Technology, Pedagogy, Learning Theory and Challenges (see Figure 3). Each card has a detailed description such that players can pick up the information from the card directly. The intent is to externalize teachers' TPACK-L reasoning process by interrelating these four card decks.

[2] CARD-*tamen*™TPACK-L card game was designed by a research group at UConn and The Pericles Group (www.practomine.com) under the leadership of Dr. Stephen Slota and Dr. Michael F. Young.

Figure 3. CARD-tamen™ TPACK-L Suits

The game begins with one player acting as the judge and the others acting as technology coordinators who are tasked with establishing the best possible argument for the randomly drawn card situation—these roles rotate in a clockwise fashion after each round. At the start of a round, the judge announces a content objective of his/her choosing (e.g., ideal topics selected from the Common Core State Standards or curricular guide). The content objective is then paired with a series of three face-up cards, one from each of three "suits" (i.e., Pedagogy, Theory, Challenge).

Five cards from the fourth suit, Technology, are then dealt face-up in the center of the table (see Figure 4).

Figure 4. CARD-tamen™ TPACK-L Game Setting

The player sitting to the judge’s left has two minutes to examine the face-up cards, consider his/her approach to the content objective, and declare which technology cards s/he will use to offer an instructional approach to the judge’s content objective and the three face-up instruction, theory, and challenge cards. This player then has up to two minutes to present his/her proposal to the group. For example, in one of the rounds I studies, players were given reflection journaling (i.e., Instruction), social learning (i.e., Theory), limited resources (i.e., Challenge) and wiki, internet, word processor, cellphone, projection device (i.e., Technology). For this round, the judge chose her content area as the grade five Common Core curriculum, literacy skills in

implementing collaboration using technology. Given these contexts, gameplay unfolded as follows:

> Player 1: Okay, so I'm going to talk about instruction with reflective journaling and I think that literacy skill at that level is really important to make sure that there is a place for a student to work through their ideas and just overall words and getting things on paper. So I think, for that, we can use a word processor, but the spell checker is possibly off, so that we can initially see whether there are areas where they would need some help. So this is more of focusing on grammar and sentence structure of students. And then, I think this approach also helps with time, which is a huge issue with limited resources. So this approach will help with the teacher being able to quickly read through the student's work to see whether they have any issues.

This passage shows that Player 1 is working to construct a classroom use of word processing that is focused on the curriculum, grammar and sentence structure, and addressed the wider school challenge of limited resources. After the proposal has been made, the remaining players offered counter-proposals, spending up to two minutes presenting alternative approaches to the same problem and the Instruction, Theory, and Challenge cards showing:

> Player 2: Okay, since we are working with younger children, Vygotsky, definitely ZPD in there and I will probably be in charge of the class. I would partner them up for a final project. It would be a reflective journal and you want one student to be a little bit stronger than other students. Then, they can benefit from each

other's help when they are working together. I personally would not use a cellphone with my younger children. I'll definitely start with a word processing to make sure that they have skills…umm video game… my own six-year-old and eight-year-old boy both benefit a lot from the ABC math, so I would like to have my kids play the ABC math before they collaboratively put a writing piece in reflection journal.

Here we see that Player 2 has moved the discussion toward a theory of learning and attempted to explain why Player 1's ideas might be effective. In this way, the game provides scaffolding for teachers drawing on their knowledge of learning theory in the context of technology integration. Once all proposals and counter-proposals have been made in the two minutes, the judge declares a winner and provides a brief explanation justifying his/her selection. The justification must be rooted in the technology integration strategies described by the TPACK-L framework.

Exploratory Document Analysis Study

To answer two research questions, this study used a prototype card game, *CARD-tamen™* TPACK-L, with the intent to capture the teachers' pedagogical reasoning process associated with the TPACK-L framework. The major focus of this study was to explicitly delineate teachers' TPACK-L reasoning in the game context. In doing so, this study provided readers with details and examples of the expanded framework for teachers' competency for technology integration. In addition, group comparisons were provided to demonstrate the differences in the quality of TPACK-L reasoning, trying to document the spectrum of TPACK-L

reasoning according to the level of expertise. This way, this study also discussed the possibility of a game as an assessment tool to capture the quality of TPACK-L reasoning among the different experts. Since this study attempted to generate an in-depth understanding of the new framework alongside the detailed instantiation of the framework, exploratory document analysis was considered an appropriate methodology.

Context and participants

Thirty-four in-service teachers—19 newly matriculating and 15 graduating— enrolled in an accelerated educational technology Master's program at UConn were study participants. The participant ages ranged from 28 to 55. They played the card game at least three times with different groups as one of their course activities, and their gameplay was audiotaped.

Four faculty members specialized in learning and educational technologies were also recruited as an expert group. All of them have been studying this area for over 10 years. Like the Master's group, they also played the designed card game and their gameplay was audiotaped.

Procedure

Nineteen newly matriculating students (i.e., 1st-year Master's Group) were divided into four groups, and played CARD-*tamen*^{TM} TPACK-L on three different occasions. After each game session, participants were regrouped and played the game with another set of participants. Each game took approximately an hour. Twelve hours of audio recordings were taken. Of three gameplay sessions, only audio recordings of the second and last gameplay sessions were used for data analysis, largely because the first gameplay session was a practice session for all players and did not run completely. For 15 graduating students (i.e., 2nd-year Master's Group), the same procedure was used. That is, they were also divided into three groups and played CARD-

tamen™ TPACK-L three times with different players. Nine hours of audio recordings were created from the graduating cohort. Of these audio recordings, only the second and last gameplay sessions were used for data analysis for the same reasons. In addition, a group of four faculty members (Faculty Group) played the game once, producing one hour of audio recording.

Qualitative data analysis unfolded as a ten-step process (Appendix A) beginning with the import of all hours of audio recordings for data analysis (i.e., approximately 15 hours) into QSR NVivo 11 for Mac. The data then was parsed into individual utterances and transcribed by me for data analysis. This generated 254 occasions of the individual utterances for the 1st-year Masters Group, 195 occasions of the individual utterances for the 2nd-year Masters Group, and 41 occasions of the individual utterances for the Faculty Group.

Data analysis

The basic principles of grounded theory data analysis (Strauss & Corbin, 1998) guided this study. First, I developed an open coding scheme to identify trends across player discussion and whole-group performance by naming, categorizing, and describing common words, phrases, and concepts used throughout gameplay. A list of these code words was compiled and compared against the transcripts. This allowed for instances in which a code could emerge near the end of a transcript, even if unnoticed in the earlier sections. This also allowed for checks to ensure that a code is used consistently throughout the transcript. Codes and concepts were sorted, compared, and contrasted until saturated—that is, until analysis produced no new codes or concepts and when all data were accounted for in the core categories of the grounded theory paradigm model, in an attempt to ensure their validity. With this constant revision and comparison of the transcripts, these codes and concepts were subsumed under broader and more abstract categories. By the end of this stage, the categories, codes, and relationships were integrated to form a

theoretical framework and were present diagrammatically. This framework, the final product of the study, explained the central theme of the data as well as accounting for observed variations.

To improve rigor in the thematic analysis, peer debriefing was employed to obtain consensus for open codes and categories, as well as to ensure the credibility of the research by reducing the bias of a single researcher. This analytic triangulation technique, peer debriefing, was employed in a way that a group of doctoral students who took the same course (i.e., advanced qualitative research) met weekly for a semester and discussed and verified interpretations, coding decisions, and the development of categories.

To classify and identify an array of teachers' TPACK-L reasoning within gameplay, an axial coding scheme was developed with a special focus on 1) the categories of TPACK-L framework (e.g., TCK, TCKL, TPACK, TPACK-L) and 2) the range of quality of their reasoning amongst groups (e.g., matriculating group, graduating group, and faculty group). In addition, all of the instances of TPACK-L reasoning across the groups was counted and presented graphically to show the difference in groups by using visual representation methods (i.e., data clouding). To help establish construct validity, a group comparison analysis was employed with the scores of TPACK-L reasoning from each group, so as to examine that game play differs across the different expert groups.

Findings

Trends and Affordances for a Card Game to Externalize Teachers' Pedagogical Cognition related to Technology Integration

My initial coding to characterize the trends of gameplay identified 26 associated concepts, and these concepts were combined into 6 broader categories through the initial stage of analysis. These categories explained the trends of the gameplay as well as the affordances of gameplay for

promoting and assessing players' pedagogical reasoning in the sense of evaluating the decision-making processes (see Table 2). The six major categories included (1) generation; (2) instantiation; (3) rationalization; (4) challenges; (5) strategic thinking; and, (6) reflection.

Table 2.

Major Categories of the Gameplay concerning the Process of Teachers' Decision-making

Concepts	Categories	Theme
• Creating a new situation • Bringing the relevant issue • Bringing own experience • Bringing other sources	➢ **Generation:** ways in which players make own pedagogical proposal	Gameplay can promote teachers' decision-making/reasoning in relation to TPACK-L
• Explaining how it works • Detailing	➢ **Instantiation:** ways in which players describe what their pedagogical approach look like and how it works	
• Content knowledge • Technology knowledge • Pedagogy knowledge • Learning Theory • PCK • TPK • TPACK • TPACK-L	➢ **Rationalization:** ways in which players justify their solution based on knowledge of each domains related to TPACK-L framework	
• Gameplay/rule • Difficulty of a given context • Time constraints • Self-talking • Giving up	➢ **Challenges:** the degree to which a player feels pressured and faces difficulties or challenges in a given situation	
• Sequencing • Matching • Building up from other's • Different approach	➢ **Strategic Thinking:** ways or strategies of building on players' thoughts	

• Debating/after-talk • Debriefing/Reflecting • Evaluating/Judging	➢ **Reflection:** ways in which players reflect and evaluate their pedagogical solution	

These emergent categories from this initial stage of analysis were used as the basis for identifying the main themes that captured players' gameplay reasoning process as well as for examining the links between codes, concepts, and categories. Using the techniques of constant comparison and trimming (Glaser & Strauss, 1967), the diagrammatic representation of the data emerged as seen in Figure 5.

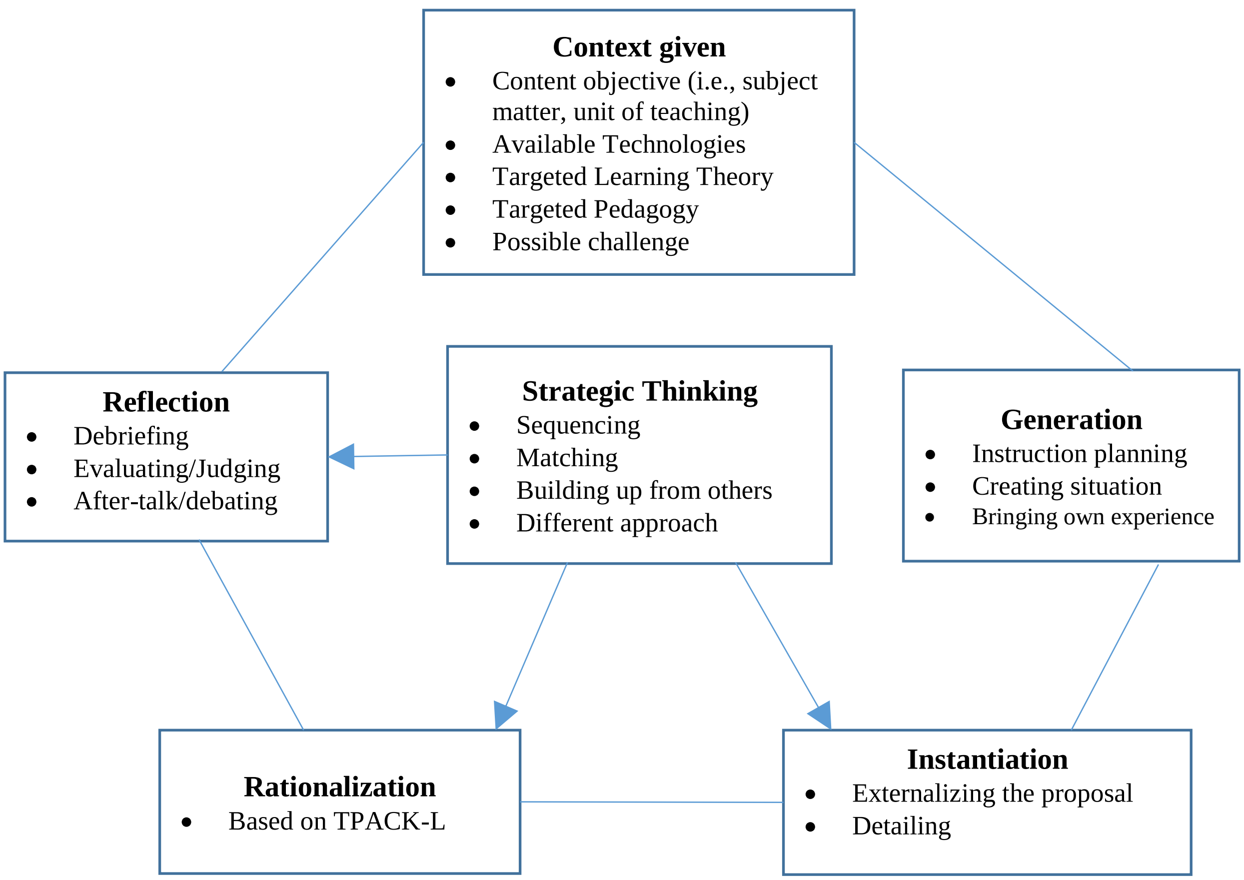


Figure 5. Players' Decision-making/Reasoning Process during Gameplay

This framework captures players' pedagogical reasoning process with regard to technology integration in such a way that players were asked to come up with their best pedagogical solution for teaching the given content with the appropriate pedagogy, technologies and learning theory in mind. This reasoning process is characterized by four stages: generation, instantiation, rationalization, and reflection. This pedagogical decision-making process is well aligned with Shulman's (1987) pedagogical reasoning and action model. Shulman identified the professional practice of teaching that teachers undergo during the teaching process, including comprehension of subject knowledge, transformation of subject knowledge into teachable representations, instruction, evaluation of students' learning and the teacher's performance, reflection and new comprehension. Even though the reasoning process that occurred in gameplay was not identical to the Shulman's pedagogical reasoning, it explicitly includes the most vital process of pedagogical reasoning identified by Shulman, such as comprehension of knowledge (as justifying phase) and transformation (as generation process), instruction (as instantiation process) and evolution and reflection (as reflection phase). As such, the reasoning process occurring in the gameplay provides a window onto how teachers make decisions concerning the use of technology. The detail of players' pedagogical reasoning process in the game context is illustrated as follows.

Generating the instructional plan

Over the course of gameplay, players began generating their instructional approach by picking up some possible technologies coupled with the given pedagogy (i.e., instruction) and learning theory as they saw fit. In this process, they relied on sequencing and matching the given

cards to generate and address their pedagogical approaches, meaning that players' thinking and reasoning occurred *on the fly* by interacting with the given cards. Consider one example:

> *Player 1:* Okay, so I'm going to talk about the instruction with reflective journaling [*planning*], and I think that literacy skill at that level (grade 5) is really important to make sure that [*bringing own thought*] …. so I think for that, we can use a Word Processor ….so the spell checker possibly is off [*creating situation*], so that we can initially see whether there are areas that they would need help and we will be able to see on time…
>
> *Player 2:* I would start with projection devices to have them understand what programing syntax is in your direct instruction [*planning*], then I would use video recorders and online video with my students so that I would actually have them to record the video and posting online to help teach others how to do the programing [*creating situation*].

As seen, the players kept unfolding the ideas in ways that they planned their instruction, created situation, and even brought their own experience, knowledge, and thought as they saw fit. This process (i.e., generation) occurred throughout the whole gameplay in a same pattern. That is, players started their approach by planning appropriate instruction with their own experience and knowledge with regard to the given cards, and built it up through creating various instructional situations on the fly. In sum, in this process, players attempted to transform their tacit knowledge in regard to the given context into a more refined instructional approach.

Instantiating the proposed approach

After generating the basic structure of the instructional plan, players tried to explicate their thoughts and knowledge in a way that gave various examples. In doing so, they attempted to elucidate not only what their approach looks like, but also how this approach works in a more concrete manner. Over this process, players articulated their knowledge of technology and pedagogy. For example, player 3 proposed:

> *Player 3*: …what I would do is for the instruction is that students really have to explore the idea on their own by creating an online video and posting Edmodo [LMS application] that you've created. And they can use their smart tech to record, for example smartphone, iPad that they may technically have, which actually applies to technical support because they use their own devices…. And, they record a video, actually, an instructional video of how to use their favorite apps. So … here is a video that demonstrates the usage of this command to... and so then, they will post this video onto the Edmodo social network. And, what will happen here is, I think, this is constructing their own knowledge through having to generate these instructions for the app or tasks they are trying to do.

As seen, players externalized and detailed their approach, with the goal of fully addressing how their approach works. This process (i.e., instantiation) thus has to do with a player's effort to articulate their idea (i.e., the quality of their articulation of knowledge). Interestingly enough, unlike other reasoning process, there were some variations in the instantiation reasoning process across the groups (approximately 6 % coverage in 1st-year

Master's Group, 14% coverage in 2nd-year Master's Group, and 21% coverage in Faculty Group), indicating that players with a higher expertise might be better at externalizing their proposal.

Rationalizing the proposed approach based on their TPACK-L knowledge

Rationalization explicitly represents and captures players' knowledge of TPACK-L. While reasoning, players justify their approaches, and in so doing, reveal their knowledge of TK, PK, CK, and Learning Theories. There were various ranges of players' TPACK-L knowledge unfolding during this rationalization process, and this reasoning process played a pivotal role in the winning of the gameplay: players with higher levels of TPACK-L were more likely to win the round. Player 4 showed the TPACK-L reasoning in her arguments, and she won this round.

> *Player 4*: My approach is for literacy and collaborative writing. I would focus mainly on a wiki. Umm, I think that a wiki is considered as a word processor, because you can craft a document collaboratively [TK]. I think using a wiki hits both social learning and reflective journaling very well, because students are able to reflect their writing while they are reading and wiring a document through the wiki, and they are also able to write it together [TPACK-L]. So, you can group your students…like for not strong readers, you can pair them up with someone who is skilled at reading and writing online [PK]. And then, I think the focus for me would be on having a wiki to write a collaborative reflection on a book that your students are reading in a class.

As seen, when she justified her approach, she relied on her knowledge of technology, pedagogy, and learning theory. This example showed the transactional and integrative aspect of

technology integration cognition. Her usage of technology was shooting for supporting her instruction and was guided by an understanding of learning theory, as opposed to using technology as a simple tool in pursuit of effective instruction.

Reflecting and self-and co-evaluating the players' argument

After presenting their own proposal in the given context, players had chances to reflect and evaluate their approach. That is, players self-evaluated their arguments and/or made corrections of other players' arguments. For example, when the judge evaluated one of the player's arguments, the judge attempted to give the player some corrections, "*I think you don't understand schema theory, somehow you quantified schema because that is going to be bigger. However, this is wrong understanding of how schema works.*" Also, the judge evaluated another player's argument concerning cognitive apprenticeship, providing some general comments: "*I like the Jasper Series examples you mentioned, but I did not see any cognitive apprenticeship piece other than 9th graders being expert somehow…*" This way, players were able to have a chance to receive feedback on their approach, as well as to self-evaluate their own approach.

Strategic Thinking

There were not many variations in how to play this game, but some explained that they built their arguments on what other players played. For example, player 5 and 6 said:

> *Player 5*: OK, what I'm going to do is kind of same way what you [other player] did.
>
> *Player 6*: Hmm…Actually you totally stole my idea but…

In addition to building off of one another, players also used different approaches:

Player 7: I'm taking a completely different approach to this. Way, way, way back in the day, I actually wrote a program in French…. that whole thing again helped to know the language and command form [programming language] ….

Player 8: My approach is quite different. The way I would do is…

Challenge and Difficulty

While playing this game, many players commented on the challenges of making their own arguments due to a lack of knowledge of theory, pedagogy, and technology, and of course, the complexity of making the interplay among them. For example, many players frequently put, "*I don't know the rest of the cards* [Theory and Technology cards]*," "Hmm…I have no idea of what this means* [Pedagogy] *so I just skip this," "I'm not going into detail about this* [Theory]*,"*and, *"I'll pass this round."* In addition, it appeared that the time constraint also challenged the way they played this game.

Teachers' TPACK-L Reasoning in the Game Context

As previously discussed, this game captured players' pedagogical reasoning related to technology integration. Thus far, the focus has been on documenting how players' reasoning unfolded during gameplay and been centered primarily on how this reasoning process can be understood as pedagogical reasoning and action. Here, I shift to examining what the game revealed about players' technology integration cognition, with the goal to catalogue the various layers of technology integration cognition and by extension, to delineate what TPACK-L reasoning looks like.

Pedagogical Content Knowledge (PCK)

In most cases, it appeared that regardless of their expertise levels (i.e., 1st-year, 2nd-year, and faculty), players had good knowledge of PCK when coming up with their instructional idea. Given the fact that most of the players were in-service teachers with at least four years of teaching experiences, it seems obvious that they had enough expertise in PCK reasoning. Consider one example:

> I'm going to use a case-based learning (Pedagogy) as the way to have them problem-solve about climate change. So, what I'll do is to propose a problem to them about something that has affected environments. So, you know whether that would be… well…polar bears are dying, or something that the temperature is affecting food produce, all the stuff. So, they will have to work backward and figure out why this happened and what was the impact of climate change on this. At the end of the lesson, after solving their own problem, they make a news report to figure this out and report their findings and share these with others.

As seen in this example, we could see the player's reasoning that related pedagogical knowledge to the targeted instruction objective. However, in this example, we could not find any attempt to integrate classroom technologies in such a way that technology could seamlessly support the way to teach guided by a sound understanding of learning theory.

Technological, Pedagogical, and Content Knowledge (TPACK)

The 2nd-year Master's Group and Faculty Group mostly relied on TPACK reasoning to generate their instructional ideas of using technologies; yet, fewer instances of such reasoning were detected in the 1st-year Master's Group.

In one of the 2nd-year Master's Group game sessions, one of the players was given the context where experimentation was the selected pedagogy (i.e., Instruction), and available technologies were video games, blog, and word processor. Their selected content was to teach operations on the integers in math. Specifically, the Judge shared her content regarding how to teach number lines on the integers, e.g., positive and negative numbers and/or adding and subtracting on the integers. With this context, the player came up with the following argument that was aligned with the TPACK framework:

> …I would take from the point of view of a sport. I will use the case of golf. So, first I would set up a little mini golf course activity by using a Wii Sport game and have students play the golf game and ask them to collect data using Word Processor regarding how a golf is scored as a form of experimentation while playing a game. Through this activity, that is, playing a Wii Golf game and data collection (experimentation), students can get the idea of how it is scored. And then, teacher will move forward teaching in the classroom by applying their experience regarding scoring to the whole operations on the integers lesson, like plus and minus numbers on the integers, how your golf scores relate to the number line, etc.

In this example, we can see the player's TPACK strategies concerning how the player integrated the technology (i.e., Wii game) into the instruction (i.e., experimentation), in an attempt to achieve an instructional goal (i.e., teaching the operations on integers). In this example, the player critically examined the affordances of technology and strategically utilized it as suited

to the subject matter idea; yet, the players' approach was not fully guided by a sound understanding of theories of learning and teaching.

Technological, Pedagogical, Content Knowledge, and Learning Theory (TPACK-L)

In this game context, only a few TPACK-L reasoning instances were detected in the 1st-year Master's Group. However, in the 2nd-year Master's Group, several players showed the TPACK-L reasoning and came up with their proposal in light of TPACK-L. For example, the player was given the context where group presentation was pedagogy for this round, and Internet, assistive tool, and social network were available technologies. And the player was given situated learning as a theory, and as content, she had to come up with the instructional idea to teach 4th grade multiplication unit, in particular, higher table multiplication. Given this context, this player's TPACK-L reasoning was revealed as follows:

> ...so if I were using a group presentation to teach multiplication, I probably begin with my smart board and Apple TV, because I want to do a one-to-one classroom. So, I use an interactive whiteboard and then create a multiplication problem. For that, I could use the internet and find some real-world examples of how multiplication is applied to our everyday life… like how builders use it…And I am going to use social network, so we could do a micro-blogging about how to solve the problem. And I have my kids present their solution to others using the smart board and Apple TV.

Her proposal was not exemplary in term of TPACK-L strategy, since she didn't really transform the theory—situated learning— into her pedagogical approach. Yet, she attempted to

relate all of teacher knowledge in a holistic way as learning theory as a foundation for her approach (i.e., trying to create authentic learning environments). And she attempted to make the most of the affordances of given technologies and apply them to her approach in pursuit of effective instruction.

In the expert group (i.e., Faculty Group), their arguments were mostly based on TPACK and TPACK-L reasoning. Since they have strong expertise in learning theory, technology integration, and curriculum design and development, most of their arguments (7 of TPACK-L, and 4 of TPACK among 12 whole game rounds) were coded under TPACK-L or TPACK. One of their proposals well described TPACK-L reasoning process. One of the faculty was given the following context: threaded discussion as pedagogy; social network, smart technology, wiki, internet, and video editing as technologies; and, schema theory as learning theory. And they were asked to come up with the instructional idea to teach 11th grade physics class. Given this context, one of faculty addressed his approach as follows:

> Okay, I'm going to make it explicit what I'm going to use. My guys are going to study Angry Birds game and the nature of a projectile motion. And then they going to do that through social networking with other classes, other students interested, taking other physics classes. They're going to play some Angry Birds [mobile game] and they are going to have to describe their different kinds of birds that get launched. They are going to have to use Newtonian physics, projectile motion, to describe what's difference between a big bomb one verses a little blue one. And the thread discussions come in. Before they start this activity, they are going to be given an initial thought prompt of what they think of projectile motion. Then, what they are going to do is to go on the Internet and to

> do some research, trying to convince others in the social network to explain that their description [*about the difference between a big bomb and a little blue one in light of their projectile motion*] is correct. So, it's a peer review. And then, they'll go back to the threaded discussion, and give their final thoughts on the problem. This should be able to show students' growth of their schema or their understanding of it. And lastly, they have to put together a final statement that describes how each one of projectile motion works in the threaded discussion.

As seen in this example, first and foremost, his usage of technologies (i.e., using Angry Bird game, social network, and Internet) appeared to seamlessly support the way to teach (i.e., threaded discussion) and its subject matter idea (i.e., projectile motion). More to the point, his approach to technology integration was guided by a learning theory in a way that the learning theory (i.e., schema theory) underlay the design of his instruction (i.e., threaded discussion) and the usage of classroom technologies.

A Game as a Measure of Teachers' Technology Integration Cognition

In this section, I describe the potential of the game as a measure of teachers' pedagogical cognition in relation to technology integration by providing a qualitative and quantitative evidence. Toward this end, I re-examined the data with a special focus on capturing various categories of teacher knowledge that emerged from their gameplay and have coded them in light of the TPACK-L framework. This produced 133 instances across the all data sources, including 'Pedagogical Knowledge' (PK, n=29), 'Content Knowledge' (CK, n=6), 'Technological Knowledge' (TK, n=18), 'Learning Theory' (LT, n=7), 'Pedagogical Content Knowledge' (PCK, n=20), 'Technological Pedagogical Knowledge' (TPK, n=1), 'Technological Pedagogical and

Content Knowledge' (TPACK, n=30), and 'Technological Pedagogical Content Knowledge and Learning Theory' (TPACK-L, n=22). Using these codes, I examined the frequencies of these coded teacher knowledge to see the overall trends and patterns of what this game captured in regard to TPACK-L framework. These frequencies queried by the whole gameplay data were converted into a word cloud using the world cloud visualization feature of NVivo 11 where the relative size of a code is related to its frequency (see Figure 6). As seen in Figure 6, it appeared that the game mostly captured players' TPACK and TPACK-L knowledge. In other words, this gameplay could elicit the teacher's pedagogical reasoning in relation to technology integration.

Figure 6. Overall Patterns of Game Play

The result of the overall trends and patterns of the gameplay posed another question regarding how different the quality of teacher knowledge in relation to technology integration is among the three different level of expertise groups. To answer this question could offer another insight into the game as an assessment tool, making a case that gameplay could capture players' different competencies for technology integration in accordance with their expertise level.

First, each group's frequency in relation to teacher knowledge was examined as conducted in the previous section, producing three different word clouds (see Figure 7). As depicted, this clearly showed that there was a difference in their reasoning among the different

expert groups. In the 1st-year Master's Group, players have relied primarily on PCK when making their argument in this game. Also, what was striking was that each domain of teacher knowledge, such as PK, TK, LK, CT, frequently appeared in a solitary manner, not an integrated manner, as compared to other groups. This result seems quite reasonable to me, because they (i.e., 1st-year Master's Group) were in-service teachers who have at least four years of teaching experience—meaning that they seem to have solid PCK—, but they were the ones who had just started the program that aimed to teach the wise integration of classroom technologies in the classroom (i.e., TPACK and TPACK-L reasoning). It could thus be said that they had difficulty in TPACK-L reasoning that is an integrative aspect of pedagogical design thinking. In the 2nd-year Master's Group, as compared to the 1st-year Master's Group, they mostly relied on the TPACK and TPACK-L reasoning. They had already been taught TPACK and TPACK-L reasoning (i.e., wise integration of technology) over the year. As with this, for Faculty Group who was denoted as an expert group, most of their arguments were coded as TPACK-L. In summary, as seen in Figure 7, this game could detect the different levels of knowledge in relation to technology integration. As noted, the novice group mostly relied on the PCK thinking, whereas the expert groups were more likely to rely on the TPACK and TPACK-L reasoning. To reiterate, this result indicated to me that the gameplay could capture the different levels of teacher knowledge based on their expertise level, thus providing usability of the game as a measure of teacher knowledge in relation to technology integration.

1st Master's Group   2nd Master's Group   Faculty Group

Figure 7. Pedagogical Reasoning Patterns Among the Groups

As with such qualitative evidence, I also conducted a quantitative analysis to examine their group differences. Doing so supported the qualitative data analysis, making a strong argument that the gameplay could capture different quality of TPACK-L argument based on the different expertise. To this end, each segment of player's argument in regard to teacher knowledge was parsed. And these segments (i.e., argument parts related to teacher knowledge) were scored in light of the TPACK-L framework in such a way that the player's argument that hit PCK was scored as 1, the player's argument that hit TPACK was scored as 2, and the player's argument that hit TPACK-L was scored as 3. This way, the qualitative data (i.e., codes) were converted into the quantitative data (i.e., continuous variables). This data produced a total of 95 samples with three groups, including 52 instances for 1st-year Master's Group, 31 instances for 2nd-year Master's Group, and 12 instances for the Faculty Group (Table 3). With these datasets, Kruskal-Wallis test (i.e., one-way ANOVA on ranks), a non-parametric test, was performed to compare the group difference, since the data appeared that all of the three groups were not normally distributed as a result of the Shapiro-Wilk test ($p <.0001$).

Table 3

The Counts of Players' Argument Scores Among Groups

Group	0	1 (PCK)	2 (TPACK)	3 (TPACK-L)	Total (N)
1st year Master's Group	7	25	17	3	52
2nd year Master's Group	4	4	15	8	31
Faculty Group	0	0	5	7	12

The results of the Kruskal-Wallis test indicated that there was a significant difference in the median, χ^2 (2, N = 95) = 23.146, $p < .0001$. Follow-up tests, Mann-Whitney test, were conducted to evaluate pairwise differences among the three groups, controlling for Type I error across tests by using the Bonferroni adjusted alpha levels of .0167 per test (.05/3). As seen in Table 4, the results of these pairwise tests indicated a significant difference between the 1st-year Master's Group and the 2nd-year Master's Group ($p = .004$), between the 1st-year Master's Group and the Faculty Group ($p < .0001$), and between the 2nd-year Master's Group and the Faculty Group ($p=.011$).

Table 4

Pairwise Differences Between Groups

Group	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-tailed)
1st year – 2nd year	518.500	1896.500	-2.868	.004
1st year – Faculty	68.000	1446.000	-4.437	.000
2nd year – Faculty	99.500	595.500	-2.544	.011

Conclusions and Discussion

The purpose of this study was twofold: (1) to propose a new body of teacher knowledge of technology integration called TPACK-L, as well as to delineate what this pedagogical design thinking looks like in a card game play context; and, (2) to describe the potential of the game as an assessment environment for teachers' technology integration cognition. First, by proposing an expanded framework, TPACK-L, for teacher knowledge in regard to technology integration, this study particularly highlighted the importance of understanding theories of learning in technology integration practice. As discussed, optimal instruction with technology not only requires understanding the integrative aspect of teacher knowledge (i.e., intersection of content, pedagogy, and the associated learning technologies), but also understanding foundational theories of learning to guide their instruction and curriculum. From this expanded framework, it is argued that wise technology integration is an ability to systematically design instruction (i.e., pedagogical design thinking) in such a way that technology seamlessly supports what to teach, and how to teach based on a sound understanding of the foundational theories about learning and teaching.

Second, this study introduced the card game as a measure of teachers' competencies in relation to wise technology integration. Using our CARD-*tamen*™ TPACK-L card game as an assessment environment, this study delineated the pedagogical reasoning process that teachers undergo in technology integration practice, as well as catalogued various teachers' pedagogical reasoning in relation to technology integration. As a result, it is concluded that the gameplay elicited teachers' pedagogical reasoning in relation to technology integration and that the game could capture the different levels of teachers' technology integration cognition in accordance

with their expertise level. This result indicated that this game might be a useful assessment to measure teachers' competencies in relation to wise technology integration.

That being said, given the exploratory nature of the study, conclusions of the present study should be made cautiously. To make a strong argument that a game can be a useful assessment environment, further studies are needed with a strong theoretical background about game-based assessment practices as well as strong empirical design works. In addition, in order to make a better case of games as good assessments, the current game is in need of revision of the game mechanics, because I frequently observed that the players tended to build off of what other players addressed when coming up with their own idea. This finding eventually suggested me to expand the focus on assessment from the individual activity to the social activity.

Games could serve as useful assessment environments in a way that provides various realistic contexts in which enable to capture examinees' thinking and acting in context. The present study opened a window into thinking of games as assessment environments at its best. It is thus my hope that there are more studies to explore how games can be useful and valid measurements, as well as to provide practical cases of game-based assessment, so that more educational researchers and practitioners can create playful learning and assessment contexts.

References

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & education*, *52*(1), 154-168.

Bransford, J., Derry, S., Berliner, D., & Hammerness, K. (2005). Theories of learing and their roles in teaching. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 40-87). San Francisco, CA: Jossey-Bass.

Chen, C. H. (2008). Why do teachers not practice what they believe regarding technology integration?. *The Journal of Educational Research*, *102*(1), 65-75.

Choi, B., Slota, S., Lai, B., & Young, M. (2015, April). *CARD-tamen TPACK-L: Assessing teacher competency with technology integration.* Paper presented at the American Educational Research Association Annual Meeting, Chicago, USA.

Darling-Hammond, L., & Bransford, J. (2007). *Preparing teachers for a changing world: What teachers should learn and be able to do*. San Francisco, CA: Jossey-Bass.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration?. *Educational technology research and development*, *53*(4), 25-39.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Adline.

Harris, J. B., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge: Curriculum-based technology integration reframed. Journal of Research on Technology in Education, 41(4), 393–416.

Heitink, M., Voogt, J., Verplanken, L., van Braak, J., & Fisser, P. (2016). Teachers' professional reasoning about their pedagogical use of technology. *Computers & education*, *101*, 70-83.

Jaipal-Jamani, K., & Figg, C. (2015). A framework for TPACK-in-Practice: Designing technology professional learning contexts to develop teacher technology knowledge (TPACK). In C. Angeli & N. Valanides, N. (Eds.), *Exploring, developing, and assessing TPCK* (pp. 137-164). New York, NY: Springer Publications

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, *29*, 76-85.

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of educational computing research*, *32*(2), 131-152.

Koehler, M. J., & Mishra, P. (2009) What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 9(1), 60-70.

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education*, *49*(3), 740-762.

Koehler, M. J., Shin, T. S., & Mishra, P. (2012). How do we measure TPACK? Let me count the ways. In R. N. Ronau, C. R. Rakes, & M. L. Niess (Eds.), *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 16–31). Hersey, PA: IGI Global.

Koh, J. H. L., Chai, C. S., & Tay, L. Y. (2014). TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge (TPACK). *Computers & Education*, *78*, 20-29.

Liu, S. H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, *56*(4), 1012-1022.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017.

Mishra, P., Hershey, K., & Cavanaugh, S. (2007). Teachers, learning theories and technology. In M. Girod & J. Steed (Eds.), *Technology in the college classroom* (pp. 55-75). Stillwater, OK: New Forums Press.

Papert, S. (1990). A critique of technocentrism in thinking about the school of the future. *M.I.T. Media Lab Epistemology and Learning Memo, 2.* Retrieved from http://www.papert.org/articles/ACritiqueofTechnocentrism.html

Saad, M., Barbar, A. M., & Abourjelli, S. A. R. (2012). Introduction of TPACK-XL for building pre-service teacher knowledge base. *Turkish Journal of Teacher Education*, *1*(2), 1-21.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review*, *57*(1), 1-23.

Slota, S. T., Young, M. F., & Travis, R. (2013). The inevitability of epic fail: An investigation of implementation problems associated with technology-rich research innovations. In C. Williams, A. Ochsner, J. Dietmeier, & C. Steinkuehler (Eds.), *Proceedings of Games Learning and Society 9.0 Conference* (pp. 39-44). Pittsburgh, PA: ETC Press

Slota, S. T. (2014). *Project TECHNOLOGIA: A game-based approach to understanding situated intentionality* (Doctoral dissertation). Retrieved from http://digitalcommons.uconn.edu/ dissertations/638/

Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Procedures and techniques for developing grounded theory (2nd ed.). Thousand Oaks, CA: Sage.

Webb, M., & Cox, M. (2004). A review of pedagogy related to information and communications technology. *Technology, pedagogy and education*, *13*(3), 235-286.

Wilson, S. M., & Berne, J. (1999). Teacher Learning and the Acquisition of Professional Knowledge: An Examination of Research on Contemporary Professional Development. *Review of research in education*, *24*(1), 173-209.

Wilson, S. M., & Peterson, P. L. (2006). *Theories of learning and teaching: What do they mean for educators?* (Best Practices Working Paper). Washington DC: National Education Association Research. Retrieved from http://www.nea.org/assets/docs/HE/mf_ltreport.pdf

Yeh, Y. F., Hsu, Y. S., Wu, H. K., Hwang, F. K., & Lin, T. C. (2013). Developing and validating technological pedagogical content knowledge-practical (TPACK-practical) through the Delphi survey technique. *British Journal of Educational Technology*, *45*(4), 707-722.

Yurdakul, I. K., Odabasi, H. F., Kilicer, K., Coklar, A. N., Birinci, G., & Kurt, A. A. (2012). The development, validity and reliability of TPACK-deep: A technological pedagogical content knowledge scale. *Computers & Education*, *58*(3), 964-977.

CHAPTER II

ASSESSMENT ON THE FLY:

GAME-BASED APPROACH TO ASSESSMENT

Introduction

Assessment greatly impacts the way we teach and learn in the classroom (Anderson, 1998; Shepard, 2000; Young, 1995). Much research has been focused on the role of assessment in education, with the goal of addressing various aspects of assessment (e.g., assessment *as* learning, assessment *of* learning, assessment *for* learning, and assessment of teachers), evolution of assessment (e.g., technology-based assessment, etc.), validity issues on assessment practices, and assessment models from various theoretical perspectives. One growing issue concerns the development of new models and practices of assessment. This highlights a need to align assessment with the current trends of teaching and learning, since it is argued that instruction and assessment should go hand in hand (Lund, 2008; Snow & Mandinach, 1991; Young, 1995).

Over the past few decades, the educational research community has proposed various forms of assessment practices and models to more fully align assessment with current innovative instructional practices. Central to these approaches is an effort to offer a constructivist assessment practice that expands the traditional behavioristic approach to assessment. Even though such efforts have moved assessment practices forward by emphasizing formative and authentic assessment (i.e., shifting the focus on assessment from capturing only a product to capturing also a process), the underlying assumption of these efforts is, strictly speaking, not really different from that of traditional assessments, which views knowledge as bits of information that can be accumulated and constructed in the head of the individual like storage in a computer's memory, and that can thus be objectively tested independent of or in a standardized context. Suffice it to say that these efforts still hinge on a linear additive model of assessment (Young, 1995; Young, Kulikowich, & Barab, 1997).

Some researchers have argued that the traditional assessment tradition captures only a portion of human being ability—which offers an incomplete picture of human learning—on the grounds that these assessments over control the interaction of a person with context (Gipps, 1999; Hickey, 2015; Lund, 2008; Roth, 1998). Such studies have concluded that it is inevitable that the traditional approach to assessment gives rise to an issue of the validity of assessment, i.e., not fully capturing the person's true ability to adapt to context. In addition, researchers have also pointed out the practical problem of teachers' assessment practices by showing that there is a huge discrepancy between a teacher's instructional practice and their associated assessment practice (Bol & Strage, 1996; Brown, 2004; Connor-Greene, 2000; Schwartz, Lindgren, & Lewis, 2009). As stated, assessment should be aligned with the instructional outcome (Young, 1995). Simply put, if the instruction is designed and undertaken using the constructivist approach, then the assessment should rely on a constructivist process as well. Regretfully, it happens that teachers still rely mainly on a behavioristic approach to assessment, even if their instruction is guided by constructivism. Schwartz et al. (2009) stressed that current constructivist pedagogy is, more often than not, evaluated through non-constructivist means.

These issues, concerns, and problems lead to another question: "what are some alternative forms of assessment?" To this question, some learning scientists have paid particular attention to the notion of knowledge from the situated cognition or sociocultural perspective, which views knowledge as always situated in a rich social context (i.e., knowing is distributed across objects, individuals, environments, etc.), not solely in the head of the individual. That is, knowing is an interaction in context, not the form of objective substance in the head. As such, assessment should also be thought of as a social act, which aims at capturing an interaction within the context over capturing the snapshot of the individual knowledge construction.

Since this new paradigm of knowing and learning was described in the late 20th century, researchers have begun to discuss a new model of assessment (e.g., Gipps, 1999; Hickey, 2015) and the role of assessment (e.g., Fleer, 2002; Gee, 2008; Lund, 2008) from the situated cognition or sociocultural theory perspective. Although some learning scientists have attempted to propose alternative assessment models using a situated cognition perspective, many questions still remain with regard to how the interactive and situative nature of our cognition and action (i.e., knowledge) can be assessed/captured, and what the practical example of using a situated cognition approach to assessment would be in educational contexts.

Accordingly, the purpose of this study was to provide an expanded assessment model using a situated cognition perspective, as well as to present a case of such an alternative assessment practice. Specifically, this study attempted to introduce a new assessment practice by using a game as an assessment environment where a person's social interaction and contextual on-the-fly thinking can be captured. In doing so, this study presented how this alternative assessment model is used in a gaming context.

Rethinking Assessment: Moving from Product-focused to Process-focused Assessment

Traditional assessments rely mainly on a deficit model of learning that aims to remediate deficiencies in order to orient and sort students (i.e., examinees), and to detect the effectiveness of instruction (Struyven & De Meyst, 2010). Assessment, from this tradition, is thought of as an activity to determine how well individual examinees can perform or recall what they have learned. This tradition is, epistemologically speaking, based on the empiricist and/or positivist model of knowledge (Anderson, 1998; Schwartz & Areana, 2013; Shepard, 2000) that views knowledge as an objective truth (i.e., product, observable outcome/evidence). The goal of

instruction thus is to teach or deliver these presumed truths to the individuals by employing a transmission model of learning (i.e., didactic instruction or behavioristic rote learning), and therefore, the central focus of assessment is on showing proof of how well they can recall and repeat back these truths (Chopping, 1990; Schwartz & Arena, 2013; Wiggins, 1993). Many high stakes assessments in use today are predicated on the individualistic nature of cognition, which views knowledge as a product or entity stored in the head of the individual (Anderson, 1998; Gee, 2008; Hargreaves, Earl, & Schmidt, 2002; Schwartz & Arena, 2013).

Over the past decades, many researchers have written in support of an alternative assessment practice (Anderson, 1998; Black, 1998; Gipps, 1994; McLaughlin & Vogt, 1996; Perrone, 1991; Shepard, 1995). These positions could be summarized as follows. First, a need exists to reconceptualize the notion of assessment. That is, assessment should serve to support and optimize learning as an integral part of instruction, not a separate form of activity to satisfy accountability demands (Gee, 2008; Perrone, 1991). Second, we need new assessment practices that align with the new pedagogical approaches, including constructivism, sociocultural theory, distributed and situated cognition approaches to learning and knowing (Fleer, 2015; Lund, 2008; Schwartz & Arena, 2013; Young, 1995). Many studies have reported that a misalignment between instruction and assessment is a central problem for current assessment theory and practice (e.g., Fleer & Richardson, 2009; McLaughlin &Vogt, 1996), thus requiring an alternative assessment in concert with the current curriculum designs.

Some researchers have paid a great deal of attention to the reconceptualization of assessment in education. Drawing on Black and William's (1998) comprehensive review of formative assessment, the assessment research literature has begun to focus on the interrelation between assessment and learning in service of assessment for learning (AfL). The concept of

AfL had a great impact on assessment and learning practice pressing for feedback-oriented assessment practices in the classroom, such as self-assessment, peer-assessment, and portfolio assessment, with the goal to support students' mastery learning. Following by the notion of AfL, Dann (2002) and Torrence (2007) went so far as to argue that we have moved from assessment for learning to assessment as learning. Dann (2002) asserted that "assessment is not merely an adjunct to teaching and learning, but offers a process through which pupil involvement in assessment can be featured as part of learning—that is, assessment as learning" (p. 153). Central to AaL is the idea that assessment should provide students with an opportunity to monitor their own learning process and goals, so that they can achieve a deeper understanding of learning. Supporting students' autonomy in personalized learning (i.e., on-going self-assessment) is at the heart of AaL. Overall, feedback serves as a key feature in both AfL and AaL, though the central focus of feedback is different. In AfL, feedback is fundamental in students' learning process to further/advance their learning in a way that provides students with accurate descriptive evaluations of their performances, whereas in AaL, feedback is fundamental to enabling students to guide and monitor their own learning process so as to adjust their learning—i.e., in AaL, learners would use an assessment as part of their learning process.

Researchers have also paid increasing attention to developing a variety of assessment practices in line with the current paradigm of learning and teaching. This represents an effort to offer a formative and authentic approach to assessment, such as portfolio, performance-based, standard-based, mastery-based, and competency-based assessment. These approaches, in particular, point to the importance of feedback in assessment practice, trying to link formative feedback to scaffolding— a fundamental piece of constructivist theories of learning and development (Shepard, 2005). In terms of a constructivist approach to assessment, Vygotskian

theorists have attempted to frame a new model of assessment practice. Dynamic Assessment (Instrumental Enrichment) is one such the widely-accepted constructivist assessment practice (Feuerstein, 1979). With roots in Vygotsky's concept of the Zone of Proximal Development (ZPD), dynamic assessment is designed to assess processes of thinking (i.e., changing events) by examining how an individual can use their learned knowledge in a problem solving testing setting (Tzuriel, 2001). Through the use of dynamic assessments, students are compared with themselves across time in ways that first identify individuals' cognitive deficits and provide intervention or mediation (i.e., lesson or instruction) to remediate the identified deficits, and lastly retest whether an individual can benefit from intervention to produce an improved performance within the assessment context. Central to this approach is the idea that assessment should measure the learning potentials of individuals (i.e., process over product). To reiterate, major characteristics of the dynamic assessment involve a "test-teach-retest" format of assessment (i.e., mediational strategy) and a focus on the learning process and/or the learning potential (Grigorenko & Sternberg, 1998; Haywood & Tzuriel, 2002). Drawing from dynamic assessment, Schwartz and Martin (2004) introduced a new model of assessment from a constructivist perspective, called the Preparation for Future Learning (PFL) assessment. Central to this assessment is the idea that assessments should measure an ability to construct new knowledge (i.e., preparation for the future learning) as opposed to an ability to execute learned (old) knowledge (i.e., sequestered problem-solving). This model, like dynamic assessment, emphasizes the opportunities for learning during the assessment (Schwartz, Lindgren, & Lewis, 2009). Schwartz et al. (2009) asserted that PFL measures constructivist outcomes by taking into account opportunities to learn during the assessment, assuming that "students who have been

prepared to construct new knowledge will learn more during the assessment than those who have not been prepared to learn" (p. 38).

Strictly speaking, these constructivist assessment practices greatly influence our assessment practice, though these efforts seem not to provide the much-needed alternative assessment that can fully capture the situative and interactive nature of human cognition and learning, in the place of individualistic, static, product-infused nature of assessment tradition. Apparently, formative, authentic, and other forms of assessment practices from the constructivist perspective listed above are still based on a linear additive model of assessment and individualistic perspective on human cognition as solely in the head of the learner rather than a social construction. Thus, a need exists to give even greater attention to the issues on how to capture and assess social interactions and dynamics of learning and knowing, since current cognitive science suggests the essence of our cognition/knowing is not individual but social (Brown, Collins, & Duguid, 1989; Greeno, 1989; Lave & Wenger, 1991; Resnick, 1987; Rogoff, 1990). Along this line, a number of situated cognition and sociocultural theorists have offered insight into a nonlinearly-interactive-based assessment practice that acknowledges assessment as a social and collective practice that integrates human perception-action with the physical and social environment (Gee, 2008; Gipps, 2002; Hickey & Zuiker, 2005; Lund, 2008; Young, 1995). In the next section, I describe situated and sociocultural perspectives on assessment in greater detail.

Assessment as Social Dynamics*:* Situated Cognition Approach to Assessment

From the situated cognition perspective, knowledge exists as an interaction with the world (i.e., situated in context), and evolves dynamically on the fly, rather than being acquired

from the environment as a form of static representation (i.e., product or memory) in the learner's head. That is, knowing is a competent action in a context, which is inseparable from doing (Clancey, 1997; Lave & Wenger, 1991; Roth, 1998). Such a different conception of knowledge entails a change in the way knowing is assessed and what counts as an appropriate assessment of cognition and learning. At its heart, assessment should capture the interactive/situative nature of knowing and learning as opposed to capturing some static snapshot in time of what an individual can do. As such, the test taker's interaction with the test environment needs to be considered as the unit of analysis, emphasizing the process in addition to the product(s) of knowledge and learning. Any situated cognition approach to assessment should assess the processes of learning and learning in social settings (Hickey & Zuiker, 2005; Lund, 2008) due to the fact that the individual is always in a social context and a setting with affordances and constraints. Lund (2008) thus suggested that the unit of analysis for assessment be a collective practice, which means that assessment is a mutually-mediated action that captures interrelationships between the individual and the collective as well as the mediating tools. So what is assessed from this perspective involves the learners' capacity for sharing and coordinating knowledge through joint participation in a social problem-solving activity and by using available tools in the realistic assessment context (Gipps, 2002; Lund, 2008; Young et al., 1997). It is also very important to assess one's competency over time in a real or realistic context. In this regard, a situated cognition approach to assessment focuses on the extent that the assessment situation reflects what has actually been learned, as opposed to accountability or generalizability of assessment (i.e., product) (Roth, 1998; Wilson & Sloane, 2000; Young et al., 1997).

Drawing upon such foundation, researchers have provided principles for a situated cognition approach to assessment. For example, Hickey (2015) provided an alternative

assessment framework, called *Participatory Assessment* that highlights the social and cultural aspects of knowledge when assessing learning. He proposed four assessment design principles:

- Principle 1: let contexts give meaning to concepts and skills.
- Principle 2: assess reflections rather than artifacts.
- Principle 3: assess individual knowledge prudently.
- Principle 4: measure achievement unobtrusively.

Shaffer and Gee (2012) also pointed to the constraints of the current assessment practices by arguing that learning and assessment are quite separate things. They argued that we should assess whether learners can make good choices and understand the consequences of their choices. In other words, assessment should evaluate whether students make the kind of choices that experts do in the target domain, as they work with other people to solve complex problems. In this regard, assessment needs to capture multiple variables in the social context and track how students' decisions and actions are related to overall individual and group development. That is to say, assessment should provide information concerning what students can do over time and tell us about the course of their development and how it can be improved, which is in turn inseparable from instruction.

All in all, the situative view of assessment emphasizes questions about the quality of students' participation in social activities, including inquiry and sense-making, and considers assessment practices as an integral part of a more general systems of social activity. What this means is that every activity of inquiry and behavior is evaluated moment by moment and provides immediate feedback to be able to inform reasoning and acting toward the goal of successfully participating in the activities of a community of practice. When knowing is considered as abilities to successfully participate in socially distributed practices of thinking and inquiry in various target domains, assessment also needs to be focused on evaluation of these

abilities (i.e., player/student interactions with learning/gaming environments).

In Search of Robust Theories of Games for Situative Assessment Context

Games as Assessment Contexts for Situative Cognition and Action

Games have long been attractive as learning environments given that games provide goals (i.e., objectives), rules for constrained interactions, relevant/immediate feedback, content mastery, and more importantly, create playful spaces where players are welcome to explore the context (i.e., engaged participation), share and build the experience with others (i.e., co-construction) (Gee, 2003; Shaffer, 2006; Squire, 2006; Young, 2004). Furthermore, Gee (2008) and Young (2004) have argued that games are powerful learning environments because they actually illustrate the way human thinking works (i.e., cognition and action) from the situated and embodied cognition standpoint.

Several studies have also pointed to the affordances of games as useful assessment tools (e.g., Chin, Dukes, & Gamson, 2009; Loh, 2012; Shute & Ke, 2012). Particularly, several learning scientists have pointed to the fact that games may create good assessment contexts to be able to capture the interactive/situative nature of cognition and action (Schwartz & Arena, 2013; Shaffer & Gee, 2012; Steinkuehler & Squire, 2014; Young et al., 2012). Shaffer and Gee (2012) argued that games are good assessments in that every action/decision that players make in a gaming context requires players' ability or knowledge in the moment on many dimensions, and collaborative play hinges on the situated and embodied nature of human cognition and action (i.e., thinking *in situ* in the gaming context, strategizing while acting in the context, etc.). Steinkuehler and Squire (2015) also asserted that a game itself is a good assessment tool in that games enable us to track and monitor players' performance, provide just-in-time feedback on any

performance, and offer rich data on problem-solving *in situ.* In addition, some games enable us to make observations in authentic contexts where we create the complex real-world scenarios required to evaluate players' situative actions and cognition (DiCerbo, 2014). In sum, games might be able to actualize a situative aspect of assessment for capturing the interactive nature of human cognition and action, far beyond capturing the individualistic cognition/knowledge that is an impoverished and partial representation of human cognition from traditional tests.

Cases of Using Games as Assessment Contexts

In this section, I review some of the examples of using games as assessment contexts and examine how they utilized a game as an assessment context.

CRESST UCLA (http://cresst.org/games-simulations/): The National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at UCLA has developed a variety of games for assessment that measure and analyze various aspects of learning processes and outcomes, including problem-solving, cognitive skills, and mastery of content (e.g., math, science, etc.) that is aligned with recent Common Core State Standards (CCSS). What they have focused on is that games can capture and track players' action during the game, which can support inferences about players' ongoing understanding, providing information about performance and the process of players' cognition and action (Baker & Delacruz, 2008).

Theme Park Hero by Revelian (http://www.revelian.com/theme-park-hero/): Theme Park Hero is a mini-cognitive videogame designed to assess potential candidate's problem solving ability. In this game, a player, as a park manager, is tasked with keeping the park operating effectively and solving the problems that come up. This game as an assessment can capture multiple factors

from gameplay such as players' mental ability, attention, cognitive speed, spatial aptitude and numerical processing ability (Figure 1).

Figure 1. A Screenshot of Theme Park Hero

Cisco Networking Academy's Aspire (http://www.cisco.com/c/m/en_us/training-events/aspire-video-640px.html): Cisco, a computer networking company, has developed technology-enabled assessments to help measure and improve various learning outcomes. One of their efforts is to design and develop educational games as learning and assessment environments drawing from the evidence-centered design (ECD) framework. *Aspire* is one of the game-based assessments that they have designed to assess players' networking skill for becoming the networking engineer, including not only designing and troubleshooting networks but also working with customers and making business decisions (Figure 2).

Figure 2. A Screenshot of Cisco Networking Academy's Aspire

SimcityEDU: Pollution Challenge!: GlassLab (2013) have developed and utilized SimcityEDU: Pollution Challenge! as a game-based assessment tool to measure students' ability to problem solve and explain complex systems in relation to the environment in a modern city. This game is designed for grades 6-8 and is aligned to Common Core and Next Generation Science Standards (NGSS; Achieve, 2013). In this game, students play the role of the mayor of a city who is tasked with dealing with the challenging work of addressing environment impact. In doing so, the game creates assessment situations for students to act and reason in the gaming environment, evaluating the students' level of complexity of systems thinking (Figure 3).

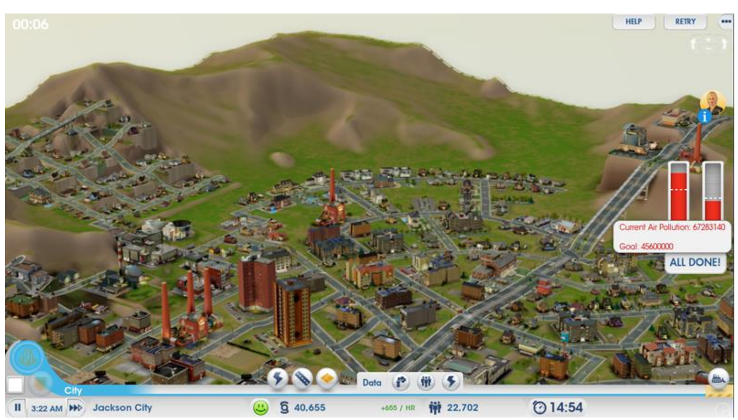


Figure 3. A Screenshot of SimcityEDU

KEEP COOL (http://www.spiel-keep-cool.de): KEEP COOL is a board game deigned to teach and assess players' knowledge of climatology. In this board game context, players take a role within global climate politics, communicating with other stakeholders and making decisions to effectively reconcile climate protection with particular interests. Eisenack (2013) reported this game had a great deal of educational potential in the sense of assessment, such as debriefing, reflection, feedback, and content mastery.

Families of Chemical Elements Game (2012): Mariscal et al. (2012) developed an educational card game, called "*Families of Chemical Elements Game*." This game is designed for high school students to teach and assess knowledge about recognition of group structure in the Periodic Table elements. The goal of this game is to collect complete families of the elements with other players. Mariscal et al. (2012) have reported that the game was a useful tool for assessing students' level of memorization of chemical symbols and of knowledge of the Periodic Table.

As illustrated above, some researchers have begun to examine that game could be useful assessment tools. The listed examples particularly show that games could serve as assessment contexts and provide an innovative assessment practice, though these examples are still not sufficient to make a case for games as situative assessment contexts as following reasons.

First, the games listed above were designed to measure cognitive and procedural tasks based primarily on an individualistic model of assessment. That is to say, these efforts still relied on a "within-person" approach, in an attempt to show the trajectory of how well each individual can learn (master information) in the gaming context. This can serve as a good formative assessment tool; yet, as previously argued, the very central focus of typical formative assessments is still based on the individualistic nature of the human mind (Young et al., 1997),

ignoring the importance of social interactions in the human mind. This, in turn, leaves us with a question: “in what ways might we be able to capture the situative and socially interactive nature of the human mind using this game approach?”

Second, most recent efforts of developing games as assessment tools were based on the Evidence-Centered Design framework to capture a more complex performance. This framework has been used to design and develop other types of assessments, including current teacher certification examinations (Pearlman, 2004), and Advanced Placement tests (Huff, Steinberg, & Matts, 2010). Yet, this assessment model rests exclusively on a linear additive model of assessment that aims to provide valid evidence (estimates) of an individual performance in an aggregated manner. Doing so, as argued, cannot fully capture the complex nature of human ability in a social context. This, in turn, leaves us with a question: “what would count in assessment to capture human cognition and action in a rich social context?”

Third, one of the common themes that came across from these games and research was that they found the affordance of games as good assessments from the playfulness of games. They presumed that the playfulness of games in turn helps create an optimal assessment context by reducing the stress that traditional assessments evoke. However, this playfulness (the role of playfulness) is a controversial topic in gaming research, which really needs to be clearly defined. As such, we need to have a theoretical framework for making a game-based assessment by defining “playfulness” with a clear description. This involves acknowledging that not all games are fun, and that fun may be orthogonal to the game mechanics.

As reviewed, current efforts of game-based assessment are still in need of further research on the design and development of assessment required to capture the situative nature of human cognition and action. In particular, from my analyses of the current practices, it appears

that we need to address the following issues: 1) when we use games as assessment, we need to have a clear framework for capturing interactive and situative cognition; and, 2) when it comes to a game-based assessment practice, many rely on the playfulness of the game without having a clear definition of 'playful,' thus needing to have a clear definition of what it means by 'playfulness' in a gaming context and how this playfulness impacts assessment parameters for the situative nature of human cognition and action.

Playful Assessment: An Assessment Model for Games for Situative Assessment Contexts

Definition of Playful Assessment

Playful assessment = Doable assessment

Too often, people assume that 'playful' is our pleasant experience or mood that stems from some sort of sugar-coating entertainment filled with fun activities. Yet, I view that 'playful' is not necessarily fun, but rather must be doable (i.e., inducing agent's intention). That is, 'playful' has more to do with our engagement, participation or intentionality in an activity. Most good games and our optimal experiences could be characterized as '*doable*,' thereby helping us persist in doing a given task, take challenges/risks, and achieve goals. Resnick (2006) also described that playful conveys a stronger sense of active participation in an activity with full motivation, as opposed to a merely entertaining action. If the task was not playful—i.e., the task is in some sense not doable, it is less likely to involve optimal learning. Csikszenmihalyi's Flow Theory and Vygotsky's ZPD clarify the very gist of the notion of playful and doable learning.

With this in mind, *Playful Assessment* is any assessment environment/context in which learners (i.e., examinees) have a full opportunity for exploring, discovering, and experimenting by interacting within the given context. In this sense, central to *Playful Assessment* is creating

environments where individuals can exhibit doable actions in the sense of goal-driven activity, not just having examinees put in the assessment context passively with the goal of evaluating whether they are doing right. Thus, the very focus of *Playful Assessment* is on capturing the quality of exploration, thinking, and acting within the context (i.e., relational adaptive process), as opposed to capturing the properties of individual knowledge (i.e., solitary product).

Suppose you are observing your child playing in a playground. On the playground, there are so many things to play with (e.g., slides, monkey bars, swings, and seesaws), but the playfulness can only be detected by the individuals who see the value of it and have an ability to act on it. Since situated cognition asserts that our ability or knowledge is always determined within the context/environment, to capture this ability (i.e., relational or situational dynamic), we should take into account agents' adaptive interactions with the environment over simple actions, results or product. *Playful Assessment*, thus, centers on capturing '*how*' players participate in, act in, think with assessment environments over *'what'* they participate in, act it, and think in the given context.

Playful assessment = Play-full assessment

Playful Assessment is considered as an assessment context/environment that is a full of play. Considering how children play army soldiers and play houses, Vygotsky (1978) argued that play is an essential and leading factor for human development, creating an imaginary but realistic situation where children can hone (test and construct) their developing adult ability. This process of play is deemed as a low-threshold-high-ceiling (i.e., ZPD) approach to learning *in situ*. Play always occurs within such a fuzzy zone of our capability, but clearly shows a transitional stage of the ability within the given context. As such, our true ability is not cross-sectional, but multi-dimensional or dynamics in the given context. In order to capture this ability, assessment should

promote '*play'* that can in turn reveal the fuzzy zone or continuum (distance) of our ability (i.e., play-full-ness) in the context. Assessment should address one's play-full-ness (i.e., acceptable legitimacy of one's performance or progress) in the given context.

Key Aspects and Design Principles of Playful Assessment

From the above conception of *Playful Assessment*, I view an assessment as a playful (i.e., doable) participation in a game (i.e., play-full) activity, rather than treating an assessment as a positivistic evidence of individual knowledge. This proposed assessment model is built upon Gibson's Ecological Psychology and Situated Cognition. Here, to help better understand this assessment model, I list some of the key aspects and design principles of *Playful Assessment*:

1. *Playfulness* (doable, goal-oriented action): *Assessment should create a play-full activity in the realistic context.*

Drawing from Gibson's Ecological Psychology, humans are information detectors, perceiving and acting with a specific goal within the information array of the environment at all times. Our abilities to act always come into being as a form of 'competent-acting' in a context. This goal-driven action is mutually defined and codetermined by the effectivities (i.e., abilities of an individual to act) and affordances (i.e., properties of environment that invite action) in the moment. Therefore, to capture this situative and interactive nature of human cognition and action, we should create *play-full* assessment contexts (i.e., non-linear, complex, and authentic assessment setting) and capture how examinees interact (use and find) with the given environment.

2. *Collective Practice* (co-assessment): *Assessment should involve and promote social interaction.*

Sociocultural theorists and situated cognition theorists view learning as an interpersonal engagement and participation in culturally valued activities (Lave & Wenger, 1991; Rogoff, 1990; Vygotsky, 1978). Through this interpersonal participation, we could collaboratively create intersubjectivity—i.e., mutual understanding or adoption of common goal— (Rogoff, 1990), perceptual attunement (Gibson & Gibson, 1955), identity formation (Lave & Wenger, 1991), and competent acting-in-the-context (Roth, 1998). The essence of knowing is thus a social process or a collective common ownership in the context. Therefore, assessment should also take into account this collective ownership process. In other words, assessment should address learners' capability for sharing and constructing knowledge through joint efforts and using available artifacts, because every assessment is also a social process. For instance, most of our assessment practices in a community of practice, such as job interviews, college admissions, comprehensive exams for graduate students, etc., are always carried out using multiple assessment materials (triangulation) by a group of experts in the area. Even classroom assessments are also social practices in that a teacher uses a rubric, answer sheet or other resources (i.e., social cultural artifacts in that context). These artifacts serve to create a social interaction that works together for assessing students' ability (i.e., collective practice). Suffice it to say that every assessment can be considered as social practice, co-measuring the performance to socially negotiate whether the performance has a functional value for the given community of practice. Therefore, assessment should foster this social interaction. Peer evaluation, and group or collective evaluation that require agreement on the common ownership of knowledge should be considered

as a pivotal process of assessment practice. *Playful Assessment*, thus, should involve and encourage social interactions.

3. *Transitional dynamics* (identity change): *Assessment should capture the trajectory of learning in the given context with the intent to identify the individual's social change.*

From situated cognition and sociocultural theory, learning is an enculturation process, which is a gradual socialization process in a community of practice. Learning, thus, results in changing one's identity from the novice to more central participation in a community of practice (Lave & Wenger, 1991; Rogoff, 1990). Through such active participation, knowledge is created, reflected, and evolved in the active form of competence, tool, or the language bound to the social context of a community of practice (Brown et al., 1989; Lave & Wenger 1991; Resnick, 1987; Whitehead, 1929). Assessment should identify and capture the individual's social change in the given context—i.e., detailing what kinds of language, process of problem-solving, or strategic thinking they use and find within the assessment context. This could involve examinations of the frequency of participation of activity, quality of participation, social role defined within the social activities, i.e., whether examinees serve as an apprentice or a master in the course of social activities.

4. *Ecological Validity* (authenticity/fidelity over generalizability): *Assessment should establish the ecological validity of assessment.*

In traditional assessment practices, reliability and validity of scores are crucial for producing the quality of assessments. In terms of validity, situated cognition theorists emphasize the ecological validity of assessments, which is the extent to which the assessment situation reflects the actual situations and functions that students encounter in the world (i.e., in the authentic context). Roth (1998) opined that in most traditional assessment practices, there is a

considerable difference between the assessment context and the actual learning situations, thereby failing to capture individuals-acting-in-situations. If learning is to be viewed as competent-acting-in-the-context and we are to assess such situative cognition and action, then we should assess the performance in some realistic context that resembles, as closely as possible, situations in which authentic activity and learning occur. We should align assessment performances by observing these practices in their natural contexts. In this respect, Roth (1998) argued that assessment must include a social dimension/setting (having to do with the actual learning) to have the ecological validity. Young et al. (1997) also argued that assessment should make the interaction as the unit of analysis to show a functional validity in the given context, being able to establish the ecological validity of the assessment. Therefore, *Playful Assessment* should take into account the fidelity of assessment, as opposed to the classical notion of validity, e.g., generalizability or so.

A Case Study: Playful Assessment for Evaluating Teachers' Competency with Technologies

I conducted a case study to present how the proposed principles of *Playful Assessment* unfold in a game-based assessment practice. To this end, this study used *INFLUENCE*[3]—a collaborative board game designed to evaluate team-based problem-solving ability as a technology coordinator—as a purposeful case to not only propose the situative approach to a game-based assessment practice, *Playful Assessment*, but also to explicate how this new framework for assessment comes into play to measure knowledge as situated.

[3] *INFLUENCE* was designed by a research team at UConn's Two Summers Program, including Dr. Michael Young, Dr. Stephen Slota, Ben Lai, Elijah Clapp, and me.

Methodology

Context and Participants

INFLUENCE consists of a playing board plus 10 Theory, 10 Pedagogy, 10 Technology, (+ 10 event cards for round 2 and beyond), 8 Admin, 8 Student, 8 Teacher, and 8 Community objectives cards. Initially three Technology cards, and the top Theory and top Pedagogy cards are turned over to create the school setting. Then one objective for each of the four constituent groups (i.e., admin, students, teachers, and community) are revealed.

Fourteen in-service teachers enrolled in the Master's program in educational technology were participants in this study. The ages of the participants ranged from 28 to 55. Playing the card game two times with different groups was one of their course activities, and their gameplay was audiotaped.

Game

INFLUENCE is a collaborative board game designed to evaluate a team-based problem-solving ability as a technology coach. The objective of this game is, as technology coaches, to handle the stakeholders' (i.e., Administrators, Teachers, Parents, and Students)' needs by proposing the best technology integration strategy. The game starts with one player as a spokesperson of the technology coaches group and the rest of the players serving as technology coaches. This role rotates every round and the play is measured in rounds. Also, each round represents one school year. The goal of the game as a group is to make a successful school year by handling each stakeholders' goals. Game play begins with each of the stakeholder's goal, and Pedagogy, and Learning Theory cards given. After Stakeholders objective cards, Pedagogy, and Learning Theory cards are displayed, the spokesperson flips three Technology cards face-up onto the table. Once all cards are revealed, the group has five minutes to discuss their strategy in

regard to how the chosen technologies will be integrated with the given pedagogy and learning theory to address one or more of the Stakeholder group goals. After five minutes have passed, a spokesperson (i.e., a Technology Coach representative) is given two minutes to describe their best strategy for the given context. After the spokesperson's proposal, the reset of the players assume the role of each of the stakeholders, weighs the Technology Coaches' proposal and determine the degree to which the stakeholder group goals are fulfilled or not. Three levels of judgment can be made: satisfied, neutral, and unsatisfied. If a proposal is fulfilled, the respective Stakeholder game token moves one level toward the center of the game board. If a proposal is unfulfilled, the respective stakeholder game token moves one level toward the outer edge of the board. Lastly, if a proposal is neutral, the respective Stakeholder game token stays at the current level. After each round, scoring is based on the number of move-ups and the number of using cards. Once the appropriate Stakeholder game pieces have been moved and scoring has been done, the players rotates roles and reset the board for the next round. Play continues in this fashion until all of the players serve as a spokesperson of the technology coaches group.

Procedure

Fourteen newly matriculating students (i.e., 1st-year Masters group) were divided into three groups, and played *INFLUENCE* two times as a group. After each game session, participants were regrouped and played the game with a different set of participants. Each game took approximately an hour. From these whole gameplay sessions, 6 hours of audio recordings were taken. Of a total of six gameplay sessions, only four gameplay sessions (i.e., approximately 4 hours of gameplay) were used for data analysis, since two gameplay sessions did not run completely.

Qualitative data analysis unfolded as a six-step process (Appendix B) beginning with the import of all hours of audio recordings for data analysis (i.e., approximately 4 hours) into QSR NVivo 11 for Mac. Each gameplay recording then was parsed into gameplay event units, including context given, collaborative play, presentation, and judging. This generated eight occasions of gameplay event per each gameplay session.

Data analysis

The basic principles of case study (Merriam, 1998) were employed to illustrate the specific occasion of how this game involves the element of the *Playful assessment* framework, with the intent to provide an in-depth understanding of the situated cognition approach to game-based assessment practice. First, using player statements as the unit of analysis, recorded audio data were parsed into several emerging themes (i.e., categorization), and the categorized data were aggregated to seek a collection of instances across the data. Second, these aggregated categories were collapsed into several themes. Finally, the themes were interpreted and described in light of the *Playful Assessment* framework.

Findings

The purposes of this study were to provide an understanding of the alternative assessment practice, *Playful Assessment,* which aims to measure the situative and interactive nature of human cognition and action, as well as to present a case of *Playful Assessment* in practice. Specifically, this study uncovered how the *Playful Assessment* came into play in the case of the *INFLUENCE* collaborative game context. In what follows, I describe how this game promotes the principles of *Playful Assessment* during the gameplay and document which game actions can be used to estimate the situative and interactive cognition in a gaming context.

Finding 1: The Game Creates a *Playful Assessment* Environment

INFLUENCE, a collaborative card game, is an example of *Playful Assessment* that seamlessly incorporates the proposed designed principles. It turns out that the game can promote these principles over the course of gameplay. Details are discussed as follows:

Principle 1: *Creating Playfulness* (doable, goal-oriented action)

The game creates playfulness in a way that offers complex real-world scenarios/issues to be addressed as well as that provides players with various roles (e.g., technology coaches, stakeholders, spokespersons, and evaluators), such that players are induced to enact goal-oriented actions by dynamically adopting various goals moment by moment as the gameplay proceeds (e.g., providing additional game objectives, different gaming contexts). Three particular instances of goal-oriented actions emerged during the gameplay: 1) setting up common goals; 2) articulation of the proposal, and 3) co-evaluation of the proposal.

Once the game cards were revealed, players strategically established the common goals by examining the cards (situations) and the given game set-ups (i.e., interacting with the gaming environments). In terms of setting up common goals, one of the groups discussed as follows:

> [Player 1]*: Okay, I think a student objective is perfectly tied to our plan.*
>
> [Player 2]: *Well, these* [Teachers and Community objectives] *are not really well matched. My gut tells me that we cannot tie in all of the objectives, but we'll just hit these two* [Students and Administration objectives] *because it doesn't affect any of these objectives moving backward* [game scores], *which is okay.*
>
> [Player 3]: *Yeah I agree, that is a good way to nail it down.*

Such gaming actions that interact with the game context and other players constantly create a new goal as well as induce players to adopt the goal and behave so as to achieve the goal they have set up. Doing so creates *playfulness* of the game as an assessment environment, enabling to detect players' goal-oriented actions.

While players were establishing the common goals and collaborating, particular game actions were observed from the spokesperson in each round. I observed that they more actively interacted with the game context and other players with a special goal to articulate his or her proposal in a clearer fashion. I also observed that most of spokespersons took notes on what their group discussed, asked questions to flesh out the proposal, and even led a discussion in that round. Such observed game actions turn out to be player's goal-driven actions, allowing the player to exhibit one's full capability to address the given issues.

In terms of co-assessing the spokesperson's proposal, the game creates a situation where each player takes the role of each of the stakeholders and weighs in on to what extent the proposal successfully addressed the issue. Through a dice roll, the players determine their predispositions (e.g., easygoing, critical, and hard-ass) to the judgment (i.e., difficult level of judgment). In a sense, this judgment context might best reflect the real-world assessment situation where there are always various dispositions at work and thus cannot be controllable. Based on their predisposition of choosing, players' judgment on the spokesperson were unfolded as follows:

> [Player 1: Easygoing]: *Yeah, as students, you mentioned what I'm looking for. I'm pretty satisfied with your proposal.* [+1 point]
>
> [Player 2: Hard-ass]: *As the administrator, we were concerned about the utilization of data to help improve decision making. You mentioned the*

improvement of decision making, but it was vague. I'm not really sure at all what that looks like in real-world projects as those are tough to quantify and collect data, especially related to the common core state standards. That is why we are not satisfied with what you were saying. [-1 point]

[Player 3: Critical]: *As the community, we are pretty happy with the most of what we've heard, but we are thinking more about the accountability and comparing across the state…I didn't hear about math and language art that much… how data is going to be collected and interpreted. That is what we are really concentrating on. So I have a little concern about that in terms of the accountability issue. I did hear whole a lot of great things, but I didn't really hear about the detailed plan of that. So I stayed here*. [0 point]

As seen, the game activity creates *playfulness* of the game as an assessment environment where every player has a unique intention to perform a particular game action and dynamically interacts with the game context, thereby enabling gameplay as an assessment to capture and nurture the situative and interactive nature of cognition and action during the gameplay.

Principle 2: *Promoting Social Interaction* (co-assessment)

As described, collaborative play is the hallmark of this game and of situated learning and assessment. Throughout the gameplay, players were invited to come up with their strategy to address the given issue, as well as to collectively evaluate the proposed idea. That is, the game creates two unique instances of nurturing social interactions: 1) co-construction of the idea; and,

2) peer assessment. This way, the game promotes social interactions while playing the game as an assessment environment.

In terms of co-construction of the idea, players were given five minutes to come up with their best solution to address the given issues collaboratively. In this co-work process, each player was able to build a shared understanding, common ownership of knowledge and even legitimately steal knowledge by sharing and interacting with other players. One of groups, as an example, was given the context where teachers are concerned with how available technology can optimize instruction, overcome time constraints and facilitate independent professional development, as well as the community wants to have a compelling press plan that describes the community benefits. In order to address such issues, the group set out to come up with the idea as follows:

> [Player 1]: *Maybe… social network and mobile technology can be connected, and we can try to convince the community to download the twitter app and tweet up to date what is going on our school.*
>
> [Player 2]: *Yeah, we can do community and school tweeters. So every Friday, school posts what students do and achieve…things that need to be praised. That way can let community satisfy.*
>
> [Player 3]: *Also, teachers are looking at optimizing instruction and overcoming time constraints and independent professional development. So we can do create webinar, right?, so that they can do the PD*[professional development] *on their own time.*

[Player 2]: *Yeah, we can utilize a streaming video for that*[PD] *and well…we can use a google classroom to create the professional development site and everyone has access to it and go find them.*

[Player 4]: *Yeah, as a tech coordinator, we can create those professional development online modules and also use a badge system. So, we can help teachers to do an independent professional development. And teachers can get a badge once they are done.*

As with this, another crucial part of the game is to give players an opportunity to undertake peer assessment. In so doing, the spokesperson was able to hear from a variety of resources and receive direct feedbacks on what he/she has proposed. During this peer assessment process, players (the judges) frequently engaged in communication with the spokesperson to evaluate his or her knowledge by asking further questions.

Principle 3: *Capturing the Transitional Dynamic*

The game, *INFLUENCE*, does not quantify or identify each player's change in their social role (i.e., moving from the novice to the expert), though the game soundly offers plausible estimates of such players' transitional dynamics in the sense of the quality and frequency of participation in the activity. As a result of the whole game analysis, particularly examining players' interaction patterns during the co-construction process, it turned out that players' particular social role in each round was identified as either an expert or a novice, an information giver or a receiver, or an active participant or a passive participant. The dialogue below describes how the gameplay captures players' transitional dynamics that show their social roles in this

gameplay. The game context that players were given was as follows: (1) Administrators want to develop a plan to reduce school expenditures; (2) Students want to improve the student-centeredness of teacher instruction; (3) Teachers want to improve the academic rigor as part of course participation; and, (4) the Community wants to improve opportunities for use of an interdisciplinary curriculum. In order to address these stakeholders' needs, players needed to use the following three technologies: collaborative cloud writing tools, blogs, and mobile technologies. They were also given the project-based learning as Pedagogy and the community of learners as Theory to generate their technology integration proposal.

> [Player 1]: *Okay, community, teacher and student all are aligned with the project based learning which we are applying. So the real-world scenarios that include some sort of manufacturing or mathematical components piece of it. And for administration, we have to cut money.*
>
> [Player 2]: *Well, what technology does well is to cut cost. Well, having a Google Docs will create a paperless classroom and we don't have to worry about the purchase of software because of those cloud-based technologies. In addition to that, thanks to the mobile device management system, we don't need to purchase a textbook year in and year out. We can push out and take back the textbooks every year, so not have to purchase new textbooks.*
>
> [Player 3]: *and also, we can have them speak to the community, concerns as well about how to create things a little bit more interdisciplinary. We could have teachers partner up across the disciplines. For instance, we could have an English teacher work with a math and science teacher to look at a project or*

create some simulations, and we could incorporate this like blogging about it. Right? Creating either an individual or a group blog. Then you can publish that to the community to help show the community about what we are doing, but at the same time we wouldn't have to cut… reading and writing skills will be embedded within an English portion of it.

[Player 1]: *Yeah, but also simultaneously gaining a real-world experience having to do with factories in town…*

[Player 2]: *in terms of teachers, teachers looking to improve academic rigor…the Project-Based Learning and Student-Centered Instruction they are doing a lot more…*

[Player 1]: *[chimes in] critical thinking, real-world problem-solving skills…all higher-order thinking…*

[Player 2]: *Yeah… and we can incorporate in the cycle of the continuous learning. So not only are they doing the Project-Based Learning, but also they have to reflect on the project as well. It may not be a one-time project, but the iteration of project that they can improve and work on students' master of learning.*

[Player 4]: *Projects that they choose themselves, right? and we want to be told what to work on as long as the project covers the skills that we are looking for.*

[Player 1]: *Yeah and we can provide some menu types of options. So this is the project and seven different tasks in this project. Everyone in the group has to pick one or two of the tasks that they want to work on.*

[Player 3]: *Yes, this is always more rigorous too, I think. If you have the student invest in a creation of what they are doing, instead of looking at their end product.*

So for them to be able to draft their idea that they want to tackle and they want to look. That leads to much higher-order thinking than just saying that here is your problem. It will increase their higher order thinking.

[Player 1]: *Yeah, student-ownership issue can be covered by this idea.*

In this round, Player 2 served as the spokesperson, and five players played this game. Among them, as seen in the dialogue, Player 1, 2, and 3 mostly led the group discussion by actively sharing, adding, and expanding their ideas; whereas, Player 4 did not really actively participate in the group work, but mostly agreed with what other players proposed. Interestingly enough, Player 5 said nothing but listened to what others were talking about. In this case, Player 1 and 3 are identified as active participants or experts in this context; however, Player 4 and 5 are identified as passive participants or novices in this context. Most interestingly, it was observed that in the case where the player who actively participated in the discussion served as a spokesperson, that round showed higher game score gains; however, in the case where the players who were less active as a spokesperson, that round showed lower game score gains.

Principle 4: *Focusing on Authenticity*

Play of this game has some authenticity by providing realistic contexts where technology coaches might face in their real life. This way, the game demonstrates some degree of ecological validity in a manner that it reflects the real-world cognition and action in the gaming context.

Finding 2: Collaborative Gameplay Can Capture Situative and Interactive Cognition

What observable game actions and cognition can be used to estimate situative and interactive cognition and action?

During the gameplay, three observable game actions and cognition were identified: establishing the goal; co-constructing the proposal; and, elaborating and presenting the proposal. Every game round, players are given a new situation that involves each of stakeholders' needs to be addressed and possible technologies, learning theory, and pedagogy cards. The players as a group then strategically think of the ways they can address the given stakeholders' needs. Doing so invites players to establish a common goal for each round, thereby inducing players' goal-oriented actions and cognition over the course of the round collaboratively.

After setting up their goal, players were given a situation where they must come up with their best solution to address each of stakeholders' needs by taking the given cards into account. In this co-constructing process, players were given an opportunity to actively interact and share their thoughts with other players. Also, during this co-constructing work, the Speaker was able to flesh out his/her thoughts by participating in this collaboration as well as legitimately stealing from others' ideas.

Once the player built up the proposal, the spokesperson was given a situation where he or she elaborates and presents the proposal that he/she has made with the help of others. In this process, the player usually took some notes of what he or she is going to say and articulated the proposal as professionally as possible as a leader of the technology coach team. This articulation serves as a pivotal part to score the gaming performance.

In what ways can overall game results capture situative and interactive cognition and action?

Game results can capture how articulately the player addressed what they had discussed collaboratively.

Each round of gameplay is scored based on the spokesperson's proposal. And this scoring is made by the rest of the players who serve as one of representatives of the stakeholders. They weigh in on whether the spokesperson's proposal meets the stakeholder's objective. The spokesperson's proposal is evaluated by the judges (i.e., the rest of the players) on the basis of the degree to which the spokesperson well and articulately hit their needs. Since the spokesperson's proposal was made by other players' help and support, it appears that this judgment eventually shows the quality of how well and successfully the spokesperson made the most of the collaborative construction work within the gaming context. This in turn clearly shows that evaluation process occurring in the gaming context is based purely on collective and interactive nature of human cognition. Accordingly, overall game scores could capture and represent the player's interactive and situative cognition and action.

Game results can capture how actively the player participated in the co-construction work.

What's obvious is that the quality of spokesperson's argument is based on the quality of active interactions during the co-construction process in gameplay. In terms of players' interactivity, three types of players' interaction were observed: confirmation of the provided idea from others; asking questions to the contributor; and, actively leading the discussion. Although this game did not incorporate any game mechanics to estimate these interactive actions for the game scores, I frequently observed a much higher quality of player's argument when the spokesperson actively interacted with other players over the course of the co-construction process in gameplay. To assure this investigation, I counted the frequencies of these interactive actions over the whole game sessions and recorded their final game as seen in the Table 2.

Table 2.

Overall Game Outcome of Gameplay

Group	Spokesperson	Interactive actions (occasions)	Objectives addressed* (game score)
Group 1	Player 1	4	Score: +1 • Admin 0 • Students 0 • Teachers +1 • Community 0
	Player 2	1	Score: -4 • Admin -1 • Students -1 • Teachers -1 • Community -1
	Player 3	4	Score: +1 • Admin 0 • Students 0 • Teachers 0 • Community +1
	Player 4	5	Score: +1 • Admin +1 • Students 0 • Teachers 0 • Community 0
Group 2	Player 1	5	Score: +2 • Admin +1 • Students 0 • Teachers 0 • Community +1
	Player 2	4	Score: +2 • Admin +1 • Students -1 • Teachers +1 • Community +1
	Player 3	3	Score: -2 • Admin -1 • Students 0 • Teachers 0 • Community -1
	Player 4	4	Score: +1 • Admin +1 • Students 0 • Teachers 0 • Community 0

* +1 (met), 0 (neither met or unmet), -1 (unmet)

With this dataset, I conducted a correlation analysis to see if there was any association between spokesperson's interactive actions and the game scores. It showed that there was a positive correlation between players' interactive actions during the gameplay and their game scores ($r = .919$, $p < .001$).

From this exploratory analysis, it appears that overall game results could capture how actively the player participated in social activities. This thus showed that the game legitimately captured the situative and interactive nature of cognition and actions, which views knowing as an active participation in a social practice.

Summary and Conclusions

Assessment plays a key role in our teaching and learning and is a key to educational reform (Anderson, 1998; Shepard, 2000). There have been many innovative attempts and endeavors to develop new ways of teaching and learning in accordance with the new paradigm of education; however, innovation in assessment research and practice lags behind. In the present study, the *Playful Assessment* framework was proposed to build a theoretical framework for game-based assessment practice using a situated cognition and sociocultural perspective. In addition, to better explain the proposed alternative assessment model, a case study was conducted by using *INFLUENCE*, a collaborative game, as a special case of *Playful Assessment* practice. In so doing, this study aimed to provide readers with a much-needed guidance for the research and practice on game-based assessment from the situated cognition perspective.

From the proposed *Playful Assessment* framework, I would argue that assessment should be thought of as a social activity that is an integral part of general systems of activity that aim to capture mutually-mediated actions (joint participation) as well as contextually-coordinated actions (codetermination of acting with the environments). In this regard, the present study

defined assessment as a playful (doable) participation in a playful (play-full) activity. In terms of the unit of analysis, what is assessed from this assessment model is that we are to estimate to what extent the one actively and successfully participates in social activities with the legitimacy of the activity that is determined by the community of practice (i.e., the quantity and quality of participation).

To help better explain the proposed *Playful Assessment* practice, a case study was conducted. As discussed, *INFLUENCE,* the designed collaborative game, created an assessment environment in such ways that promote the proposed principles of *Playful Assessment*. More interestingly, the gameplay provided observable actions and cognition to be able to estimate the situative and interactive cognition and action. More to the point, the overall game results provided estimates of capturing how articulately and actively the player participated in social activities (i.e., quantity and quality of participation). That is to say, the findings of the present study imply that games might be able to capture the situative and interactive nature of cognition and action in such ways that the game play (scores) could detect the more active participant in the activity, as well as that the game scores showed that the more active participants received better scores determined by the community of practice in this gameplay (i.e., other players).

Although the findings of the present study are encouraging, many questions still remain with regard to which game actions can best be used to estimate the player's interactive and situative cognition and how the game can serve as a valid assessment environment. From the gameplay analyses and observations, it was still somewhat obscure to estimate and detect each individual player's performance, largely because the game mechanic itself was not able to identify or quantify each player's performance in anyway. It is thus needed to have clearer game outcomes that can be used to estimate one's situative interactive cognition in the game play and

to compare them with the real-world performance to establish the ecological validity of the game as an assessment environment, making a case that the game can serve as a valid assessment environment. This eventually guides to the next iteration of the game design and research study work.

References

Anderson, R. S. (1998). Why talk about different ways to grade? The shift from traditional assessment to alternative assessment. *New directions for Teaching and Learning*, *1998*(74), 5-16.

Baker, E. L., & Delacruz, G. C. (2008). A framework for the assessment of learning games. *Computer games and team and individual learning*, 21-37.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: principles, policy & practice*, *5*(1), 7-74.

Black, P. J. (1998). *Testing, friend or foe?: the theory and practice of assessment and testing*. Psychology Press.

Bol, L., & Strage, A. (1996). The contradiction between teachers' instructional goals and their assessment practices in high school biology courses. *Science Education*, *80*(2), 145-163.

Brown, G. T. (2004). Teachers' conceptions of assessment: Implications for policy and professional development. *Assessment in Education: Principles, Policy & Practice*, *11*(3), 301-318.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, *18*(1), 32-42.

Chin, J., Dukes, R., & Gamson, W. (2009). Assessment in simulation and gaming a review of the last 40 years. *Simulation & Gaming*, *40*(4), 553-568.

Chopping, 1990;

Clancey, W. J. (1997). *Situated cognition: On human knowledge and computer representations*. Cambridge university press.

Connor-Greene, P. A. (2000). Assessing and promoting student learning: Blurring the line between teaching and testing. *Teaching of Psychology*, *27*(2), 84-88.

Dann R (2002). *Promoting assessment as learning: Improving the learning process.* New York: Routledge.

DiCerbo, K. E. (2014). Game-based assessment of persistence. *Educational Technology & Society*, *17*(1), 17-28.

Hargreaves, A., Earl, L., & Schmidt, M. (2002). Perspectives on alternative assessment reform. *American Educational Research Journal*, *39*(1), 69-95.

Eisenack, K. (2013). A climate change board game for interdisciplinary communication and education. *Simulation & Gaming*, *44*(2-3), 328-348.

Feuerstein, R. (1979). *The dynamic assessment of retarded performers: The Learning Potential Assessment Device, theory, instruments, and techniques*. Baltimore: University Park Press.

Fleer, M., & Richardson, C. (2009). Cultural-historical assessment: Mapping the transformation of understanding. *Early childhood education: Society and culture*, 130-44.

Fleer, M. (2002). Sociocultural Assessment in Early Years Education--myth or reality?. *International Journal of Early Years Education*, *10*(2), 105-120.

Fleer, M. (2015). Developing an assessment pedagogy: the tensions and struggles in re-theorising assessment from a cultural–historical perspective. *Assessment in Education: Principles, Policy & Practice*, *22*(2), 224-246.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, *1*(1), 20-20.

Gee, J. P. (2008). Game-like learning: An example of situated learning and implications for opportunity to learn. *Assessment, equity, and opportunity to learn*, 200-221.

Gibson, J. & Gibson, E. (1955). Perceptual learning: Differentiation or enrichment? *Psychological review*, 62(1), 32-41.

Gipps, C. (1994). Developments in Educational Assessment: what makes a good test?. *Assessment in Education: Principles, Policy & Practice*, *1*(3), 283-292.

Gipps, C. (1999). Chapter 10: Socio-cultural aspects of assessment. *Review of research in education*, *24*(1), 355-392.

Gipps, C. (2002). Sociocultural perspectives on assessment. *Learning for life in the 21st century: Sociocultural perspectives on the future of education*, 73-83.

Greeno, J. G. (1989). A perspective on thinking. *American Psychologist*, *44*, 134-141.

Grigorenko, E. L., & Sternberg, R. J. (1998). Dynamic testing. *Psychological Bulletin*, *124*(1), 75.

Haywood, H. C., & Tzuriel, D. (2002). Applications and challenges in dynamic assessment. *Peabody Journal of Education*, *77*(2), 40-63.

Hickey, D. T., & Zuiker, S. J. (2005). Engaged participation: A sociocultural model of motivation with implications for educational assessment. *Educational Assessment*, *10*(3), 277-305.

Hickey, D. T. (2015). A situative response to the conundrum of formative assessment. *Assessment in Education: Principles, Policy & Practice*, *22*(2), 202-223.

Huff, K., Steinberg, L., & Matts, T. (2010). The promises and challenges of implementing evidence-centered design in large-scale assessment. *Applied Measurement in Education*, *23*(4), 310-324.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Loh, C. S. (2012). Information Trails: In-process assessment of game-based learning. In *Assessment in game-based learning* (pp. 123-144). Springer New York.

Lund, A. (2008). Assessment made visible: Individual and collective practices. *Mind, Culture, and Activity*, *15*(1), 32-51.

Mariscal et al. (2012)

McLaughlin, M. &Vogt, M. (1996). *Portfolio in teacher education.* Newark, DE: International Reading Association.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education.* San Francisco, CA: Jossey-Bass Publishers

Pearlman, M. (2004). The design architecture of NBPTS certification assessments. In R.E. Stake, S. Kushner, L. Ingvarson, & J. Hattie (Eds.) *Assessing teachers for professional certification: The first decade of the National Board for Professional Teaching Standards* (pp. 55–91). United Kingdom: Emerald Group Publishing Limited.

Perrone, V. (1991). *Expanding Student Assessment*. Washington, DC: Association for Supervision and Curriculum Development.

Resnick, M. (2006). Computer as paint brush: Technology, play, and the creative society. In D. Singer, R. Golikoff, & K. Hirsh-Pasek (Eds.), *Play = learning: How play motivates and enhances children's cognitive and social-emotional growth*. (pp. 192-208). New York, NY: Oxford University Press.

Resnick, L. B. (1987). The 1987 presidential address learning in school and out. *Educational researcher*, *16*(9), 13-54.

Rogoff, B. (1990). *Apprenticeships in thinking. Cognitive development in social context.* Oxford, England: Oxford University Press.

Roth, W. M. (1998). Situated cognition and assessment of competence in science. *Evaluation and Program Planning*, *21*(2), 155-169.

Schwartz, D. L., & Martin, T. (2004). Inventing to prepare for future learning: The hidden efficiency of encouraging original student production in statistics instruction. *Cognition and Instruction*, *22*(2), 129-184.

Schwartz, D. L., & Arena, D. (2013). *Measuring what matters most: Choice-based assessments for the digital age*. Cambridge, MA: MIT Press.

Schwartz, D.L., Lindgren, R., & Lewis, S. (2009). Constructivism in an age of non-constructivist assessments. In S. Tobias and T.M. Duffy (Eds.) *Constructivist theory applied to instruction: Success or failure?* (pp. 34-61). New York, NY: Taylor and Francis.

Shaffer, D. & Gee, J. (2012). The right kind of gate: Computer games and the future of assessment. In M. Mayrath, J. Clarke-Midura, & D. Robinson (Eds.), *Technology Based Assessment for 21st Century Skills: Theoretical and Practical Implications from Modern Research.* New York, NY: Springer-Verlag.

Shaffer, D. W. (2006). *How computer games help children learn*. New York, NY: Palgrave Macmillan.

Shepard, L. A. (1995). Using Assessment to Improve Learning. *Educational Leadership*, *52*(5), 38-43.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational researcher*, *29*(7), 4-14.

Shepard, L. A. (2005). Linking Formative Assessment to Scaffolding. *Educational leadership*, *63*(3), 66-70.

Shute,V., & Ke, F. (2012). Games, learning, and assessment. In D. Ifenthaler, D.Eseryel, & X. Ge (Eds.), *Assessment in game-based learning: Foundations, innovations and perspectives* (pp. 43-58). New York: Springer Science & Business Media B.V.

Snow, R. E., & Mandinach, E. B. (1991). Integrating assessment and instruction: A research and development agenda. *ETS Research Report Series*, *1991*(1).

Squire, K. (2006). From content to context: Videogames as designed experience. *Educational researcher*, *35*(8), 19-29.

Steinkuehler, C. & Squire, K. (2014). Videogames and learning. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (2nd ed.). New York, NY: Cambridge University Press.

Struyven, K., & De Meyst, M. (2010). Competence-based teacher education: Illusion or reality? An assessment of the implementation status in Flanders from teachers' and students' points of view. *teaching and teacher education*, *26*(8), 1495-1510.

Torrance, H. (2007). Assessment as learning? How the use of explicit learning objectives, assessment criteria and feedback in post-secondary education and training can come to dominate learning. 1. *Assessment in Education*, *14*(3), 281-294.

Tzuriel, D. (2001). *Dynamic assessment of young children: Principles, approaches, and procedures*. New York, NY: Plenum Press.

Vygotsky, L. (1978). *Mind in society: The development of higher mental process.* Cambridge, MA: Harvard University Press.

Whitehead, A. N. (1929). *The aims of education*. Cambridge: Cambridge University Press.

Wiggins, G. P. (1993). *Assessing student performance: Exploring the purpose and limits of testing*. San Francisco, CA: Jossey-Bass.

Wilson, M., & Sloane, K. (2000). From principles to practice: An embedded assessment system. *Applied measurement in education*, *13*(2), 181-208.

Young, M. F. (1995). Assessment of situated learning using computer environments. *Journal of Science Education and Technology*, *4*(1), 89-96

Young, M. F. (2004). *An ecological description of video games in education*. Paper presented at the International Conference on Education and Information Systems Technologies and Applications (EISTA), Orlando, FL, July, 2006.

Young, M. F., Kulikowich, J. M., & Barab, S. A. (1997). The unit of analysis for situated assessment. *Instructional Science*, *25*(2), 133-150.

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., ... & Yukhymenko, M. (2012). Our princess is in another castle a review of trends in serious gaming for education. *Review of educational research*, *82*(1), 61-89.

CHAPTER III

PLAYFUL ASSESSMENT FOR EVALUATING TEACHERS' EXPERTISE IN TPACK-L

Background

Key to assessment instrument development is to provide evidence that the designed assessment produces consistent (i.e., reliable) and credible (i.e., valid) results. If an assessment was not able to validly capture what it is supposed to measure, it has little values formatively or summatively. Assessment developers thus make an effort to establish the validity of an assessment, making a case that scores of the instrument produce credible and accurate results.

To be valid in an assessment context, developers must establish good criteria for ensuring that the results produced by the assessment represent one's true ability. In this regard, traditional test theorists rely on classical test theory, that assumes that observed scores are simply the sum of true scores (i.e., true ability) plus error scores. This assumes that there is an individual factor and all else is error, taking no account of other factors such as context. Hence, their central focus is to interpret the observed scores within the designed assessment, examining how well an assessment measures the individual's targeted knowledge, skills, or behaviors in such a controlled assessment context. Validity from this tradition rests mainly on construct validity of the designed assessment per se, which is a context-free approach to validity (Wainer & Braun, 1988). This tradition seeks to standardize the complex and often uncontrollable nature of contextual factors and the relational nature of situated cognition, presuming all other variations as error scores (Resnick & Resnick, 1992). As such, in order to understand validity from this tradition, we must assume that, first, every condition in which the developed assessment is employed is the same and, second, that our cognition (i.e., think, feel, and act) exists and operates in the same way independently of the context.

However, some theorists argue that cognition is always situated in the context, and contextual complexities (i.e., constraints) can substantially define the nature of many activities

(Clancey, 1997; Gibson & Gibson, 1955). Theorists coming from a perspective of situated cognition and sociocultural theory, in particular, assert that knowing is a social enterprise and is a form of competent action achieved in a rich social context (i.e., context-laden) (see e.g., Cole & Engestrom, 1993; Greeno, 1997; Lave & Wenger, 1991; Rogoff, 1990; Roth, 1998; Salomon & Perkins, 1988). Our true ability always exists and operates as an interaction within the environment on the fly, co-defined by properties of the individual and properties of the environment.

Many interpretivists who are aware of the role of context in the phenomena thus argue that there is a need to understand validity in a broader way. This includes examining trustworthiness, quality, or rigor of the measurement within the context, as opposed to a single context-free generalizability (i.e., accuracy or precision of the scores across the context) (Lincoln & Guba, 1985; Maxwell, 1992; Schimuckler, 2001; Seale, 1999). In particular, the error term from classical test theory may not be entirely error at all, but rather needs to be taken into account to define our true ability (Bateson, 1972; Hutchins, 2010; Young, 1995). Central to validity or credibility of any assessment from this alternative tradition is that we should give attention to a relational aspect of our cognition that is coupled with the context, situation, or environment. We need to integrate contextual complexities into any analytic framework (i.e., unit of analysis) for the validity of an assessment. In this respect, a need exists to provide a context-laden approach to validity in such a way that examines to what extent the interaction with the assessment context really represents what happens in the real world, as well as to what extent the assessment context is really related to practical contexts (Wiggins, 1993). The bottom line is that we should produce evidence showing that the results from the assessment really capture one’s daily practice. Validity, thus, must account for the fidelity of the assessment

context. The current psychological science calls this type of validity as “ecological validity” or “contextual fidelity.”

Drawing upon such a context-laden approach to assessment and validity, I report on the use of a game-based assessment that has evidence of ecological validity. Specifically, this study attempts to develop a playful assessment for measuring teachers’ technology integration cognition in the classroom. To this end, I first introduce the game-based assessment practice and discuss cognitive ecological accounts of the game as a playful assessment. I then present the process of establishing the validity of the developed game, with a goal of providing empirical evidence that gameplay can capture teachers’ real-world technology integration practice.

Ecological Validity: Context-Laden Approach to Validity

One issue that learning scientists who are devoted to the design and development of various educational innovations must address is whether the observed experiment or assessment results are a good indicator of the phenomenon in the real world. In this respect, learning scientists have highlighted the importance of establishing ecological validity of the design work (Collins, 1993; Young, 1995; Young, Kulikowich, & Barab, 1997). At its heart is that results from the experimental setting should truly be observed in the daily practice of a community.

The idea of ecological validity has a long history in psychological science, though there is no clear consensus on its definition (Schmuckler, 2001). As a starting point, “ecological validity often refers to the relation between real-world phenomena and the investigation of these phenomena in experimental contexts” (Schmuckler, 2001, p. 420). In psychology, ecological validity is widely defined as “the extent to which the environment experienced by the subjects in a scientific investigation has the properties it is supposed or assumed to have by the experimenter”

(Bronfenbrenner, 1977, p.51). At its heart, ecological validity is concerned with the integrity of the real-life situation in the experimental context. As such, the ecological validity has to do with representativeness and naturalness, “with a primary consideration that the environment contains crucial features of naturalistic settings” (Schmuckler, 2001, p. 421).

About Game Design

The game used for this study was *EXPERTISE*. This game is the result of several iterations of game design. I worked to design a game as an assessment that captures teachers' pedagogical design thinking in relation to technology integration. To this end, two theoretical frameworks, the *Playful Assessment* framework (i.e., situated cognition approach to assessment model) and the TPACK-L framework (i.e., teacher knowledge of technology integration), guided me and provided the design principles for this game-based assessment.

I implemented the designed game repeatedly to see how the designed game worked, and from this implementation, I identified several design issues and refined the design work based on formative data. The criteria for a final design were twofold: 1) how the game promoted the *Playful Assessment* design principles; and, 2) how well the game elicited TPACK-L cognition during gameplay. Accordingly, three phases of iterative game design and research were conducted.

Phase 1. In Phase 1, I used an existing card game, CARD *tamen*™ TPACK-L to begin to assess teachers' technology integration cognition. In the first implementation, I found that the game served as a useful assessment that elicited the players' technology integration cognition, as well as that the game captured the different quality of players' technology integration cognition. Yet,

in terms of the usability of the game mechanics, it appeared that players more often than not tended to build off of one others' ideas to generate his/her own technology integration strategy over the course of the game play, which diminished the playfulness of the game as well as revealed some drawbacks to the assessment environment for capturing the individual. These findings suggested to me that there was a need for a collaborative assessment tool to capture the interactive and situative nature of human cognition. So I moved to design a collaborative board game.

Phase 2. From the first implementation, I and colleagues at UConn redesigned the game, and developed *INFLUENCE*. In this redesign process, we focused on developing a collaborative game and attempted to see how this collaborative gameplay could capture the situative and interactive nature of the player's competencies with technology integration into classroom instruction. As a result of this implementation, we found that the gameplay could reveal *how articulately* the players addressed what they have discussed collaboratively as well as *how actively* the player participated in a collaborative problem-solving activity. Such results indicated to me that, to a degree, the refined collaborative game mechanics worked to capture the situative and interactive nature of pedagogical design thinking. That being said, it failed to clearly show which game actions could be used to estimate each game players' interactive and situative cognition, and any validity of my observations had yet to be shown.

In addition, this game did not fully capture teachers' technology integration cognition; instead, the game focused more on a problem-solving strategy to resolve social issues typically experienced by technology integration specialists (e.g., lack of resources, reduction of school expenditures, and etc.). So, there was a need to revise the game to fully capture teachers'

technology integration cognition. The next revision of game mechanics was designed to capture more of each individuals' situative and interactive performance in regard to technology integration.

Phase 3. To implement additional iterative refinements, I and colleagues at UConn revised game mechanics in a way that game results can be used as estimates of players' pedagogical design thinking in relation to technology integration. From this refinement, a new game, *EXPERTISE*, was designed, and with this revised game, I carried out this study to see how this refined game performed as a valid assessment environment for the teachers' technology integration cognition.

EXPERTISE*:* A Collaborative Game for TPACK-L Competency

The *EXPERTISE* game set-up is shown in Figure 1 (one board, three technology card decks, one theory card deck, and two pedagogy card decks). Each player also has an expert level card that showed an individual player's expert level (i.e., game scores) in light of TPACK-L over the course of the gameplay. Four players can play this game. In every round, players are given two technology cards, one pedagogy card, and one theory card as their instructional context. The game starts with one player (i.e., Speaker) sharing his or her content area for a lesson that could involve technology integration, and the rest of the players serve as co-teachers to help him/her determine possible technology applications. The game runs two rounds, meaning every player plays as a teacher (i.e., Speaker) who shares their lesson content at least two times. In the first round, players use the first round pedagogy card deck that includes more traditional instructional strategies such as direct instruction, group discussion and the like; and, in the second round, they

use the second round pedagogy card deck that includes more complex and innovative teaching strategies, such as problem-based learning, gamification, anchored instruction and the like.

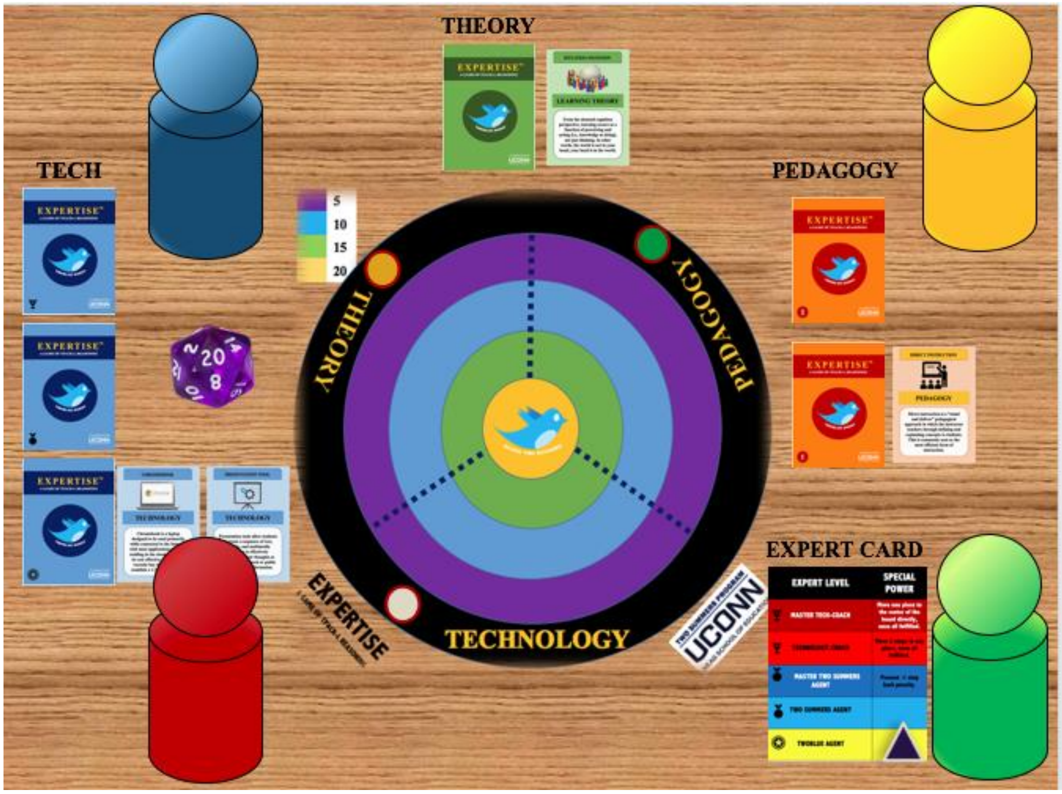


Figure 1. *EXPERTISE* Game Set-up

Once the Speakers shares the content area, all of the players together have three minutes to discuss their best solution to teach the given content by taking the given technology, pedagogy, and theory into account. After this co-construction process is done, the Speaker has two minutes to describe how the chosen technologies will be integrated with the given pedagogy and learning theory. Once the Speaker's proposal is done, each of the other players then serves as the reviewers in one of the areas (i.e., technology, pedagogy, and learning theory) and weighs whether the Speakers' proposal meets each of the TPACK-L components. To this end, players roll for their predisposition regarding their judgment using dice. This determines their severity of

judgment, from easygoing, through critical, to hard-ass for each round. The other players weigh the Speaker's proposal based on their role and expertise. If the proposal successfully hits any of the components of TPACK-L, the game token placed for each of the TPACK-L components moves one step inward toward the center of the board. Once co-players' judgments are done, the Speaker's expert level is promoted based on the result of the judgment. If all of the components are successfully addressed (i.e., three components move in)—which means the Speaker hits TPACK-L reasoning perfectly—, his/her game expert level is promoted two ranks. If the proposal meets two components of TPACK-L, his/her expert level is promoted one rank. If the proposal meets only one component or does not meet any, his/her game level stays at the current level. But if the proposal fails to meet any of the components of TPACK-L, his/her game level is down-graded accordingly. This way, the player's expertise in TPACK-L during the gameplay is scored. After this co-judgment is done, the Speaker also has a chance to judge the co-players' performance, evaluating as to how well and successfully players participated in the co-construction process. So the Speaker picks one of the co-players who was most helpful that round, and the player is promoted one level-up in his or her expertise level. In terms of the expert level, there are five expert levels: Two Blue Agent; Two Summer Agent; Master Two Summer Agent; Technology Coach; and, Master Technology Coordinator. At the end of the gameplay, each player' final expert level can be recorded.

In addition, in each round, players are asked to use a proper technology card deck according to their expert level. Let's suppose that the player expert level is Two Blue Agent, this player should play with Two Blue Agent technology card deck. If the player expert level is Master Two Summer level, this player should use Master Two Summers level technology card

deck. This way, game difficulty is adjusted and becomes more challenging for some players as the game proceeds.

By using this game as a measure of teachers' technology integration cognition, this study aimed to examine to what extent this gameplay can be used to estimate teachers' technology integration practice in their classroom (i.e., context-laden approach). In what follows, I first describe the ecology of this game as Playful Assessment, and then, document the validation process of this game as an assessment environment that has rich contextual fidelity (i.e., ecological validity).

Cognitive Ecology of Gameplay for the Playful Assessment

Next, I explore the dynamic nature of cognitive ecosystems of this gameplay. In particular, I analyze the cognitive ecology of the *EXPERTISE* game for Playful Assessment, with the goal to shed light on the interconnected nature of cognitive ecosystems of this game as an assessment. This section first introduces cognitive ecological accounts of the *EXPERTISE* gameplay by examining how the players' cognitive process unfolds within this game context. These analyses include how players interact with other players in this game context, and how they interact with the game environment. And lastly, this section discusses these interactions in light of the *Playful Assessment* framework, trying to discuss the cognitive ecosystems of the game as a *Playful Assessment* environment. In so doing, I attempt to discuss the functional value of this game as an assessment environment for teachers' pedagogical design thinking in relation to technology integration.

Cognitive ecology is the study of cognitive phenomena in context and can be defined as the multidimensional context (i.e., a network of mutual dependence/influence of our cognitive

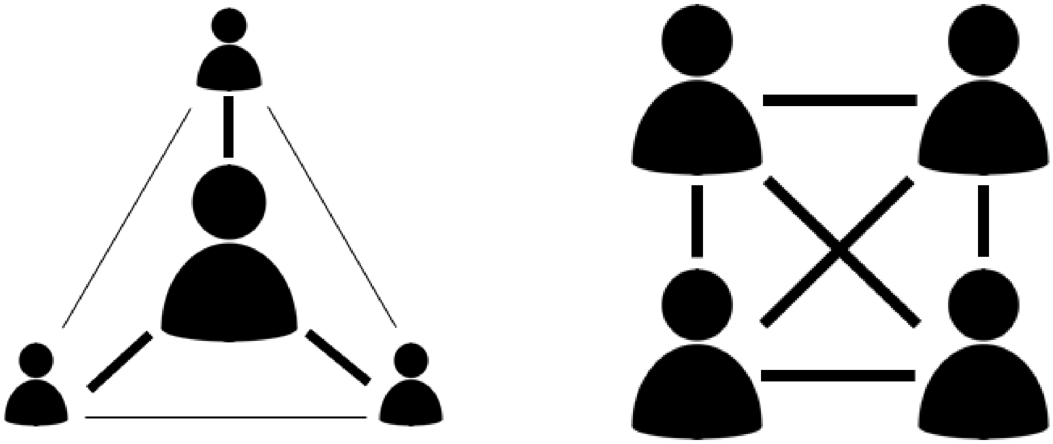
ecosystems) in which our cognitive processes (e.g., think, act, feel, sense, etc.) develop and operate in rich ongoing interaction with the environment (Hutchins, 2010). To explore and understand cognitive ecology is crucial in that our cognition is a biological system or function (i.e., mutual accommodation through the coupling of perception and action), not a logical process, bound to the environment (Bateson, 1972; Gibson, 1986; Goodwin, 1978). Simply put, if an agent can perceive any stimuli in the context and act upon it accordingly, it is cognitive. It is thus essential to study such relative and interconnected aspect of cognitive ecology for the sake of a full understanding of cognitive phenomena.

Our design defines four specific events occurring during *EXPERTISE* gameplay:1) *Context given*; 2) *Co-construction process* (i.e., collaborative discussion); 3) *Proposal*; and, 4) *Judgment*. In each game round, players are first given an instructional context by the playing cards initial setup that includes two technology cards, one pedagogy, and theory card along with the Speaker's selected content area (i.e., the subject matter chosen). With this instructional context in mind, players collaboratively generate their best technology integration plan by taking the given technology, pedagogy and theory into account. The Speaker, then, proposes his/her approach to the wise integration of technology. And lastly, the rest of the players judge whether the Speaker successfully addresses each of components in light of TPACK-L framework.

In each game event, interactions among players occur with a specific goal and in various ways. In the event of *Context given*, players' primary goal for interaction should be to establish the shared goal and/or co-ownership of understanding of the given instructional context by communicating (e.g., asking, answering, or explaining) with each other. The most frequently observed interaction in this event was that the player kept asking questions about the context if they did not fully understand it, and the rest of the players answered these questions to the point

where every player understood the context for the round of play. In light of the cognitive ecology, this interaction can be understood as: the game allows players to establish intersubjectivity such that they can build the co-ownership of knowledge as this game play proceeds.

The most dynamic interactions among the players take place in the event of *Co-construction* due in large part to *EXPERTISE*'s collaborative game mechanics. Two specific patterns of interaction/communication happened in the *Co-construction* process: 1) Speaker-led communication (i.e., wheel communication pattern); and, 2) Joint communication (i.e., network communication pattern) (see Figure 2). In the case of the Speaker-led communication, players interacted with others in such a way that the Speaker, first, briefly introduced his or her technology integration plan and other players served as technology coaches tasked with scaffolding the Speaker's original plan. It thus appears that this communication pattern is more or less a one-directional interaction focused on the Speaker. Yet, in the case of the Joint communication, all of the players tried to contribute equally to the generation of their idea. Any of the players who had an idea starts the discussion, and they openly interacted with each other together. When they came to agreement of their approach, they finished this group discussion. In this interaction pattern, there is no one leader but all contributors over the course of their co-construction process. Interestingly enough, whichever interaction patterns players took during their game play, the specific process/trend of their communication can be depicted in Table 1.



Wheel Pattern *Network Pattern*

Figure 2. Communication Patterns of Game Play

Table 1.

Communication Trends Over Co-construction

	Goal	Act	Phrase	Outcome (*The idea becomes…*)
	extend	agree	*I agree…* *You're right…*	wider
		add	*…and…, …or…* *so that…*	deeper
Collaborative Discussion Begins	make certain	ask	*Why…, What…* *Does…Can…* *Is…*	more specific
		answer		
	propose	explain	*What if…,* *How about…*	richer
	concur	consent	*Are we good?* *Are we done?* *Are you ready?*	mutual

Following is an example showing this pattern. In this example, the players were given the following game context: interactive white board and smart technology as available technologies;

reflective journaling as pedagogy; and, constructionism as theory. Also, they were asked to teach a topic of "the causes of the American revolution." Given such instructional context, their interaction unfolded as follows:

P1 [Speaker]:	So, we have to create something that has to do with a rationale for the Boston Tea Party or something or reasons why they were doing it…
P2:	You could create a situational class where students have to deal with taxation without a representation. So handing them out like fake money and you take it from them. And have that money to be used for something like…privileges they can buy like no homework and stuff like that.
P1:	so we could use *Classdojo* [application] for that?
P2:	*yes...*
P1:	…for the currency system? So we will be using Smart Tech like tablet PC or something?
P2:	*You're right…and* you can just randomly take it away from them.
P3:	okay, and we have to make something…
P4:	*How about* making a web site where they could create a piece of propaganda using their smart technologies either for the British or the U.S.
P3:	*...so that* they can project it on to the interactive whiteboard. And *they can do the reflective journaling of it?*
P4:	Yes, they can reflect on how they…well… we have to discuss that.
P3:	okay, *what about this*…we divide a class into two, colonies and the British. And we treat the colonies very poorly and treat the British wonderfully. And then, they have to create a piece of propaganda. And then we do project them on the interactive whiteboard. And, at the end, we have them to do a reflective journaling as to how they did feel to be treated poorly and how they did feel to be one of delegates.
P4:	*Is the reflective journaling on the paper or…?*
P3:	*No…*
P1:	We can do it on the Smart Tech.
P2:	*Alright, are we good?*
P1, 3, 4:	*Yes…*

As illustrated, players' cognition appears contextualized in the game and distributed across players; and, it arises from a dynamic social interaction and evolves *on the fly*. That is to say, cognition is situated in its social context. As far as the interactions with the game environment are concerned, in the *Proposal* process, players physically interacted with the game environment in such a way that when the Speaker addressed his/her proposal, they sequentially looked at the given cards and addressed their approach accordingly. Also, many of players gathered all the cards and put them in front of the table, and then they arranged them in order to prompt their idea generation. This interaction (i.e., cognitive phenomenon) can also be fully understood in a sense that our cognition is grounded in multiple ways, including bodily state, situated action, and material and social settings (Barsalou, 2008; Glensberg, 1997; Hutchins, 1995; Lakoff & Johnson, 1980).

These interactions can be viewed in light of the *Playful Assessment* framework, in an attempt to better understand the cognitive ecology of this game as the Playful Assessment. In particular, these interactions may best be explained based on the key aspects and principles of my *Playful Assessment* framework, which involves playfulness (doable, goal-oriented action), collective practice (co-assessment), transitional dynamics (identity change), and ecological validity (fidelity).

First and foremost, such social and physical interactions constantly change the constraints (i.e., game settings or situation), such that the players are attuned to and act upon a changing game environment on the fly. For instance, one player starts the discussion and another player jumps in and adds another idea (i.e., creating new situations), and from that, players can extend their idea based on such on-going stimuli. Such interactions help players to adopt the new goals and react to them, which can estimate players' playfulness (i.e., goal-oriented action or active

participation) within this game. In addition, throughout the whole gameplay, players are placed in a situation where they collectively create co-ownership of knowledge by providing feedback in the moment, based on the context/situation unfolding over time. In particular, players' interactions in the *Judgment* process fully capture the collective practice of Playful Assessment in such a way that players are given an opportunity to have both self-assessment and peer-assessment. This enables players to evaluate to what extent players articulate the approach as well as how well they interact with each other in the game context. Such game outcomes or players' performances are eventually represented as individual players' expert level (from the Two Summer Agent to the Master Technology Coordinator) as this gameplay goes. Interestingly enough, according to their expert level, their interaction pattern also changes, largely because they play the game with more challenging game set-ups based on their expert level (e.g., new card sets). That is, they interact with the game context differently as the gameplay proceeds. The game set-up thus invites players to show their expertise, thereby providing an estimate of each player's identity change over the course of gameplay. In regard to the fidelity of the gameplay, players are placed in a realistic situation where one player asks for advice on teaching his/her subject matter with given technologies, and the rest of the players serve as technology coaches to help him/her out to give a creative and effective instructional solution. In such a realistic context, players interact with each other according to their roles in a manner that asks and answers questions and further develops a teaching/learning objective. This way, the game creates and nurtures the fidelity of the real-world instructional context.

In Search of Context-laden Validity of *EXPERTISE* as an Assessment

To establish the context-laden validity of the *EXPERTISE* game as an assessment, I went through two processes of evaluating validity of the game as an assessment. In particular, I sought

to find an answer to the question of to what extent the designed game can be used as an assessment in an ecologically valid way.

For this study, fourteen in-service teachers enrolled in the Master's program in Educational Technology played the *EXPERTISE* card game on at least two different occasions with different groups, and their gameplay was audiotaped. Each gameplay event took approximately an hour. From these whole gameplay sessions, 6 hours of audio recordings were taken. In addition, each player's game scores (i.e., expert level at the end of the game) was collected. With these data, I conducted two process analysis concerning validation in an attempt to establish the context-laden validity of the game as an assessment of technology integration ability.

Process 1: To what extent does the game capture players' practical knowledge?

Participants and Setting

Fourteen in-service teachers who played the *EXPERTISE* were asked to give a presentation on how to wisely integrate available technologies in their classroom as part of their Master's program capstone works. Specifically, they were asked to present one example of the wise integration of classroom technology by describing its use in the classroom, the content it addresses and a learning theory that would support or explain its effectiveness. This task is thus designed to express the participants' technology integration knowledge in their own classroom context, and this, *performance assessment*, is a feasible way to assess one's complex reasoning competencies (e.g., problem-solving, higher-order thinking, etc.) (Resnick & Resnick, 1992) and is thus regarded as one of the credible methods to measure the participants' technology integration knowledge (Koehler, Shin, & Mishra, 2012).

Data Sources and Analysis

Data sources used in this process were the participants' *EXPERTISE* game scores and their presentation scores. Since all of participants played the game twice with different groups, the average of their two game scores was used for the data analysis. Also, their presentation was evaluated and scored by the course instructor from 0 to 10. With this dataset, I conducted the convergent validity of the game. In particular, correlation analysis was conducted between their average game scores and their final presentation scores (i.e., performance assessment), in an attempt to make a case that the game scores could estimate their practical knowledge in relation to the wise integration of technology in the classroom.

Result

The descriptive statistics show the basic features of the data (see Table 2). The result of a correlation analysis showed that the participants' game scores were strongly correlated with their presentation scores (r =. 637, $p < .05$). That is, the participant who had higher scores on their *EXPERTISE* gameplay was more likely to have higher scores on their TPACK-L performance task. As described, this performance task was exclusively designed to evaluate the participants' knowledge in relation to the wise integration of technology in the classroom, which the *EXPERTISE* game also exactly aims for. The result thus showed convergence of the two measures assessing the participants' knowledge in relation to wise technology integration (i.e., TPACK-L competency), thereby providing the evidence of convergent validity. Accordingly, this result indicated that the *EXPERTISE* gameplay could be used as a valid estimate of how to wisely integrate technology in the classroom from its construct (i.e., TPACK-L) standpoint.

Table 2.

Descriptive Statistics for the dataset

	N	Range	Mean	Std. Deviation
Performance Assessment	14	1.00	9.5357	.23732
EXPERTISE Game Scores	14	5.00	8.5000	1.65250

Process 2: To what extent do the game scores really parallel real-world practice in relation to technology integration?

Participants and Setting

For this analysis, I selected two players as example cases and conducted field observations of their daily teaching, with the intent to document how their technology integration practices were present in their actual classroom settings and any connections that could be made to their prior gameplay in *EXPERTISE*. These participants were asked to allow me to visit their regular class twice a week for a month. Both participants work at the same middle school in a high-achieving and wealthy school district in Connecticut. A brief profile of the participants is described below. To protect the confidentiality of these participants, pseudonyms were used.

‘Ms. A’ is a life science teacher with 8 years of teaching experience. She teaches 7th grade life science and also serves as a gradebook program coach in her school. She holds her B.A. in Ecology and Evolutionary Biology and Master’s in Secondary Biology and Science as well as a 6th Year Certificate in Educational Technology. In terms of her gameplay profile, her

expert level in the game context was "Master Technology Coordinator," which is the highest game level out of five ranks.

'Ms. M' is a language arts teacher with 8 years of teaching experience. She has been teaching in her present school since 2014. She teaches 6^{th} grade language arts. She holds her B.A. in Elementary and Special Education and Master's in Remedial Reading and Language art as well as a 6^{th} Year Certificate in Educational Technology. In terms of her gameplay profile, her expert level in the game context was "Technology Coach," which is the second highest game level out of five ranks.

Case Analysis

To begin to describe the ecological validity (i.e., contextual fidelity), this process of follow-up observations was conducted. I documented the participants' teaching with technologies during this observational study. I also conducted informal and unstructured interviews with these participants, asking their strategy to use classroom technologies. These field observations were analyzed to see if players' expert level defined from the gameplay paralleled their TPACK-L expertise in practice. In addition, each teacher provided a document of self-reflection on their technology integration plan. This document was analyzed to capture their TPACK-L competency alongside the data from my field observations. Doing so documented how the gameplay might estimate the teacher's technology integration practice in their classroom, thereby making a case that the gameplay can be used as an ecologically valid measure of teachers' technology integration cognition.

Subjectivity

While doing this observational investigation, my subjectivity could play a role in shaping the study, from research design to data collection, to data analysis, and to interpretation. It is thus very important to disclose who I am in relation to what and whom I study, so that I can identify how my own thoughts, feelings, belief and desires may come into play over the course of the research. In so doing, this subjectivity, as Peshkin (1988) noted, can benefit the study, not just distort the study. In this respect, I should be aware of the fact that my role and position in this observational study might affect the interpretation of the research outcomes, since I am the one who designed the game as well as the one who has a strong desire to make a case that the game can be used as a valid assessment of teachers' technology integration cognition.

Given overt subjectivity, what I realized is that I might give more attention to what I want to observe (e.g., the moments where the teachers used technology wisely) in an attempt to account for the attainment of the study. As such, while conducting this observational investigation, I should systematically seek out my own subjectivity at various angles and times by reflecting and monitoring myself. One of the efforts I made during the observation was that I took notes of every instructional activity with three specific observational points in mind: what activities the teacher did; how the teacher instructed these activities; and, what technologies the teacher used for the activity. Also, these notes were made in a time sequence in order more to objectively capture the whole class activities to prevent selecting only specific exemplary occasions that I might have wanted to observe for the sake of my study.

Findings

This observational study was designed to investigate how two selected teachers integrated classroom technologies in their classroom and to what extent their expert level defined

from the *EXPERTISE* gameplay paralleled their technology integration practice in their classroom. Through such interpretive analyses, emerging patterns in the data led to the overall theme in relation to their teaching with technology that illustrates the ways these teachers utilized technology in their classroom.

Ms. A's student-centered learning with technology.

Ms. A's classroom was equipped with one teacher laptop, one classroom computer, and a Smartboard. During the period of the class observations, she covered a unit on the musculoskeletal system of the human body. For most periods, she asked her students explore the topic on their own by providing such activities as a WebQuest, individual and small group activities, self-directed activities with guided resources (handouts, textbook, etc.), and learning centers. Ms. A's class primarily used student-centered learning with the teacher as a facilitator. I determined that a primary goal of her instruction, thus, was to create learning environments where students can explore, discover, and construct their knowledge, which is rooted in Piagetian cognitive constructivism. Her instructional approach was also present in her interview responses regarding her teaching strategy. She said, "*For the most parts, I like to have kids explore the topic, and guiding and helping students to build their own knowledge is very important."* She went so far as to say that "*in my class, students were learning about the topic through self-directed activities. This way, I want to teach them some necessary skills like how to use the pertinent information and time management that they will need to have going forward."* This interview also showed that her pedagogy highly emphasized and promoted self-regulated learning.

To support her instruction, I observed that her integration of technology could be generally characterized as "*learning with technology*." During the observations, she integrated

various technologies to support students' learning, such as a table cart (i.e., one-to-on computing), iPod, students' own device (i.e., BYOD), Google Docs (i.e., collaborative writing tool), Quizlet, and Kahoot. Specifically, she attempted to utilize those technologies as cognitive tools, so that students can learn with technologies, not from the technologies (i.e., technologies as information tools or productivity tools). That is, students used these technologies as more an intellectual partner for their learning in a way that they used these technologies to support their thinking and problem-solving rather than to help promote the transmission of fact by providing a predefined or prescribed information. In a deep sense, students themselves functioned as designers of their own learning with the technologies over the course of the unit.

Ms. M's guided instruction within a resource-rich environment

Ms. M's classroom, like Ms. Amanda's, was equipped with one teacher laptop, one classroom PC, and a Smartboard. During the observation period, she taught a nonfiction unit, in particular signposts (numbers or statistics and quoted words). The whole unit was designed to help students prepare for their final speech project. Specifically, the students were asked to give a presentation on any topic of their choosing using nonfiction signposts they have learned. In every single unit, she attempted to help students develop their project by providing various prompts and brainstorming questions. Her class was filled with guiding questions and various feedback. To better help students prepare for their speech project, she provided various articles that not only had information about nonfiction signposts, but also could be helpful for them to build their speech structure. Also, more often than not, during her instruction, she assigned a certain amount of time to have them work on their project, and she inspected her students' works

individually. Based on each student's need, she provided personalized feedback. During the whole unit, students were constructing their own speech project with guidance from the teacher.

To support her instruction, she mostly used a Smartboard to project the questions/prompts and various course materials (e.g., articles, contents, etc.) to teach the content. She also used various Ted talks (www.ted.com/talks) videos to teach her students about what a good speech looks like and what components are included in a good speech. During the observations, she provided resource-rich learning environments with technologies, such that her students could easily and effectively access a variety of information resources they needed for their own project. Often, she used a tablet cart (one-to-one computing) and classroom PC, so that students could search online for any information they needed. Students could also use the teacher's printer to print out any document (e.g., articles, data, etc.) they found and could use them to develop their own speech project. Her students used Google Docs and shared their draft speeches with the teacher. Ms. M provided feedback through the shared Google Docs. From my observation, students could learn and construct their own project within such a resource-rich classroom environment.

Overall, this observational investigation showed that to a degree, the participants' game performance (i.e., expert level) paralleled their technology integration practices in their actual classrooms. As illustrated, Ms. A wisely used various technologies to support her instruction as learning tools that could enhance students' learning. It was also observed that her technology integration practice was much in line with her selected pedagogical approach. Her gameplay profile defined her expert level as a Master Technology Coordinator, a teacher who is capable of wisely integrating technology in the classroom. It could thus be said that her technology

integration practice in the classroom appeared to match with her expert level defined by her game play.

In M's case, I was not able to observe any case where she used various technologies as central learning tools (e.g., cognitive tools to enhance learning) rather than supplementary information repository. That being said, her approaches to technology integration were still appeared to be an effective use of technology to support her instructional goal, which centered on helping students build their own speech project. Her game profile defined her expert level as a Technology Coach, a teacher who can effectively use various technologies to support instruction. It could thus be said that her technology integration practice was in accordance with her game play performance, to a degree.

Consequently, as a result of my observational investigations, the gameplay outcomes appeared to parallel the participants' daily teaching practice in regard to technology integration. In these limited observations, it can be suggested that the gameplay, to a large extent, has its contextual fidelity (i.e., representativeness), thereby being able to capture teachers' pedagogical design thinking in relation to technology integration in an ecologically valid manner.

Conclusions and Discussion

To provide evidence of validity is of paramount importance to the design and development of any assessment, in that validity has to do with the credibility of the assessment (i.e., the quality of the assessment). In this regard, test developers use various sources of validity evidence, with a goal of constructing the precision of test scores psychometrically. Central to this practice is to standardize the assessment environment in order to maximize its precision of the scores and to minimize contextual "noise" (i.e., context-free), thereby making the scores more

valid and reliable. That is, in order to establish a good quality of assessment, traditional test theorists rest on the investigation of consistency and replaceability of the assessment. Two assumptions underlie such conventional assessment design work: the decomposability of knowledge in to elements; and, the decontextualization of knowing—which falsely assumes how our knowing works in the real world, i.e., messy uses of knowledge in context (Resnick & Resnick, 1992). The issue or problem of the standard assessment development practice that this study mainly raised is that such objectivistic and positivistic design criteria on assessment, in particular its validation, are psychometrically useful but are not able to fully capture our abilities in use, due in large part to the fact that they ignore such contextual "noise" to interpret the scores. As discussed throughout this study, our knowing always exists and operates in a rich social context. Hence, it is not too much to say that conventional assessment design work has a drawback to its authenticity and/or fidelity of assessment. In practice, this issue has long been a dilemma among assessment developers, because the fidelity to the criterion on assessment situations entails the complexity and ambiguity of the task, as well as maximizes the freedom to respond (Wiggins, 1993). More to the point is that such conditions eventually work against standardization and reliability. As argued, if we acknowledge the fact that the contextual "noise" is a vital part of our knowing, the context-free approach to assessment design and validation (i.e., reproducibility-centered validation process) is of little value. Thus, reproducibility of the assessment scores across the implementations is not our primary concern any longer. This eventually led me to propose alternative criteria on assessment design and validation, with the goal of constructing fidelity of the assessment (i.e., context-laden approach to assessment design and validation).

This study, thus, sought to find alternative criteria for the assessment development and validation process, so that we can make a case that the assessment has contextual fidelity over replaceability or generalizability. I would argue that the criteria of a good assessment (the quality of assessment) are twofold: 1) functional value (its value in the real world); and, 2) its congruence with the reality (contextual fidelity or ecological validity). That is to say, a good assessment should have functional value as an assessment that allows examinees to perceive and act in the moment in the assessment context. This in turn tells us as to how they interact in the assessment context, thereby showing the learner's playfulness (goal-oriented actions) in the context (i.e., detecting similar functional values in the environment in the future). In this respect, Young (1995) argued that assessment should be designed and validated in a more functional way, as opposed to their mere stability as an instrument. Also, a good assessment should have contextual fidelity, meaning the assessment requires sensitivity to the context. This can be made possible by evaluating to what extent the assessment simulates the daily practice in a community.

With this in mind, I particularly sought to answer the questions of how the game *EXPERTISE* might have functional value as an assessment and to what extent this assessment can be used as a good assessment. Toward this end, this study first delineated the development process by using the game as an assessment environment, and then discussed ecological accounts of the gameplay as an assessment, with a goal to document the functional value of the assessment. In addition, this study sought to find preliminary data concerning the fidelity of assessment for measuring teachers' technology integration cognition, which aims to provide empirical evidence showing that the gameplay really represents teachers' daily teaching practice. Specifically, two validation studies were conducted to attain this goal. In light of the results of this study, conclusions are broken down into two major points:

First, I propose that the game can be used as a measure of teacher technology integration cognition. In particular, this study introduced a game-based assessment practice and discussed a cognitive ecological account of the game as a playful assessment. The result of the cognitive ecology analysis indicates that the game allows players to perceive various contextual stimuli and act on it on the fly, thus enabling the assessor to estimate player's playfulness (i.e., goal-oriented action or active participation) in the game context—i.e., capture the interactive and situative nature of teacher's pedagogical design thinking in relation to technology integration. It can thus be concluded that the game has functional value as an assessment.

Second, this study provides some evidence showing that gameplay can be used as a valid estimate of teacher's technology integration practice. Toward this end, this study employed two validation techniques: convergent validity and field observation as alternative criteria on a good assessment (validity). The result of convergent validity indicates that the gameplay can detect and simulate some of the player's applied authentic technology integration competency in the classroom. Also, the result of follow-up observational study indicates that the game, to an extent, has contextual fidelity, such that the gameplay can feasibly estimate the player's daily teaching practice.

As in any empirical study, there are some limitations that should be considered, providing directions for future research. First, given the limited sample size (n=14) and the purposive sampling, the findings are not generalizable to a large population. However, I believe that the findings are still very informative, because the findings provided exploratory evidence showing that the gameplay may have functional value as an assessment as well as the contextual fidelity of the assessment. This will provide a potential starting point for future research about game-based assessment practices as well as a context-laden approach to assessment design and its

validation. Second, since field observations were conducted with only two selected participants (i.e., a convenience sample of two high scoring players), this observation, thus, only provided a limited view of how the players' technology integration practice is present in the classroom. In a sense, such a small and selected case dilutes the quality of the investigation, due in large part to the fact that it was not able to provide richer contexts and broader phenomena with various cases. Such limitations concerning the limited sampling eventually suggest that more research is needed with larger and various sample/cases, in hopes of providing richer insights into how the gameplay represents the contextual fidelity. Lastly, while doing the observational study, I relied on my own insight as a lens or an instrument for the study. Or course, I attempted to document the participants' instructional practice with technology in a very genuine way. This helped to capture the participants' technology integration practice in a more exploratory way. Yet, if the goal of the study is to provide more empirical evidence with larger samples and various cases, there is a need to have some rubric in order for the researchers to somehow reliably quantify and/or qualify such observations. Using such rubric would help improve the trustworthiness of data collection and analysis.

References

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617-645.

Bateson, G. (1972). *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. University of Chicago Press.

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American psychologist*, *32*(7), 513.

Clancey, W. J. (1997). *Situated cognition: On human knowledge and computer representations*. Cambridge university press.

Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. *Distributed cognitions: Psychological and educational considerations*, 1-46.

Collins, A. (1993). Design issues for learning environments (Technical report No. 27). New York, NY: Northwestern University, Center for Technology in Education.

Gibson, J. J., & Gibson, E. J. (1955). Perceptual learning: Differentiation or enrichment. *Psychological Review*, 62, 32-51.

Gibson, J. J. (1986). The ecological approach to visual perception. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Glenberg, A. M. (1997). What memory is for: Creating meaning in the service of action. *Behavioral and brain sciences*, *20*(01), 41-50.

Goodwin, B. C. (1978). A cognitive view of biological process. *Journal of social and biological structures*, *1*(2), 117-125.

Greeno, J. G. (1997). On claims that answer the wrong questions. *Educational researcher*, *26*(1), 5-17.

Hutchins, E. (1995). *Cognition in the wild.* Cambridge, MA: MIT Press.

Hutchins, E. (2010). Cognitive ecology. *Topics in cognitive science*, *2*(4), 705-715.

Koehler, M. J., Shin, T. S., & Mishra, P. (2012). How do we measure TPACK? Let me count the ways. In *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 16-31). IGI Global.

Lakoff, G., & Johnson, M. (1980). The metaphorical structure of the human conceptual system. *Cognitive science*, *4*(2), 195-208.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Lincoln, Y. S., & Guba, E. (1985). *Naturalistic enquiry*. Beverly Hills, CA: Sage.

Maxwell, J. (1992). Understanding and validity in qualitative research. *Harvard educational review*, *62*(3), 279-301.

Resnick, L. B., & Resnick, D. P. (1992). Assessing the thinking curriculum: New tools for educational reform. In *Changing assessments* (pp. 37-75). Springer Netherlands.

Rogoff, B. (1990). *Apprenticeships in thinking. Cognitive development in social context.* Oxford, England: Oxford University Press.

Roth, W. M. (1998). Situated cognition and assessment of competence in science. *Evaluation and Program Planning*, *21*(2), 155-169.

Salomon, G., & Perkins, D. N. (1998). Chapter 1: Individual and social aspects of learning. *Review of research in education*, *23*(1), 1-24.

Schmuckler, M. A. (2001). What is ecological validity? A dimensional analysis. *Infancy*, *2*(4), 419-436.

Seale, C. (1999). Quality in qualitative research. *Qualitative inquiry*, *5*(4), 465-478.

Wainer, H., & Braun, H. I. (1988). *Test Validity*. Hilldale, NJ: Lawrence Earlbaum Associates.

Wiggins, G. (1993). Assessment: Authenticity, context, and validity. *Phi delta kappan*, *75*(3), 200-08.

Young, M. F. (1995). Assessment of situated learning using computer environments. *Journal of Science Education and Technology, 4*(1), 89-96

Young, M. F., Kulikowich, J. M., & Barab, S. A. (1997). The unit of analysis for situated assessment. *Instructional Science*, *25*(2), 133-150.

EPILOGUE

What we know from this dissertation study was that game scores can be of assessment value, provided that the game design aligns with the targeted context. At the macro level, this dissertation study presented a comprehensive investigation of how the designed game-based assessment worked in practice through three iterations of the game and research design works. Many studies often place their research emphasis in either providing conceptual ideas (i.e., theory-driven research) or describing empirical evidence (i.e., data-driven research). Yet, there are not many studies that aim to present in what ways the proposed theory and/or conceptual idea would work in practice with explicit cases and detailed supports. This dissertation study thus finds the value of the study from its refining works that put conceptual ideas fully into practice with the support of empirical evidence.

In this dissertation study, I proposed two conceptual frameworks: TPACK-L (i.e., teacher knowledge for the wise integration of technology in the classroom) and Playful Assessment (i.e., alternative game-based assessment model using the perspective of situated cognition and sociocultural theory). Drawing on these proposed frameworks, I attempted to document and analyze how the designed game could be used as a valid assessment environment. Specifically, the first chapter focused on delineating what TPACK-L framework looks like citing data from gameplay, and discussed the potential of a game as an assessment environment using the existing game, Card-*tamen*™ TPACK-L. The second chapter aimed to propose and describe an alternative game-based assessment model called Playful Assessment drawing from the perspective of situated cognition and sociocultural theory, and examined how the designed collaborative board game, *INFULENCE*, could serve as a Playful Assessment environment that can capture the situative and interactive aspect of teachers' technology integration cognition. The

findings of the second study indicated that collaborative gameplay outcomes could estimate to what extent the player actively and successfully participated in social activities. Lastly, the third chapter aimed to provide empirical evidence showing that game results of the newly designed game, *EXPERTISE*, can be used to estimate teacher's technology integration cognition in an ecologically valid way. This study found that the designed game had functional value as an assessment that captured the situative and interactive aspect of teachers' pedagogical design thinking in relation to technology integration, as well as that gameplay outcomes appeared to parallel the players' daily teaching practice with technology.

As noted, this dissertation study sought to find an answer to the broad question of *how* as opposed to only *what* games might assess, changing the focus to a social presence and not just the tradition static achievement of an individual mind. However, this dissertation study did not sufficiently provide a much-needed answer to the questions concerning "*when*" and "*why*." That is, this study did not fully address under what conditions the designed game-based assessment worked and why the proposed alternative approach to assessment practice would work better than what we have done before—I described this as the traditional assessment practice in this dissertation study. This eventually comes down to the limitations of this dissertation study. As described in my three studies, no single piece of research is sufficient, providing much room for continued study. Among the various limitations that I experienced from this study, what stood out to me was that the proposed situated cognition approach to game-based assessment practice imposes complexities beyond the traditional assessment practice that this dissertation study mainly addressed. Accepting non-linear dynamics, complexity and the natural variability of assessment conditions ends up becoming quite difficult to simplify into a single estimate of a one's ability. In the case of this dissertation study, players' scores (i.e., outcomes) were varied

and dependent on who they played with, in which conditions they played (e.g., game cards that appeared), and what intentions they had for game play. Of course, reproducibility of scores (i.e., reliable product over testing) are not the primary concern of the proposed alternative assessment practice; instead, the situated cognition approach to assessment is concerned more with process of learning as much as product. That said, if we are to employ this alternative assessment practice as comparable with traditional assessment practice, there still needs to be further studies with regard to which criteria and/or estimates we can use to address one's increasing ability to detect appropriate information and act upon it within rich social assessment environments in a more reliable fashion. This could be made feasible by analyzing the players' interactions and dynamics during gameplay from various perspectives and frameworks. Such investigations have not been deeply addressed in this study. The findings of this dissertation study did not provide clear answers to the question of "*when*" and "*why*," thereby leaving us with further research to be able to address drawbacks and weaknesses of the proposed situative approach to game-based assessment practice. So my study is only a beginning. It is thus my hope that there are more studies with regard to how examinees interact with assessment environments and in what ways we can capture the quality of the examinees' ability in rich social environments in a reliable way, such that we could better understand and estimate the situative and interactive aspect of one's ability in rich social contexts.

APPENDIX A

A Stepwise Process of Qualitative Data Analysis

Process	Outcome
1. Import audio recordings into QRS NVivo 11 for Mac	15 hours of audio recordings
2. Parse the data into individual utterances	480 occasions of individual utterances
3. Transcribe the parsed data	
4. Identify trends across players' utterances via open coding (i.e., naming and categorizing phrases and concepts usage)	26 concepts
5. Subsume phrases and concepts under broader and more abstract categories by creating nodes within QRS NVivo 11	6 categories
6. Define the subsumed categories and select representative statements from the references	11 representative statements selected from 1817 references
7. Review and verify the final categories and representative statements through peer debriefing process	
8. Use established nodes to review and axially code data across the datasets	Diagram representation of player's decision making-process (Figure 5)
9. Generate an emergent theme of gameplay analysis as identified through the axial coding process	Gameplay can promote teachers' decision-making/reasoning in relation to TPACK-L (Table 2)
10. Review and verify the diagrammatic representation and overall emergent theme via peer debriefing process	

APPENDIX B

A Stepwise Process of Qualitative Data Analysis

Process	Outcome
1. Import audio recordings into QRS NVivo 11 for Mac	4 hours of audio recordings
2. Parse the data into gameplay event units	32 occasions of gameplay events
3. Transcribe the parsed data	
4. Name and categorize phrases and occasions via open coding	8 codes were created, including '*doable action*,' '*setting up common goals*,' '*articulation of the proposal*,' '*co-evaluation of the proposa*l,' '*co-construction of the idea*,' '*peer assessment*,' '*social role*,' '*authenticity*.'
5. Aggregate the categories and collapse them into 4 general themes based on the elements of Playful Assessment	Theme 1: Creating Playfulness Theme 2: Promoting Social Interaction Theme 3: Capturing the Transactional Dynamic Theme 4: Focusing on Authenticity
6. Describe each theme in light of Playful Assessment framework	

APPENDIX C

Consent Form for Participation in a Research Study

University of Connecticut

Principal Investigator: Michael F. Young, Ph.D.
Student Researcher: BeomKyu Choi, M. A.,
Study Title: Playful Assessment: A Game-Based Approach to assessing Teachers' Competency for the Wise Integration of Technology in the Classroom

<u>Introduction</u>

You are invited to participate in a research study to explore the effect of playing card games for assessing knowledge of the wise technology integration in K12 classroom. The context for this work is the Technological Pedagogical Content Knowledge (TPACK) framework.
Through this study we hope to be able to document how both use of games and game mechanics can be used as innovative and effective assessment tool in live classroom environments.

<u>Why is this study being done?</u>

In response to the increased interest in teachers' professional competencies, teacher educators and educational researchers have paid particular attention to the issues concerning how to help pre-and in-service teachers acquire teaching competencies and, by extension, how to ensure whether teachers are armed with such competencies during their preparation programs.
With this regard, this study seeks to find a way to access teachers' competencies in relation to technology integration by using the designed card game. In particular, this study aims to explore to what extent the player's game ability can warrant their real world practice in technology integration.

<u>What are the study procedures? What will I be asked to do?</u>

If you give permission to take part in this study, you will be asked to play this card game specially designed to assess the integration strategies at the intersection of TPACK and Learning Theories.
The game is a collaborative board game designed to measure your pedagogical reasoning in relation to technology integration practice. Several Technology cards are dealt to the table and the top card of the Theory and Pedagogy decks is turned over to establish the context. One player selects a content objective (such as a goal from the Common Core State Standards) and remaining players help her/him out to teach the given content with the given technologies by taking Theory and Pedagogy into consideration.

As with this game play, your gameplay will be videotaped. The video recording will be only used for the research purpose to find out the cognitive process underlying the gameplay. In the

video recording, your face will be blurred, blacked out or replaced with. Only the edited video will be retained and the original video recording will be destroyed. Also, reference to your name will be replaced pseudonyms for data analysis.

Once you give consent to use your video, the video file will be retained for five years and will be encrypted and stored on portable media.

What are the risks or inconveniences of the study?

We believe there are minimal risks and no known risks associated with this research. The time required to play this game is the only anticipated inconvenience for you. The game play takes approximately one or two hours total.

What are the benefits of the study?

You will not benefit directly from this study, but may enjoy the game play nonetheless. The study hopes to reveal the assessment potential of card game play related to growth toward substantial learning standards. The study may uncover beneficial learning outcomes from playing games that may not be present in other forms of learning.

Will I receive payment for participation? Are there costs to participate?

There are no costs to you for participating in this study.

How will my personal information be protected?

We will do our best to protect the confidentiality of the information we gather from you but we cannot guarantee 100% confidentiality. You may be identifiable from the recording of your gameplay. For the sake of confidentiality, you will be asked to use a pseudonym while playing the game. Only data with pseudonyms will be used and saved for the research purpose. Also, in the video recording, your face will be blurred, blacked out or replaced with. Only the edited video will be retained and the original video recording will be destroyed. Only video file from your consenting to use will be retained for the research purpose and will be encrypted and stored on portable media (i.e., thumb drive). The data thumb drives will be stored in a locked cabinet.

You should also know that the UConn Institutional Review Board (IRB) and the Office of Research Compliance may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

Can I stop being in the study and what are my rights?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate.

Whom do I contact if I have questions about the study?

Take as long as you like before you make a decision. We will be happy to answer any question you have about this study. If you have further questions about this project or if you have a research-related problem, you may contact the principal investigator, (Dr. Michael Young, (860) 486-0182) or the student researcher (BeomKyu Choi, (213) 281-8972). If you have any questions concerning your rights as a research subject, you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802.

Documentation of Consent:

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible hazards and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

______________________	______________________	___________
Participant Signature:	Print Name:	Date:

Relationship (only if not participant):__________________________________

______________________	______________________	___________
Signature of Person Obtaining Consent	Print Name:	Date:

APPENDIX D

Consent Form for Participation in a Research Study

University of Connecticut

Principal Investigator: Michael F. Young, Ph.D.
Student Researcher: BeomKyu Choi, M. A.
Study Title: Playful Assessment: A Game-Based Approach to assessing Teachers' Competency for the Wise Integration of Technology in the Classroom

Introduction

You are invited to participate in a research study to explore the way in which a card game can be a valid and useful assessment of teachers' competency for wise integration of technology in the classroom. Through this study we hope to be able to document how both use of games and game mechanics can be used as an innovative and effective assessment tool in live classroom environments.

Why is this study being done?

In response to the increased interest in teachers' professional competencies, teacher educators and educational researchers have paid particular attention to the issues concerning how to help pre-and in-service teachers acquire teaching competencies and, by extension, how to ensure whether teachers are armed with such competencies during their preparation programs.
With this regard, this study seeks to find a way to access teachers' competencies in relation to technology integration by using the designed card game. In particular, this study aims to explore to what extent the player's game ability can warrant their real world practice in technology integration.

What are the study procedures? What will I be asked to do?

Participation in this study requires no effort on your part beyond your normal instructional practice taking place in your classroom. If you give permission to take part in this study, the student researcher will visit your classroom once per week for two months and will be observing your daily teaching. The student researcher will take notes on how you integrate learning technologies in the classroom. All observations will only note you (i.e., teacher) by using pseudonym to protect confidentiality. Any of your students will not be included in this observation and study.
In addition to observing work, you will be asked an interview with regard to your technology integration practice over the course of class observation. Your interview will be audiotaped, and your name will be replaced by pseudonym for data analysis.

What are the risks or inconveniences of the study?

We believe there are minimal risks and no known risks associated with this research. You may experience some inconvenience for your teaching being observed by the student researcher. But the student researcher will not evaluate or judge your teaching but only describe genuinely how you use technology for your teaching.

What are the benefits of the study?

The study hopes to reveal the assessment potential of card game play related to growth toward substantial learning standards by observing your real-world practice.

Will I receive payment for participation? Are there costs to participate?

Approximately, ten class observations will be taken place for two months. You will be compensated at $10 per a class observation. You will be given this compensation when a class observation is done.

How will my personal information be protected?

We will do our best to protect the confidentiality of the information we gather from you but we cannot guarantee 100% confidentiality. For the sake of confidentiality, your name will be replaced with a pseudonym in transcripts of data coding.
Only audio files and field notes from your consenting to use will be retained for the research purpose and will be encrypted and stored on portable media (i.e., thumb drive). The data thumb drives will be stored in a locked cabinet. The audio files will be destroyed right after data coding.

If, during the course of this research study, a UConn employee suspects that a minor (under the age of 18) has been abused, neglected, or placed at imminent risk of serious harm, it will be reported directly to the Department of Children and Families (DCF) or a law enforcement agency.

You should also know that the UConn Institutional Review Board (IRB) and the Office of Research Compliance may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

Can I stop being in the study and what are my rights?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate.

Whom do I contact if I have questions about the study?

Take as long as you like before you make a decision. We will be happy to answer any question you have about this study. If you have further questions about this project or if you have a research-related problem, you may contact the principal investigator, (Dr. Michael Young, (860) 486-

0182) or the student researcher (BeomKyu Choi, (213) 281-8972). If you have any questions concerning your rights as a research subject, you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802.

Documentation of Consent:
I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible hazards and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

______________________	______________________	___________
Participant Signature:	Print Name:	Date:

Relationship (only if not participant):__________________________________

______________________	______________________	___________
Signature of Person Obtaining Consent	Print Name:	Date: