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Games, Claims, Genres & Learning

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### Abstract

We offer a framework for conducting research on games for learning. Building on a survey of the literature on games, we suggest a categorization scheme (physiological and psychological) of the range of claims made for games. Our survey identifies three critical issues in the current scholarship. They are, a lack of authentic, situated research studies; a lack of sensitivity to the pedagogical affordances of different game genres; and a lack of emphasis on the importance of acquiring disciplinary knowledge (i.e. content). We offer the Technological Pedagogical Content Knowledge (TPCK) framework as a way to address these concerns and guide future research in this area. We argue, that assessment on learning from games needs to consider the specific claims of games, as they interact with genre and content knowledge. Finally, we introduce an ongoing study that utilizes this approach.

## Games, Claims, Genres &amp; Learning

The nature of technology and the way we socialize ourselves has changed over time (Johnson, 2005) and the affects of these changes are reflected in the myriad of arguments about technology integration in schools (Cuban, 1986). Electronics games form a large part of the media environment of today's children. In 2006, 30% of the most frequent computer game players and 40% of console game players were under 18 years old (Entertainment Software Association, 2006). Further, American children between 8 and 18 years old play video games for an average of 7 hours/week (National Institute on Media and the Family, 2005). It is evident that games capture children's attention and engage them in important ways. Clearly, designers, educators, and researchers need to develop a better understanding of how to integrate electronic games in classroom teaching. This requires knowing that the value of electronic games for learning comes not from merely inserting games into the curriculum but rather on how different game genres reflect underlying pedagogical strategies that allow for learning in different content areas.

This advent of games in everyday life comes at a time of perceived crisis in education. For instance the President of the Federation of American Scientists, Henry Kelly says that Education in the USA is facing a critical problem in that it must educate students to face the challenges of the 21st century (Federation of American Scientists, 2005; Kelly, 2005). International studies such as Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) and national assessments such as the National Assessment of Educational Progress (NAEP) show that US students are not performing up to standard in mathematics, science, or literacy (Gonzales et al., 2004; Hampden-Thompson, Johnston, & American Institutes for Research, 2006). The report by the Federation of American Scientists argues that video games may be a powerful way of helping students learn what they need in order to succeed in a globalized world.

Video games capture children's attention and imagination because they challenge, present fantasy, and generate curiosity, through interactivity and intelligent design of game-play (Malone, 1981). Thus, it is not surprising to hear that games present a unique opportunity to educators to use the interests of children as a way to educate them. The use of video games for learning is argued by many to arise from the affordances of video games – in particular, video games allow learners to immerse themselves in highly interactive and engaging experiences. Such experiences can lead to contextual learning of complex activities and the development of understanding, skills, and innovativeness (Fabricatore, 2000; Greenfield et al., 1994; Subrahmanyam, Greenfield, Kraut, & Gross, 2001).

Based on increased possibilities for learning from video games, it is not surprising that a great deal of attention is being paid to the role of video games in education (Foreman, 2003; Kelly, 2005; Shaffer, Squire, Halverson, & Gee, 2005). There are a wide range of claims made about games, both positive and negative. On one hand, are positive claims such as a recognition of the power games have to motivate learners, while on the other are negative claims, such as the idea that playing violent video games can lead to increased aggressive behavior. The wide diversity of these claims makes it difficult to engage in a rational discussion about the effects of games because different groups can have wildly divergent conceptualizations of the kinds of games (and their effects) they are talking about. It is clear that we need to develop a way of classifying

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or categorizing these claims in order to develop a shared frame from within which to discuss these issues. In the section below, we discuss and elaborate on the various types of claims made by people designing, using, and studying video games, with the goal of developing such a categorization scheme.

### *The Claims of Games*

Proponents of games say that we should be preparing students to be innovative, creative, and adaptable in order to deal with the demands of learning in domains that are ill-structured (Federation of American Scientists, 2006; Gee, 2003, 2005a, 2005b, 2007a). They go on to argue that (see for example, (Gee, 2003; Prensky, 2001) games provide many of the essential affordances that are needed for learning in these contexts (Foreman, 2004). Games, according to these scholars, are a medium in which students are intrinsically motivated to be competent, autonomous, cognitively flexible, risk takers (without serious consequences of taking these risks). Further, playing games differs from interaction with other media because “one literally learns by playing” and usually does not sit down to read a manual first (Sandford & Williamson, 2005). Thus, it is argued that games present an opportunity to use the interests of children as a way to educate them in a situated and embodied manner for the kinds of skills increasingly required for surviving and thriving in a globalized world (Barab, Bransford, Greeno, & Gee, 2007; Barab, Dodge, & Ingram-Goble, 2007; Gee, 2007b).

Opponents to the use of games for learning argue that games are just another technological fad (akin to predictions made about cinema and television in the years past). They argue that video games may be a waste of time, and possibly cause increased violence and aggression, and decrease prosocial behaviors in players (Walsh, 1998). Moreover, they argue that playing games has negative consequences such as inactivity and obesity, emphasis on the superficial as opposed to the deep ideas and ways of thinking that characterize disciplinary learning.

What is interesting is that both groups, while seemingly disagreeing with each other, actually agree with each other at a more fundamental level. What both groups share is a deterministic stance towards technology — that this new technology of video games will lead to specific effects on users of the technology. In other words, what both sides agree on is that children can learn from games, or that games can lead to changes in behavior. What they disagree on is whether this learning is beneficial or harmful.

Irrespective of which camp one agrees with, we believe that it is important for us, as scholars and researchers, to carefully study the kinds of claims being made for games and to what extent these claims are based on armchair theorizing and wishful thinking rather than sound research. For this purpose we conducted a comprehensive survey of claims about games for learning (Mishra & Foster, 2007). We surveyed over 60 different sources of information. We cast a wide net, including in our search online magazines, empirical and conceptual articles, newspaper articles, weblogs, web journals (electronic and paper), game websites, books, university websites, and conference proceedings.

Through this process we ended up with over 250 distinct claims that we transcribed either written verbatim or paraphrased (See examples in Table 1). Using a grounded theory analysis,

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the claims were then systematically and thematically assigned a code relating to game effects or learning such as “expertise development” or “logical thinking.” After assigning the claims to themes, the themes were then coded and assigned to two emergent broad groups of “psychological” and “physiological” effects. Further, coding the list of claims within the psychological effects group led to identifying four sub-categories. These sub-categories within the psychological group include: practical skills, cognitive skills, motivation, and social skills. Within the physiological effects group there were fewer claims than in the psychological effects group, which resulted in seven specific but comprehensive categories of effect (See Figure 1). Within both the psychological and physiological claims, there were both positive and negative effects.

*Table 1: Examples of the claims of games for learning*

“Game users are no more likely than non-game users to be involved in risk-taking behavior” (Bosworth, 1994).
Proficiency at game may afford players a temporary sense of mastery, control, and achievement” that was previously found lacking (Mitchell & Savill-Smith, 2004, p. 8).
Violent video games increase aggressive cognition, physiological arousal, and aggressive behavior and affect and decrease prosocial behavior (Anderson & Bushman, 2001; Carnagey & Anderson, 2004).
Frequent gaming orients one to a computer society (Greenfield et al., 1994).
Simulator games can help in the development of all intellectual abilities and <i>a mind for machines</i> ” (De Aguilera & Mendiz, 2003, p. 11).
Videogame playing empower players in a way that translates into real world activism (civic activism) (Williams, 2004).
“Heavy use of computer games is associated with negative rather than positive outcomes in terms of academic achievement, self-esteem and sociability” (Roe & Muijs, 1998, p. 1).
“Computer games and simulators enhance learning through visualization, experimentation, and creativity of play. Increased learning occurs by problem solving in a complex interactive multidisciplinary environment and by "seeing" causal relationships between individual actions and whole systems” (Betz, 1996).

One clear distinction between the two major categories (the physiological and psychological) was that the physiological scheme focused on claims that are more developmental or behavioral. In contrast, the psychological scheme focused on claims that are cognitively and socially oriented. We must add the caveat that there is no clear or sharp distinction between these categories and there is (as should be expected) some degree of overlap between them i.e. there are some psychological claims that one could say cause physiological effects and vice versa. Our analysis indicates that these claimed effects are related to learning and development in four ways, by shaping attitudes, affecting behavior, influencing understanding, and affecting spatial and motor abilities. In the sections below we describe each of these categories (and sub-categories) in greater detail.

### *Physiological Scheme*

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Within the physiological scheme, there were seven specific effects of how games relate to learning and development. These include aggressiveness, violence, antisocial behavior, introversion, motor skills, coordination, and obesity. An example of these claims is, “violent video games increase aggressive cognition, physiological arousal and aggressive behavior and affect and decrease prosocial behavior” (Carnagey & Anderson, 2004).

### *Psychological Scheme*

The psychological scheme could further be broken down into four sub-categories about how games relate to learning and development. These include practical skills, cognitive skills, motivation and social skills as shown in the continuum of psychological claims in Figure 1. Social skills also encompass identity formation, which also has sub-themes relating to it such as valuing roles and role-playing (See Fig 1).

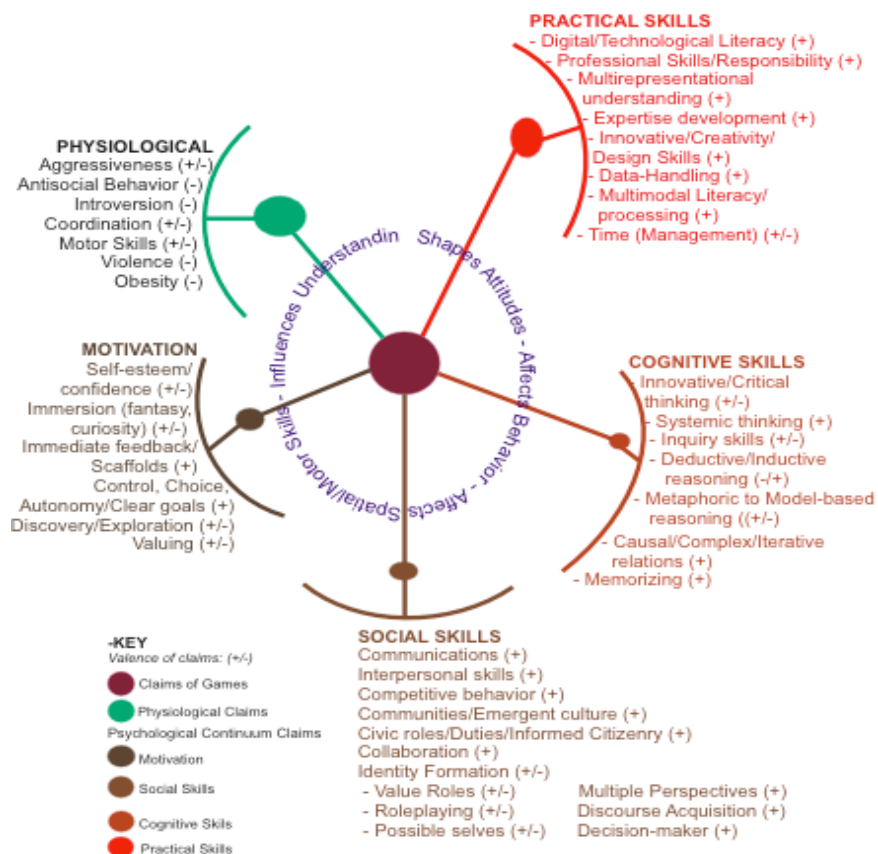
*Practical skills:* Practical skills refer to learning in games that contribute directly to the development of skills that are applicable to the real world or authentic settings. It is argued that game-playing can lead to learning on how to use technology, as well as expertise development, innovativeness, and creativity. It is worth noting that these are skills that have been identified as being critical for success in the 21st century (Greenfield et al., 1994; Shaffer & Gee, 2005).

*Cognitive skills:* Another set of claims about games was related to the acquisition of cognitive skills. It was argued that games, through linking knowledge and doing support the idea of learning by doing (Barab, Hay, Barnett, & Squire, 2001; Shaffer et al., 2005). People who make these claims argue that players learn by engaging in some activity and develop firsthand experience of that activity or system. Based on arguments about affordances of electronic games for immediate feedback, socialization and collaboration, cognitive supports, problem solving, and transfer to name a few, proponents make claims about what is possible for learning based on research in the cognitive sciences. For instance, two such claims are, “the instant feedback and risk-free environment invite exploration and experimentation, stimulating curiosity, discovery learning and perseverance” (Kirriemuir & McFarlane, 2004) and “virtual worlds of games are powerful because playing games means developing a set of effective social practices” (Shaffer et al., 2005).

*Motivation:* A third sub-category of claims in the psychological domain had to do with the motivational power of games. For instance, these sets of claims emphasize the affordances of game environments to intrinsically motivate students to learn (Cordova & Lepper, 1996). These claims are based on motivational principles for empowering learners including the ability to grant power, autonomy, and challenge at player’s level and implications for learners’ identity. For instance, the fact that certain electronic games allow you to take on an identity different from your own leads to the claim that, “People learn most deeply when they take on a new identity that they really want” (Foreman, 2004). Similar claims are made based on the fact that games provide challenges adjusted to the player's ability, provide the player with clear and immediate feedback, and give players choice and control over their actions (Games-To Teach Research Project, 2006).

*Social skills:* The fourth sub-category in the psychological category has to do with the development of social skills. In this context, social skills are related to when players collaborate with other players or when players learn about working with others in gaming situations. It is argued that playing games allows players to develop interpersonal skills, learn to work with others and develop identities that could be good or bad depending on the type of game and player’s personality. An example of these claims is video games allow “social and collaborative practices to emerge” among players (Sandford & Williamson, 2005).

*Figure 1.* Emergent themes from the claims of games



### *The claims of games: Identifying problems*

One first benefit of this survey and categorization of the claims for games is that it provides us (as scholars and researchers) a way to systematically talk about games and what benefits (or harms) they can bring to the learning process. By breaking these claims down in to different categories (somewhat independent categories, and sub-categories) we can make some sense of the varied arguments being made, both for and against the use of games for learning.

Additionally, categorizing these claims allows us to study which of these claims are supported by research and which are reasoned arguments based on the affordances provided by games. In brief, our survey revealed that there is much that we still need to know about the relationship between games and learning. In particular we identify three key problems in these claims being made for learning games: (a) The kind of support (research or theoretical) that underlies many of these claims; (b) Treating games as being a monolithic entity (i.e. ignoring game genres and their differential potential for learning; (c) The content neutral nature of many of these claims. We consider each of these in turn.

### *Research and theoretical support for the claims for games*

In their recent review of the games literature, Mitchell & Savill-Smith (2004) said that the literature base relating to the use of computer games for learning appears to remain small. In a similar vein, Williams (2004) found that research in game-based learning continues to use

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inappropriate samples, conflated variables and failure to acknowledge game genre which limits their claims. Thus, the claims of games we present above seems to have emerged mainly from lab studies and continues to be echoed by researchers without verification. Most of these claims are based on logical arguments and some from small scale lab studies; most have not been confirmed in studies. In fact, these reviews (Kirriemuir & McFarlane, 2004; Mitchell & Savill-Smith, 2004; Randel, Morris, Wetzel, & Whitehill, 1992) all found that there are no firm conclusions about learning, although most students reported an interest in using games to learn rather than using conventional classroom instructions. It is worth noting that these studies were not longitudinal, hence long-term game effects could not be validated. In two recent dissertations (Egenfeldt-Nielsen, 2005; Squire, 2004) which were more naturalistic (situated in classrooms), they revealed that students learned “superficial information – not enough to satisfy students educational needs, but enough for them to grasp on it.” In Squire’s dissertation, which examined students playing Civilization III, one of his conclusions was that there was an incompatibility between the game content and what was required for the school curriculum. However, both Squire and Egenfeldt-Nielsen concluded that students developed a more holistic understanding and interest in historical information.

Our review showed the strengths and weaknesses of current research practice. Generally the strengths are that there is a trend in studies moving away from lab environments such as Beckett and Shaffer (2005), Williams (2004), Egenfeldt-Nielsen (2005), and Squire (2004). Further studies such as Beckett and Shaffer are seeking to augment game playing with reality-based support to try and get children to develop epistemic frames (Shaffer, 2006; Shaffer & Gee, 2005).

In conclusion, most of the claims of games are not supported by research or the research support is from small studies, which puts into question the generalizability of the results to different contexts and populations.

#### *Games as Monolithic Entity (i.e. ignoring game genres)*

There are many different kinds of games (which we consider being different genres) and it is clear that these claims of learning (we list and categorize above) do not apply equally to all games. Clearly playing *Guitar Hero* has very different learning consequences (both physiological and psychological) than playing *World of Warcraft* or *Space Invaders*. Too often arguments about learning from games have treated games as a monolithic entity, leading people to assume that the pedagogical value of one game is the same as that of another. Such thinking is problematic. Mixing the strengths and weaknesses across genres of games with others misrepresents the varied potential that different genres of games can offer. We argue that it is important to look carefully at game genre because each game genre reflects a certain design stance taken towards any given domain. In other words, the design of a game, the kinds of choices regarding game-play, structure, the nature of progress through a game, nature of representation and so on, are all the results of conscious (and maybe subconscious) decisions made by game designers. This design stance, from an educational point of view, can be seen to be an implicit pedagogical approach—with implicit theories of learning, behavior and epistemology. Electronic game genres influence game play mechanics which then influences what can be done and learned through playing electronic games. Similar to how movie genres

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shape the design stance behind a movie that is created, video game genres shape the mechanism and design stance in games.

Organizing video games by genres is not a new idea. However, our goal is not merely to classify various game genres but rather to try and connect these genres to the claims of games in order to develop a systematic approach for the study of games and assessment of kinds of learning that can occur through playing different genres of games.

A survey of the game genre literature indicates that there is little agreement on how game genres are created or classified. This has led to multiple classification schemes, based on existing categorizations and conceptualizations, such as according to existing movie genres, and visual representation and aesthetics (Apperley, 2006; Caldwell, 2004; Wolf, 2001). These approaches include Apperley's (2006) idea of using interactivity or non-representational characteristics to examine genres; Wolf's (2001) classification of genres based on the *Library of Congress Moving Imagery Genre-Form Guide*; and King and Krzywinska's (2002) four levels of classification according to platform, genre, mode, and milieu.

Apperley (2006) synthesizes these approaches and asserts that the key aspects of video games are their interactivity characteristics, the way the games are played (or experienced). In contrast to the visual aesthetics (or iconography) of games, which can vary greatly, Apperley argues that it is these interactivity characteristics that are common to all games. This typology would allow us to focus on the non-representational, specifically interactive, characteristics of video games in order to create a "more nuanced, meaningful, and critical vocabulary for discussing video games" (p. 7). This view is similar to Wolf's (2001) classification of video game genres developed by the Library of Congress Moving Imagery Genre-Form Guide<sup>1</sup>.

Both Apperley and Wolf argue that video game genres should be classified via interactivity i.e. video game genres should be classified by the way people experience or proceed in them because other classification strategies (such as classification by iconography) ignore the differences and similarities found in a player's experience of a game. We believe that classifying games on the basis of interactivity makes sense when we think of educational games as well. We adopt Apperley and Wolf's use of interactivity to classify game genres due to its flexibility for educational purposes. Contemporary learning theories argue that learning is not a simple process of transfer of information but rather is developed through the learner's active engagement with subject matter, situated within specific contexts. Espen Arseth's notion of ergodicity, defined as non-trivial effort used to traverse text can be fruitfully applied here. Thus we can view

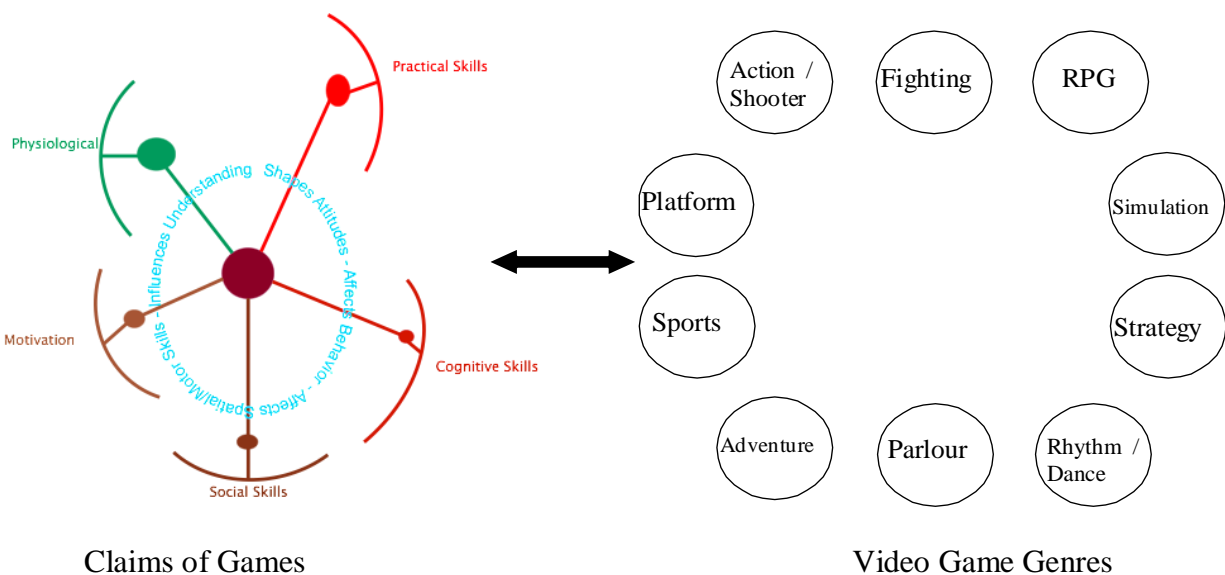
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<sup>1</sup> However, Wolf's (2001) view of genres based on a movie model does not recognize and transforms with advancement in technology. Movie genres remain static and rarely change even with technological advancement (Apperley, 2006). Apperley argues that the collapse of the video game industry in the 1980s was partially due to static genres which became too formulaic for game players. Game players prefer genres that advance and exploit the current technology, even though they may break down at the fringes or blur with other genres. This is important because it shows the fluid nature of game genres. Myers (2003) contends that game genres develop as a result of the technological contexts and are therefore not lasting or fundamental as are movie genres. More importantly, however, is Wolf's idea of using interactivity over iconography or thematic analysis to examine game genres, which is similar to Apperley's notion of using non-representational characteristics of game, specifically the interactive ones.

interactivity as the non-trivial effort or actions taken in playing video games. It is this effort to traverse the “text” of the video game that sets this medium apart. Video games have specific objectives (akin to learning goals) that a player tries to complete through specific interactions with the system. Game mode, milieu, and platform also affect the spaces and social relations created by the game, and thus the interactive, ergodic process of playing the game.

Our analysis indicates that there are approximately ten main game genres (See Fig. 2). They include: action/shooter, fighting, role-playing, simulation, strategy, rhythm/dance, parlour, adventure, sports, and platform games. These ten are by no means meant to be exhaustive (particularly given the rapid rate of evolution of games and game genres), but merely represent one scheme that covers most of the other sub-genres. For instance, in our content analysis we saw that most of the games covered under shooter were also action so we combined those genres to be one. Further, many games can fall into more than one genre. Finally, we must accept the fact that game genres will change with time, through the advent of new technologies and new techniques of game-play.

Figure 2. How the claims of games for learning and game genres should connect in research



The relationship between game genres and the claims of game is two-way. A given genre may be connected to many different claims about learning from games, and a given claim may be connected to multiple genres. For instance, role-playing games (RPG) may afford more opportunities for developing identities because one plays through a surrogate character. They may, through the insertion of quests and puzzles, also help in the developing of physiological skills.

That said, we argue that focusing on the connection between game genres and the claims of games can be a key unit for assessment in game-based learning. *What we have argued so far provides a premise for the practical, cognitive, social, and motivational affordances for a particular game. The genres provide a situated or contextual place for examining these*

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*affordances within particular domains.* The claims of games for learning are hypotheses to be examined within game genre while the genres describe the nature of interaction within an electronic game as well as the expected pedagogical and epistemological stance. The genres provide a lens to address video games as a semiotic domain via the interactivity characteristics or the way the game is experienced/played within each genre. This enables the assessment of the internal or content aspects of games and the external aspects or the ways of seeing, believing, acting, interacting, and thinking within the domain (Gee, 1999, 2003).

*The content neutral nature of many of these claims*

Gardner (2006) has argued that the most important invention of the past 2000 years has been “the scholarly disciplines.” These disciplines, he writes, “represent the most advanced and best ways to think about issues consequential to human beings.” He continues, that “the sort of discipline involved in scholarly modes of thinking is far from intuitive... [and] is difficult to attain.” This is because, “we have not evolved to carry out historical studies, compute trigonometric functions, compose a fugue, pursue a set of experimental investigations in biology, chemistry, or physics, let alone to create testable theories in these spheres” (Gardner, 2006, pp. 137-138). In other words, acquiring disciplinary knowledge is difficult and requires the devotion of years of education in the big ideas and nuances of the disciplines.

If games are to be successful for pedagogical purposes they need to consider ways in which disciplinary knowledge can be thoughtfully integrated with game-play. In other words, it is critical that games embody in them, ways of thinking and working with information that is particular to a given subject matter. It is important to realize that disciplinary knowledge varies greatly from one discipline to another and needs to be reflected in both the design and research into games for learning. Most current research in learning from electronic games does not address this issue of disciplinary knowledge—restricting itself, for the most part, to generic bromides about learning.

Game designers and researchers contend that games embody a theory of learning that is reflected by the best research in the cognitive sciences (Foreman, 2003, 2004). However, ignoring the unique aspects of disciplinary knowledge for a given content area indicates that these learning theories, though useful in principle, may not be as much so for actual application. It is no surprise that, while games for entertainment are good at embodying pedagogy for learning the rules of those games in order to win, games for learning are often characterized as “chocolate covered broccoli” (Laurel, 2003).

We argue that this interplay between games, pedagogy and content needs to be understood better, if the claims of games are to hold true. The problem is related to the kind of pedagogy employed by commercial games versus those employed by educational games. Educational game designers are faced with the conundrum of trying to use game pedagogies that worked in entertainment settings to educational settings. To clarify, we are not arguing that simulation strategy games like *Civilization* or *The SIMS* do not allow students to participate in discourses such as history, economics, and so forth at a level where they develop critical understanding of the process of learning and understanding semiotic domains (Gee, 2003; Squire, 2004), but rather that this lack of emphasis on disciplinary knowledge can become a significant stumbling block as games

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increasingly become part of the learning environment (particularly when attempting to integrate with school settings).

In Squire's (2004) dissertation examining the commercial simulation strategy game *Civilization III* integration in classrooms, he found that the game content was incompatible with the school curricula and hence school goals, though, students learned general things about history and engaged in critical dialog about the historical content. However, some researchers and historians contend that *Civilization* has design limitations (such as a mismatch between content and game-play dynamics) that end up promoting naïve understandings of history (such as a belief that history has a definite goal) (Caldwell, 2004; Friedman, 1999).

A good example of how the pedagogical constraints of schools can restrict how technology is designed and used relates to the use of educational computer games. A study comparing commercial games to educational games found that commercial games often were more demanding than educational games in terms of cognitive effort as well as in time required for mastery (Heeter, Chu, Maniar, Winn, Mishra, Egidio & Portwood-Stacer, 2003). Educational games were easier to install, easier to learn, less complex, shorter, less challenging to play, and required less social interaction than commercial games. Heeter and colleagues (2003) asserted that these qualities resulted mainly from the need to fit game-playing into standard school schedule 45-50 minute timeslots. What was clear from the study was that the constraints of working within a school setting led to game-design solutions that constrained playability, particularly related to the length and complexity of game play and thus limited what students could learn from the game. The authors argue that constraining games to a format that is playable in classroom settings may pose a bigger challenge to designers interested in creating fun, educational games than the need to integrate curriculum-based subject matter. This emphasis on pedagogy through play leads Heeter et al. to argue that educational games are schizophrenic, in that they continually try to serve two masters, content learning and fun.

Clearly game designers and scholars need to think of some manner in which to talk about this gap. We argue that the Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006) is one way of making this connection.

### *Technological Pedagogical Content Knowledge and Games for learning*

Technological Pedagogical Content Knowledge (TPCK) is a framework used to describe teacher knowledge for technology integration (Mishra & Koehler, 2006)<sup>2</sup> (see Fig. 3). Within the context of game design (or game design research) the TPCK framework can help us identify some important aspects in the design of an education game. The framework can help point to critical components that need to be considered in any assessment of learning from educational gaming. We describe below some of the critical components of the TPCK framework. Readers seeking a more detailed description should visit the <http://www.tpck.org> website.

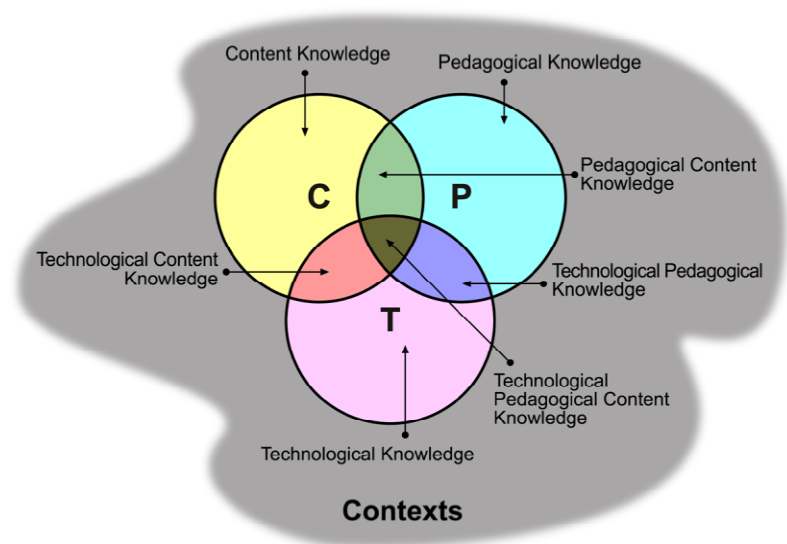
### *Figure 3: Technological Pedagogical Content Knowledge*

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<sup>2</sup> A range of scholars have made arguments regarding TPCK (or variants thereof). A relatively comprehensive list of references to TPCK in the research literature can be found at <http://www.tpck.org/>

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The TPCK framework builds on Shulman's (1986) idea of pedagogical content knowledge—the crafting of content for pedagogical purposes, and argues that any technology solution to a pedagogical problem needs to consider the role play by three components: content (C), pedagogy (P) and technology (T). The intersection of P and C is what Shulman would call Pedagogical Content Knowledge (PCK).

From the point of view of educational games, we can see the intersection between T and P as Technological Pedagogical Content Knowledge (TPK). The TPCK wiki describes TPK as follows: Technological Pedagogical Knowledge is knowledge of the existence, components and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies. This might include an understanding that a range of tools exists for a particular task, the ability to choose a tool based on its fitness, strategies for using the tool's affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies. What is interesting from the point of view of learning games is the strong family resemblances (Wittgenstein, 1953) TPK has to the classification of game genres we discussed earlier. The TPCK framework provides for a focused analysis on how technology integrates with content and pedagogy. Game genres, especially when seen through the lens of interactivity, are just a shorthand way of describing how a particular game integrates pedagogy and technology.

If a good educational game should seamlessly integrate all three aspects of TPCK, namely T, P, C, our analysis of game genres shows that two of the three components of TPCK are already present (i.e. T and P). Clearly what is missing from the discussion is any discussion of C (content). Thus the goal of educational game designers is to think about how this third circle can be brought into the framework. The inclusion of the TPCK approach provides us with a framework for analyzing the content of games and how they integrate with game genres, and through that provide us insight into how learning could occur and how that learning could be assessed. In the next section we provide an example of how the TPCK framework can be fruitfully used in the design of a research study on learning from games. This is from an ongoing project currently being developed by the first author.

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*Games and Learning Assessment Framework: An Example*

The focus of this study is on the kinds of learning that students can get from playing an economic simulation strategy game *RollerCoaster Tycoon 3: Platinum (RCT3)*. *RCT3* is one of the games from the *RollerCoaster Tycoon* series of games first developed by Chris Sawyer in 1999. The aim of the game is to build the best amusement park and generate as much profit as possible while managing other resources. The design and building of the theme park is directly related to how much profit is made in terms of cost-benefit, opportunity cost, or balancing constraints and affordances in the amusement park. The game, like others in the genre, allows players to control a whole theme park from managing resources, training and disciplining workers, building rides and trying to maintain a beautiful and clean park while also entertaining visitors and VIP's. Players can design their own theme park, rollercoaster, and other rides or they can modify existing parks and purchase the rides. Players must also meet the needs of patrons visiting their park by building facilities such as food stalls, drink stands, ATMs, information booths, bathrooms, benches and many more amenities. Central to the game is that players must manage their resources and balance their budgets in expenses and income. Players must also consider the affordances of their designs of rides with respect to the game needs as dictated by terrain and available money, their needs – how they want their park to look, and the visitors needs for a certain excitement level and intensity of rides. *RCT3* allows for the development of practical skills related to expertise development, cognitive skills related to systemic thinking and critical thinking, motivational affordances such as valuing, and social skills related to identity/possible selves and communication skills.

Table 2. Example of Approach to Research Plan

<b>Game</b>	<b>Claims</b>	<b>Genres</b>	<b>Content</b>
RollerCoaster Tycoon 3: Platinum	Practical Skills	Simulation	Economics
	Cognitive Skills		Mathematics
	Motivation	Strategy	Social Studies
	Social Skills		Information and Technological Literacy

The genre also helps in establishing what questions to ask because it gives the researcher an idea of the pedagogical stances in the games and also the epistemological stance. For instance, the following are some characteristics within the simulation strategy genre which provides a good place to start: 1) the focus within the genre is on planning and skill resource management to achieve victory, 2) *RCT3* is production-economic focus, 3) expertise development in skills related in the game, and 4) the game is activity-based around observation and intervention.

The complexity of games (given the claims and genres) indicates that learning from games is a complex process. We believe that this argues for learning assessments and evaluations that utilize mixed-methods that combine the control of lab-based studies with the richness of description of more qualitative approaches. A mixed-method combining both quantitative and qualitative methodological frameworks has the potential for game-based studies to be both authentic and generalizable beyond their settings, sample or within game genres depending on a

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researcher's focus. The proposed games and learning assessment framework adopts a mixed-method approach to better understand games and their relations to learning.

### *Conclusions and Implications*

There are two key sets of implications of our work. The first has to do with how our framework can influence decision makers about selecting games for learning. For instance, school teachers can use our framework (claims, games and genres) to help identify which games would be most appropriate for their classroom and that match their learning objectives. Additionally, parents could develop a better understanding on the types of game to get for their child and how to talk about games with their child. For policymakers, decisions on use of games in school based on game genres, pedagogy, and disciplinary affordances is crucial in an era where games are being used without much empirical support.

The second set of implications has to do with developing guidelines for future research and development in the area of games for learning. One key implication, in this regard, is that our work on listing the claims of games could be the basis of future research in this area. It is clear that the current claims about games for learning needs to be verified empirically and with appropriate research designs or assessments. The *claims of games survey* revealed that the claimed effects are related to four broad psychological effects—motivation, cognitive, practical and social. However, the physiological and the psychological effects are related to learning and development in four ways, by shaping attitudes, affecting behavior, influencing understanding, and affecting spatial and motor abilities. As the field of game design and its relationship to learning matures as a discipline, we should become more nuanced about what games can (and cannot do).

We suggest that these ideas should be used as a guide not the end point for what games afford because (a) games are continually evolving; and (b) most of these claims are unsubstantiated by research. This of course should be seen as an opportunity to scrutinize these claims and consider them as the basis for future research. Thus, each of these claims can be considered as being a hypothesis worthy of further study and investigation, thereby allowing these claims to be validated.

Another key implication of our work is that designers and researchers need to think more deeply about how content (disciplinary knowledge) can be fruitfully integrated within the design of games and then how different game genres can impact learning. One of the themes that emerged from our survey is that the claims about games for learning are usually presented as being content-neutral. They often do not distinguish what is learned such as what subject matter is most important for particular game-genres. What is learned from *Tetris* or *Pac-man* may be useful for senior citizens who need to maintain hand-eye coordination and not younger children who will develop that ability. Simulations can teach subject matter, but may be less successful in being integrated within the typical lecture-demonstration model that characterizes most school curriculum. We argue that research should carefully consider the pedagogical affordances of specific game genres (e.g. adventure, fighting, role-playing, simulations, action, sports and strategy games as well as their hybrids). Each game genre represents a different pedagogy and each pedagogical stance represents a different epistemological stance. Thus, research should

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elucidate which genre is better for what content. Research in game-based learning should connect claims to genres, rather than discuss games as if all games afford the same learning and skills development with respect to disciplinary knowledge/subject matter knowledge.

More broadly, we would like to see research on games and learning that better describes how subject matter knowledge integrates with the game-play. This to us, is the single most important challenge facing us as scholars and researchers. Games if they are to be successful in changing student learning need to go beyond being “chocolate covered broccoli” but rather move towards approaches that develop creative and powerful ways for learners to engage with the essential qualities of subject matter. Thus game designers need to start with key concepts in the domain in question, identify what is good learning in this area, and build the game around it. This will clearly require a greater level of collaboration between game designers and content experts, a collaboration that depends on an acknowledgement that neither group can do this alone.

A better understanding of the fact that content, pedagogy, and technology interact with varying levels of success is needed. Teaching with technology is a difficult thing to do well. Until game-based learning and design deals with the interaction of content, pedagogy, and technology (what has been called Technological Pedagogical Content Knowledge) (Mishra & Koehler, 2006), it is unlikely that there will be significant progress in this domain’s research program. The TPACK framework suggests that Content, Pedagogy, and Technology have roles to play individually and together. Teaching successfully with games requires continually creating, maintaining, and re-establishing a dynamic equilibrium between each of these three components.

In a recent editorial in the journal *Contemporary Issues in Technology and Teacher Education*, Bull et al., (2007) speaking of the challenge of using technology effectively for student learning, described this challenge as being a “wicked” problem (Rittel & Webber, 1973) and argued that the design of best practices for technology integration has to deal with:

... incomplete, contradictory, and changing requirements characterized by complex interdependencies among a large number of contextually bound variables. The wicked problems of technology integration require us to develop innovative and creative ways of confronting this complexity. Research indicates that such innovation occurs best at the intersection of disciplines and that “the more diverse the problem-solving population, the more likely a problem is to be solved” (Lakhani & Lars, 2007).

It is only by respecting the “wicked nature” of the problem, and recognizing the value of collaborative work, across fields, and accurate representations, through a greater sensitivity to the kinds of claims being made, and better descriptions of the research that the true potential for games as an agent for learning can be achieved.

## References

- Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science, 12*(5), 353-359.
- Apperley, T. H. (2006). Genre and game studies: Toward a critical approach to video game genres. *Simulation Gaming, 37*(1), 6-23.
- Barab, S. A., Bransford, J. D., Greeno, J. G., & Gee, J. P. (2007). *Embodied cognition: A more meaningful ontological unit*. Paper presented at the 2007 AERA Annual Meeting.
- Barab, S. A., Dodge, T., & Ingram-Goble, A. (2007). *Reflexive play spaces: A 21st century pedagogy*. Paper presented at the 2007 AERA Annual Meeting.
- Barab, S. A., Hay, K. E., Barnett, M., & Squire, K. (2001). Constructing virtual worlds: Tracing the historical development of learner practices. *Cognition and Instruction, 19*(1), 47-94.
- Beckett, K. L., & Shaffer, D. W. (2005). Augmented by reality: The pedagogical praxis of urban planing as a pathway to ecological thinking. *Journal of Educational Computing Research, 33*(1), 31-52.
- Betz, J. A. (1996). Computer games: Increase learning in an interactive multidisciplinary environment. *Journal of Educational Technology Systems, 24*(2), 195-2005.
- Bosworth, K. (1994). Computer games and simulation tools to reach and engage adolescent in health promotion activities. *Computers in Human Services, 11*(1), 109-119.
- Bull, G., Park, J., Searson, M., Thompson, A., Mishra, P., Koehler, M., et al. (2007). Editorial: Developing technology policies for effective classroom practice [Electronic Version]. *Contemporary Issues in Technology and Teacher Education, 7* from <http://www.citejournal.org/vol7/iss3/editorial/article1.cfm>
- Caldwell, N. (2004). Theoretical analysis of turn-based computer. *Media International Australia, 2004*(110), 42-51.
- Carnagey, N. L., & Anderson, C. A. (2004). Violent video game exposure and aggression: A literature review. *MINERVA PSICHIATR, 45*, 1-18.
- Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization and choice. *Journal of Educational Psychology, 88*(4), 715-730.
- Cuban, L. (1986). *Teachers and Machines: The classroom use of technology since 1920*. New York: Teachers College Press.

- De Aguilera, M., & Mendiz, A. (2003). Video games and education (Education in the face of a "parallel school"). *ACM Computers in Entertainment*, 1(1), 1-14.
- Egenfeldt-Nielsen, S. (2005). *Beyond edutainment: Exploring the educational potential of computer games*. Unpublished Dissertation, IT-University of Copenhagen, Copenhagen, Denmark.
- Entertainment Software Association. (2006, May 10, 2006). 2006 sales, demographic and usage data: Essential facts about the computer and video game industry. from <http://www.theesa.com/archives/files/Essential%20Facts%202006.pdf>
- Fabricatore, C. (2000, September 26, 2006). Learning and videogames: An unexploited synergy. Retrieved September 27, 2006, from <http://www.learndev.org/FabricatoreAECT2000.pdf>
- Federation of American Scientists. (2005). *National summit on educational games: Fact Sheet*. Washington, DC.
- Federation of American Scientists. (2006). *Summit of educational games: Harnessing the power of video games for learning*. Washington, DC.
- Foreman, J. (2003, September 26, 2006). Next generation educational technology versus the lecture. *EDUCAUSE Review* Retrieved September 27, 2006, from <http://www.educause.edu/ir/library/pdf/erm0340.pdf>
- Foreman, J. (2004). Game-based learning: How to delight and instruct in the 21st century. *EDUCAUSE Review*, 50-66.
- Friedman, T. (1999). Civilization and its discontents: Simulation, subjectivity, and space [Electronic Version]. *From Discovering discs: Transforming space and genre*. Retrieved April 23, 2007 from <http://www.duke.edu/~tlove/civ.htm>.
- Games-To Teach Research Project. (2006, March 2003). Vision. *Games-To teach* Retrieved March 24, 2006, from <http://cms.mit.edu/games/education/vision6.html>
- Gardner, H. (2006). *Changing minds: The art and science of changing our own and other people's minds*. Cambridge, MA: Harvard Business School Press.
- Gee, J. P. (1999). What is literacy? In C. Mitchell & K. Weiler (Eds.), *Rewriting literacy: Culture and the discourse of the other* (pp. 3-11). Westport, CM: Bergin and Gavin.
- Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave MacMillan.
- Gee, J. P. (2005a). Learning by design: Good video games as learning machines. *E-Learning*, 2(1), 5-16.
- Gee, J. P. (2005b). What should a state of the art instructional video game look like? *Innovate*, 1(6).
- Book chapter by Aroutis N. Foster and Punya Mishra – Handbook of Research on Effective Electronic Gaming in Education*

- Gee, J. P. (2007a). *Good video games + good learning: Collected essays on video games, learning and literacy*. NY: Peter Lang Publishing, Inc.
- Gee, J. P. (2007b). *Video games and embodiment*. Paper presented at the 2007 AERA Annual meeting.
- Gonzales, P., Guzman, J. C., Partelow, L., Pahlke, E., Jocelyn, L., Kastberg, D., et al. (2004). *Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003 (NCES 2005-005)*. Washington, DC: U.S. Gov Printing Office U.S. Department of Education, National Center for Education Statistics.
- Greenfield, P. M., Camaioni, L., Ercolani, P., Weiss, L., Lauber, B. A., & Perucchini, P. (1994). Cognitive socialization by computers games in two cultures: Inductive discovery or mastery of an iconic code? *Applied Developmental Psychology, 15*(1), 59-85.
- Hampden-Thompson, G., Johnston, J., & American Institutes for Research. (2006). *Variation in the relationship between nonschool factors and student achievement on international assessments* (No. NCES 2006-014). Washington, DC: U.S. Department of Education, Institute for Education Sciences, NCES.
- Heeter, C., Chu, C., Maniar, A., Winn, B., Mishra, P., Egidio, R., et al. (2003). *Comparing 14 plus 2 forms of fun (and learning and gender) in commercial versus educational space exploration digital games*. Paper presented at the International Digital Games Research Conference.
- Johnson, S. (2005). *Everything bad is good for you: How today's popular culture is actually making us smarter*. NY: Penguin Group.
- Kelly, H. (2005). Games, cookies, and the future of education. *Issues in science and technology* Retrieved October 18, 2006, from <http://www.fas.org/resource/07152005161632.pdf>
- King, G., & Krzywinska, T. (Eds.). (2002). *Screenplay: Cinema/videogames/interfaces*. London: Wallflower Press.
- Kirriemuir, J., & McFarlane, A. (2004). *Literature Review in Games and Learning* (No. 8). Bristol, Canada: Nesta Futurelab.
- Lakhani, K. R., & Lars, B. J. (2007). Getting unusual suspects to solve R&D puzzles. *Harvard Business Review, 30-32*.
- Laurel, B. (Ed.). (2003). *Design Research Methods and Perspectives*. Cambridge, Massachusetts: The MIT Press.
- Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 5*(4), 333-369.
- Mishra, P., & Foster, A. (2007). The claims of games: A comprehensive review and directions for future research. In R. Carlsen, K. McFerrin, J. Price, R. Weber & D. A. Willis (Eds.), *Book chapter by Aroutis N. Foster and Punya Mishra – Handbook of Research on Effective Electronic Gaming in Education*

*Society for Information Technology & Teacher Education: 2007 18th International Conference*. San Antonio, Texas: Association for the Advancement of Computing in Education (AACE).

- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054.
- Mitchell, A., & Savill-Smith, C. (2004). *The use of computer and video games for learning*. London: Learning and Skills Development Agency.
- Myers, D. (2003). *The nature of computer games: Play as semiosis* NY: Peter Lang Publishing.
- National Institute on Media and the Family. (2005, 4/22/05). Effects of video game playing on children. Retrieved October 21, 2005, from [http://www.mediafamily.org/facts/facts\\_effect.shtml](http://www.mediafamily.org/facts/facts_effect.shtml)
- Prensky, M. (2001). *Digital Game-Based Learning*. New York: McGraw-Hill.
- Randel, J., Morris, B., Wetzel, C., & Whitehill, B. (1992). The effectiveness of games for educational purposes: A reviews of recent research. *Simulation and Gaming*, 23(3), 261-276.
- Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155-169.
- Roe, K., & Muijs, D. (1998). Children and computer games: A profile of the heavy user. *European Journal of Communication*, 13(2), 181-200.
- Sandford, R., & Williamson, B. (2005). *Games and learning: A handbook from Futurelab*. Bristol, UK: Futurelab.
- Shaffer, D. W. (2006). *How computer games help children learn*. NY: PALGRAVE MACMILLAN.
- Shaffer, D. W., & Gee, J. P. (2005). Before every child is left behind: How epistemic games can solve the coming crisis in education.
- Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, 87(2), 104-111.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Squire, K. (2004). *Replaying history: Learning world history through playing civilization III*. Unpublished Dissertation, Indiana University.
- Subrahmanyam, K., Greenfield, P., Kraut, R., & Gross, E. (2001). The impact of computer use on children's and adolescents' development. *Applied Developmental Psychology*, 22, 7-30.
- Book chapter by Aroutis N. Foster and Punya Mishra – Handbook of Research on Effective Electronic Gaming in Education*

Walsh, D. (1998, December 1, 1998). 1998 Video and Computer Game Report Card. Retrieved October 29, 2005, from [http://www.mediafamily.org/research/report\\_vgrc\\_1998-1.shtml#1998](http://www.mediafamily.org/research/report_vgrc_1998-1.shtml#1998)

Williams, D. C. (2004). *Trouble in river city: The social life of video games*. Unpublished Dissertation, University of Michigan, Ann Arbor, MI.

Wittgenstein, L. (1953). *Philosophical investigations*. New York,: Macmillan.

Wolf, M. J. P. (2001). Genre and the video game. In M. J. P. Wolf (Ed.), *The medium of the video game* (1 ed., pp. 232). Austin, TX: University of Texas Press.

### **Key Terms and Definitions:**

1. Technological Pedagogical Content Knowledge (TPCK) – A framework for integrating content into technology (games) and analyzing games. Also see TPCK.org for more information.
2. Game interactivity – The way games are experienced or the non-trivial effort or actions taken in playing video games.
3. Platform - The hardware system on which the game is played e.g. PDA, GBA and cell phones.
4. Game mode - Mode in which the game is experienced. It may affect players movement as tightly structured or multidirectional or multilinear.
5. Milieu - Visual genre of the game e.g. science fiction or horror.
6. Games – refers to types of electronic games - arcade, video and computer games.
7. Claims of Games – broad claims made about what games (video and computer – digital) offers for learning. They usually fall within two schemes – psychological or physiological.
8. Psychological scheme of claims – These are focused on claims that are cognitively practically, motivational, and socially oriented.
9. Physiological Scheme of claims – these are seven specific claims refreing developmental behavioral claims.