

Journal of Information Literacy

ISSN 1750-5968

Volume 9 Issue 2

December 2015

Article

Bebbington, S. and Vellino, A. 2015. Can playing *Minecraft* improve teenagers' information literacy? *Journal of Information Literacy*, 9(2), pp. 6-26

<http://dx.doi.org/10.11645/9.2.2029>



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Can playing *Minecraft* improve teenagers' information literacy?

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Abstract

Some research suggests that a significant number of Generation Z teenagers (those born in the late 1990s or early 2000s) display an insufficient level of information literacy (IL) to function effectively in an information-based society. Yet many of them are gamers who succeed at accomplishing game-related tasks that require a number of IL skills such as information seeking, the critical assessment of sources and relevance ranking of information. This paper describes the results of an interpretive case study of the information behaviours of teenage gamers that supports the hypothesis that the online game *Minecraft* supports the development of such IL skills. The online interactions of 510 participants of a public discussion forum on *Minecraft* and interviews from eight teenage *Minecraft* gamers, as well as the game itself, were analysed. This study suggests that some aspects of *Minecraft*'s design effectively induce players to seek out game-related information in affinity spaces (online informal learning spaces), select appropriate sources, evaluate the information shared by fellow gamers and decide which information best satisfies their needs.

Keywords

information literacy, gaming, *Minecraft*, teenagers, Canada

1. Introduction

While a number of Generation Z teenagers (usually defined as those born in the late 1990s or early 2000s) may have a good grasp of information technology, there is evidence that a significant number of them nevertheless exhibit an inadequate level of information literacy (IL). As several studies have shown (Barnes et. al 2007; Beheshti 2012; Salisbury and Karasmanis 2011), the abilities that contemporary teenagers have to determine what, and how much, information is needed to accomplish a task, to critically assess the quality of information sources and to identify relevant information are, as a general population, insufficient for them to function effectively in an information-centred society. As Large (cited in Beheshti, 2012) noted in his literature review on the IL of the previous generation of teenagers, young people in the internet age struggle with information seeking; they have trouble “selecting appropriate search terms, move too quickly through the web pages while spending little time reading the materials, and have difficulty judging the relevance of the retrieved pages.” (p. 55). This observation is still true of a significant segment of Generation Z.

It follows that any alternative educational methods that could supplement the formal classroom methods normally used to teach IL would be of benefit both to teenagers and to society at large. We believe that some kinds of sandbox video games, in which there are no preset narratives, rules or objectives embedded in the game design, and where the player establishes the goals and

objectives of the game, may offer such an alternative. *Minecraft* is such a game, and, as we argue in this paper, it both requires and encourages the development of IL skills.

Minecraft is one of the most popular and successful video games ever built. It boasts over 100 million registered users worldwide, and, on any given day, between 2 and 3 million players login on *Minecraft* servers. It is an “open world” game, one in which players are able to roam freely through virtual worlds of their own design and whose movements and behaviours are almost unconstrained. *Minecraft* players can, either individually or collaboratively with other players, mine, gather and assemble various Lego-like virtual blocks in order to design their own structures such as buildings, cities and artefacts. What a player can build in *Minecraft* is limited only by the player’s knowledge and creativity; the end result of a game can be anything from a simple house to a complete recreation of Ancient Rome. In 2014, the Danish Geodata Agency (2013) made public its project which used *Minecraft* to recreate the entire country of Denmark to scale.

We chose *Minecraft* for this study for several reasons besides its enormous popularity. First, *Minecraft*’s sandbox design encourages players to seek information both from within the game itself and from a variety of external sources (for example from other players or online forums) and offers players many opportunities to exercise general-purpose IL skills. Secondly, a significant proportion of *Minecraft* users contribute actively to discussion forums, video demonstrations, tutorials, and blogs, providing an abundance of data on players’ information-seeking behaviour. The principal source of our text data came from the discussion threads found in *Minecraftforum.net*, the official forum for *Minecraft*, which is also its largest, with over 2.5 million members and over 24 million posts. Finally, unlike some more recent variants like the survival horror game *The Forest*, *Minecraft* is a relatively non-violent game that is already being used in some school communities for subject-specific educational purposes (List and Bryant 2014).

This paper summarises the results of an interpretive, qualitative case study performed for a Masters in Information Studies (MIS) thesis (Bebbington 2014) that analysed the online interactions from among 510 participants in 20 threads of a public discussion forum. The analysis of the discussion threads demonstrates both how IL skills are being practiced by gamers during game play and how these skills are manifested by participants in an associated affinity space (online informal learning spaces). These results were then corroborated by an analysis of interviews from eight teenage *Minecraft* gamers concerning their information-seeking and evaluation practices during gameplay and in discussion forums.

This paper is divided into five sections. The literature review surveys some of the pertinent related research on IL and video games; the following section offers an analysis of the design features of the *Minecraft* video game that pertain to IL. The fourth section provides an analysis of threads in the discussion forum that illustrate IL skills among players as well a summary of the results of interviews with teenage gamers. The last section draws some conclusions from this study and suggests possibilities for future investigation.

2. Literature Review

It could be argued that Generation Z is a demographic with much greater technological and informational challenges than those of previous generations. According to Lee et al. (2013), these challenges arise as a result of the ubiquitous access to the web and the emergence of big data, cloud computing and smartphones. The demands placed on teenagers by an increasingly global, information-centric online society therefore places a premium on their IL skills.

The question of what constitutes IL is itself the subject of much literature, some of which precedes the internet era. Yet the essence of some of those definitions still applies today. At its core, the concept of IL centres on how effectively and efficiently a person can locate, evaluate and subsequently use information. In 1989, the Presidential Committee on Information Literacy noted that: “To be information literate, a person must be able to recognize when information is needed

and have the ability to locate, evaluate and use effectively the needed information” (ALA 1989, p.19).

While there are more nuanced contemporary IL models (such as Nasset 2013), for the purposes of this paper we will use the following definition:

Information literacy is the ability to know when there is a need for information, to be able to identify, locate, evaluate, and then use that information effectively to make informed decisions.

This definition is a synthesis of several definitions drawn from IL standards published since 1989, and closely aligns with the one provided by the Chartered Institute of Library and Information Professionals (CILIP), which defines IL as “knowing when and why you need information, where to find it, and how to evaluate, use and communicate it in an ethical manner”. In the context of this study, we focused on the elements of need, discovery and evaluation. (CILIP 2013)

Our choice of definition aims to encompass information use contexts beyond the classroom. We agree with Martin’s (2012) assertion that IL should be looked upon as a collection of skills that demands critical thinking, collaboration and communication that apply to everyone, not just students, librarians and academics. We also concur with Campbell (2008), who recommends that, whatever definition we choose for IL, it should be able to include new and evolving information environments.

One of the manifestations of teenagers’ engagement with information and technology is gaming. According to the Entertainment Software Association of Canada (ESAC) in 2012, 79% of Canadian teenagers (13-17) were gamers, with 46% playing every day, making it plausible to suggest that a large percentage of teenagers in Generation Z are gamers, at least to some degree (ESAC, 2012). The game genres played by teenagers span the range of action-adventure, first-person shooters and role-playing games. But game designers are also integrating an increasing variety of genres into one game. For example, a first-person shooter game may incorporate elements of a role-playing or puzzle-solving game. Hence, the range of skills that teens need to play these games effectively is increasingly diverse and complex.

Many studies have explored the educational value of serious games. A recent literature survey of empirical studies on serious games (Connolly et al. 2012) identified 129 papers that discussed the perceptual, cognitive, behavioural, affective and motivational aspects of games. While several of these aspects are foundational for IL as defined above, there are only a few studies that specifically explore the IL elements of video games or how these skills are used in video game affinity spaces.

Nass et al. (2014) analysed a variety of games designed specifically for the purpose of teaching IL skills in an effort to discover or design a game to support library-related IL education. These included: *Library Scene*, an educational game that teaches students about basic library skills (e.g. the Dewey decimal system); the *Scott Rice and Amy Harris Information Literacy Game*, a digital hybrid of *Monopoly* and *Trivial Pursuit*; and *Secret Agents in the Library* which teaches students how to finding information in a library. The authors found that games designed specifically to enhance IL incorporate small puzzles or problem-solving elements. They also noted that the video game *Legend of Zelda*, which, like *Minecraft*, takes place in an “open world”, requires players to search for sources of information to solve puzzles and to evaluate the relevance of information in a manner that resembles typical information search and evaluation strategies used to write a research paper.

Some studies have shown that video games provide opportunities for learning by letting players think, talk and read (Adams 2009; Gee 2007; Steinkuehler 2008); all key cognitive competencies that underpin IL skills. Other studies have focused on the extent of teenagers’ engagement with each other during game play. In a study conducted by Shaffer (2012), 85% of the 180 teenage

gamers surveyed communicated with others online while playing and 72% stated that they played collaboratively with others in the same room. The gamers in the study stated that they preferred playing online because of the opportunities it afforded to meet new people, and also for competition, escapism and collaborative play. Shaffer concluded that, by using online communication tools, teenage gamers were making efforts to fulfil their social and learning needs; they were engaging with others, both new acquaintances and established friends, as well as learning new strategies for enhancing their game play.

Several studies have focused on the function of affinity spaces for learning and literacy. Gee (2007) defines an affinity space as an online informal learning space that allows users to create and share knowledge or seek information around a common theme or topic. They are community environments that gamers often rely on to obtain information about formal play strategies, or to solicit opinions and obtain feedback on something they have done or created. Lammers et al. (2012) showed that affinity spaces provide abundant opportunities to analyse informal learning activities, especially literacy.

Schrire (2006) maintains that affinity spaces provide occasions for collaborative learning exchanges that are conversational in nature. When collaborating and communicating, players develop social skills and shared meanings, leading to a community with shared values (Shaffer et al. 2005). It is these shared values and common interests that motivate participants to continue interacting with one another in affinity spaces (Silius et al. 2013). Participants who find the content in these spaces to be useful also tend to use the available resources and to inform others about them (Silius et al. 2013). Furthermore, the relationships that develop among participants in these environments can be the mainspring behind learning through collective information sharing, assessment, feedback, debate and consensus (Barnes et al. 2007). Therefore, affinity spaces provide ample opportunities for participants to practise their IL skills, particularly information seeking and knowledge creation (Steinkuehler 2008).

There are two aspects of affinity spaces that are indicative of the presence of IL skills: the use of a specialised language that is required when searching for information; and shared knowledge, which is essential for locating information (Gee, as cited in Martin, 2012). According to Martin (2012), interest-driven communities are a manifestation of a collective intelligence that provides a wealth of information to anyone seeking information about a given topic: "...a collective intelligence is held together by the dynamic and social process of acquiring knowledge, which allows for continuous participation and the reaffirming of social ties" (Martin, 2012 p. 94).

This collective intelligence, she claims, fosters collective IL practices. In her analysis of a discussion forum centred on *World of Warcraft*, Martin found that IL is often a collaborative and collective activity, where communities of people primarily help each other with their information needs through information sharing and evaluation. In an earlier work, Martin (2011) found that, to be played well, *Second Life* and *World of Warcraft* require their players to be information literate. Without sufficient IL skills, a player may not be able to identify when information is needed, where to find it or how to determine what information would be most effective.

Affinity spaces are therefore an ideal setting in which to study IL because they are informal environments that are both natural and enclosed (Meyers 2013) and ideal for observing the processes of seeking and sharing of information. Affinity spaces allow participants to collect, share, evaluate, and deliberate about information with other likeminded individuals, and can evolve into communities of practice in which participants work together to fulfil their information and social needs. The need that players have to go outside *Minecraft* to find information in order to play effectively indicates that gamers experience knowledge gaps, and possibly frustration or confusion about the game. Sense-making theory as applied to information seeking in games thus requires an understanding of the information seeker's context: experience, prior knowledge, barriers and habits that influence the player's ability to make sense of a particular knowledge gap. As new information is discovered, the gap closes, thus resolving feelings of frustration and confusion and allowing the individual to move forward (Reinhard and Dervin 2011).

2.1 Research ethics

The research undertaken for this paper was approved by the University of Ottawa Ethics Board and conforms to the 2010 Tri-Council Policy Statement (Canadian Institutes of Health Research et al. 2010). All the interviews with children were performed with the consent of both the participant and his or her parent(s) and we made every effort to ensure complete anonymity and confidentiality in these interviews.

The data collected from online discussion forums were publicly accessible and there was no need for us to register with these forums to access their content. The terms of service for *Minecraftforum.net* explicitly state that it “does not guarantee any confidentiality with respect to any such submissions” (Curse Inc. 2011). While this forum does offer a premium (members-only) service enabling private conversations among subscribers, such discussions were not used for this research. The existence of such a private forum implies, even without a detailed reading of the terms of service, that the non-premium forums are public. Hence the expectation of privacy by users would be low. The authors of another study employing public message board discussions among video game players (Bourgonjon et. al 2015) also did not deem it necessary to obtain the informed consent from the players because no registration was required to consult the forums.

Furthermore, as is evidenced in our analysis, the intent of both the questioners and the respondents in the forum discussions was to make their knowledge, views and opinions public. There is no reason to believe that our analysis of these discussions in the context of IL would affect the original authors, emotionally or otherwise, even though our use of these texts is different from the ones for which they were originally intended. None of our analysis passes judgement on the participants’ remarks and none of their remarks have any bearing on their ethical, religious or political views.

As we note below, many of the conversations in these public forums were most likely between teenagers, although the exact age of the participants was not available to us. It is unreasonable to expect that all these teens complied with the forum’s terms of service requirement that children younger than 18 years of age “may only access account-related features using a parent or guardian’s account so long as the parent or guardian consents and accepts full responsibility for the conduct of the child.” (Curse Inc. 2011). Nevertheless, we made sure that the information gathered from these forums was only about the *Minecraft* game, that it was not sensitive or controversial in nature, and that no real names were used. We have every reason to believe that our practices are consistent with the AoIR ethical decision-making and internet research guidelines (AoIR 2012).

3. *Minecraft* design features

Minecraft’s IL characteristics can be inferred both from a qualitative analysis of the game itself and an examination of the discussion threads in a *Minecraft* affinity space (discussion forum). Our qualitative analysis of the *Minecraft* game follows the framework set out by Consalvo and Dutton (2006), which was used both by Chess (2009) to analyse a variety of videos games geared to women and by Glas (2010) to analyse *World of Warcraft*.

As indicated in the introduction, *Minecraft* is a sandbox game that enables players, either individually or collaboratively to gather and manipulate various building blocks to create their own world. Blocks consist of a variety of virtual resources, such as materials and tools with which players can build objects in their world. While the game appears at first to be somewhat unsophisticated, it is, in fact, a complex game that requires considerable thought, skill and creativity. *Minecraft* can be played on almost any console, computer or portable device, although the mobile versions offer fewer game options. Players can play on their own or in multiplayer mode where they interact with other players online.

The game can be played in two main modes: *survival* and *creative*. In survival mode, players are challenged to collect tools used to gather, construct or cultivate resources while fighting hostile monsters. Staying alive also requires that players manage their health and hunger. In creative mode, players are not required to maintain their health or eat, nor are the monsters able to kill them. In creative mode, the player's inventory is continuously full and, typically, his or her time is spent focused on creating.

Consalvo and Dutton's toolkit for the qualitative analysis of games (Consalvo and Dutton, 2006) identifies four aspects of games, which, they claim, are the most revealing for understanding how they are played: the object inventory; the interface study; the interaction map; and the game play log. In this framework, an object inventory refers to the objects that can be found in a game and how players can interact with each of them. This, in turn, determines the strategies and skills required by gamers. The interface study includes an analysis of the design components that helps or informs players about the current state of their game and informs them about the consequences of their decisions. The interaction map describes how gamers can interact with non-object elements of the game and reveals information about the ways in which gamers relate with other characters, whether they are controlled by other gamers or non-player characters. Finally, the game play log is an analysis of the game as a whole that explores emergent aspects of the game, such as the unintended interactions between characters and objects.

Our analysis of *Minecraft* using this framework reveals an object inventory list of more than 350 built-in objects that fall into eight main categories: materials, foods, tools, potions, information, weapons, armour, transport and decorations. Materials are the principal drivers of the game, regardless of the mode in which it is played, and are used primarily for building, farming and crafting. Foods are the second most important items since they are essential for survival in every mode except creative mode. Although the other items are not necessary for playing, they enhance the gaming experience by offering the player a considerable range of possibilities for creative expression.

The function of an object in *Minecraft* often depends on the function of other objects in ways that are not obvious and are specific to the design of *Minecraft*. For example, carrots, which cannot be farmed from seed, are found when zombies drop them, may be consumed to decrease hunger, used in combination with a stick to steer a pig, and altered into golden carrots for use in potions that heal horses and breed rabbits. Thus learning what functions objects perform in the game is a critical element of complex knowledge acquisition that requires some information seeking and evaluation in order to play the game effectively.

The items categorised as information in *Minecraft*, although few in number (only six), have additional attributes that make them valuable, particularly when playing with others. For example, a virtual book and quill together, allow players to document their explorations, provide instructions and directions and record the information they have learned. Once complete, the book can be signed, saved and left in the virtual world for others to read and facilitates the sharing of information in asynchronous gameplay. Similarly, a special kind of *Minecraft* block, called a sign, can contain written instructions or directions for other players and placed anywhere in the virtual world, thus giving players the opportunity to share their knowledge and develop reputations as resourceful, experienced and reliable players.

Given the large number of available objects, a player is unlikely to remember all of them, or, indeed all their functions and relationships to other objects. Moreover, relying only on one's prior knowledge about certain items (for example that sand can be used for farming) may not be sufficient in some situations. Without actively seeking additional information, a player may never discover an object's lesser-known functions (such as that sand, as well as gunpowder, can be used for crafting TNT). Therefore learning about the various functions that objects can perform requires seeking information from outside *Minecraft*, whether from fellow gamers directly or from affinity spaces such as the official *Minecraft Wiki* (2015), discussion forums devoted to *Minecraft* or

even *YouTube* (in which a search for “*Minecraft*” produces about 59 million hits: approximately one-third of all of *Google*’s search results).

Selecting the relevant information from the significant quantity of available information requires the player to assess its reliability. For example, when a gamer decides that she needs information about how to make a tool, she must then assess which answer from among the ones she finds, provides her with details that that are sufficiently reliable for her to succeed at making it. This is a process that requires critical thinking skills that are enabled by the game itself: as players become better informed about the various elements found in the game, they can practice what they have learned by empirically testing the validity of this new information in gameplay.

4. Analysis method for discussion threads and interviews

To identify the IL skills that *Minecraft* players manifest when using an affinity space, we collected 610 messages written by 510 participants across a total of 20 discussion threads, taken from *minecraftforum.net*, the official discussion forum for *Minecraft* and dated between August 2011 and June 2013. These discussion threads and some of their attributes are listed in Table 1.

While it was not possible to ascertain the precise age of the participants, circumstantial evidence such as the handle names, the writing style of the messages and an informal poll of *Minecraft* players (Pew 2012), indicates that the majority of players are teenagers or young adults.

Table 1: Summary of *Minecraft* discussion threads

Thread title	Number of replies	Number of participants (including the information seeker)	Time span	Request type
1. "Official" Mining Strategies?	27	22	4 days	Strategic
2. What's the most useless item in <i>Minecraft</i> ?	77	72	15 days	Opinion
3. Remove Enchantments?	17	16	10 months	Strategic
4. Can't craft fireworks?	6	7	6 months 6 days	Strategic
5. Noob question: How did they die?	15	10	1 month	Strategic
6. How do YOU find your diamonds?	17	16	1 day	Strategic
7. Major FPS drop from 60-around 9 randomly. HELP!	25	7	13 days	Technical
8. What causes Omen edited maps to become corrupt?	7	6	< day	Technical
9. Question about enchanting books	9	6	< day	Strategic
10. How do I paste in books, chat etc.?	6	6	1 year 2 months	Technical
11. Living in THE END! Is it possible?	22	20	1 month 10 days	Strategic
12. What mob do you hate?	37	38	2 days	Opinion
13. HELP! Can't join a single server on vanilla <i>Minecraft</i> , on tekkit, on anything!	11	7	< day	Technical
14. What do you do with...	5	4	< day	Strategic
15. Any program to help design builds in <i>Minecraft</i> ?	7	7	< day	Strategic
16. How far do hostile mobs have to fall to be one hit kill?	28	22	1 year two weeks	Strategic
17. How to make mobs not turn invisible?	12	8	< day	Strategic
18. In Lava Half-Heart Game Closed. How Can I Save Myself?	26	25	1 day	Strategic
19. SMP Pranks?	246	217	1 year 7 months	Opinion
20. Help! My arm, chests, all creatures and several objects are black!	11	11	1 day	Technical

Notwithstanding the possibility of bias in the use of a non-probability method, we used purposive sampling to select the discussion threads. We believed that the most effective way to find players who manifested IL skills was to select discussion threads whose very origin was an information request or request for help or feedback. In contrast, random sampling would have introduced a great deal of noise from players discussing software bugs, complaints about the *Minecraft* server and irrelevant discussions about how the game should evolve in the future.

However, the initial purposive sampling criterion yielded some threads which had few or no responses and it became immediately apparent that a second criterion for selecting threads needed to be introduced, namely that there be a minimum of three replies.

Each message in the 20 discussion threads was assigned a code starting with the initial request for information. Each thread began either with a request for technical information ($n=5$) (such as information on the technical workings of *Minecraft*, the device being used, operating system etc.),

strategic information ($n=12$) (such as information directly related to *Minecraft* and/or how to play), or a request for the opinions of others ($n=3$). On average, each thread contained 30 replies and posts from an average of 25.5 participants.

After the initial phase of open coding, broader categories began to emerge. The coding process for these messages employed a grounded theory methodology that places the player at the centre of the process of meaning construction. The specific coding cycle for this study was similar to the one Bowers (2011) used to investigate the complex relationships that exist between former athletes' sports identities and sports video games. It began with open coding where the units of the discussion thread were assigned codes (for example 'Defining an information need'). Next, the categories were identified (using axial coding) according to the IL skill that was demonstrated in individual messages in the discussion thread. These codes were then assembled into three broad categories: information evaluation; information seeking; and information sharing. Finally, the messages were analysed in relation to the definition of IL provided above in order to identify the relationships and connections among the codes and categories.

As each new code was added to a message, we compared it with the previously coded messages to ensure that it was put into the most appropriate category. For example, the discussion thread sample "...So *what DO YOU do with your TNT overflow?*" (Thread 14) was initially coded as 'Defining an information need'. In the second round of coding, this portion of the discussion thread was assigned an additional code of 'Strategic (gameplay) information need'. This was done to further clarify the type of information being requested and, later, to investigate the impact that the type of information request had on the replies, as well as the subsequent IL behaviours exhibited in the forum. This technique allowed for a certain degree of flexibility in the fine-tuning of codes and categories. The principal author of this paper performed the first round of coding herself and completed the subsequent rounds with two additional coders.

4.1. Analysis of discussion threads

The time frames within which these discussions took place varied according to the conversation. The average duration of a discussion thread in the sample was 98.75 days, the shortest being half a day and the longest being 14 months. We found that opinion-based discussions generally continued for a considerably longer time period and contained many more replies than their technical and strategic counterparts. This is probably due to the limited number of possible solutions that exist for any given strategic or technical problem.

In four out of the twenty threads, the initial information seeker did not contribute to the discussion beyond the initial information request. Two of these started with an opinion-based information request and the other two started from a strategy-based information request. In the remaining 16 discussion threads, the original information seeker replied and conversed with the other discussion thread participants. From among these, the initial information seeker contributed an average 3.25 postings to the thread. More often than not, the initial information seeker was the dominant contributor to the threads. This was particularly so for technical or strategic game play information requests, perhaps because they rely more on accuracy than opinions do, and are likely to have fewer direct implications for the information seeker's gameplay. Ten of the twenty discussion threads had participants that contributed more than one message. The average number of postings per participant in these cases was 2.4.

We initially assigned a total of 1477 codes to the discussion threads messages. The axial coding process described above yielded a total of 34 codes, based on the kind of IL activity we identified within the threads. All of these 34 codes were then brought together into the three major information literacy categories mentioned above: information evaluation; information seeking; and information sharing. From among the 610 messages comprising the 20 threads, 11 codes belonging to the category information seeking were applied 179 times, 10 codes belonging to the category information sharing were applied 1033 times and 13 codes belonging to the information evaluation category were applied 265 times.

4.1.1 Information seeking

The ability to recognise that one needs to find information is an essential component of our chosen definition of IL. The codes assigned to the category 'Information seeking' were concerned with the information-finding process embarked upon when attempting to satisfy an information need. A table of all the codes, frequencies and percentages for 'Information seeking' can be found in Table 2.

Table 2: Summary of code frequencies for 'Information seeking'

Codes	Number of Applications	Codes by Percentage
Providing context	52	29%
Defining an information need	30	17%
Providing further context	19	11%
Strategic information need	17	10%
Validating information need	14	8%
Drawing on prior knowledge	12	7%
Request for help	10	6%
Asking for more information	9	5%
Technical information need	9	5%
Opinion based information need	3	2%
Stating what information is not wanted	1	0.5%

The code 'Providing context' was applied in cases where the information seeker provided some context or subsequently included an explanation for why the information was needed or wanted in response to another participant's reply. We identified 52 such cases. For example, the following information seeker was looking for ideas to "prank" his friends. When a reply occurred he refined his information request by providing the following additional context:

im the server owner so materials aren't a problem. i just wanna get a really pissed reaction or really confused reaction out of them. im running craftbukkit so getting plugins wouldn't be a big deal for me. i don't want to have to screw around with backups so everything i do has to be reversible. no fires or killing people where we can't get the items back. (Thread 19, SMP Pranks?, bigjeep, August, 7, 2011)

The code 'Defining an information need' was applied when a participant made a request for information. We identified 30 such instances. In each of the 20 discussion threads, the code 'Defining an information need' was applied at least once because each thread began with the expression of an information need as established in the data collection criteria. In addition, another ten requests for information were made within the collected threads by either the original information seeker or by another participant. For example, one of the discussion threads in the sample was initiated by the following request: "*Is there a way to remove enchantments in 1.2.5?*" (Thread 3, *Remove enchantments?*, Andrewdale, June 18, 2013)

In some cases information seekers provided additional information or context when they were asked for it, or in response to a reply in the thread; 19 such instances were identified and each was coded 'Providing further context/information'. The exchange below, taken from the thread "*What causes Omen edited maps to become corrupt?*", is one such example:

Initial Request: After finally finishing the basic outline of the head waited till the server saved again closed it all out went to open Omen again and it now it won't open it created a new default map that replaced the other. Anyone got any ideas of what went

wrong? (Thread 8, *What causes Omen edited maps to become corrupt?*, coradon, October 20, 2012)

Reply #2: *"That has happened to me are you closing the server console with ctrl+c?"* (Thread 8, *What causes Omen edited maps to become corrupt?*, chariot, October 20, 2012)

Reply #5 (from initial information seeker): *"No I've just been waiting for the server to save then I hit the X in the top right corner. Is there a preferred method to closing it that doesn't cause problems? (I'm an XP user Linux)"* (Thread 8, *What causes Omen edited maps to become corrupt?*, coradon, October 20, 2012)

The code 'Strategic information need' was applied 17 times. In addition to initial requests for strategic help that began 12 discussion threads, five other requests for strategic help were identified within the threads. These five additional requests were related, or similar, to the initial request for information. For example, the initial request: *"Is there a way to remove enchantments in 1.2.5?"* (Thread 3, *Remove enchantments?*, Andrewdale, June 18, 2013) received the following response: *"i got a bunch of gold armor from skelly's with enchants and want to take the chants off the gold and put it on my diamond armor, but doesn't look like you can..."* (Thread 3, *Remove enchantments?*, savagedogballs, June 18, 2013).

The code 'Drawing on prior knowledge' was applied to cases in which the information seeker provided information such as recalling past experiences or indicating what she or he already knew about the information they were requesting. We identified twelve such instances in the sample. Six initiating requests for technical information were coded 'Technical information need' and three additional messages occurring inside the main threads were assigned this code. The code 'Opinion based information need' was also applied in three instances. An exemplary request taken from a discussion thread in the sample is the following message: *"What do you think is the most useless thing in minecraft? Do not post about something you've never used."* (Thread 2, *What's the most useless thing in minecraft?*, Snipe7r, March 13, 2013)

Instances in which discussion participants responded with an acknowledgement that they either required the same information as the initial request or who expressed the belief that the request was valid or interesting, were coded as 'Validating information need'. This code was applied in 14 cases. The code 'Asking for more information' was used when a participant requested more information from the information seeker and it was applied nine times.

We can see from the coding in this sample that information-seeking behaviour is a dynamic community-driven process, with information being exchanged and shared among multiple participants. The information sought in these threads was largely about strategy: how to do various things within the game. The information seeker would make an initial request but the information sought became more refined as exchanges took place between interested participants. Participants would provide additional context or more information as the information seeker refined and communicated his or her needs. Some participants validated the information seeker, stating that they were looking for the same or similar information. As participants help information seekers to refine their needs, they are inadvertently helping the information seekers to develop and improve their abilities to define an information need and articulate their knowledge.

4.1.2 Information sharing

The category 'Information sharing' contained codes related to the sharing of information, i.e. solutions, opinions or suggestions pertaining to a *Minecraft* related query requested by a forum participant. Ten codes were assigned to this category and applied a total of 1030 times. As Martin (2012) has previously shown in the context of *World of Warcraft* discussion forums, the number of participants in discussion threads related to the sharing of solutions, opinions or suggestions is high. Hence the high number of code applications in this category for *Minecraft* was not surprising. The average number of replies to information requests in the sample is set out in Table 3.

Table 3: Summary of code frequencies for ‘Information sharing’

Codes	Number of Applications	Codes by Percentage
Providing information/solutions	405	40%
Expressing opinion	248	24%
Justifying answer	112	11%
Sharing of experiential information	91	9%
Repeating previously mentioned information	49	4.7%
Offering suggestion	37	3.5%
Providing examples	33	3%
Providing a reference	24	2%
Expanding on another’s reply	21	2%
Sharing of indirect information	10	1%

There were 405 applications of the code ‘Providing information/solutions’. This code was assigned when information was being shared either in different ways for example as a reference or based on experience or when the information being shared was of different types (opinion, reference, or an example). Therefore, each code identified as ‘Providing information/solutions’ was refined to determine how and what was being shared. As a result, additional codes were applied. The length and complexity of the information shared varied considerably; some replies were short and succinct while others were in-depth instructions or explanations. The following simple factual response to an inquiry is an example of a short query to which we applied the code ‘Providing information/solutions’: “23 blocks to severely damage mobs 24 to kill them” (Thread 16, *How far do hostile mobs have to fall to be one hit kill?*, CitrusZinus, December 5, 2012).

The large number of ‘Providing information/solutions’ code applications is indicative of the participants’ willingness to share their knowledge and to help fellow gamers satisfy their information needs. This collaboration and exchange between participants and the information seeker is characteristic of the support that online communities can provide to fellow members with common interests and goals. This dialogue allows information seekers to use their critical thinking skills to assess the information shared by information providers, thus enabling them to further refine their information needs.

The code ‘Expressing opinion’, which indicates that replies or parts of replies offer a personal opinion, was the second most frequently applied code. However, it was sometimes difficult to distinguish between an opinion and an expression of factual information. Such cases needed to be interpreted in the context of the initial information request. For example, in one response to the information request “*What mob do you hate?*”, the information seeker received the reply: “*No other mob as stealthy and dangerous as the creeper.*” (Thread 12, *What mob do you hate?*, Danster500, February 24, 2013). While this reply may be interpreted as someone sharing a fact about a hostile mob, it was actually articulated in response to a question soliciting opinions. Therefore, it was interpreted as someone expressing his or her opinion.

Sharing opinions allows players to share their knowledge in a context in which they are permitted to demonstrate a bias and thus provides them with the opportunity to make critical judgments knowing that the information provided may not be fully factual. IL requires both an understanding of bias and the ability to recognise it in order to make appropriate.

The responses to requests for information often included justifications. The code applied in those cases was ‘Justifying answer’. A small number of replies (n=33), coded as ‘Provides examples’, included the offer of additional information in the form of hyperlinks, videos, images, or referrals to other discussion threads. The code ‘Providing a reference’ was applied 24 times. This code was used when a participant shared information originating from someone else and gave credit or

provided access (primarily via a hyperlink) to the primary source. In some cases (n=5) the participant simply referred directly to the original source.

After having read some of the messages in a thread, some respondents elaborated on a previous respondents' reply and those were coded as 'Expanding on another's reply'. A number of replies (n=49) were repetitions of previously mentioned solutions. It was not possible to determine whether these repetitious responses were indicative of the responders' intention to corroborate or of a failure on the responder's part to read previous replies in the discussion thread.

4.1.3 Information evaluation

The category of 'Information evaluation' encompasses various activities that one might observe when information is being assessed for truth and relevance. Thirteen codes were assigned to this category and are listed in Table 4.

Table 4: Summary of code frequencies for 'Information evaluation'

Codes	Number of Applications	Codes by Percentage
Assessing information	87	32%
Discrediting/correcting wrong information	28	10%
Crediting a good informer	27	9%
Providing a reference	24	8%
Questioning informer/information	22	8%
Agreeing with a previous reply	17	6%
Reflecting	12	4%
Potential use of information	11	4%
Discrediting bad informer	11	4%
Stating information is not useful	11	4%
Stating information is useful	10	4%
Use of information	6	2%
Self correcting	5	2%

Approximately one third of these messages were assigned the code 'Assessing information'. This code was applied whenever there was an indication that a participant's reply was based on previous information found in the discussion thread. Of the 87 instances in which that code was applied, 20 pertained to a message posted by the initial information seeker, with the remaining 67 referring to other respondents. The exchanges falling under the code 'Assessing information' were further refined to indicate how information was evaluated. The skill of information evaluation is an important component of information literacy since it requires elements of critical thinking and reflection on the part of the player and is essential for deciding whether information is useful or not.

The code 'Discrediting/correcting wrong information' was applied 28 times, accounting for 10% of the applied codes in this category. Any reply that made an attempt to discredit or correct previous information had this code applied. The exchange below, which took place among 3 participants in the "How to make mobs not turn invisible?" discussion thread, is a typical example:

Initial request: *At a far enough distance mobs turn invisible. Is there a way to turn this off?* (Thread 17, Weterman/user_837235, February 23, 2013)

Reply #1: *They don't turn invisible they despawn* (Thread 17, Crimsolite, February 23, 2013)

Reply #2 (from initial information seeker) @Reply#1: *No they turn invisible* (Thread 17, Weterman/user_837235, February 23, 2013)

The code 'Providing a reference' exists in both the information seeking category and the information evaluation_category and it was applied whenever a message contained a reference to further information (such as a link to another resource). Our assumption was that if a participant chose to share a reference, they did so because they had assessed the relevance of this resource and decided that it was valuable and relevant to the original information request.

The code 'Agreeing with another's reply' was applied when we found that a response indicating that the responder had agreed with a previous reply. Seventeen such cases were identified. For some replies (n=10) it was not obvious whether the message was, in fact, someone agreeing with a previous reply or someone simply adding a reply that coincidentally agreed with a previous post. If a reply to a post gave any indication that the responder had used information from a prior post or expressed that he/she was going to use the information, the assumption was that the responder, having made an initial assessment, felt that the information was adequate enough for further trial and validation. For these cases we applied the code 'Potential use of information'. In cases where the information was actually used, we applied the code 'Use of information'.

The number of applications of 'Discrediting or correcting wrong information' and 'Evaluating information' in the category information evaluation, indicates that a significant portion of the participants are critically assessing the information being shared in the discussion forum. Participants do not hesitate to discredit incorrect information, or reveal a bad informer. They display discriminating behaviour and, in so doing, allow for others to learn which information is valuable and which is not. This behaviour may make other participants wary of sharing incorrect information and encourage all gamers to validate their information before sharing it.

4.2 Teenager interviews

For the third phase of this study, we recruited a convenience sample of eight teenage *Minecraft* players and conducted semi-structured interviews that focused on their information seeking and evaluation practices during game play and in affinity spaces. Interviewees were recruited via a flyer posted in the local public library and community centre. The participants were either 15 or 16 years old and the interviews were conducted in a glass-wall study room at a local library. Every interview was conducted, recorded and transcribed by the first author and each lasted approximately 30 minutes.

A narrative analysis of the interview transcripts, based on a process explained by Josselson (2011), revealed the unifying themes and patterning relationships. The narrative analysis used a categorical, interpretive approach to discourse analysis, which aims to extrapolate sections of the narrative that belong to a category obtained from coding and then compares these categories to other narratives. This strategy therefore has some degree of subjectivity and is consistent with a meaning-making approach to interpreting the transcripts. This type of approach has been used by Stock (2008) to examine IL development among college students. Similarly, Moline (2009) interviewed teenage gamers using this technique to assess their perceptions of learning.

The analysis began with an initial overall reading of each interview transcript to examine how the narrative unfolds in each interview and to identify the general themes that emerged. Next, each interview was re-examined to discover the parts that contained more meaning and additional sub plots and to place them in context with the general themes. Thus we conducted several readings of each interview and made connections between themes and patterns that were extrapolated to game-events, information behaviours and emotional responses that occurred during game play. All extrapolations and notes were recorded by hand on the interview transcripts.

Five IL skills emerged from this analysis: the ability to recognise an information need; to identify information sources; to locate them; to evaluate information; and to use it.. All eight interviewees were able to recognise when they experienced an information need during gameplay, and all of them were able to provide an example of when this occurred. For example, participant 104 once

reported having wanted information about how to create a secret door. Not only did he recognise that he needed more information to succeed, he used his prior knowledge to help refine his need:

when I tried to make um like a secret door kind of thing in my house and that was like really complicated because you need like a bunch of different things but I only play on survival so well first of all getting it was difficult, but then um actually how the mechanics work in Minecraft are pretty neat like you would need to have a lever 70 and then it would need to be attached to red stone and then you need to sort of make a trail around and then have it touch what you want moved. So I had no idea how to do that and one of the things is that you need to have it in one of the corners of the room so that the walls just pulls out.

Participant 104 refined his lack of information with his prior knowledge that the secret door had to be placed in a corner in order to work. He also recognised that he had to learn how to successfully build the mechanism so that the trigger, when touched, would open the secret door.

All eight interviewees were able to identify and locate information sources that helped them satisfy their *Minecraft*-related information needs. Five of eight interviewees mentioned relying on specific *Minecraft*-focused information sources such as a *Minecraft*-specific *YouTube* channel, a *Minecraft* discussion forum and a specific *Minecraft* map creator's discussion threads.

Although all interviewees were able to describe how they assessed information and how they decided whether it was what they needed, the process of evaluating information appeared to differ for each interviewee. For example, interviewee 108 reported looking up information in the *Minecraft Wiki* and subsequently verifying its accuracy on a discussion forum before using it. Interviewee 102, on the other hand, determined whether the information in a *YouTube* video would be useful by looking at the video's star rating and reviews.

Three subthemes emerged from the interviews that influenced how the teenagers evaluated information: trial and error; humour; and trust. Five of the eight interviewees reported using a trial and error process once they had narrowed down the information that they believed best met their needs. In the words of interviewee 104, *"Umm, I'll normally look at the different answers and whichever seems most logical, I'll pick that one and I'll try it and if it doesn't work then I go back and find something else that makes more sense until it works."*

For some interviewees, the criteria for selecting information sources extended beyond their usefulness to include how they were presented. Three of the eight interviewees reported that entertainment and humour influenced their assessment of information. Interviewee 107, for example, mentioned that his preference for certain *Minecraft*-specific *YouTube* channels was, *"Oh, just because the people that do it are funny."* Their preference for resources that are entertaining or humorous did not detract from their need to have accurate information, although humour was important enough among three of the interviewees that reliable and humorous information sources were regular "go-to" sources of information.

The notion of trust was a third theme that emerged from the information evaluation portion of the interviews. In *Minecraft*, false information can potentially end one's life in the game; at the same time, some actions require accuracy (for example, a recipe to make bread), and others do not (such as building a house). When asked how they would know whether the information they found was true, three interviewees stated that they could not understand why someone from within the community would share false information or waste another gamer's time. According to interviewee 106, *"I trust the people playing and putting up this information would just be telling the truth instead of putting up some random thing and waste like 5 minutes of your time."*

Seven of the eight interviewees made specific mention of using the information they found for their *Minecraft*-related information needs. Interviewee 101, for instance, recounted how despite having come across information that was not completely accurate, he was still able to achieve his objective with that information.

5. Conclusion

Minecraft players who need information to satisfy the objectives they set for themselves in gameplay often seek it in affinity spaces such as the *Minecraft* wiki and discussion forums or from other sources like *YouTube*. When information needs are self-imposed, as they normally are in sandbox games, the information seeker is highly motivated both to find the required information and to integrate the new information with existing information. Squire's (2008) research suggests that the need to learn a new skill and to find information only occurs when a player has new goals and the desire to advance, in a just in time fashion, creating a stronger connection between what is being learned and the task at hand than if the information or skill was learned at a time when it was not needed. *Minecraft* provides opportunities for goals to be established by the player and for information to be searched for when it is needed.

Minecraft also permits multiple players to play simultaneously in the same virtual world, thereby enabling the task of collaborative information seeking, sharing, learning and game play. Game-specific tools also allow players to share information asynchronously, for example by leaving behind information on a sign or in a book. Communication and collaboration are often manifested in multiplayer online games, enabling players to work collaboratively to learn skills, assimilate information, find solutions to problems and ultimately achieve their game play goals (Squire 2006).

Minecraft's game design encourages the acquisition of new knowledge, and the impact of applying that new knowledge becomes evident to the players as they use it to achieve their goals. In particular, *Minecraft's* design encourages its players to:

- Assess the information accessible to them during gameplay in order to make decisions
- Recognise a need for information and identify information gaps
- Identify what sources will provide the information they need, within or outside the game
- Locate and assess the needed information, either alone or collaboratively
- Apply the new information and assess the results

Minecraft also contains the elements necessary to motivate players to seek information by infusing them with the need to find information. From the vantage point of Dervin's information-seeking theory (Dervin, 1998), *Minecraft* creates an ideal information-seeking environment for players to develop their IL by creating opportunities for players to seek information in order to close the knowledge gaps that naturally occur during game play.

5.1 Limitations of the study

This study has several limitations in both method and scope that must serve as caveats to the conclusions that we have drawn from it. The IL categories into which the discussion threads were classified and the codes that were applied to individual threads are not as clearly delineated as they would have been had the codes and categories pre-existed with analytical definitions. They were, instead, obtained from a bottom-up analysis and different researchers could have interpreted and labelled these threads differently, thus generating results that differ from ours.

The small number of interviewees and the sampling method for obtaining them does not provide any guarantee that they adequately represent the general population of teenage game players for *Minecraft*. Furthermore, given the small size of the sample, it was impossible to account for variations in demographic features in the population of teenage players, such as family income or educational achievement. Out of the eight interviewees, only one was female, thus severely underrepresenting the gender distribution of teenage *Minecraft* players.

Our claim that the interviews corroborate the discussion board analysis would be better substantiated if the interviewees had been sampled from the participants in the discussion groups rather than separately recruited, local teenage players. However, this would have required another

layer of ethics approval, possibly crossing international boundaries. In addition, the narrative analysis of the interviews is interpretive and hence the results obtained from the interviews are somewhat dependent on the authors' reading of the discussion thread texts.

Finally, we believe that most of the IL skills discussed in this paper do not depend strongly on specific characteristics of *Minecraft* itself but rather on the generic characteristics of open world sandbox games. However, to support this general claim, it would be necessary to replicate this study on a representative sample of such games that also have related affinity spaces. Thus, in addition to the limitations above, the scope of our conclusions properly applies only to *Minecraft*.

5.2 Future directions

Our analysis of discussion threads in an affinity space showed that participants in the discussion forum exhibited a number of IL skills including: recognising an information need; information seeking; using a variety of information resources; sharing information; and the evaluation and use of information. The participants were discerning in their choice of sources whether they were in an online affinity space or with fellow gamers in person. They often relied on more than one resource and the notions of trust, humour, and trial and error played a role in the evaluation of the information that they obtained from those sources.

The question of whether these IL skills, once developed in *Minecraft*, are transferable to other contexts, such as scholarly information-seeking, requires further research. Martin (2012) suggests that the IL skills needed in both situations are one and the same. All information seekers are looking for the most appropriate resources in which to find the best information. Furthermore, since gaming and academic environments both involve affinity spaces and social media, teenagers who develop IL skills to succeed in one environment should be able to apply it in the other. One way to answer the question of whether IL skills obtained from gaming are transferable would be to conduct a longitudinal study that assessed the IL competencies of a sample of teenagers both before and after a period of *Minecraft* play and affinity space engagements, and then compared it with a control group who had not been exposed to a similar gaming experience.

In the meantime, we believe our study indicates that *Minecraft* could be used to great benefit by educators not just to teach content-rich subjects such as geography (List and Bryant 2014) but also to enrich formal methods of IL education in the classroom with an enjoyable game that simultaneously engages children's attention, promotes creativity and refines their ability to seek relevant information, evaluate it and use it to make informed decisions. For example, teachers may want to use *Minecraft* for a research project that involves students researching information about a historical event or location (for example, a First Nations village) and having them then recreate the event or location in the game.

Minecraft's affinity spaces are informal learning environments in which teenagers can participate by creating and sharing information, ideas, opinions and feedback, and provide opportunities for the development of their own IL and improve that of others. Bringing together like-minded teenagers to participate and collaborate in communities of practice to fulfil some of their informational and social needs, leads not only to the development of individual skills but also to the development of an awareness of their participation in the creation of an emergent collective intelligence.

Acknowledgements

Many thanks to Claire Dormann, Daniel Paré and Mary Cavanagh for their many valuable suggestions and contributions on earlier drafts of this paper, as well as to the anonymous reviewers for their insightful recommendations for additions, improvements and references to related research.

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