Abstract

The aim of this paper is to explore ambient learning and emergent learning in the context of emerging and next generation technologies such as wireless grids. Using WeJay, an early pre-standards social radio tool, research with faculty and students provides insight into the potential of wireless grids for learning in distributed technology-pervasive environments. Findings are interpreted in terms of their implications for educational, research, and practice settings. Expanded notions of workplace, educational spaces, and places of research are advanced together with the value and importance of leveraging associated learning and predictive analytics data. This paper contributes to research on: ambient and emergent learning, pervasive learning spaces (PLSs), ambient intelligence (AmI), and wireless grids. Responding to earlier calls for a new research agenda around learning in technology-pervasive environments for the 21st century, this paper elucidates a new learning approach based on ambient intelligence (AmI) with wireless grids.

Keywords: Ambient learning, emergent learning, learning analytics, personal learning networks, wireless grids.

1 INTRODUCTION

This research study explores ambient and emergent learning in relation to ambient intelligence (AmI) with wireless grids. Using WeJay social radio in beta form, this research represents one of the first studies of use experience among faculty and students with emerging and next generation wireless grid technologies [1]. Several types of learning approaches have been identified in the education sector, as follows [2], [3] – self-paced learning, digital reference-ware, collaboration-based learning, simulation-based learning, and game-based learning. Two relatively new approaches are social learning and mobile learning. This study advances ambient and emergent learning as encompassing and extending other learning approaches.

In exploring the contemporary issues of ambient and emergent learning in 21st century technology-pervasive environments, a case study approach is used along with multiple methods of data collection. Analysis of qualitative data was undertaken through the use of content analysis, pattern matching, and explanation building. Quantitative data was analyzed through the use of descriptive statistics. A deductive approach was employed during content analysis to gather emergent insights. In support of the theoretical perspective and conceptual framework developed for the study, an inductive approach was used in relation to the research literature. Based on emergence theory, from a social and socio-technical perspective, and the key constructs of creativity, innovation, and context awareness, a conceptual framework was established through which to explore ambient and emergent learning.

1.1 Definitions

Definitions from the research literature are intended to provide a context for key terms used in this research study.

1.1.1 Ambient Intelligence

McCullough defines ambient as "that which surrounds but does not distract" [4] while Dourish and Bell refer to ambient intelligence (AmI) as one of several interpretations of ubiquitous computing [5]. De Ruyter and Aarts [6] describe AmI as, "the embedding and integrating, on a mass scale, of
technologies that are sensitive and responsive to humans in everyday environments in increasingly invisible and unobtrusive ways."

1.1.2 Ambient Learning

Ambient learning is referred to by Bick, Kummer, Pawlowski, and Veith [7] as the next generation of mobile learning where digital learning environments "provide contextualized, personalized knowledge for learners" based on anywhere, anytime learning spaces within daily life. According to Li, Feng, Zhou, and Shi [8], learning opportunities are everywhere present in technology-pervasive environments. As such, 21st century information-rich spaces support the potential for curiosity, interest, and engagement to occur in daily life, enabling deeper learning, sharing, and collaborations [9].

1.1.3 Emergent Learning

Emergent learning is described by Signet [10] as pragmatic, and defined as learning that presents the need for "overcoming challenges, especially those that have no simple solutions, but require discipline, ongoing attention, learning through experience, and adaptation." Although Signet defines emergent learning in a workplace context, this definition applies more broadly to formal and informal educational settings in 21st century learning environments [9].

1.1.4 Technology-Pervasive Learning Environments

Pervasive learning spaces (PLSSs) are defined by Laine, Islas Sedano, Joy, and Sutinen as "a branch of mobile learning with an emphasis on context-awareness" [11]. Laine et al. claim that PLSs "create bridges from the real world to the virtual world, allowing the context-sensitive utilization of real-world objects and information in the learning process."

1.1.5 Wireless Grids

Wireless grids refer to, "an emerging form of network for sharing resources, creating resources, facilitating connections across devices and enabling ad hoc interactions" [12]. Devices include smartphones, sensors, tablets, to name a few. Additionally, wireless grids are described as, "A human centric open access gateway to shared resources for mobile and wireless electronic devices interconnecting at least one device to at least one other device or resource. A device can establish a grid and become a member of one or more wireless grids" [13].

What follows is a brief review of the ambient and emergent learning literature.

2 AMBIENT & EMERGENT LEARNING LITERATURE

Schmidt and Cohen [14] identify the need for education to be adaptable, a key dimension of ambient intelligence with wireless grid environments [1]. Laine et al. [11] approach pervasive learning spaces (PLSSs) from the perspective of technology integration, pointing to three critical factors – context awareness, available resources, and unobtrusiveness of the technology. One or more of these factors would seem to have something in common with Chauncey's notion of frictionlessness and frictionless learning [15]. Although working in a formal, structured learning environment with many supports for students, Chauncey's research involving a wireless grid tool, reveals the types of emergent learning possible for both students and educators [16]. With carefully designed learning spaces, Chauncey articulates her concept of frictionless learning where "environments provide optimal space, time, resources, and community interaction to support achievement of individual and group learning goals" [15].


In describing emergent learning in the context of practice settings, Signet [9] acknowledges that, "In complex and changing situations, there are no right answers", adding that organizations are called upon "to adapt their strategies and action plans, in-course, to achieve the results they want." Citing
futures research on workplaces of the future [20], Fidler identifies the need for a range of skills for information professionals going forward, including novel and adaptive thinking [21]. McKenna, Arnone, Kaarst-Brown, McKnight, and Chauncey elucidate the workplace of the future in conceptualizing 21st century information spaces, supportive of ambient and emergent learning [22].

Schadler and McCarthy [23] identify the importance of mobile learning for business, pointing to mobile as critical to engagement. Engagement is based on a combination of smart devices, social networking, and smart products, contributing to predictive analytics. Predictive analytics in turn, generate situation and context-rich experiences on an as-needed basis. Indeed, practice settings are called upon to reconfigure the C-Suite to include a Chief Mobility Officer (CMOO).

In educational settings, Johnson, Adams Becker, Cummins, Estrada, Freeman, and Ludgate [24] provide a near to long term glimpse of technologies to watch. Johnson et al. identify a mid-term horizon for learning analytics to assist in "deciphering trends and patterns from educational big data, or huge sets of student-related data" in advancing "a personalized, supportive system of higher education." This data is described by Johnson et al. as "visually explicit streams of information about any group of students or individuals, in real-time." Johnson et al. [24] point to the shifting of education paradigms to include "online learning, hybrid learning, and collaborative models." Emerging and next generation technologies are also contributing to "the emergence of new scholarly forms of authoring, publishing, and researching." This development is said to "outpace sufficient and scalable modes of assessment", as in, "creating a gap between what is possible and what is acceptable", according to Johnson et al. [24]. Bass [25] also points to the importance of learning analytics while Schadler and McCarthy [23] include predictive analytics for educational environments.

Bayne, Knox, Macleod, Ross, and Sinclair [26] describe an e-learning and digital cultures program, delivered as a Massive Open Online Course (MOOC). According to Bayne et al., the course is an opportunity for "teachers, learning technologists, and people with a general interest in education who want to deepen their understanding of what it means to teach and learn in the digital age." The course is also concerned with "the relationship between people and technology", a key concern of ambient intelligence (AmI) [6] and wireless grids researchers [1], [22], [27], [28]. The course places "an emphasis on learner-led group formation"; is an "exploration of the MOOC format"; and "is intentionally imprecise to invite experimentation and creativity" [26]. As such, the course represents an example of emergent learning in action.

The importance of wireless grids in support of collaborative learning has been developed by Ramnarine-Rieks, McKnight, and Small [29]. In describing next generation wireless grid technologies, Ramnarine-Rieks et al. refer to "an emerging infrastructure that will fundamentally change the way we think about and use computing". In alignment with this thinking is that of human-centered computing (HCC) researchers, where Sebe [30], building on the work of Canny [31], describes computing as "infrastructure around human activity." Ambient intelligence (AmI) with wireless grids offers the potential for a new type of learning, building upon existing learning approaches, while introducing new possibilities for interaction; autonomy, awareness, and intuition [28]; and personalization. In the analysis and findings of ambient and emergent learning, a discussion of other leaning approaches in relation to AmI with wireless grids will be limited to the example of game-based learning. Opportunities exist in future studies for more detailed analysis of the many other learning approaches and their potential in AmI with wireless grids environments.

The methodology used for this research study will now be described.

3 METHODOLOGY

Using a single case study and multiple data collection methods, the use experience of university students and faculty with the next generation WeJay social radio tool was investigated in-depth. This research was conducted through the Wireless Grids Innovation Testbed (WiGiT) Lab, School of Information Studies, Syracuse University. This study represents research into the first wireless grid edgeware application to emerge through the WiGiT Lab. Following sign up for the study, participants were invited to download and install the WeJay Social Radio Station tool; create a radio station; create a radio show with content of their choice; host or co-host the show with another individual; and stream the show for shared listening within WeJay, with Facebook friends, and with others who wished to tune-in to the broadcast through the WeHeartRadio website over the Internet.
In studying contemporary issues such as those pertaining to the use of emerging and next generation information technologies such as ambient intelligence with wireless grids, use of the case study approach is particularly amenable [32].

This largely exploratory study employed an unstructured approach whereby participants were provided with minimal supports and influences. Maximal exploration was encouraged over a four month research study timeframe. Data collection methods included: tool use activity data, interviews, focus groups, and survey. From the activity data, use interaction information was captured indicating whether, how, and to what extent participants engaged with WeJay. The quantitative activity data was enriched and triangulated for rigor with qualitative evidence gathered through interviews and focus groups. Pretested protocols guided the interview and focus group processes. A survey instrument was developed, based on interview and focus group data. Following pretesting, the instrument was administered to participants to measure use experience. With a mix of closed and open ended questions, the survey contributed to the quantitative and qualitative dataset, respectively.

Using content analysis, insight was gathered inductively from focus group data, interviews (n=22), and the open ended survey data. Deductive coding enabled further development of a coding glossary based on the theoretical framework and the research literature underlying the key constructs of the study. Emergence theory supports the notion that everyone and everything is evolving, dynamic, and developing and as such, allows for the use of inductive and deductive approaches. Using a second coder, testing and refining of coding techniques and practices occurred. Qualitative data was segmented into 1000 text segments and separately coded by each coder and comparatively analyzed for inter-coder reliability (91%-94%). For quantitative data, descriptive statistics were used to present the analysis and findings (n=34). Several types of triangulation [32], [33] were conducted contributing rigor to the study. Types of triangulation included: data triangulation across multiple sources of evidence; methodological triangulation across different methods and across quantitative and qualitative data; and investigator triangulation through the use of multiple coders.

4 ANALYSIS & FINDINGS

This study revealed a strong interest on the part of faculty and students in using a tool for educational environments that supports ambient and emergent learning. The highlights of findings are presented below in terms of – context awareness and ambient learning; emergent learning; and ambient and emergent learning for education and research.

4.1.1 Context Awareness & Ambient Learning

A wide range of commentary and engagement occurred in discussions of context awareness, specifically – smartness and types of awareness such as location, presence, recommending, resources, and situation. In the words of one participant "WeJay is cool. But I would feel as if it was even more social if some of these context awareness things could make connections for me that I couldn't necessarily make on my own." From the use perspective, another participant proclaimed, "see, that's the great thing about this, it's more than just hosting something out for people to listen to, there is an ambient experience around the whole process of this thing."

4.1.2 Emergent Learning

Study participants engaged in a variety of emergent and spontaneous behaviours in support of learning. For example, a number of individuals de-anonymized in support of opportunities for social networking, sharing, collaboration, and learning. Rather than viewing the two brief instructional videos provided by the researcher, some participants preferred to receive instructional tutorials from other participants. One respondent stated, "I did not watch the videos, I had a tutorial from" another user. The study was designed to explore emergent attitudes and behaviours, enabling participants to learn about themselves in relation to the use experience. As a tool designed to support sharing, collaboration, autonomy, and interactivity, one participant stated after using the product – "I don't like to share control of my radio station." Another participant acknowledged – "I personally am not a Facebook person. I'm not a big social media type person." On closer probing however, it turned out that this participant uses and appreciates the value of other social media tools such as Skype. In the course of casual use and interaction with the tool, two types of experience are described. In the first case, the participant stated: "I was broadcasting my show, just chatting with the person who was listening, you know as far as myself I don't particularly participate in those types of things so yeah it was definitely an experience for me, a positive one." In the second case, the participant indicated that,
"it got me thinking about other aspects of social media and maybe the next frontier of social media." In terms of modelling behaviour, one participant stated, "Well, being able to see what other people were doing was really nice too."

4.1.3 Ambient & Emergent Learning for Education & Research

For educational settings, one participant explained, "I was thinking that this would have been an ideal tool for the classroom, giving students a different way of communicating and interacting with each other." From the perspective of researchers, another participant added, "Well, it's affected proposals. I want to include it as part of the activities I'm suggesting in these proposals."

4.1.4 Game-Based Learning

During the WeJay use experience a number of participants interpreted the tool for gaming purposes. In one instance, a gaming idea emerged involving a mobile learning and play type of game. Described as a scavenger hunt, the game was designed for use in an urban environment. The participant explained the function of creating radio stations as a mechanism to develop a game where the radio station attributes were equated to clues needed for the scavenger hunt. While this activity was playful with the intent to entertain, the participant also found the exercise to be engaging and motivating, particularly during the development of the game strategy component. Further, the mobility dimension of the game contributed the element of discovery during play.

5 DISCUSSION & CONTRIBUTIONS

Although limited by the use of an early AmI with wireless grids beta tool, this first use, pre-standards product also represents the strength of this research. Based on a small sample size, this study nevertheless affirms the importance and potential of ambient and emergent learning for 21st century technology-pervasive learning environments. Where Laine et al. [11] identified the importance of context awareness, available resources, and unobtrusiveness of the technology as factors critical for technology integration in pervasive learning spaces (PLSs). This study confirms and extends these findings, making contributions in a number of ways.

5.1 Contributions

5.1.1 Ambient Learning & Autonomy

In awareness-based learning environments, participants identified the need for autonomy and control affordances for people, when interacting with technology. Awareness-based systems must be human-centered, taking into consideration the needs and requirements of people using the systems.

5.1.2 Emergent Learning & Awareness Analytics

Recommendations were made by participants for more extensive forms of awareness in the AmI with wireless grids environment. With increased awareness, through a combination of embedded data collection techniques combined with information made available by uses, leveraging of this information for analysis enables enhanced smartness. Leveraging awareness information contributes to learning analytics, predictive analytics, and any number of analytic products to enhance the flow, value, and benefit of information in ambient and emergent learning environments.

5.1.3 Ambient & Emergent Learning with Wireless Grids

Wireless grid edgeware technology has the potential to enable PLSs to interact with existing infrastructures such as the Internet and to operate in new forms of ad hoc, infrastructureless spaces. As such, AmI with wireless grids holds the potential to usher in new types of learning approaches, environments, and products.

6 CONCLUSIONS & RECOMMENDATIONS

This study contributes to the ambient and emergent learning literature, the pervasive learning spaces (PLSs) literature, and that of ambient intelligence (AmI) and wireless grids. Further, this paper identifies the need for further research into existing and developing notions of ambient and emergent learning with wireless grids and other next generation technologies.
Use of an early pre-standards wireless grid tool revealed a high degree of interest in this next generation technology. A wide range of interpretations for use were identified, along with many recommendations for tool development and improvement, in support of further development opportunities for practice and research. More research is required into the nature, impact, and implications of ambient and emergent learning approaches and tools for 21st century learners and educators.

Based on recommendations for improvement of the wireless grids edgeware gridlet tool, research based on another iteration of the tool is required. Indeed, the time appears to be ripe for development of an ambient education gridlet in support of ambient and emergent learning, by and for places of work and research.

As an emerging space, this paper invites further development of AmI with wireless grids in relation to the range of learning approaches discussed in the ambient and emergent learning literature section (section 2).

ACKNOWLEDGEMENTS

The development of the Wireless Grid Innovation Testbed (WiGiT) is primarily funded by the support of the National Science Foundation (NSF) Partnership for Innovation (PFI) program grants NSF #0227879 (2002-2006) and continued under NSF # 0917973 (2009-2011). The views expressed are those of the author.

REFERENCES


