Computers in Human Behavior 32 (2014) 324–334

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Information Seeking, Information Sharing, and going mobile: Three bridges to informal learning

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ARTICLE INFO

Article history:
Available online 8 September 2013

Keywords:
Information Seeking
Information Sharing
Mobile access
Formal to informal learning
Instrument development

ABSTRACT

This paper introduces a new perspective on information behavior in Web 2.0 environments, including the role of mobile access in bridging formal to informal learning. Kuhlthau's (1991, 2007) Information Search Process (ISP) model is identified as a theoretical basis for exploring Information Seeking attitudes and behaviors, while social learning and literacy concepts of Vygotsky (1962, 1978), Bruner (1962, 1964) and Jenkins (2010) are identified as foundations for Information Sharing. The Guided Inquiry Spaces model (Maniotes, 2005) is proposed as an approach to bridging the student's informal learning world and the curriculum-based teacher's world. Research within this framework is operationalized through a recently validated Information and Communications Technology Learning (ICTL) survey instrument measuring learners' preferences for self-expression, sharing, and knowledge acquisition interactions in technology-pervasive environments. Stepwise refinement of ICTL produced two reliable and valid psychometric scales, Information Sharing (*alpha* = .77) and Information Seeking (*alpha* = .72). Cross-validation with an established Mobile Learning Scale (Khaddage & Knezek, 2013) indicates that Information Sharing aligns significantly ($p < .05$) with Mobile Learning. Information Seeking, Information Sharing, and mobile access are presented as important, complimentary components important, complimentary components in the shift along the formal to informal learning continuum. Therefore, measures of these constructs can assist in understanding students' preferences for 21st century learning.

1. Introduction

The ever-changing information technologies (IT) of our time are redefining traditional teaching and learning. Thirty years of noteworthy evidence has demonstrated that IT-supported learning contexts are at least comparable in efficacy to traditional, time-scheduled, face-to-face instruction (Francescato et al., 2006) and that appropriate applications of IT can, in fact, enhance student learning (Voogt & Knezek, 2008). However, the nature of formal to informal instruction has made it difficult to gain necessary acceptance of the significance of informal learning processes by many institutions and resulted in efforts such as the TRAILER project for recorded verification of informal learning (García-Peñalvo et al., 2012). Knowing that IT is capable of serving as a catalyst for change in pedagogical roles, Hawkridge (1990) emphasizes the pressing need to widen acceptance of informal learning and establish models of instruction that go beyond the provision of learning management systems (LMS) to the implementation of personalized learning environments (PLEs) (Conde, García-Peñalvo, & Alier, 2011).

Research indicates that formal to informal learning models can offer readily available, user-centered learning options and services (Conde et al., 2012) that place the learner, as user, in control of the learning experience. Recognizing the many challenges facing educators in the rebalancing of formal to informal learning trends, the great variability of changing classroom roles, and the shifting level of teacher–student control over learning activities (Cox, 2012), there is great interest among educators and learning technologists in new instructional models that will capitalize on the affordances of the wide array of available information technology and mobile access tools. Educational institutions, teachers, and students are being challenged to demonstrate an active engagement in the open world as described by Bonk (2009) in his book *The World is Open*. Just as the availability of information on the Internet is causing the world to be more open, access to databases and academic courses available on demand, often via mobile devices, is changing the extent, the activities, and the timing of learning interactions (García-Peñalvo, de Figuerola, & Merlo, 2010). The interaction between communities, creative processes, Information Sharing,

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0747-5632
http://dx.doi.org/10.1016/j.chb.2013.08.008

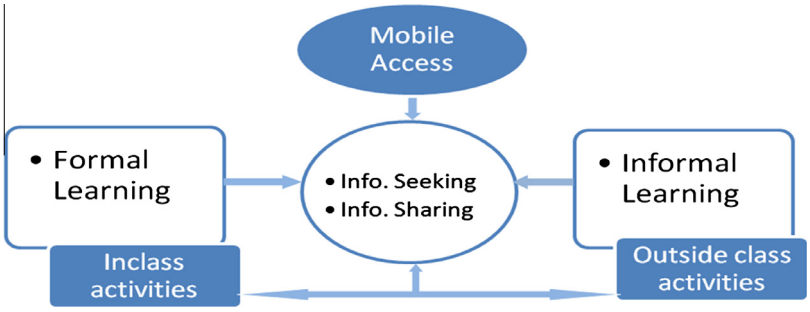

Fig. 1. Formal to informal learning: Conceptual relationships among Information Seeking, Information Sharing, and mobile access.

Information Seeking, and the wider social contexts enabled by mobile technologies and Web 2.0 applications can be used to enhance the creative process, create new learning contexts, and bridge the gap between formal and informal learning (Khaddage & Knezek, 2012).

Dewey (1938) introduced the concept of informal learning as experiences requiring continuity of experience and interaction. Osborne and Dillon (2007) conducted a complex analysis of informal learning as a concept and associated definitions have evolved over time. Informal learning has been described as that which takes place outside the formal educational environment and is self-directed, intentional, interest-based rather than curriculum-based, non-assessment driven, and non-qualification oriented (Eshach 2007; Laurillard, 2009). Laurillard (2009) further defined informal learning as placing the learner at the center of the process and giving the learner the locus of control. A broader view of formal and informal learning, that is well suited to education in the digital information environments of our time, would be Bernstein's (1971) view of learning—a formal to informal continuum that is based on the opportunity for learners to frame, classify, and evaluate knowledge.

Certainly the use and availability of mobile technologies continue to redefine formal and informal learning. Lai, Khaddage, and Knezek (2013) identify collaboration, coordination, and communication as key components for the connection of formal to informal learning. The authors of the current research contend that mobile access and information behavior (Information Seeking, Information Sharing) are major components facilitating the shift in formal to informal learning in the digital age, as modeled in Fig. 1. They contend that the Information and Communications Technology Learning (ICTL) and Mobile Learning (ML) instruments are useful tools to assist in better understanding students' learning preferences and information behaviors, thereby allowing for design and implementation of instructional models that will offer students, as end-users, with locus of control and opportunities for formal to informal learning.

2. Conceptual rationale

2.1. Formal to informal learning

The evolution of digital technologies, from personal computers and Internet access to mobile devices with continuous access, have resulted in new opportunities for learning and a gradual blurring of the line between formal and informal learning (Cox, 2012). Many students today are reportedly using IT more during leisure time than in the school setting. Students' formal and informal use of IT is of great interest to educators and learning technologists who recognize that learning, both in and outside of school, plays an important role in the intellectual growth and development of students (Passey, 2000), especially when IT can be used to create school-to-home links (Pachler, 2007). Pachler (2007) found that students with higher computer usage at home make greater use of computers at school. Students who have access to school learning resources at home reportedly benefit from the home-to-school links for class work and homework (Pachler & Redondo, 2005; Underwood et al., 2007). This cycle of computer use and connection between formal and informal learning environments creates a connection between school and home. It also results in a clouding of the concepts that separate (school) work and leisure activity (Pachler, 2007).

Somekh and Davis (1991) introduced a model for transforming pedagogy with a view towards pupil autonomy in learning with computers. They recognized the need for a shift from a learning context within the confines of the classroom to a more interactive, complementary exchange between teacher and learner (Somekh & Davis, 1991). Learning environments of the 21st century include a wide array of hardware devices and software that support flexible use of connected laptops and mobile devices. Technology-driven learning environments enable students to seek information and communicate where and when they choose to do so, resulting in connections between informal and formal learning. Cox (2012) conducted a review of technological developments available in education from 1968 to 2011. Analysis of trends in educational applications of IT during the last several decades reveals a shift in the center of instructional control away from course designers and teachers in the direction of the teacher and the learner, and from the teacher to the learner (Cox, 2012). This shift in control from teacher to learner is thought to be related to information communications technology (ICT) developments, such as Web 2.0, that provide Internet interaction and the power to network, publish, share, and collaborate with experts and peers alike.

School-to-home and student-to-instructor connections are important points of focus for new models of pedagogy that can connect informal and formal learning. Kuhlthau's (1991) Information Search Process (ISP) model depicts the Information Search Process in traditional and digital environments (Kuhlthau, Maniotes, & Caspari, 2007), allowing educators to guide students' learning interactions in and outside the traditional classroom. Viewed as an instructional model, guided inquiry depicts a teacher-to-student-to-curriculum connection that allows discourse to direct students' information behavior towards educationally meaningful activities that are associated with knowledge construction. Maniotes' (2005) guided inquiry model refers to the guided learning space as the *third space*, wherein *curriculum* intersects with the *student's world* for complementary student–teacher communications that support formal to informal learning (Fig. 2).

2.2. Information Seeking

The influx of technology into formal and informal learning environments has created the need for better understanding of student information behaviors for formal and informal learning interactions in Web 2.0 environments. Information Seeking, as

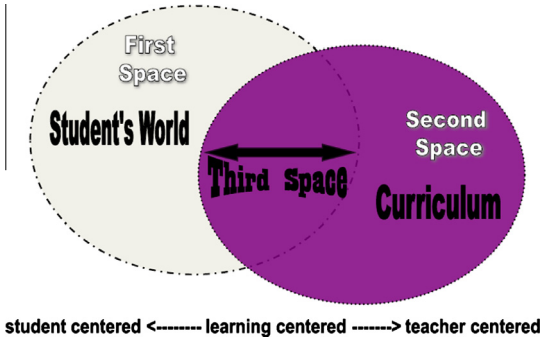

Fig. 2. Maniotes' third space model.

one of the earliest forms of learning through the World Wide Web, often takes the form of acquiring knowledge from a server-based system, which is a Web 1.0 function (Cox, 2012). However, as searches become more complex, two-way interaction and human guidance are also commonly involved. The field of information science provides a framework within which these ideas can be given analytical context. The model adopted for this research is based, in part, on the Information Search Process model established by Kuhlthau (1991).

Kuhlthau's Information Search Process model was devised in the 1980s and revised in the 1990s. This model depicts the six stages of student information searching activity: initiation, selection, exploration, formulation, collection, and presentation (Fig. 3) (Kuhlthau, 1991). These stages are helpful for understanding the primary tasks to be accomplished when students engage in complex Information Seeking behaviors that can be useful for directing learning activities. Within the educational context, emphasis should be placed on supporting information behavior tasks that are associated with independent learning and knowledge construction (George et al., 2006). Established for an understanding of student information behavior in support of guided instructional, diagnostic, and intervention programs, Kuhlthau's ISP model was initially recognized for its usefulness in providing insight on Information Seeking behavior in traditional library environments. Kuhlthau (2007) revisited the Information Search Process in technology-pervasive environments by conducting an extensive review of related literature for a research inquiry project that examined student information behavior among $n = 574$ school students. Results indicated that Kuhlthau's ISP model continues to be useful for understanding affective, cognitive, and physical dimensions of student Information Seeking behavior and knowledge acquisition in the digital, technology-rich information environment of Web 2.0 (Kuhlthau, Heinstrom, & Todd, 2008). Additional findings indicate that while some stages in the search process may be intensified in new instantaneous information environments, "...the Information Search Process seems to be an over-arching process regardless of search venue, print, or digital format..." (Kuhlthau et al., 2008). Kuhlthau's model serves as a foundation for the instrumentation developed and concepts explored as part of the learning preference study reported in this research.

2.3. Information Sharing

Information and communications technologies utilizing the Internet provide unprecedented options for social interactions that are being viewed as opportunities for knowledge seeking and sharing. The seemingly unlimited new media contexts, information access, and communications options in formal and informal settings are often regarded as venues for interactive and engaging teaching and learning (Arnone, Small, Chauncey, & McKenna, 2011). Bruner (1962) identified a relationship between social interactions and the development of higher order cognitive functions. He believed that technology tools support the development of cognition and the evolution of specialized human capabilities. He theorized that, over time, humanity "has changed by linking himself with new, external implementation systems rather than by any conspicuous change in morphology" (Bruner, 1964, p. 68). Vygotsky's Social Development Theory recognized social interaction as a precursor to development, consciousness, and cognition in a progressive cognitive growth model. Vygotsky's model depicts the development of cognitive function as a two-stage process: initially on a social level and subsequently on an individual level (Vygotsky, 1962; Vygotsky, 1978).

The everyday presence and application of information and communications technology to teaching and learning in many parts of the world today (Christensen & Knezek, 2006) justifies efforts to address the concern that an education that does not include new media-based technologies will not adequately

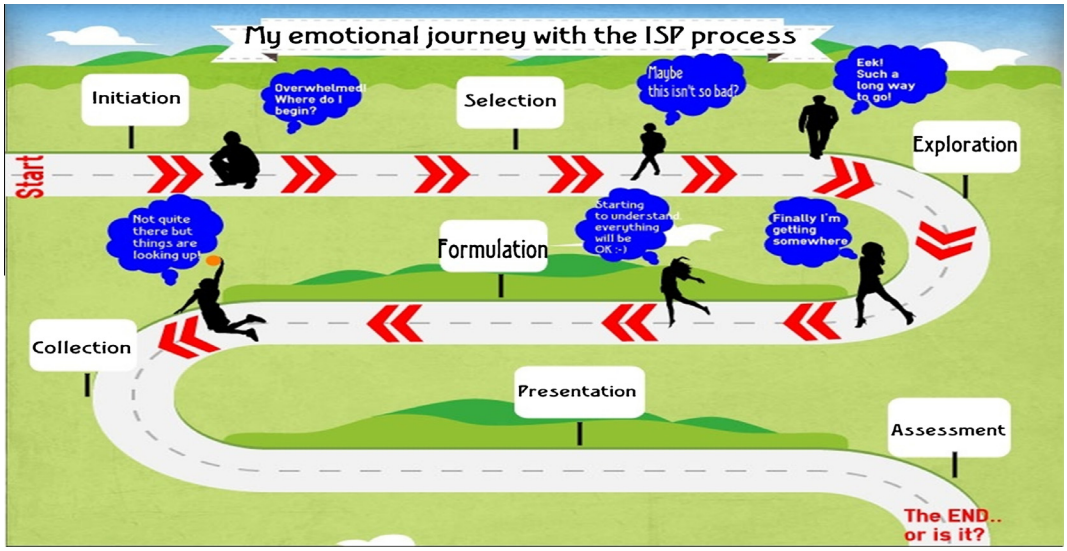

Fig. 3. Kuhlthau's ISP model: Stages of inquiry.

develop student potential, leaving students with a deficit in digital literacies that may contribute to student disengagement from classroom activities (Judson, 2010) and hinder academic achievement. Felt (2010) identifies new media literacy skills as a set of cultural competencies, social skills, and information communications tool skills that are essential for success in education in the 21st century. New media literacy skills have become necessary for content- and process-based learning interaction (Jenkins, 2010). Sometimes referred to as transmedia navigation in the framework of Jenkins, Clinton, Purushotma, Robison, and Weigel (2006), new media literacy skills for Information Sharing support and enrich social learning interactions with a variety of communications media. Learning with transmedia navigation is one of many developing theoretical paradigms relevant to information behavior as a basis for critical analysis of the scales developed and concepts explored in this paper.

2.4. Mobile Learning technologies

Measuring student technology attitudes towards new modes of learning interaction and Information Seeking in technology-pervasive learning environments is of particular interest to educators and learning technologists who seek to leverage the power of ICT for effective teaching and learning. Also of great interest are learners' attitudes towards learning with mobile technologies. The role of mobile technology in education is yet to be clearly defined (Kearney, Schuck, Burden, & Aubusson, 2012), and given the prospective affordances of this technology, it is reasonable that many current papers present convincing arguments for the benefits that mobile technologies and applications can bring to learning environments. For example, Khaddage and Lattemann (2013) point out that mobile technologies and applications offer benefits such as portability, simplicity, and availability. A multi-year study conducted by Kolko, Rose, and Johnson (2007), researchers at the University of Washington, reported on the adoption of information and communication technologies in Central Asia stating that the rate of mobile phone usage is outpacing that of Internet adoption and that the Internet is being accessed primarily through public access sites. These researchers also reported a trend towards the combination and conflation of technology-related Information Seeking and communication usage patterns. Due to the rapid growth of mobile devices throughout the world (World Bank, 2012) and the rapid emergence of mobile technologies and applications (Henríquez & Organista, 2012; Khaddage & Knezek, 2012; Khaddage & Lattemann, 2009), the need has emerged for studies of affordances and barriers that might enhance or constrain the adoption of Mobile Learning in higher education.

Mobile Learning is the desired outcome for application of mobile technologies to distance learning. However, its implementation and use in creating new bridges and avenues for learning has been relatively slow (Duncan-Howell & Lee, 2007). The widespread availability of mobile technology and the association of Mobile Learning with new forms of communications-related activities for engaged learning spotlight the affordances that Mobile Learning brings to a broad range of formal and informal learning activities in the 21st century (Andrews & Tynan, 2012). Cox (2012) contended that research approaches investigating innovative ways of teaching and learning with ICT in the future should address technology-enhanced learning "outside formal educational settings" (p. 2), as well as the opportunities presented by "the uptake of thin client technologies" (p. 5) that are mobile and personalized. Lai (2011) devoted a section of his work on digital technology and the culture of teaching and learning in higher education to "...how digital technologies may provide a more active and flexible learning experience by adopting a participatory pedagogical approach and by blending formal learning with informal learning..." (p. 1263).

3. Methods

3.1. Instruments

The two surveys employed in this research study were: (1) the Information and Communications Technology Learning survey, and (2) the Mobile Learning Scale. The development of the Information and Communications Technology Learning survey is described in detail in subsequent sections of this paper. The Mobile Learning Scale v1.0 also plays a key role in this study and therefore its development history and psychometric properties are briefly discussed. ML v1.0 was originally created from the key points developed for a paper on Mobile Learning prospects for informal learning in higher education (Khaddage & Knezek, 2011). Many of the points of focus for the ML scale also emerged during working group discussions at the UNESCO International Summit on ICT in Education that was held in Paris in 2011 (Knezek, Lai, Khaddage, & Baker, 2011).

3.1.1. Development of Information and Communications Technology Learning (ICTL) survey

The Information and Communications Technology Learning (ICTL) survey was designed and validated to address questions relating to students' preferences in utilizing ICT and to assist in understanding individual differences in information behavior. Instrument development included analysis for internal consistency reliability, principal components exploratory factor analysis, multidimensional scaling, and higher order factor analysis. Survey items were initially gathered by the first author of this paper who sought out surveys related to learner choices and preferences in activities, and the role of ICT in technology-rich information environments. A review of literature did not reveal validated instruments for the measurement of student learning preferences for use of ICT activities and interactions with information within the ubiquitous communications landscape of the 21st century (Mills & Knezek, 2012). Items for a 15-item prototype instrument, the Information Communications and Technology Learning (ICTL) survey version 1.0, are displayed in Fig. 4. Survey questions are Likert-type, rated on a 5-point scale, with response choices from 1 = strongly disagree to 5 = strongly agree. Note that item 9 is negatively worded in relation to other items, requiring that response ratings be reversed before summing (or averaging) with ratings from other items to form a Likert-type scale. The reverse coding for item 9 results in answer choices having increasing value along the response scale from 1 to 5.

3.1.2. The Mobile Learning (ML) survey

The Mobile Learning Scale version 1.0 is a 7-item, unidimensional, Likert-type survey instrument developed by Khaddage and Knezek (2011) for use with higher education students. Items were drawn from the key points developed on Mobile Learning prospects for informal learning in higher education (Khaddage & Knezek, 2011; Khaddage & Knezek, 2012). The construction of the Mobile Learning Scale version 1.0 was completed by pairing each of the seven item stems with five-point (strongly disagree to strongly agree) Likert-type rating categories. Pertinent demographic items were also included. Each attitudinal item was purposely worded as a judgment, in the manner that judgment tasks are normally defined in psychometric scaling methods (Dunn-Rankin, Knezek, Wallace, & Zhang, 2004). Therefore, the items are not designed to record ratings but rather judgments or beliefs, including perceptions of Mobile Learning devices and tools (applications or apps) for informal learning, and feelings about using theories

	Information and Communications Technology Learning (ICTL) Survey
1.	I would like to be a participating member of an online community.
2.	I use Internet technology to explore topics of interest.
3.	I like to share interests and reflections online.
4.	I like to enroll in classes to continue my education.
5.	I use Internet communications and other technology tools for self-expression.
6.	I learn many things by interacting with other Internet users.
7.	I like to take classes from good professors.
8.	I use Internet communications technology tools when I want to learn about something new.
9.	I learn best in a traditional classroom setting.
10.	Internet technology helps me be successful in my college classes.
11.	More classroom learning should include interactive communication technology experiences.
12.	The things I need to know are taught by instructors in the classroom.
13.	I learn more when I regulate my own learning experience and seek information on things that I want to learn about.
14.	I use Internet communications technology to keep current on topics related to my field of expertise.
15.	I post information that might be of interest to other people.

Fig. 4. Information and Communications Technology Learning (ICTL) survey items. *Note*: ICTL v1.0 2011 by L. Mills & G. Knezek.

and models to incorporate Mobile Learning into higher education (Knezek & Khaddage, 2011). Knezek and Khaddage (2011) found the internal consistency reliability for the seven-item instrument to be very good (*alpha* = 0.85) (DeVellis, 1991) among 81 undergraduate and graduate university students completing the survey in a large Midwestern university in the United States during August and September of 2011. Knezek and Khaddage (2012) verified this instrument to be capable of measuring pre-post changes in attitudes resulting from Mobile Learning activities designed to introduce the instructional potentials of Mobile Learning to undergraduate students who were pre-service teacher candidates ($t = 2.27$, 13 *df*, $p < .05$, *ES* = .48). Khaddage and Knezek (2013) identified trans-national differences in perceptions of Mobile Learning ($f = 12.2$, 1×126 *df*, $p < .001$, *ES* = .60) with the Mobile Learning Scale. This instrument will serve as one of the major quantitative indicators in the current study—viewed alone and in conjunction with the ICTL scales. A list of the items on the Mobile Learning Scale version 1.0 is provided in Fig. 5.

3.2. Sample

The participants of this study were undergraduate students in higher education who agreed to participate in an exploratory study by completing a learning preference survey battery that included a variety of instruments designed to measure dimensions of learning with technology. Subjects were enrolled in one of two institutions of higher education in Texas (USA). They attended either a junior community college with a 2-year curriculum or a 4-year state university. The junior college students were invited to complete the survey while enrolled in a required computer and technology competence course. More women responded to the invitation to participate than did men. The 4-year university students who were requested to complete the survey were enrolled in a pre-service teacher classroom technology course. The majority of students enrolled in the university pre-teacher course were women. The sixty-two ($n = 62$) respondents completed the survey battery online during the fall semester of 2011. Participants were 89% women ($n = 55$) and 11% men ($n = 7$). The age range spanned from 18 to 59 years of age.

3.3. The refinement of the Information And Communications Technology Learning (ICTL) survey

3.3.1. Reliability and validity

Reliability analysis was used to assess the internal consistency of the instrument scales according to Cronbach's Alpha index. As shown in Table 1, Cronbach's Alpha for all 15 items of the ICTL instrument is considered "respectable", (*alpha* = .77) according to reliability guidelines by DeVellis (1991). Exploratory factor analysis and principal components analysis (PCA) with varimax rotation was conducted in order to identify scales/factors that are orthogonally aligned (Mertler & Vannatta, 2005). PCA produced four factors with Eigen values greater than one. Scree plot analysis (Fig. 6) indicated a two, or possibly four, factor solution in light of Stevens' suggestion that constructs in the sharp decent of the graph, before the first point of leveling, be retained (1996). The four-factor solution was selected because the items within each factor were judged to have greater content validity. These four

Instructions: Select one level of agreement for each statement to indicate how you feel.
SD = Strongly Disagree, **D** = Disagree, **U** = Undecided, **A** = Agree, **SA** = Strongly Agree

	Mobile Learning Scale	SD	D	U	A	SA
1.	The rapid development of Mobile Learning devices and tools (Apps) has empowered informal learning.	①	②	③	④	⑤
2.	Mobile Apps could be integrated seamlessly to support informal learning.	①	②	③	④	⑤
3.	Mobile Apps could bring enormous opportunities into universities to further empower informal learning.	①	②	③	④	⑤
4.	Student acceptance of Mobile Learning in higher education would be high.	①	②	③	④	⑤
5.	Recent developments in Mobile Learning are leading to the exploration of new methods/models at universities.	①	②	③	④	⑤
6.	Theoretical models and methods can assist in informing the design for mobile learning Apps.	①	②	③	④	⑤
7.	The integration of mobile applications, mobile social networking platforms, and other mobile technologies has become pervasive in teaching and learning.	①	②	③	④	⑤

Fig. 5. Mobile Learning (ML) scale version 1.0 items. *Note*: ML v1.0 8/2011 by F. Khaddage & G. Knezek.

Table 1
Cronbach's Alpha internal consistency reliabilities for ICTL scales.

Scale	No. of items	Item numbers	Cronbach's Alpha	DeVellis guidelines
ICTL – total scale	15	1–15	0.77	Respectable
Online reflection	6	3, 5, 11, 6, 15, 1	0.88	Very good
Internet Exploration	4	7, 2, 13, 4	0.70	Respectable
ICT Research	3	8, 10, 14	0.43	Unacceptable
Classroom Learning	2	12, 9	0.54	Unacceptable

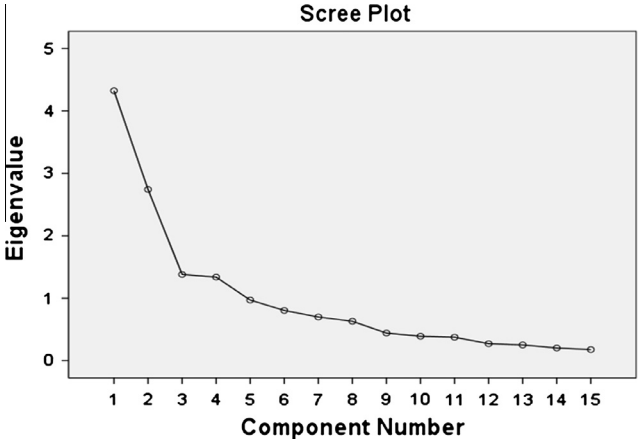

Fig. 6. Scree plot for exploratory factor analysis of ICTL items.

factors (Table 1) were tentatively named Online Reflection, Internet Exploration, ICT Research, and Classroom Learning, with *alphas* of 0.88, 0.70, 0.43, and 0.54, respectively, when subjected to post hoc internal consistency reliability analysis. Measurement scales produced for these factors were found to have internal consistency reliabilities ranging from "very good" for Online Reflection to "unacceptable" for Classroom Learning, according to guidelines by DeVellis (1991).

Fig. 7. Scree plot for higher order factor analysis.

3.3.2. Factor analysis

Higher order factor analysis was conducted to explore possible constructs at a higher level of commonality among the four scales indicated by PCA: Online Reflection, Internet Exploration, ICT Research, and Classroom Learning. This procedure indicated that two of the four components explained a cumulative 70% of the variance in learning preference. A Scree plot analysis of the four higher order factors (Fig. 7) also appeared to support a two-factor solution by revealing two factors before the sharp decent of the line graph.

Internal consistency reliability was computed for these two higher-order construct scales for the $n = 62$ subjects of this research. The first scale, Information Seeking, was found to have *alpha* = .72 (respectable, according to DeVellis (1991)). Cronbach's *Alpha* index for the second scale, Information Sharing, was .77 (respectable, per DeVellis' guidelines (1991)). Items numbers for survey questions forming each higher-order scale are listed in Table 2.

In summary, higher order factor analysis for ICTL subscales indicated two possible factors that, upon examination by researchers, also proved to have content (face) validity. One factor brought together the items related to ICT for seeking information related to areas of interest, expertise, or study (Fig. 8). The other factor encompassed items that were related to ICT use for reflection, communication, and sharing (Fig. 9).

Table 2
Item scales emerging from higher order factor analysis.

ICTL scale	# Items	Item numbers	Cronbach's Alpha	Rating (DeVellis)
ICTL – total scale	15	1–15	0.77	Respectable
Information Seeking	7	2, 4, 7, 8, 10, 13, 14	0.72	Respectable
Information Sharing	8	1, 3, 5, 6, 9r, 11, 12, 15	0.77	Respectable

Note: Item #9 was reverse coded.

ICTL Information Seeking

2. I use Internet technology to explore topics of interest.
4. I like to enroll in classes to continue my education.
7. I like to take classes from good professors.
8. I use Internet communications technology tools when I want to learn about something new.
10. Internet technology helps me be successful in my college classes.
13. I learn more when I regulate my own learning experience and seek information on things that I want to learn about.
14. I use Internet communications technology to keep current on topics related to my field of expertise.

Fig. 8. ICTL Information Seeking items.

ICTL Information Sharing

1. I would like to be a participating member of an online community.
3. I like to share interests and reflections online.
5. I use Internet communications and other technology tools for self-expression.
6. I learn many things by interacting with other Internet users.
9. I learn best in a traditional classroom setting.
11. More classroom learning should include interactive communication technology experiences.
12. The things I need to know are taught by instructors in the classroom.
15. I post information that might be of interest to other people.

Fig. 9. ICTL Information Sharing items.

3.3.3. Multidimensional scaling

Multidimensional scaling (Dunn-Rankin et al., 2004) was conducted to further examine the underlying factors for the ICTL survey. The ALSCAL Euclidian distance model with a maximum of two dimensions was generated to examine distances and proximities for items in relation to one another. Two main output clusters are visible on the Euclidean distance model (Fig. 10). This two-scale alignment confirms results of higher order factor analysis. Instrument items in quadrants II and III, together with item #8, which is located near the *Y* axis, were identified as belonging to the first of two scales derived by factor analysis. All remaining items, in quadrants I and IV, were identified as belonging to the second scale. This two-factor solution was accepted and resulted in the Information Seeking and Information Sharing scales of the ICTL.

The instrument refinement process conducted for this study, which identified Information Sharing and Information Seeking scales, was confirmed by a related study of learning preference for (n = 147) adult subjects (76% women and 24% men) who completed the ICTL online (). The Cronbach's Alpha internal consistency reliabilities of ICTL Total, ICTL Information Sharing, and ICTL Information Seeking scales, as interpreted by DeVellis' (1991) guidelines, were found respectively to be respectable (a = .77), very good (a = .83), and respectable (a = .71) for the n = 147 respondents (Mills, Knezek, & Wakefield, 2013).

4. Results

4.1. Age differences on the scales

Differences among age groups for the constructs developed in this paper were examined by running analysis of variance procedures for each of the scales of Information Seeking, Information Sharing, and Mobile Learning. The age groupings beyond 40 years old were excluded from this analysis due to the small numbers of respondents in the 41–50 year age category (n = 3), and equally small numbers (n = 3) in the 50+ age category. The three age groupings identified by the survey that contained non-trivial numbers of respondents were: (1) 18–20 years old (n = 18), (2) 21–30 years old (n = 25), and (3) 31–40 years old (n = 13).

As shown in Table 3, in the area of Information Seeking there were significant (p < .05) differences among the three age groups of 18–20 year olds, 21–30 year olds, and 31–40 year olds. Fig. 11 graphically illustrates that the group mean plot for the age range 21–30 had the highest mean values, higher than the younger group, 18–20 years of age, and also higher than the older group, 31–40 years of age. A Tukey post hoc test (not shown) confirmed that Information Seeking for those in the 21–30 age group was significantly (p < .05) higher than both the 18–20 and 31–40 age groups. Additional research is planned to determine if individuals in the 21–30 age group that are drawn from other samples and from other regions of the United State or the world would also have relatively higher mean dispositions for Information Seeking.

No significant differences by age (p < .05) were found for the other two constructs of Information Sharing perceptions and Mobile Learning attitudes, which were also included in this study (Table 3). However, it is noteworthy that the patterns of the high and low means among the three age groups differ for each construct, shown in Table 3. For example, it appears that for Information Sharing, the youngest group (18–20) is low while both older groups have nearly equal positive perceptions of Information Sharing. Conversely, in the area of Mobile Learning, the trend appears to

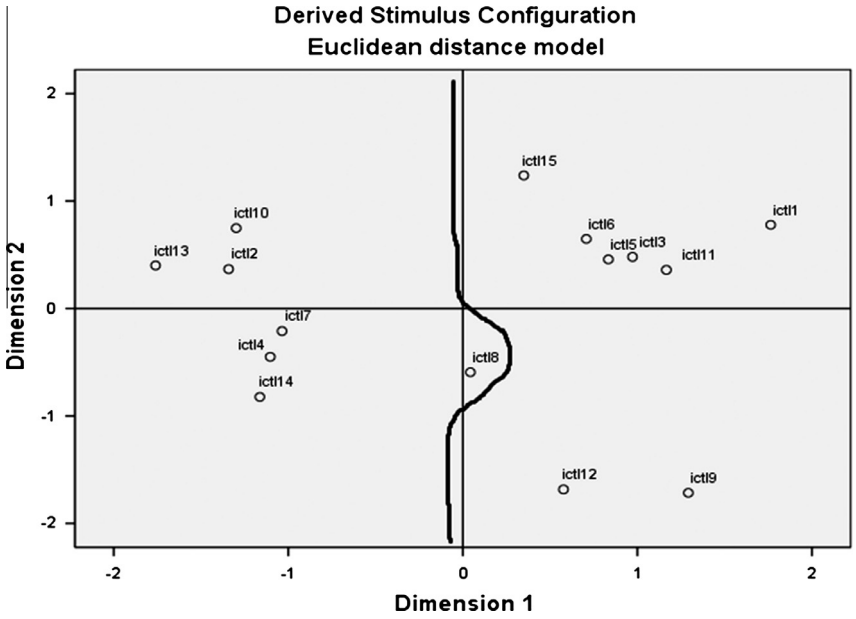

Fig. 10. Multidimensional scaling plot of ICTL items based on Euclidean distance model.

Table 3
Analysis of variance for perceptions of Information Seeking, Information Sharing, and Mobile Learning across three age groups.

Age groups 1–3		*N*	Mean	Std. deviation	Signif. (*df*, *F*, sig.)	Effect size (Cohen)
ICTL Information_Seeking	1	18	3.74	0.38	($F(2,53) = 4.33$, $p = .018$)	1, 2 = 1.22
	2	25	4.20	0.51		1, 3 = 0.36
	3	13	3.88	0.71		2, 3 = 0.61
	Tot.	56	3.98	0.56		
ICTL Information_Sharing	1	18	3.48	0.62	($F(2,55) = 0.65$, $p = .527$)	1, 2 = 0.31
	2	25	3.70	0.66		1, 3 = 0.28
	3	13	3.71	0.79		2, 3 = 0.03
	Tot.	56	3.63	0.68		
Mobile Learning Scale	1	18	4.17	0.44		1, 2 = 63
	2	24	3.79	0.83	($F(2,55) = 2.03$, $p = .141$)	1, 3 = 03
	3	13	4.14	0.63		2, 3 = 0.73
	Tot.	55	4.00	0.69		

be that the middle age group (21–30), which was highest on Information Seeking, is lowest on perceptions of Mobile Learning, while both the youngest and the oldest age groups are nearly equally high. Further research is needed in this area.

4.2. Cross-validation of scales

Concurrent validity was examined for the three scales of ICTL by correlation analysis with the Mobile Learning Scale version 1.0 introduced in Section 3.1.2. Correlation analysis revealed concurrent validity between ICTL scales and the Mobile Learning Scale. Significant correlations ($p < .01$) were found between Mobile Learning (ML) total scale score and two ICTL measures: (a) ML with ICTL_Total, $r = .37$ ($p < .003$), and (b) ML with ICTL Information Sharing, $r = .38$ ($p = .003$). These magnitudes of Pearson Product Moment Correlation are considered moderate in effect size according to guidelines by Cohen (1988). These findings confirm that the ICTL survey scales have demonstrable criterion-related validity in the form of alignment with an established Mobile Learning Scale (Table 4).

Additional criterion-related evidence for maintaining separate scales representing the three constructs of Information Seeking, Information Sharing, and Mobile Learning was found through examination of correlations between levels of computer and

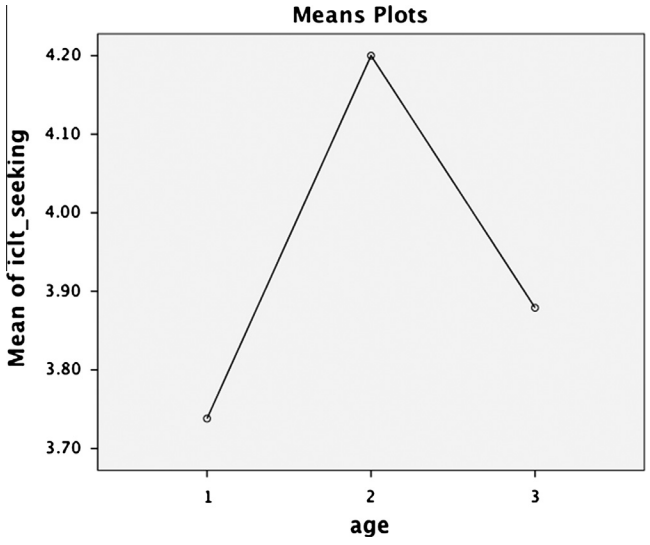

Fig. 11. Group mean plots for perceptions of Information Seeking behaviors among three different age groups. *Note*: (1) Age groups: (1) 18–20, (2) 21–30, and (3) 31–40.

Table 4
Bivariate correlations analysis for ML and ICTL factors, and Creative Tendencies.

Pearson product moment correlations					
Sig. (2-tailed)	ML scale	ICTL_Sharing	ICTL_Seeking	ICTL_Total	Creativity
ML scale	1	0.383	0.064	0.374	-0.158
		0.003	0.625	0.003	0.225
	61	60	61	60	61
ICTL_Sharing	0.383	1	0.235	0.802	0.051
	0.003		0.068	0	0.696
	60	61	61	61	61
ICTL_Seeking	0.064	0.235	1	0.689	0.322
	0.625	0.068		0	0.011
	61	61	62	61	62
ICTL_Total	0.374	0.802	0.689	1	0.248
	0.003	0	0		0.054
	60	61	61	61	61
Creativity	−0.158	0.051	0.322	0.248	1
	0.225	0.696	0.011	0.054	
	61	61	62	61	62

Table 5
Correlations of Information Seeking, Information Sharing, and Mobile Learning with hours of access in home and work environments.

Pearson product moment correlations			
Sig. (2-tailed)	ICTL_Seeking	ICTL_Sharing	ML scale
Computer	0.071	.334	0.22
Hours	0.582	0.008	0.089
Home	62	61	61
Computer	0.183	0.188	-0.051
Hours	0.155	0.148	0.695
Work	62	61	61
Internet	0.075	.310	.387
Hours	0.565	0.016	0.002
Home	61	60	60

Internet usage and the scale scores of the participants. As shown in Table 5, Information Sharing was found to be positively correlated with the number of hours of computer use at home per week ($r = .33$, $p = .008$) and with the number of hours of Internet use at home per week ($r = .31$, $p = .016$). Conversely, Information Seeking was not significantly correlated ($p < .05$) with either. Perception of Mobile Learning was positively and significantly correlated ($p < .05$) with the number of hours of Internet use at home per week ($r = .39$, $p = .002$) but Mobile Learning was not significantly correlated $p < .05$) with the number of hours of computer use at home per week. The strengths of the associations between the three constructs and different location-based types of information technology access vary widely depending upon which construct is being assessed. This provides evidence that none of the three constructs are redundant with another, and all three should be retained to provide a broad perspective when examining learning preferences along the formal-to-informal learning continuum.

Further research is warranted to determine whether these newly validated scales relate to seemingly relevant measures established well before the 21st century emphasis on informal learning. For example, Fraser (1998) reviewed ten classroom environment instruments with good measurement properties, and it appears that among these the *College and Classroom Learning Environment Inventory* (CUCEI) has scales with specific items related to the informal learning focus of the *Mobile Learning* (ML) scale. In addition, the *Constructivist Learning Environment Survey* (CLES) has scales with specific items related to *Information Sharing* as defined in the current study. Tsai (2008) revision of the *Constructivist Internet-based Learning Environment Survey* (CILES_R) examined an *Ease of Use* scale that would appear to be related to mobile access and included three scales (*Relevance, Multiple sources and interpretations, and Challenge*) with items pertinent to *Information Seeking*, plus four scales (*Student negotiation, Cognitive apprenticeship, Reflective thinking, and Epistemological awareness*) with items judged to be related to *Information Sharing*. The authors of the current study conjecture that a higher-order factor analysis using scale scores from the CILE and Tsai's CILES-R might result in *Information Seeking, Information Sharing,* and *Ubiquitous Access* as three of the higher order constructs that could emerge. In addition, and conversely, inclusion of some of the most relevant high-performing items from CUCEI and CILES on the next revision of ICTL would likely strengthen the measurement of ICTL's Information Seeking and Information Sharing scales, while also providing marker or cross-validation items (DeVellis, 2012) to previous, established research. Additional work is planned in this area.

5. Results

5.1. Limitations

Limitations of this study include a small and limited sample size, $n = 62$, of adult participants who were from Texas, USA and predominantly women (89%). The reliability and consistency of ICTL Total, Information Sharing, and Information Seeking scales were re-verified (Mills, Knezek, & Wakefield, 2013) in a related study of $n = 147$ geographically dispersed, adult participants who responded to email and social media invitations to participate. These volunteer survey participants were also predominantly women.

This study is also limited by the data, which were self-reported, and by the constraints on exploratory, quasi-experimental design associated with administering surveys to samples of convenience. Therefore, the learning preferences reported in this study are only marginally generalizable to the samples represented. Additional research is planned to explore the finding of this study in samples that are representative of larger populations.

5.2. Findings

A major finding of this study is the validation of scales of the ICTL for assessing barriers to, and affordances of, formal to informal learning in the digital age by identifying information behaviors in technology-pervasive information environments. The ICTL scales were defined by a multi-step refinement process and were found to have content and construct validity. The Information Seeking scale demonstrated criterion-related discriminant ability by identifying significant ($p < .05$) differences among the three age groups: 18–20 year olds, 21–30 year olds, and 31–40 year olds. Analysis of variance with Tukey post hoc tests confirmed that participants in the 21–30 age group were significantly more positive in attitude towards ICT Information Seeking.

ICTL scales were further examined for criterion-related concurrence by cross-validation with ML and Creative Tendencies scales. Bivariate correlation analysis of associations between ML, total disposition towards ICTL, Information Seeking, Information Sharing, and Creative Tendencies indicated that:

- Learner perceptions of Creative Tendencies are associated with preference for Information Seeking ($r = .322$, $p = .011$).
- Preference for Information Sharing is associated with preference for ML ($r = .383$, $p = .003$).
- Preference for ML is related to preference for learning with ICTL ($r = .374$, $p = .003$).

Additional information is provided in the bivariate correlations reported in Table 4.

6. Discussion and conclusions

A comprehensive review of informal learning research reveals a need to better understand teaching and learning with computer-related technologies. For this study, formal to informal learning was envisioned as a conceptual continuum in order to identify the relationships between formal to informal learning and mobile access, Information Seeking, and Information Sharing. Findings from the analysis of $n = 62$ undergraduate college students revealed a measurable relationship between preferences towards information behavior (such as Information Sharing) and preference for Mobile Learning.

Additional research is needed to advance the understanding of differences in learner perceptions of ICT use in online, classroom, and blended courses, as well as in learning outside structured curricular environments. The authors contend that mobile access, Information Sharing, and Information Seeking can be viewed as foundational components facilitating the shift in emphasis from formal to informal learning in the digital age. They suggest that an understanding of information behavior in technology-rich environments can help to answer pedagogical concerns associated with the following trends: (1) shifts in control of instruction from teacher to student, (2) student-driven informal learning activities that are often unguided, and (3) interest in tapping into the strengths of information technology for a connection between school and home, as well as informal to formal learning.

For example, in a related study of preference for learning with social media, significant relationships were found between student perception of social media communications and information behaviors (Mills, Knezek, & Wakefield, 2013). Learner's perceptions that social media can result in "rapid feedback from professors" trended positively with:

- Preference for ICTL Total ($r = .394$, $p = .002$).
- Preference for Information Sharing ($r = .394$, $p < .0005$).
- Preference for ML ($r = .372$, $p = .003$).

These magnitudes of the Pearson Product Moment Correlation reflect moderate effect sizes according to guidelines by Cohen (1988).

There are many aspects to the choreography of teaching and learning that are richly facilitated through the appropriate use of technologies. Validated instrument scales such as the ICTL Information Seeking, Information Sharing, and ML can help to understand learning preferences for the purpose of supporting formal to informal learning. The scales of the ICTL, Information Sharing and Information Seeking, are also of interest as the basis of taxonomy for identification of student learning behaviors in Web 2.0 Internet environments. Cattell (1987), as one of the originators of factor analysis, observed that taxonomy built upon empirical data for general, group, and specific factors will support a theoretical framework and schemata for ordering data and further experimentation. Cheetham and Chivers (2005) developed a taxonomy of informal professional learning that includes over a dozen categories of experience for learning. The ICTL survey provides factors for a high-level taxonomy from which to gauge learners' dispositions toward Information Seeking and Information Sharing in Web 2.0 Internet environments, and can therefore guide in the design of new instructional models for support of the formal to informal learning continuum.

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