EFFECTIVENESS OF MOBILE LEARNING IN THE INDIAN CONTEXT

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INTRODUCTION

Learning communities are the collections of learners working together toward mutual goals. Using technology, they shall engage in problem solving and dialogue with learners at different places. A learner can observe a model within a relevant and real situation. Then the learner has the opportunity to try the techniques in a similar situation. Part of the process requires the learner to plan, reflect upon, and articulate her actions, during the process. The learner receives gradually less support from the mentor as she gains competence and confidence until; finally, the learner is able to work independently.

Mobile learning or M-Learning has different meanings to different people. Though it is related to distance education and e-Learning, it is different in its focus on learning with mobile phones at different situations. A definition of mobile learning says: Any sort of learning happening when the learner is not at a predetermined place or learning happening when the learner is taking advantage of mobile technology opportunities. In fact, mobile learning reduces the limitations of distance by the mobility of mobile devices. The term covers: learning with portable technologies including but not limited to handheld computers, MP3 players, note books and mobile phones. M-learning focuses on the mobility of the learner, interacting with portable technologies, and learning that reflects a focus on how society and its institutions accommodate and support an increasingly mobile population. There is a new direction in mobile learning including mobility of instructors and creation of learning materials on the spot, in the field, using smart phone with special software such as AHG Cloud Notes, Audacity, etc. Usage of mobiles to create teaching aids and materials is important in informal learning.

GROWTH AND DEVELOPMENT OF MOBILE DEVICES

Indian telecom industry underwent a high pace of market liberalization and growth since 1990s and now has become the world's most competitive and one of the fastest growing telecom markets. The industry has grown by 20 times in 10 years. In 2001, it was 37 million and in 2011, it was 846 millions. India has the world's second-largest number of mobile phone users, i.e., 929.37 million as of May 2012. It has the world's third-largest Internet user-base with over 137 million as of June 2012. The number of mobile phones produced and purchased every year grows continuously, and new devices such as iPad are expanding the notions of portability. With increased screen real estate, battery life, and input options, mobile devices have become a viable alternative to laptop computers. The mobile phone connections are greater than the land-line connections. Now they are in the ration 20:1. Over the past 10 years, M-Learning has grown from a minor research interest to significant projects in workplaces, schools, cities, and rural areas around the world. There are differences among academics industry and national perspectives, and between the school, higher education, and life-long sectors.

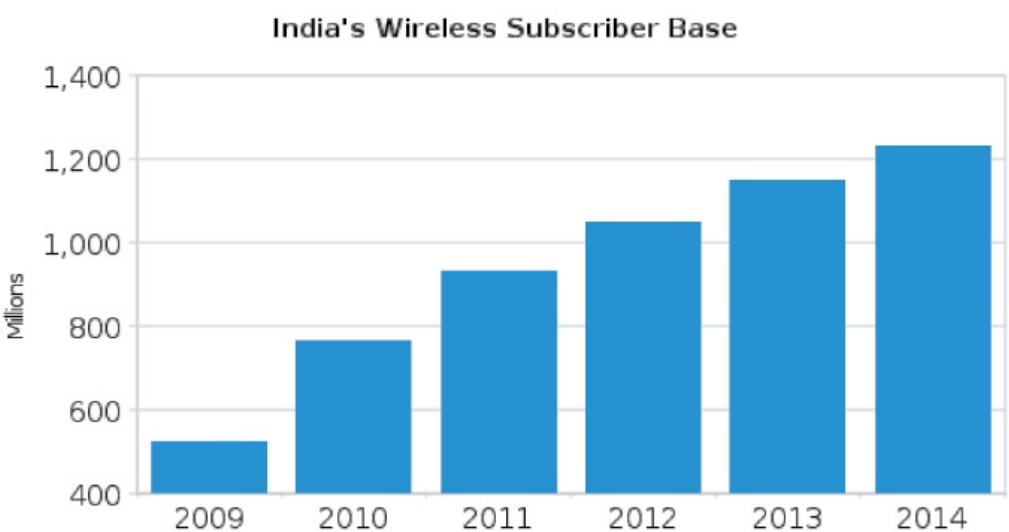

Fig. 1.1: Growth of Mobile Devices in India

ADVANTAGES OF MOBILE PHONES

Mobile phones have many advantages over desktop and laptop devices. They are always close at hand, available with internet access whenever it is needed, easy to use for web browsing; and much of the available content seamlessly adjusts for optimal display on many devices. A full range of networked information and applications are available wherever we go. The Internet is pervasive; ever-present and accessible from wherever signal is available. Many people use laptops for more involved web browsing, reading, watching videos, or to use internet applications, and smart phone for simple tasks such as a quick glance at email, social networks, etc. Smatphones provide specialized applications to access online financial information, read and contribute to social networking sites, check email, browse and upload media, and so on. Mobile and wireless data networks continue to evolve, supporting faster connections and higher bandwidth throughput.

CHARACTERISTICS OF MOBILE DEVICES

Mobile devices and technologies are pervasive and ubiquitous and alter the nature of learning, the ways that learning can be delivered and the balance between training and performance support. This means that mobile is not merely the timeless concept of learning; rather, mobile learning is emerging as an entirely new and distinct concept alongside the mobile workforce and the connected society. Mobile devices create:

- New forms of knowledge;
- New forms of art and performance;
- New forms of commerce and economic activity; and
- New ways of accessing them.

The need to organize and navigate through bite-sized pieces of mobile learning content also impacts on these notions of knowledge and learning and perhaps individual learners may create their own ontologies in personalized settings.

We shall explore the nature of mobility for understanding mobile learning. For each learner, the nature of mobility has a variety of connotations and these have affect mobile education. One may learn while driving, walking, travelling or sitting, providing hands-free and eyes-free learning. They impact the definition of mobile learning.

FRAMEWORK FOR THE RATIONAL ANALYSIS

OF MOBILE LEARNING (FRAME MODEL)

It is the abbreviation of **F**ramework for The **R**ational **A**nalysis of **M**obile **E**ducation. It is a comprehensive model covering different aspects of mobile learning such as the learner and device usability. It explains the pedagogical issues of information overload, knowledge navigation, and collaborative learning. It involves convergence of mobile technologies, human learning capacities, and social interaction in mobile learning. It helps educators and trainers to develop mobile learning materials and to use effective teaching and learning strategies for mobile education. It also helps guide the development of mobile devices for mobile learning. This model consists of three components, namely **Device (D), Learner (L),** and **Social (S) aspects.** The intersection of Device Usability (DL) and Social Technology (DS) is the mobile technology affordance **(Norman 1999)**. The intersection labeled interaction learning (LS) contains instructional and learning theories with an emphasis on social constructivism. Hypothetically, the primary intersection, the convergence of all three aspects, defines an ideal mobile learning situation. By evaluating the level of usage of all the areas of FRAME model, the users may design effective models and mobile learning experiences.

Wireless, networked mobile devices can shape culturally sensitive learning experiences and the means to cope with the growing amount of information in the world. By using a mobile device, the learner can consult a web page, access audio or video tutorials, send a query via text message to a friend, or phone an expert for practice or guidance. The learner may use one or several of these techniques. How can learners have a full mobile experience, practitioners design suitable mobile access activities and materials, and mobile learning implemented in informal and formal situations?

FRAME model provides insights into these problems. As per the model, the mobile learning experiences exist within the information context. Collectively and individually, learners consume and create information. The interaction with information is mediated through technology. Through these interaction complexities, the information gets meaning and use. The FRAME model can be represented by a Venn diagram. In this, the three aspects intersect.

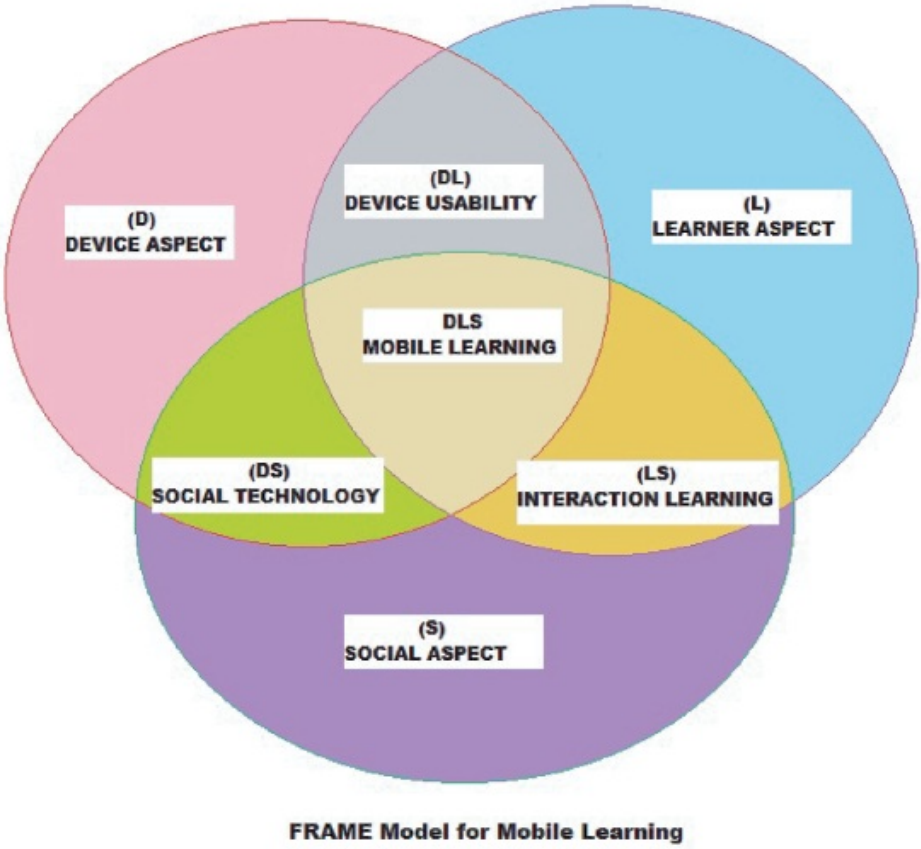

Fig. 1.2: FRAME Model

The three circles represent **Device (D), Learner (L),** & **Social (S) aspects.** The intersections where two circles overlap contain attributes that belong to both aspects. The attributes of Device Usability (DL) & Social Technology (DS) intersections describe affordances of mobile technology **(Norman 1999)**. The intersection labeled interaction learning (LS) contains instructional and learning theories with an emphasis on social constructivism. At the center of the Venn diagram, all three aspects intersect (DLS), representing the ideal mobile learning situation. By assessing the degree by which all three areas of FRAME model are utilized in mobile learning situations, users may design more effective mobile learning experiences.

Device Aspect (D): The device aspect (D) refers to the physical, technical, and

functional characteristics of a mobile device (Table 1.1). The physical characteristics include input and output capabilities, internal processes such as storage capabilities, power, processor speed, compatibility, and expandability. These characteristics result from the hardware and software design of the devices and have a significant impact on the physical and psychological comfort levels of the users. It is important to assess these characteristics because mobile learning devices provide the interface between the mobile learner and the learning task (s) as described later in the device usability intersection (DL).

Mobiles should be designed with high psychological and physical comforts, to bridge the human beings with technology. Device characteristics have a significant impact upon usability. When the weight, size, composition and structure match the psychological and physical capacities of the learner, the device becomes portable. The input and output capabilities should match the human motor functions and perceptions. Similarly, the speed and capacity of the device memory, file storage, processor, and file exchange require appropriate error-free response rates timed to the user's needs and expectations. Well-designed mobile phones enable the learners to engage in cognitive tasks mentioned in the Learner Aspects (L) rather than the devices themselves.

Table 1.1: Device Aspects of FRAME Model

Criteria	Examples & Concepts	Comments
Physical Characteristics	Size, weight, composition, placement of buttons and keys, right/left handed requirements, one/two hand operability.	Affects how the user manipulate the mobile.
Input Capabilities	keyboard, mouse, stylus, touch screen, trackball, joystick, touchpad, hand/foot control, voice recognition.	Allows selection and positioning of objects or data on the device.
Output Capabilities	Monitor, speaker, audio and tactile	Allows human body to sense changes in the device; allows user to interact with

	output mechanisms.	the device. Mobile devices are often criticized for small screen-size.
File Storage and Retrieval	Storage devices such as RAM, ROM, USB devices, CD, DVD, and SD cards.	Consistency and standardization of storage and retrieval systems affect usability.
Processor Speed	Processor Speed Response rates is the reaction speed of the device to human input.	Determined by the amount of RAM, file storage speed, user interface speed, and system configuration. Long or short response rates effect error rates as the user may forget initial goals and/or task sequences.
Error Rates from	Malfunctions resulting from flaws in hardware, software, and/or interface design.	Users are unable to perform desired tasks and lose confidence in the device.

Shneiderman and Plaisant (2005)

Learner Aspect (L): The learner aspect (L) takes into account an individual's cognitive abilities, memory, prior knowledge, emotions, and possible motivations (Table 1.2). This aspect describes how learners use what they already know and how they encode, store, and transfer information. This aspect depends on knowledge transfer and discovery learning theories.

Table 1.2: Learner aspects of FRAME Model

Criteria	Examples & Concepts	Comments
Prior knowledge	Cognitive structures already in memory, anchoring ideas, schema theory, Gagne's conditions for learning.	Affects how easily a learner can comprehend new concepts. Potential problems include reluctance to adopt new procedures.
Memory	Techniques for successful encoding with the use of contextual cues: categorization,	A variety of stimuli and the multimedia

	mnemonics, self-questioning, semantic & episodic memory, tactile, auditory, olfactory, visual imagery, kinesthetic imagery, dual coding, and encoding specificity.	inclusion aid learners to understand and retain major concepts easily.
Context and Transfer	Inert vs Active knowledge.	Actively utilizing information to understand, remember and transfer concepts in different situations.
Discovery Learning	Applying concepts and procedures in new situations, finding solutions for novel problems.	May stimulate learner to develop skills to filter, choose, and recognize relevant information in different situations.
Emotions and Motivations	Feelings of the learner towards a task; reasons or accomplishing a task.	Activity Theory provides additional avenues of Investigation into motivation.

The Learner Aspect (L) is based on the belief that the learner's prior knowledge, motivation, intellectual capacity, and emotions have significant impact on encoding, retaining, & transferring information. Actively selecting or designing learning activities rooted in authentic situations as well as encouraging learners to discover laws within physical and cultural environments are powerful pedagogical techniques. Mobile learning allows the learner to access content in different formats, highlight contexts and use information and helps to increase encoding, remember and transfer of information.

Prior knowledge, past experience, a learner's environment, task authenticity, and presentation of content in multiple formats influence learning. Semantic memory consists of non-contextually based general concepts. Mobile learning helps learners utilize episodic memory. This type of memory is based on direct experiences such as travel to other countries, visiting museum, historic sites, and case studies in professional settings. This helps them to be active. The ability to recollect a concept mostly depends on the learner recollects its use.

Remembering the use of a concept or tool may also aid the learner in transfer of the concept into other contexts. Materials presented in different formats—as proposed in Dual Coding Theory—allow the brain to actively process content through various channels.

Social Aspect (S): The social aspect takes into account the processes of social interaction and cooperation (Table 1.3). Individuals must follow the rules of cooperation to communicate—thereby enabling them to exchange information, acquire knowledge, and sustain cultural practices. Rules of cooperation are determined by a learner's culture or the culture in which an interaction take place. In mobile learning, culture may be physical or virtual. One should realize that there are constraints on participants in a dialogue. Such constraints provide guidelines and predictability for behavior that enable effective communication. When a user joins a new community, he shares his own system and learns that of the new community.

Cooperative communication requires that contributions are as informative as necessary, accurate, relevant, and sufficiently clear. When a participant neglects to follow one or more of the rules, miscommunication may occur. When users ignore the rules, it leads to miscommunication. Users sometimes voluntarily break rules, etiquette and procedures to achieve some effects. They should pay attention to each other during dialogue so that they may detect breakdowns and interpret them accurately. It is through interaction that people receive feedback which, in turn, reinforces social and cultural beliefs and behaviors.

Table 1.3: Social Aspects of FRAME Model

Criteria	Examples & Concepts	Comments
Conversation and Cooperation	Social constraints; 4 maxims: quantity, quality, relation, and manner.	Affects quality and quantity of communication; mis-communications may occur when any of the 4 maxims are not met.
Social Interaction	Conversation as a cooperative activity, sharing of signs and symbols.	Agreement on the meaning of signs and symbols may affect reinforcement of social and cultural beliefs and behaviors.

Intersections

There are three types of intersections between the basic i. Device Usability Intersection (DL); ii. Social Technology Intersection (DS); and iii. Interaction Learning Intersection (LS). Finally the intersection of all these domains is called Mobile Learning (DLS). Let us discuss them in detail.

Device Usability Intersection (DL): The device usability intersection contains elements that belong to both the device (D) and learner (L) aspects (Table 1.4). This aspect relates characteristics of mobile devices to cognitive tasks related to the manipulation and storage of information.

Table 1.4: Device Usability Intersection of FRAME Model

Criteria	Examples & Concepts	Comments
Portability	Portability & durability (dependent on physical characteristics, number of components, & materials used in constructing the device).	Affects the user's ability to move the device to different environments and climates.
Information Availability	Anywhere, anytime access to information stored in the mobile. (This is different from transfer of information which is a DS characteristic.	Enables just-in-time learning; information accompanies the user; the user can retrieve stored information when and where it is needed.
Psychological Comfort	Learnability, comprehensibility, transparency, intuitiveness, memorability, and metaphors.	Psychological comforts affect cognitive load and the task performing speed of the users. Metaphors, chunking information, mnemonics, simplification of displays, and reduction of required actions may reduce cognitive load.
Satisfaction	Interface aesthetics, physical appearance, preferred cognitive style and functionality.	Because satisfaction and enjoyment is highly personal and culturally determined, it is very difficult to predict.

These processes, in turn, affect the user's sense of psychological comfort and satisfaction by affecting cognitive load, the ability to access information, and the ability to physically move to different physical and virtual locations.

Portability and access to information are important in mobile usability. The physical attributes of the device such as size and weight, number of peripherals, and materials used in the construction of the device decide the device portability. Highly portable devices must have resistance to humidity, dust, and shock. Information access and portability are complimentary. The information moves to the user, not the reverse. In the past, learners were required to learn information just in case they needed it in the future. Now just-in-time learning is possible; learners shall access stored content anywhere or anytime.

How quickly the learner understands and starts using the device are called psychological comfort. The users should be able to learn main functions immediately and accomplish the desired tasks (Nielsen 1993). If the device is easy to use and the user shall concentrate cognitive tasks instead of manipulating the device leads to high degree of transparency. Some methods to increase transparency & reduce cognitive load are lowering number of actions necessary to complete a task, using mnemonic devices, providing sufficient training, and using simple displays.

A commonly cited rule is the seven-plus-or-minus-two rule. It is found that most people are capable of retaining approximately seven chunks of information give or take two. Device Usability (DL) connects the needs and activities of users to the software and hardware characteristics of their mobiles. Intuitive, portable, transparent mobiles help to reduce cognitive load thus increasing task completion rates. The learners concentrate on the tasks instead of the tools.

Social Technology Intersection (DS): It describes how mobile devices enable communication and collaboration amongst multiple individuals and systems (Table–1.5). Device hardware & software provide various means of connectivity. Many mobiles have Short Messaging Service (SMS), telephony, and Internet. The means of information exchange and collaboration between users with various purposes and goals. Mobiles should be able to connect to a variety of systems by different means. Networks often require different types of wired or wireless frequencies. WiFi, Infrared, Bluetooth, CDMA, and GSM are some mobile wireless technology standards.

The Internet and the World Wide Web have become a central gateway to scientific, procedural, and cultural information. Quality of data transfer and speed are affected without adequate standards. The rules and constraints of data exchange may affect

workflow in that it can force certain types of organization upon the individuals who are interacting. By using these tools, the users shall engage in different types of collaboration.

Table 1.5: Social Technology Intersection of FRAME Model

Criteria	Examples & Concepts	Comments
Device Networking	Personal area networks (PANs), wide area networks (WANs), wireless local area networks (WLAN), synchronization software, wireless fidelity (WiFi), and cellular connectivity.	Different connectivity standards allow clients to connect to other systems, information and clients. Mobile networking is affected by low bandwidth.
System Connectivity	Internet access and document transfer protocols.	Users should be able to exchange information and documents across and within the systems. This affects the organization of individuals and systems that are attempting to interact.
Collaboration Tools	Shared tools such as calendars, authoring tools and project management tools.	Collaboration tools allow coordinating tasks, providing or attending lectures, co-authoring documents, holding asynchronous and synchronous meetings, decision making, voting, do commercial transactions, and accessing laboratory equipments.

Wireless networking is, perhaps, the most significant feature of mobile tools within the social technology intersection (DS). When users exchange relevant information at appropriate times, they participate in different collaborative and community situations that are unable to happen by distance. Hence, socio-cultural setting becomes an integral part of interaction.

Interaction Learning Intersection (LS): It represents a combination of instructional and learning theories and relies heavily on constructivism. Accordingly, learning is collaborative with meaning negotiated from various

aspects. Adhering to constructivism may vary in their level of emphasis on social interaction. Some contend that users negotiate meaning and interact with other users directly. Users do both as per the circumstances. The interaction learning intersection (LS) presented here is balanced between these viewpoints (Table 1.6). This intersection takes into account the needs of distance learners as individuals who are situated within unique cultures and environments. Such settings impact a learner's ability to understand, negotiate, integrate, interpret, and use new ideas as needed in formal instruction or informal learning. Moore propounded 3 types of interaction in ODL, learner-content referring to the cognitive changes happening due to learner engagement with course materials, learner-instructor and learner-learner. Learner access a number of information through audio, video, and text. But he cannot converse directly with the media. CBL and intelligent tutoring system may stimulate metacognitive skills adequate for self-regulation, decision making and information selection.

Table 1.6: Internet Learning Intersection

Criteria	Examples & Concepts	Comments
Interaction	Learner-learner, learner-instructor, learner-content; computer-based learning (CBL); intelligent tutoring systems, zone of proximal development.	A variety of interaction stimulates learning at different effectiveness levels based on the learner, task and situation.
Situated Cognition	Authenticity of context and audience.	Audience and a real purpose for a learning task increases learner motivation.
Learning Communities	Cognitive apprenticeships, dialogue, problem solving, communities of practice.	Learners collaborate with peers to achieve mutual goals. Learners have varying degrees of control over the learning process.

The significance of context and social negotiation of meaning is highlighted by (Vygotsky's 1978) zone of proximal development. The gap between what a learner is able to do and what he could do with help from more advanced peers is called the zone of proximal development. The interaction with peers provides more powerful learning. Authenticity does not imply that learners should interact directly with other learners, but that products of learning activities are intended for members of a real and larger community. In such situations, the learner is not passive, and action-

oriented. Cognitive apprenticeships and learning communities are high social methods of learning. They offer different levels of learner control. In cognitive apprenticeship, learners observe a human model within a relevant, real situation and try the techniques in similar situations. Learning communities are the collections of learners working together toward mutual goals. They involve in dialogues and problem solving activities with peers at different places through technology. Part of the process requires the learner to plan, reflect upon, and articulate her actions during the process. The learner receives gradually less support from the mentor as she gains competence and confidence until; finally, the learner is able to work independently.

Though social constructivism may be brought to extremes, none can deny its impact of interaction on human learning. Encouraging learners to participate in communities & cognitive collaborations helps them to use many number of situations to negotiate meaning. The center of FRAME model Venn diagram is the combination of socially grounded learning practices and the affordances of wireless mobile devices.

Mobile Learning Process (DLS): Effective mobile learning, the primary intersection of the FRAME model, results from the integration of the Device (D), Learner (L), and Social (S) aspects. Mobile learning gives access to information, rich collaboration among peers and deep learning contextualization. By providing better access, relevant information, redefining the goals and reconsidering the understanding of concepts, effective mobile learning empowers learners and growing frame of reference (the information context). Effective mobile learning provides an enhanced cognitive environment in which distance learners can interact with their instructors, their course materials, their physical and virtual environments, and each other (Table 1.7).

Table 1.7: The Mobile Learning Process

Criteria	Examples & Concepts	Comments
Mediation	Task artefact cycle, mediation.	The nature of the interaction itself changes as learners interact with each other, their environments, tools, and information.
Information Access and Selection	Information noise, identification of patterns and relationships,	As the amount of information available increases, learners must increase their efforts to recognize and evaluate the appropriateness and accuracy of information.

	relevancy, and accuracy.	
Knowledge Navigation	Knowledge production vs. knowledge navigation.	In knowledge production, teachers decide how to learn what information. They acquire the skills necessary to navigate, select, manipulate and apply information to their unique needs and contexts.

The concept of mediation is crucial for understanding the integration of the three aspects of the FRAME model. Vygotsky (1978) propounds that the nature of interaction changes as the learners interact with peers, contexts, information and the tools. In keeping with the concept of mediation, the task-artefact cycle posits that the artefacts themselves introduce possibilities and constraints that, in effect, redefine the uses for which the artefact was originally intended. The process of mobile learning is defined and continuously reshaped by the interaction between the Device (D), Learner (L), and Social (S) aspects. They must be able to identify patterns and relationships between facts amongst a growing variety of resources. Assessing worthiness is intrinsic to learning when knowledge is scarce. When it is abundant, it is important to evaluate knowledge. In addition, the relevance & accuracy of information shall shift as other information becomes available.

Educators need to respond with more flexible methods of knowledge management in order to prepare learners to navigate within an information rich world. Because the mobile learning process is defined by social, cognitive, environmental, and technological factors, mobile learning can help learners gain immediate and ongoing access to information, peers, and experts who can help them to determine the relevance & importance of information found on both Internet and in their real-life environments. This kind of access to other learners and experts can help to mitigate the negative effects of information noise and assimilation bias in which learners may be overwhelmed by the volume of information or may be reluctant to learn new procedures.

While student control is beneficial for motivation and empowerment, both simulation and explorative information retrieval need some navigational assistance to prevent the student from being lost or trapped in misconceptions. While producing knowledge, teachers decide what and how information should be learnt. They help learners to understand selecting, manipulating and applying existing knowledge in unique contexts during knowledge navigation. In this paradigm, formal and informal learning techniques may blend and teachers' roles shift that of coaches and mentors.

Researchers at a workshop titled ‘Inquiry Learning & Mobile Learning’ offered a range of learning activities supported by mobile digital tools and environments **(Laurillard, 2007):**

- exploring – real physical environments linked to digital guides;
- investigating – real physical environments linked to digital guides;
- discussing – with peers, synchronously or asynchronously, audio or text;
- recording, capturing data – sounds, images, videos, text, locations;
- building, making, modelling – using captured data and digital tools;
- sharing – captured data, digital products of building and modelling;
- testing – the products built, against others’ products, others’ comments or real physical environments;
- adapting – the products developed, in light of feedback from tests or comments; and
- reflecting – guided by digital collaborative software, using shared products, test results, and comments

Geometry of mobile devices: For many years, mobile learning proponents looked for the convergence of mobile learning with handheld technologies resulting in a basic generic mobile platform with extra learning functionalities. This might include camera and other data capture, media player capacity, and location awareness using, for example, global positioning systems (GPS). This has arrived already. The hardware manufacturers and vendors treat their markets as highly segmented and differentiated due to the nature of the hardware itself. In desktop PCs, functionality and connectivity can be added or subtracted by simply adding and subtracting internal components. In laptops, external slots and ports provide extra functionalities. Even a small palmtop computer may have two slots. Mobile technologies are monolithic, meaning they have only the functionalities for which they are made. Manufacturers cannot do variations on a basic chassis as per market situations. Hence, we cannot compare mobile learning with e-learning which was built upon a PC platform.