

Towards a Theory of Socio-Technical Interactions

Ravi K. Vatrapsu

Center for Applied ICT (CAICT), Copenhagen Business School
Howitzvej 60, 2.floor, Frederiksberg, 2000, Denmark
[vatrapu@cbs.dk](mailto:vatrapsu@cbs.dk)

Abstract. Technology enhanced learning environments are characterized by socio-technical interactions. Socio-technical interactions involve individuals interacting with (a) *technologies*, and (b) *other individuals*. These two critical aspects of socio-technical interactions in technology enhanced learning environments are theoretically conceived as (a) *appropriation of socio-technical affordances* and (b) *structures and functions of technological intersubjectivity*. Briefly, socio-technical affordances are action-taking possibilities and meaning-making opportunities in an actor-environment system with reference to actor competencies and technical capabilities of the socio-technical system. Drawing from ecological psychology, formal definitions of socio-technical affordances and the appropriation of affordances are offered. Technological intersubjectivity (TI) refers to a technology supported interactional social relationship between two or more actors. Drawing from social philosophy, a definition of TI is offered. Implications for technology enhanced learning environments are discussed.

Keywords: apperception, perception, and appropriation of affordances, technological intersubjectivity, socio-technical systems, technology enhanced learning, computer supported collaborative learning, comparative informatics.

1 Introduction

There are two interrelated aspects of interactions in designing, developing, using, and evaluating technology enhanced learning (TEL) systems: (i) interacting with technologies and (ii) interacting with others such as peers and teachers. These two interactional aspects are mutually interdependent and are termed socio-technical interactions. Despite their critical centrality, socio-technical interactions in technology enhanced learning in general have not received necessary and sufficient theoretical consideration. This paper attempts to address this theoretical lacuna and hopes to jumpstart an empirically informed theoretical discussion on socio-technical interactions. As such, this theoretical project is not merely about Human Computer Interaction (HCI) – i.e., *interacting with technology* – it is also about technological intersubjectivity (TI) – i.e., *interacting with people via technology*.

2 Theoretical Framework

2.1 Affordances

The notion of affordance was introduced by J. J. Gibson [1]. Gibson was primarily concerned with providing an ecologically grounded explanation to visual perception. The ontological foundations of the notion of affordances are materialist and dynamicist [2]. Turvey [2, p. 180] citing Lombardo [3] identifies “*the principle of reciprocity—distinguishable yet mutually supportive realities*” as the central insight of Gibson’s ecological psychology of visual perception. This principle of reciprocity is highly relevant to technology supported collaboration as multiple individuals each with a specific subjectivity and identity shape mutually supportive interactional realities. The ecological approach is dynamicist but not dialectical and processual, holding that “*everything changes in some respects, but not in all respects*” [2, p. 175]. Drawing upon foundational work in ecological psychology on the formal definition of affordances [2, 4], the following definition of *socio-technical affordance* is provided. Narrative expositions follow the definition.

2.1.1 Definition of Socio-Technical Affordance

Let $Wpqr$ (e.g., person-sending-email-to-another-person system) = (Tp, Sq, Or) be composed of different things T (e.g., concept-mapping technology); S (e.g., concept-map node creator) and O (e.g., concept-map node receiving partner). Let p be a property of technology T ; q be a property of subject S and r be a property of other O . The relation between p , q and r , $p/q/r$, defines a higher order property (i.e., a property of the socio-technical system), a . Then a is said to be a socio-technical affordance of $Wpqr$ if and only if

- (i) $Wpqr = (Tp, Sq, Or)$ possesses a
- (ii) Neither $T, S, O, (T, S), (T, O), (S, O)$ possesses a

The formal definition of socio-technical affordance presented above is for the minimal situation of dyadic interaction in technology supported interactional environments. For a social situation involving n distinct social actors, an n -tuple would characterize the system. This formalism can be read as an activity system of subject, object and tools [5]. Relating the definition to Latour’s actor-network theory [6], both actors and “actants” are implicated in the notion of socio-technical affordances. The formal definition of socio-technical affordance captures the two facets of interaction in socio-technical systems: (1) interacting with technology and (2) interacting with other persons (technological intersubjectivity to be discussed later). It is important to realize that affordances are action-taking possibilities and meaning-making opportunities in actual situations in an actor-environment system relative to actor competencies and technology capabilities. Norman’s [7] gulf of execution and gulf of evaluation can be read as gulfs in the perception of action-taking possibilities and meaning-making opportunities respectively. Socio-technical affordances are not things or widgets or features or functionalities. This category conflation has been the source of much confusion in the HCI design community [8]. Socio-technical affordances are the relational properties in particular situations of a

specific user-technology system. By virtue of being relational properties with reference to an actor, socio-technical affordances can be termed relative to the actor and/or the technology, but relativity is not subjectivity. In that sense, affordances are not subjective properties. Affordances are neither arbitrary properties nor are they socially constructed [9]. Affordances are relational through and through, as they are the informational structure to be perceived in ambient arrays of the actor-environment system. The next section presents a brief discussion of the notion of “appropriation of affordances”.

2.2 Appropriation of Affordances

Cognition in the ecological psychology sense has been articulated as the “*cooperative appropriation of affordances*” [10, p. 135]. After Rogoff and Lave [11], “*cognition is something one uses, not something one has*”. In my reading of Gibson [1], the notion of affordance simultaneously specifies the two concurrent levels of meaning and action. *Affordance is a meaning-making opportunity and simultaneously an action-taking possibility in an actor-environment system in a particular situation.* Although the perception of affordances can be accounted on ecological grounds, the perception of events cannot be accounted on strictly ecological ontological grounds [12]. The perception of events has interactional consequences in technology supported collaboration. It is here that Gibson’s rejection of a role for higher order cognitive processes is problematic. Social interactional consequences from an individual’s perception of affordances are influenced by a prospective projection into the future as well as a socio-psychological imagination of the other. Adapting Stoffregen’s discussion of behavior [4, p.125], appropriation is “*what happens at the conjunction of complementary affordances and intentions or goals*”. Based on Stoffregen’s definition of behavior [4], the following definition is offered for appropriation of affordances.

2.2.1 Definition of Appropriation of Affordances

Let $Wpqr$ (e.g., person-sending-email-to-another-person system) = $c(a, i)$ be composed of different affordances, a (e.g., e , the opportunity to compose email, f , the opportunity to forward email, g , the opportunity to solve a science problem); and complementary intentions, i (e.g., h , the intention to send email, j , the intention forward email, k , the intention to solve a science problem), where both affordances and intentions are properties of the socio-technical system.

A given appropriation b (e.g., sending email) will occur if and only if (and when) an affordance (e.g., e) and its complementary intention (e.g., h) co-occur at the same point in the space–time continuum, where c is a cultural-cognitive choice function.

Unlike orthodox cognitivist views of the representational nature of human cognition that posits “copying” the external world, the cultural cognitive conception of socio-technical affordances and their appropriation views interaction as “coping” with the contingencies of the external world [13]. Interactions in socio-technical environments are a dynamic interplay between ecological information as embodied in artifacts and individual interpretation grounded in cognitive schemas. The essential mediation of all interaction is the central insight of socio-cultural theories of the mind

[14]. The conception of interaction as being mutually “accountable” and systematic are the critical insights of ethnomethodology [15] and conversational analysis [16]. Accordingly, the cultural-cognitive choice function c represents the cultural-cognitive mediation of interaction. Interactions in socio-technical systems are conceived as the appropriation of socio-technical affordances. Even if socio-technical affordances are to be directly perceived, their appropriation is still influenced by the cultural cognition of social actors. This renders the concept of affordance ecologically cognitive. The notion of technological intersubjectivity (TI) is discussed next. TI addresses the second aspect of socio-technical interactions in technology enhanced learning environments: how participants relate to and form impressions and opinions of each other during and after technology supported interactions.

2.3 Technological Intersubjectivity

Intersubjectivity is the key presupposition underlying human social interaction [17]. Human beings are not only functional communicators but also hermeneutic actors. Technological intersubjectivity is an emergent resulting from a technology supported self–other social relationship. In technological intersubjectivity, technology mediation can sometimes (but not necessarily always) disappear like in Clarke’s [18] third law of technology.

2.3.1 Definition of Technological Intersubjectivity

Technological intersubjectivity (TI) refers to a technology supported interactional relationship between two or more participants. TI emerges from a dynamic interplay between the technological relationship of participants with artifacts and their social relationship with others.

Information and Communication Technologies (ICT) and the Internet have changed our social relations with others and objects in fundamental ways that transcend technology mediation. Our psychological perception and phenomenological relation with others is changed fundamentally by the advances in information and communication technologies and social software. Our interactions with others and objects are increasingly informed by the logic of technology, hence technological intersubjectivity. (Note that natural language is the bedrock of TI). Technological intersubjectivity deals with the ICT enabled capabilities to **place-shift** (i.e., to be physically embodied in one physical space but to be able to virtually embodied in a different place) and the ability to **time-shift** (i.e., to be able to refer back to earlier interactions or to be able to defer forward interactions).

3 Discussion

The rethinking of the productive notion of affordances can help inform the design of TEL systems. The concept of affordance has been much used, misused, and abused in fields of human computer interaction [8] as well as in the learning sciences. In my opinion, most current usages of the term affordance are far removed from its

ecological origins and subsequent developments in ecological psychology. In many ways, the concept of affordance had been subjected to “conceptual stretching” by uncritical conflation with “technology features”. By returning the concept of affordance to its ecological roots and following its intellectual trajectory since Gibson’s seminal contribution, this theoretical framework rethinks affordances as socio-technical action taking possibilities and meaning making opportunities in an actor-environment socio-technical system relative to actor competencies and technology capabilities. This allows us TEL researchers and practitioners to critically engage with design and evaluation of learning technologies by concentrating on all four aspects: (a) action taking possibilities, (b) meaning making opportunities provided by intended design or creative appropriation, (c) how these are relative to learner competencies in terms of digital literacy, domain-specific knowledge, motivation, critical thinking competencies, and (d) finally the pedagogically innovative technological capabilities built into the TEL system.

The definition and discussion of the concept of appropriation of affordance indicates that learners situated in TEL environments might choose to appropriate culturally relevant (or appropriate) affordances. That is, context-sensitive and situation-bounded embodied actions of individual learners engaged in TEL environments will be influenced by not only the micro-genetic unfolding interactional contingencies but also by the macro-structural cultural concerns and metacognitive functions [19-21]. This allows for a richer conception, instrumentation, and analysis of interactional data from the TEL environments [see 22, for a description of a design framework of usability, sociability, and learnability].

The concept of technological intersubjectivity (TI) goes beyond the traditional HCI notions (such as presence and connected presence) and the humanities’ notions (such as networked individualism, information subject) by bringing together both psychological and phenomenological aspects of technology supported social interactions [23]. This provides for a broader and deeper understanding of the new generation of learners that are increasingly growing up with pervasive and ubiquitous information and communication technologies and other computational devices and gadgets (such as the so-called millennials and digital natives). One of the prime arguments for TEL has been that in a world of constant connectivity and near ubiquity of ICTs, technologies must be leveraged pedagogically. However, as pointed earlier, there hasn’t been theoretical work that sought to bring together these macro-sociological, technological, and pedagogical trends and aspirations together into a theoretically coherent framework that can be empirically evaluated. Hopefully, these efforts will jumpstart an empirically informed theoretical discussion on socio-technical interactions in TEL.

Acknowledgments

Special thanks to Dan Suthers, Scott Robertson, Marie Iding, Marc Le Pape, Pat Gilbert, Nathan Dwyer, Richard Medina and anonymous reviewers for constructive feedback on an earlier version of these ideas.

References

1. Gibson, J.J.: The ecological approach to visual perception. Houghton Mifflin, Boston (1979)
2. Turvey, M.T.: Affordances and Prospective Control: An Outline of the Ontology. *Ecological Psychology* **4** (1992) 173-187
3. Lombardo, T.J.: The reciprocity of perceiver and environment: The evolution of James J. Gibson's ecological psychology. L. Erlbaum Associates, Hillsdale, NJ (1987)
4. Stoffregen, T.A.: Affordances as Properties of the Animal-Environment System. *Ecological Psychology* **15** (2003) 115-134
5. Kaptelinin, V., Nardi, B.A.: *Acting with Technology: Activity Theory and Interaction Design*. MIT Press (2006)
6. Latour, B.: *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press (2005)
7. Norman, D.: *The design of everyday things*. Doubleday, New York (1990)
8. Torenvliet, G.: We can't afford it!: the devaluation of a usability term. *interactions* **10** (2003) 12-17
9. Hacking, I.: *The Social Construction of What?* Harvard University Press Cambridge, Mass (1999)
10. Reed, E.S.: Cognition as the Cooperative Appropriation of Affordances. *Ecological Psychology* **3** (1991) 135-158
11. Rogoff, B., Lave, J.: *Everyday Cognition: Its Development in Social Context*. Harvard University Press, Cambridge, MA (1984)
12. Stoffregen, T.A.: Affordances and Events. *Ecological Psychology* **12** (2000) 1-27
13. Blumer, H.: *Symbolic Interactionism: Perspective and Method*. Prentice Hall (1969)
14. Wertsch, J.: *Vygotsky and the social formation of mind*. Harvard University Press, Cambridge, MA, USA (1985)
15. Garfinkel, H.: *Studies in Ethnomethodology*. Prentice-Hall, Englewood Cliffs, NJ (1967)
16. Sacks, H., Schegloff, E.A., Jefferson, G.: A Simplest Systematics for the Organization of Turn-Taking for Conversation. *Language* **50** (1974) 696-735
17. Crossley, N.: *Intersubjectivity: The Fabric of Social Becoming*. Sage, London (1996)
18. Clarke, A.C.: *Profiles of the future: an inquiry into the limits of the possible*. Harper & Row (1962)
19. Vatrappu, R.: Cultural Considerations in Computer Supported Collaborative Learning. *Research and Practice in Technology Enhanced Learning* **3** (2008) 159-201
20. Vatrappu, R.: *Technological Intersubjectivity and Appropriation of Affordances in Computer Supported Collaboration*. Communication and Information Sciences, Vol. PhD. University of Hawaii at Manoa, Honolulu: Available at <http://lilt.ics.hawaii.edu/~vatrapu/docs/Vatrapu-Dissertation.pdf> (2007) 538
21. Vatrappu, R., Suthers, D.: Culture and Computers: A Review of the Concept of Culture and Implications for Intercultural Collaborative Online Learning. In: Ishida, T., Fussell, S.R., Vossen, P.T.J.M. (eds.): *Intercultural Collaboration I : Lecture Notes in Computer Science*. Springer-Verlag (2007) 260-275
22. Vatrappu, R., Suthers, D., Medina, R.: Usability, Sociability, and Learnability: A CSCL Design Evaluation Framework. *Proceedings of the 16th International Conference on Computers in Education (ICCE 2008)* (2008) (CD-ROM)
23. Vatrappu, R., Suthers, D.: Technological Intersubjectivity in Computer Supported Intercultural Collaboration. *Proceeding of the 2009 international Workshop on intercultural Collaboration* (Palo Alto, California, USA, February 20 - 21, 2009). IWIC '09. ACM, New York, NY (2009) 155-164