

Original Paper

Developing a Framework for Conceptualizing Affordances of Technology in Education

Sijia Xue^{1*} & Zhao Han¹

¹ The College of Teacher Education, Southwest University, Chongqing, China

* Sijia Xue, E-mail: xsj2021@swu.edu.cn

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Abstract

The term affordance has been defined and interpreted diversely in different domains over decades. However, little attention has been paid to the definition of affordances in the domain of education. With the increasing application of various technologies in education, the conceptualization of educational affordances of technology is essential to fully explore the educational potential of technology and better understand how learning could be supported with the affordances of technology. This paper compares the existing literature concerning affordance theories and defines affordances in the domain of education. A framework for conceptualizing educational affordances of technology has been articulated based on the literature to interpret the notion from three aspects: technology, user, and environment. The framework would not only help practitioners to understand the certain capability of technology to provide an effective mediating tool for educational activities but also assist researchers to study the educational affordances of technology from new dimensions.

Keywords

educational affordances, technology, user, environment

1. Introduction

Since the term ‘*affordance*’ was first introduced in the field of ecological psychology by psychologist J. J. Gibson (1977, 1979), arguments about its definition and interpretation continue. Generally, views on the notion of affordance can be categorized into three groups, namely taking affordances as (a) relationships or relational properties (Gibson, 1977, 1979; Kirlik et al., 1993), (b) perceived properties (Baecker et al., 1995; Norman, 1988, 1999), and (c) interactions (Gaver, 1991; Mark et al., 1990). While different groups of theorists hold their positions on the concept, affordances are a multidimensional and multidisciplinary concept, and thus could be interpreted from different

perspectives (Evans et al., 2017). However, little attention has been paid to affordance theories for educational research. To date, there is no explicit definition of affordance in the domain of education. With the advance and increasing application of technology in education, it is essential to conceptualize educational affordances of technology to make them specific for educators and better serve educational activities. To this end, this paper compares the definitions and categories regarding affordance based on the existing literature and attempts to define the notion in the domain of education. A framework for conceptualizing educational affordances of technology is proposed based on the extant literature on affordance theories.

2. Literature review

2.1 Affordances as Relationships

Gibson (1979) defines the affordances of the environment as “what it offers the animal, what it provides or furnishes, either for good or ill” (p. 127). Furthermore, he explains “an affordance refers to both the environment and the animal and implies the complementarity of the animal and the environment” (p. 127). Similarly, Kirlik et al. (1993) define affordance as “a relationship between properties of the environment and properties of an organism’s action capabilities” (p. 934). According to Gibson (1979), affordances mean the actionable properties between the environment and an observer, which are “neither objective properties nor subjective properties or may be both” (p. 3). From Gibson’s perspective, affordances are relationships and exist naturally, which means that they do not have to be visible, known, or desirable (Norman, 1999) and they are independent of the observer’s experiences, knowledge, culture, or ability to perceive (McGrenere & Ho, 2000). The affordances of something do not alter with the changes in the observer’s needs as what an object can provide is defined by its nature rather than by an observer’s needs (Gibson, 1977, 1979).

However, affordance can be specified by information (Gibson, 1979) and there is information that reveals affordances (Turvey, 1992). The information, according to Gibson (1979), also points to two ways. On the one hand, it specifies the utilities of the environment; on the other hand, it specifies the observer himself. These two ways are accompanied by each other to specify an affordance in that the awareness of the world and one’s complementary relations to the world are inseparable (Gibson, 1979). Take a mobile social media app WeChat for example, the instant messaging feature of the app allows a teacher to answer a question about an event from a student. As the same question is being asked repeatedly by more students, the teacher may consider how she/he could address the issue once and for all. Then the teacher may send a message to a saved class group to inform other students of the event. As a result, the affordance of notification of mobile social media is perceived. To put it another way, based on the relationship view, affordances are determined by both the environment and the action capabilities of the observer, and thus are relational properties (Kaptelinin, 2014). However, Reed (1996) argues that affordance is only a relation when it is perceived and used by an animal that comes into a

relationship with the relevant feature of its environment. Although affordances are available to come into a relationship with animals, this need not occur (Reed, 1996).

2.2 Affordances as Perceived Properties

Affordances are also considered as “perceived properties” of an object that indicate how it can be utilized (Baecker et al., 1995, p. 1). This view was popularized by Norman (1988), who defines affordances as “the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (p. 9). Therefore, he stresses the importance of designs as the appearance of a device could provide critical clues required for its proper operation. Norman (1999) claims that affordances are dependent on the experience, knowledge, or culture of the user, and the ‘*affordance gap*’ occurs when the user does not understand the intended actions of the designed object because there are real affordances and perceived affordances. Thus, it is the designer who makes sure that the desired, relevant actions can be perceived by an actor because affordances indicate “the range of possible activities” but are useless if they are not readily perceivable (Norman, 1999, p. 41). Again, take the use of WeChat for instance, the instant messaging feature of the app allows a teacher to utilize it to notify an event. However, she/he may also use it to evaluate students’ work or continue to discuss a topic after class. These possible activities are not only determined by the features of the app but also depend on the teacher’s desires as well as his or her teaching experience with the app.

Besides, Norman introduced another concept of ‘*signifier*’, which refers to “any mark or sound, any perceivable indicator that communicates appropriate behavior to a person” (Norman, 2013, p. 14), to further emphasize the importance of design for perceiving affordances. While Norman’s conceptualization of affordance became popular in the design community (Bucher & Helmond, 2018), the question of how to devise or select the right signifiers remains open (Kaptelinin, 2014). At the same time, such a view of considering affordances as perceived properties is challenged by other scholars who argue that it confuses the affordances of an artifact with the information which specifies the affordances (Flach, 1995).

2.3 Affordances as Interactions

According to Mark et al. (1990), affordances are “those actions which the particular arrangement of environmental substances and surfaces will support” (cited in Amant, 1998, p. 135). Gaver (1991) puts forward the notion that “affordances are properties of the world defined with respect to people’s interaction with it” (p. 80). He particularly investigated the affordances of technologies, focusing on the strengths and weaknesses of technologies regarding the possibilities they provide the users for using them and deeming the concept of affordances as a useful tool for user-oriented analyses of technologies. According to Gaver (1991), when it comes to affordances we should “focus not on technologies or users alone, but on the fundamental interactions between the two” (p. 83). He argues that affordances can be perceptible but must be inferred from other information when they do not manifest themselves. He proposes the concepts of ‘*sequential affordances*’ and ‘*nested affordances*’ for further interpreting

the notion of affordance from the dimensions of time and space (Gaver, 1991). The former refers to situations in which acting upon a perceptible affordance generates information suggesting new affordances such that affordances can be revealed over time; whereas the latter means affordances grouped in space in which one affordance serves as context for another one. For instance, the affordance of sharing a saved file via WeChat can be perceived as an affordance of saving files that is nested within an affordance of resource sharing. Therefore, “nested affordance offers itself both as an end in itself, and as a means towards realizing another affordance” (Gaver, 1991, p. 82). As a teacher shares multiple forms of teaching and learning materials with students through the app, a sequential pedagogical affordance of WeChat may emerge such as supporting flipped classroom teaching.

Moreover, Gaver attaches importance to active exploration in identifying and using affordances of complex objects (Kaptelinin, 2014) as affordances are not only passively perceived but explored (Gaver, 1991). He also puts forward the concept of ‘*false affordance*’ to describe a nonexistent affordance indicated by information upon which an actor may mistakenly try to act (Gaver, 1991). However, this term is considered to be problematic as “it is not the affordance that is false; rather, it is the information that is false” (McGrenere & Ho, 2000, p. 183). Although Gaver agrees with the Gibsonian view that affordances imply the complementarity of the actor and the acted-upon environment, he emphasizes more on the interaction between the two. Meanwhile, according to Gaver (1991), apart from ‘*perceptible affordances*’ that consist with Norman’s (1988, 1999) notion, there are also ‘*hidden affordances*’ that must be inferred from other evidence (p. 80).

3. A Framework for Conceptualizing Educational Affordances of Technology

3.1 Defining Affordances in the Domain of Education

To date, there are few definitions associated with affordances in the context of education. However, as technology provides critical opportunities for and exerts strong impacts on teaching and learning, it is essential to conceptualize the educational affordances of technology to better leverage them for educational ends. Some interpretations of educational affordances are mainly based on the original definition of affordances although it seems controversial and even ambiguous (McGrenere & Ho, 2000). By Norman’s sense of affordance, Kirschner (2002) defined educational affordances as “those characteristics of an artifact that determine if and how a particular learning behavior could be enacted within a given context” (p. 19). However, he claims that educational affordances could also refer to “the relationships between the properties of an educational intervention and the characteristics of the learner that enable particular kinds of learning by him or her” (p. 19). This point of view on affordance is more consistent with the Gibsonian definition. It can be noted that Kirschner focuses mainly on the characteristics of an object in a learning context corresponding with Norman’s (1988) perspectives on affordances. Even though he also mentions the relational properties from a Gibsonian stance, he does not explicate what an educational intervention means.

Affordances are opportunities for actions (Sanders, 1997). In terms of educational affordances, what can be accomplished by a teacher or a learner with the features of a technology tool or an environment should be centered. Therefore, based on the interpretation of affordances theorized by different scholars, educational affordances can be defined as opportunities for an educational activity that are determined and supported by perceived and actual features of a technology tool or an environment (Xue & Churchill, 2019). The educational activity includes any teaching and learning activity that takes place in an educational context. Environment refers to the space where an educational activity occurs such as an institute or an online forum. However, affordances are neither just a technology tool nor features of the technology as features are stable whereas affordances are dynamic, emerging from the relationship between the user, the technology, and its features (Evans et al., 2017). Hence, regarding educational affordances, what should be focused on is the interactivity between the user and the technology within a learning environment. Furthermore, an affordance has '*range*', which means individuals utilizing the same features of technology may accomplish different outcomes (Evans et al., 2017). Therefore, the interpretation of affordances is relative to a frame of reference (Turvey, 1992).

3.2 Conceptualizing Affordances of an Educational Technology

While no consent has been reached on the conceptual definition of affordance, it has resulted in the analytical value of the concept (Evans et al., 2017). As noted above, Gibson looks at utility by focusing on the basic features of an artifact in relation to the user whereas Norman focuses more on usability than on utility by emphasizing how an artifact is perceived (Kirschner et al., 2004). Although no explicit definition was provided by Norman (1999) about what perceived affordances mean, it was assumed to indicate a similar meaning to Gaver's (1991) false affordances (Kaptelinin, 2014). However, such a view conflicts with the Gibsonian definition in which there is no distinction between different affordances of an artifact (McGrenere & Ho, 2000). Further, Norman (1988) also deviates from Gibson in that the former believes that the interpretation of affordances is based on an actor's past knowledge and experience. By contrast, Gibson (1977, 1979) argues that affordances exist independently of the actor's experience and culture, no matter whether he possesses the ability to perceive (Kaptelinin, 2014). In other words, what Gibson highlights is the action capabilities of the observer whereas Norman stresses the perceptual and mental capabilities of the user (McGrenere & Ho, 2000). However, both scholars agree that the perception of an affordance depends on an actor's '*picking up*' the information that specifies the affordance (Kaptelinin, 2014) even though Gibson focuses on direct perception of affordances that requires no mediation or internal processing by an actor (McGrenere & Ho, 2000). Comparatively speaking, Gaver's (1991) view on affordances aligns with Gibson's (1977, 1979) original meaning of the notion in interpreting the relationship between affordances and perceptual information, which asserts that affordances are independent of perception but need to be perceived from perceptual information. However, this notion differentiates from Norman's (1988) interpretation that couples affordances with their perception (Kaptelinin, 2014).

Based on the comparison of different conceptualizations of affordance, this study argues similarly to Sanders (1997) that “affordances are opportunities for action in the environment of some animal” (p. 99). However, this study adds that three aspects should be considered when interpreting the affordances of technology in the domain of education, including technology, user, and environment (see Figure 1). To start with, the usability of a technology tool within an environment should be made clear to a user, which may be perceived based on either the user’s previous experiences and knowledge or external information (such as design) available for revealing the affordances of the technology. The user behaves under particular physical or sociocultural contexts with particular norms taking advantage of the utility of a technology tool to achieve individual goals. The actions of a user may be influenced by individual intentions and capabilities that vary from one to another. Real affordances can only be realized through the attunement of all these three aspects.

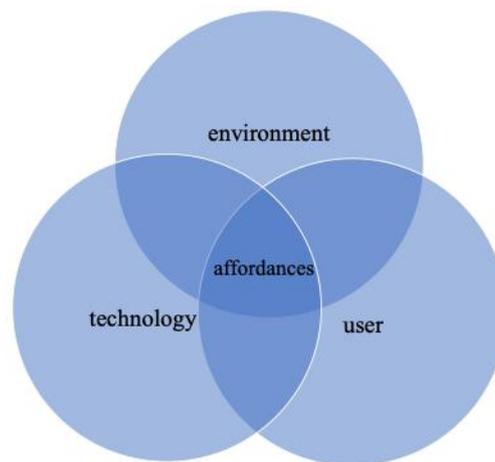


Figure 1. A Framework for Conceptualizing Educational Affordances of Technology

3.2.1 Technology

The first aspect that needs to be considered for conceptualizing the educational affordances of technology is the technology per se. Gibson (1977, 1979) assumes that all objects have a surface to reflect light, which is referred to as an ambient optic array, for animals to pick up the information that specifies affordances. Norman (1988) emphasizes the visibility of an object, which indicates “the mapping between intended actions and actual operations” (p. 8). It can be presumed that the properties of a technology tool within an educational environment to large extent determine what it could afford to a user and what a user could do with it. As Reed (1996) points out, objects of an environment can cause changes in the behavior of an animal for adaptation to that environment. Although it is speculated that all objects possess properties (Turvey, 1992), the affordances of an artifact do not necessarily come from inherent features of its materiality because affordances can also be designed into the artifact (Hutchby, 2001). For example, a screen-touch mobile phone may afford a different user experience than a keypad mobile phone does for learners of mobile learning. According to Hutchby (2001),

affordances are functional aspects that shape the action possibilities of a user in relation to a tool. Similarly, Markus and Silver (2008) also focus on what a specified user can do with a tool, particularly a technical tool, to accomplish his or her goals, which is defined as '*functional affordances*' (p. 622). Hence, the features of a technology tool may determine what it could afford for its users.

Norman (1988) claims that affordances indicate how an object could be operated. Therefore, he believes that the design of a tool is crucial for manifesting and perceiving its affordances. By contrast, McGrenere and Ho (2000) suggest that affordances should be separated from perception, to clearly distinguish the design of the utility of a tool (an affordance) from the design of usability (perceptual information specifying the affordance). According to McGrenere and Ho (2000), a useful design involves the right functions required for users to accomplish their work and achieve their goals; and a usable design contains information specifying affordances that allow for users' cultural conventions and knowledge. Again, take WeChat for example, the popularity of the app is not only due to its useful functions similar to those of other mobile social media apps but also for its usable design that considers the cultural context of its users, particularly those from mainland China. While different scholars view objects in relation to affordances from different angles, what they hold in common is that objects with particular properties within an environment are crucial for presenting, perceiving, and actualizing affordances. This is even more important in the human environment which is a selected and transformed environment, in which objects can be modified and constructed with special affordances to meet our needs (Reed, 1996). In the domain of education, a technology tool with particular features that is used in a specified teaching and learning context is also important for the realization of affordances for its users.

3.2.2 User

While Gibson (1977, 1979) emphasizes the contributions of a physical system to the actualization of interaction between the environment and an actor, he also talks about the action capabilities of the actor. Thus, properties of the user that contribute to the occurrence of the interaction should also be allowed for when conceptualizing affordances. The properties of a user have been termed as either *abilities* (Greeno, 1994), *effectivities* (Shaw et al., 1982; Turvey, 1992), or *aptitudes* (Snow, 1992), which are inherently relative to affordances. According to Greeno (1994), "an affordance relates attributes of something in the environment to an interactive activity by an agent who has some ability, and an ability relates attributes of an agent to an interactive activity with something in the environment that has some affordance. Neither an affordance nor an ability is specifiable in the absence of specifying the other" (p. 338). For Stoffregen (2003), the user aspect is an important part of the affordance notion and it is pointless to discuss affordances without considering to whom it refers. For example, the same mobile social media app may afford different things for a teacher from what it affords a student. Even teachers may use it in different ways for different purposes and needs. This is because users of an artifact may possess different *effectivity*, which refers to the "prediction, disposition, tendency, even bodily-embedded ability" to utilize an affordance (Sanders, 1997, p. 103).

Stoffregen (2003) suggests that affordances should be specific to animals with different effectivities. Likewise, Michaels (2003) maintains that “actions afforded by the environment depend on the actions in which an animal can engage” (p. 142). As he further explicates, the actualization of an affordance requires effectivity and the perception of an affordance is specific to the perceiver, which refers to the actor himself (Michaels, 2003). Kaptelinin (2014) denies Gibson’s view that affordances are independent of an actor’s general ability to perceive, arguing that the affordances of an object may change with the users’ perceptual capabilities. The perceptual activity of a user that is dynamic, interactive, and manipulative plays a vital role in the user’s total activity (Sanders, 1997). As a teacher grows from a novice user to an expert user of educational technology, not only the teacher’s abilities to use the technology may improve but also his or her perceptual capabilities of affordances. Therefore, when it comes to affordances, the users’ aspects such as their perception and effectiveness should be considered. As McGrenere and Ho (2000) claim, “the degree of an affordance exists relative to a particular user” (p. 186).

3.2.3 Environment

The third component for the conceptualization of educational affordances of technology is the environment in which the technology is used. In Gibsonian theory of affordance, there is only one world in which all animals live despite that we human animals have changed it to suit ourselves. Therefore, it is not correct to separate the cultural environment from the natural environment to distinguish the world of mental products from the world of material products (Gibson, 1979). This view has been challenged by other theorists (Greeno, 1994; Heft, 2003), who believe that the perception of affordances requires a cognitive process with inferences of norms and values. Costall (1995) disputes that the Gibsonian sense of affordance fails to explore the sociality of the material as nature has become artificial and social through various interrelated processes. Likewise, Sanders (1997) argues that the environment in which affordances manifest themselves to human beings is much more complex and thus an environment should encompass the whole realm of possible activity for an actor. As Heft (2003) explains, early experiences of encountering an object repeatedly in a uniform context may lead to considering it as possessing a fixed affordance, which is independent of any context. However, with the changes in the environment, affordance possibilities may also change and thus should be interpreted from sociocultural perspectives. For example, in an institution with conservative teaching concepts and policies, mobile devices may never be allowed in classrooms where even the Internet connection is not available. By contrast, in an institution in which innovative teaching approaches are advocated, not only the use of mobile technologies will be encouraged but also free wireless Internet access is offered. When a teacher changes his or her working place from the first institution to the second, he/she may identify more affordances of the same technology such as mobile social media for teaching and learning. Thus, the physical conditions as well as norms and values in a given environment affect the perception and realization of affordances.

Norman (1999) argues that what an actor can do and how he may behave with the affordances of an object may be affected by different types of constraints such as cultural constraints or conventions that are shared by a cultural group. For Gaver, affordances “exist not just for individual action, but for social interaction as well” (1996, p. 114). In light of this, Schmidt (2007) introduces the concept of social affordances developing the notion of affordances from the perspective of relations between human perceivers and the social environment. Therefore, although affordances are widely acknowledged as action possibilities offered by the environment, specific interpretations of this general understanding should be based on different contexts (Kaptelinin, 2014). As Zheng and Yu (2016) point out, “affordances are relational and situated, and contingent upon the purpose of human agency as well as historical and socio-institutional settings” (p. 292). Hence, the adoption of affordances should account for the characteristics of the environment in which potential actions take place. These characteristics are not constrained only to physical components, but may also include social, cultural, and even conceptual components.

4. Implications

The proposed framework has two implications. On the one hand, the framework conceptualizes the educational affordances of technology from the perspectives of technology, user, and environment such that practitioners could consider these aspects while utilizing technology for educational purposes to better understand how learning could be supported with the affordances of technology. Specifically, the features of the technology including both its usability and utility should be allowed first to make it better accommodate educational needs. At the same time, the shortcomings of technology such as the privacy issues involved in the utilization of social media for teaching and learning should also be considered as these issues may affect the acceptance and use of social media by both students and teachers for educational aims (Nicolai et al., 2017). Thus, specific features of technology should be noted and appropriated when educators intend to adopt the affordances of technology to achieve their personal goals in teaching practice. Moreover, the effectivity of the user should be considered, which may refer to the capabilities as well as experiences of using the technology of a teacher or a learner. These features of a user may affect the degree of affordance. For instance, the pedagogical knowledge regarding technology integration of a teacher may affect his or her designs of student-centered technology-based learning. Furthermore, various components of the environment in which the technology is used should be taken into consideration as affordances are context-based. For example, different policies, as well as conditions for technology integration in different institutions can provide different environments for teachers to utilize educational technology in their teaching practice. As Brown (2012) points out, teachers’ perceptions of technology are specific to the contexts in which they work. Only when these aspects are coordinated can educational technology be employed as an effective mediating tool for learning activity. On the other hand, the framework proposed provides novel dimensions for educational research on affordances particularly when there is no explicit definition of

affordance in the domain of education. Future researchers could focus on the educational affordances of technology from these three aspects included in the framework and examine how these aspects interact with each other to impact the adoption of the affordances of technology.

5. Conclusion

To conclude, while no consent has been reached on the definition of affordance, the understanding of the notion needs to recognize the multidimensionality and relational nature of affordances. As Hutchby (2001) postulates, there exist different types of affordances. These affordances may be “interrelated or compounded on any given occasion of action” (p. 448). The conceptualization and adoption of educational affordances of a technology tool involve not only the properties of the technology but also the capabilities of the user. Besides, the physical and sociocultural components of the environment in which teaching and learning activities occur should also be allowed. However, any definition of affordance should be deemed tentative before it can be proved to be compatible with a general theory of direct perception (Stoffregen, 2003). Thus, empirical studies need to be conducted to examine how the framework proposed in this study can be used for understanding the affordances of educational technology in teaching practice.

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