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TECHNOLOGICAL, ORGANISATIONAL AND SOCIO-INTERACTIONAL AFFORDANCES IN SIMULATION-BASED COLLABORATIVE LEARNING

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Abstract

Analysis of the applicability of a learning technology requires an evaluation of how the affordances of the learning environment respond to users' needs. We examine affordances in a simulation-based collaborative learning environment from the learners' viewpoint. Our analysis focuses on three types of affordances: technological, organisational and socio-interactional. The findings show how teams of learners employ the different types of affordances in their collaborative tasks. In addition, our analysis illustrates the interdependent and interlinked nature of the affordances. We offer an analytical understanding of the dynamics among different kinds of affordances and show how they can be assessed to help educators better foster, facilitate and support the learning process and the use of affordances in computer-based learning environments.

Key words: Collaborative learning, Affordances, Simulation games, Computer-based learning

1. INTRODUCTION

The use of different learning technologies has rapidly increased on all educational fields, and along with it, the study of affordances has gained momentum. The concept 'affordance' was first advanced by Gibson (1979, cited in Salomon, 1993), who used it to refer to the functional properties that determine the possible utility of an object or an environment. Affordances can be defined as action possibilities latent in the object (the learning environment) and dependent on the capabilities of the agent (learners) (Antonenko, Dawson & Sahay, 2017). Affordances are more than just technical properties of an object, as they represent an action potential that needs to be met with the respective capabilities of the user. A chair represents an everyday case in point. A chair's affordance is its sit-ability, and that it can be used for that purpose by a person who wants and is able to sit. In the context of a digital learning environment, affordances include e.g. view-ability, read-ability and move-ability.

The technological aspects have for long dominated research on digital learning environments, and the socio-interactional and organisational aspects have received less attention. However, we find that it is mandatory to gauge the interplay of the three types of affordances in more detail and develop a better understanding of how digital learning environments can be designed and applied to empower students to utilise their full capacity and all available resources. In doing so, we also re-consider the notion of affordances as resources for computer-supported collaborative learning (CSCL) (Koschmann, 2012; Park & Song, 2015; Wang, Fang & Gu, 2020; Berthelsen & Tannert, 2020).

Analysis of the applicability and usefulness of a technology requires an evaluation of how the affordances of the technology respond to the users' needs and abilities (Antonenko et al., 2017). Some examples of the affordances of social software tools are connectivity and social rapport, and collaborative information discovery and sharing (McLoughlin & Lee, 2007). As an example of the first, technology-based environments support networks of people and facilitate connections between them. These kinds of environments are representatives of what Gee (2004) calls affinity spaces, where people acquire social and communicative skills, and at the same time become engaged in the participatory culture of the environment. In these spaces, learners engage in informal learning and in creative, expressive forms of

behaviour and identity seeking while developing a range of digital literacies. One cannot assume that just because social software entails certain affordances, that is all that is required for effective learning. Careful planning and a thorough understanding of the dynamics of these affordances are mandatory (McLoughlin & Lee, 2007; Ke, Pachman & Dai, 2020). An explicit approach to identifying technological affordances of e-learning tools and the affordance requirements of e-learning tasks should be used to scaffold the learning design process (Bower, 2008; Lin, Hou & Chang, 2020).

Traditionally, a socio-culturally oriented research perspective on computer-supported collaborative learning (CSCL) is closely associated with affordances (Moate, Hulse, Jahnke Owens, 2019). The focus is on group learning and the social context in which collaboration emerges. This presentation is in line with the notion from Arvaja, Salovaara, Häkkinen and Järvelä (2007), who viewed collaboration as shared knowledge construction, where participants not only cumulatively share knowledge, but where the knowledge construction is jointly built on others' ideas and thoughts (see also Mercer, 2010). The aim is that the activities of the collaborative group are not a collection of individual activities but rather interdependent group processes (e.g. interactions) pursuing a shared conception of a problem (Roschelle & Teasley, 1995; Lin et al., 2020). Furthermore, these shared processes are mediated by the community and social context in which the group work takes place (Stahl, 2012; Stahl & Hakkarainen, 2020).

We argue that the continually increasing amount of resources allocated to the development of educational simulations by educational institutions calls for in-depth studies of affordances. We need to understand how simulations and games can be designed in pedagogically sound ways to empower users to acknowledge the affordances embedded in these environments. Furthermore, we believe that the use students make of online learning environments will very much depend on their attitudes towards these environments and on the perceived affordances. This is also the motivation of our study.

2. AFFORDANCES

Research of affordances is interdisciplinary, and while it originates from Ecological Psychology (Gibson, 1979), it has found application in Education (Kirschner, 2002; Kreijns, Kirschner, & Jochems, 2003; Xue & Churchill, 2019; Wang, Fang & Gu, 2020; Berthelsen & Tannert, 2020), Information Systems (Majchrzak & Markus, 2012), Organisation Studies and Management disciplines (Pozzi, Pigni & Vitari, 2013; Baralou & Tsoukas, 2015).

We examine the affordances of a digital learning environment perceived and utilised by dispersed student teams. The novelty of our study lies in incorporating not only the technological aspects of affordances in our analysis but also the socio-interactional and organisational dimensions in our treatment. The use of socio-interactional and organisational affordances plays a key role in how these technologies can be made to work.

As learners engage in a technology-based learning environment, they perceive 'affordances' of objects, defined as the 'acts or behaviors that are afforded or permitted by an object, place, or event' (Michaels & Carello, 1981, p. 17). Affordances are, thus, different from the properties of objects. Affordances are the perceptions of what we can do with the properties of objects. Although affordances can be perceived as preconditions for an activity, they do not imply that a specific activity will occur (Greeno, 1994; Dohn, 2009). As affordances are merely potentials for action, benefitting from them requires that they are triggered (Volkoff & Strong, 2013) or actualised (Strong, Johnson. Tulu, Trudel, Volkoff, et al. 2014). Pozzi et al. (2013) recognised four steps in the application of affordances: an affordance exists, the user perceives the affordance, the user actualises the affordance and the actualisation leads to the affordance effect. In our study, we focus predominantly on affordances as the doings in which the actors engage. In doing so, we

follow Majchrzak and Markus (2012), who noted that affordances are best phrased in terms of action verbs or gerunds, such as 'share knowledge' or 'information sharing' and involve technological, organisational and social dimensions. McLoughlin and Lee's (2007) list of potential sources of affordances in Pedagogy 2.0 environments (based on the technological possibilities of Web 2.0) allows us to identify various dimensions that create possibilities for affordances in the simulation gaming context:

- Content: Simulation gaming-based learning is learner-centred in that the students use the information in the simulation environment to generate analysis and decisions by communicating and collaborating with peers. Thus, students create, share and revise ideas and turn them into actions in the environment. The environment is open to negotiation, and learner input is often inter-disciplinary in nature and blends formal and informal learning.
- Communication: Communication is open, peer-to-peer and multi-faceted, and uses multiple media types to achieve relevance and clarity.
- Process: Situated, reflective, integrated thinking processes are iterative, dynamic and enquiry-based. Learning tasks can be authentic in nature, learner-driven and designed to enhance experiential learning and enable multiple perspectives.
- Resources: Multiple informal and formal sources that are media-rich and often global in reach.
- Scaffolds: Support for students comes from a network of peers, teachers, and the learning community.

In our case simulation, the affordances of virtual gaming include the fidelity of a real-world business environment, the ability of remote team members to talk face-to-face with each other in real-time, and the illustration of causal business operations as dynamic processes. These affordances foster the development of a participatory culture with genuine involvement and communication in which the participants are socially connected with one another. Virtual simulation gaming makes use of the affordances of the software tools that enable connectivity, communication, participation and the development of dynamic communities of learning. Affordances in these kinds of environments may stem from many sources. Simulation games can be used to facilitate:

- experiential learning tasks that would be impractical or impossible to undertake in the real world,
- learning tasks that lead to increased intrinsic motivation and engagement,
- learning tasks that lead to improved transfer of knowledge and skills to real situations through contextualisation of learning, and
- tasks that lead to richer and/or more effective collaborative learning than is possible in other learning environments.

Next, we discuss the technological and socio-interactional affordances in light of the research literature.

2.1 Technological affordances

The concept of technology affordance refers to an action potential – what an individual or organisation with a particular purpose can do with technology (Majchrzak & Markus, 2012). Technological affordances are not isolated from other issues present in the learning situation and environment. Technologies do not directly cause learning to occur but can afford certain learning tasks that may result in learning or give rise to certain learning benefits. Selwyn (2012) argued that there cannot be a predetermined outcome to the implementation of technologies. Instead, technologies are subjected continually to a series of complex interactions and negotiations with the social and cultural contexts into which they emerge. Steffens, Bannan, Dalgarno, Bartolomé, et al (2015) agreed with Selwyn's (2012), stating that techno-centrism focuses too much on the objective capabilities of the technology and too little on the social and contextual

aspects of the learning situation. The principal advantage of the more socially nuanced theoretical approach is its capacity for developing a more socially grounded understanding of the realities of educational technology (Selwyn, 2012).

The issue of categorising technological affordances and aligning them with the abilities they afford the users of the technology is seen as essential for analysing the potential utility of educational technologies (Antonenko et al., 2017). Taxonomies and categorisations of affordances in technology-supported learning environments include technological affordances such as accessibility, speed of change, diversity, communication and collaboration, reflexivity, multi-modality and non-linearity, risk, fragility and uncertainty, immediacy, monopolisation and surveillance (Conole & Dyke, 2004); multimodal auditive, linguistic, visual, gestural and spatial affordances presented by composition software (Gall & Breeze, 2005); accessibility, entertainment exchange, information repositories in asynchronous video conferencing tools (Krauskopf, Zahn, & Hesse, 2012); and multimedia access and collection, communication, and representation of thought and knowledge in handheld devices (Song, 2011). Alahuhta, Nordbäck, Sivunen & Surakka (2014) identified affordances related to enhancing team creativity in virtual worlds. The identified affordances included avatars as graphic self-representations, changing the frame of reference, co-presence, immersion, multimodality, rich visual information, simulation capabilities and supporting tools for creative work. The above taxonomies have some overlap, but they remain context-specific and are therefore of marginal assistance in the pursuit for a more robust tool for analysing technological affordances in collaborative computer-based learning environments. In an attempt to describe affordances based on their physical characteristics and emphasise their functionality, Bower (2008) proposed a methodology for matching the affordance requirements of learning tasks with the technological affordances of ICT tools. Bower's (2008) affordance classification system includes 11 different areas of technological affordances (see Table 1). In this paper, we focus predominantly on the actual action possibilities perceived and utilised by the users (usability). Moreover, we analyse the dynamics of technological, organisational and socio-interactional affordances and their combinations as reported by the learners. Expanding our treatment from a predominantly technological view allows for an appreciation of the interplay between and among the various types of affordances.

2.2 Organisational affordances

When analysing the affordances of technological environments, we can and should go beyond the technologies. Scarantino (2003) categorised affordances as being mental, basic physical or non-basic physical. Hartson (2003) recognised cognitive affordances, physical affordances, sensory affordances and functional affordances. However, Kennewell (2001) noted that ICT is just one component of the setting, although it is particularly important because of the special features it can bring to learning, such as access to information and immediate feedback to the learner.

An important aspect particularly in collaborative learning environments is the organisation and coordination of the learners' joint activities. In the context of computer-based learning to organise, collaboration can be defined as a set of activities related to collaborating, discussing or asking questions about the learning tasks (Lampe, Wohn, Vitak & Wash, 2011). In digital and virtual teamwork, organising is an elementary activity which is needed to ensure that collaboration proceeds smoothly and effectively (Hossain & Wigand, 2004; Hernández-Sellés, Muñoz-Carril & González-Sanmamed, 2019). Thus, the way the teamwork is organised has a fundamental influence on what is learned during the exercise. At first glance, organisational affordances may seem a fuzzy category, as it is sometimes difficult to discern which actions can be understood as organising. In our context, organising is regarded as assembling the available resources to attain order, structure and organisational objectives (BusinessDictionary, 2019). In addition to

assembling resources to attain certain objectives, organisational affordances also entail managing the process and the participants, which is accomplished through communication; thus, organisational and socio-interactional affordances are closely linked and intertwined. The organisational affordances may therefore guide students in organising their personal and team efforts and actions and help them achieve the goals of the course. Organisational affordances may also steer students in their choices of technologies and communication tools.

2.3 Socio-interactional affordances

Social interaction in CSCL environments needs to be purposefully facilitated via technological solutions that allow for synchronous and/or asynchronous communication between the learners. Kreijns, Kirschner and Vermeulen (2013) found that the properties of the CSCL environment function as facilitators for the learners' social interaction and, thus, work as socio-interactional devices. In CSCL environments, collaboration and learning depend largely on interaction, that is, on written and oral communication, information sharing and knowledge creation.

It is generally assumed that participants in a CSCL environment will interact because the environment makes it possible (Kreijns, Kirschner & Jochems, 2003). However, the nature of CSCL environments makes them more salient and critical in respect to social interaction than face-to-face settings. Computer-based collaborative learning environments depend on technology for mediating interactions among students and teachers, whereas face-to-face learning situations provide an unrestrained social context and direct opportunities for interaction (Weidlich & Bastiaens, 2019). The forms of interaction in groups have an impact on mutual knowledge construction and often play a central role in how successful the groups are in their collaborative task (Oliveira, Tinoca & Pereira, 2011).

Computer-mediated communication systems embedded in CSCL environments prompt what kind of messages are exchanged and how these messages are interpreted (Norman, 1999; Jeong & Hmelo-Silver, 2016). Many CSCL environments are predominantly used for task execution, except for social, off-task communication, which has been found essential for building trust among the team. This tendency is further reinforced by the fact that group members often are unacquainted with each other and have no common history (Kreijns et al., 2003). Thus, many socio-interactional elements affect communication in CSCL environments that need to be taken into account.

Socio-interactional affordances comprise the various synchronous and asynchronous forms of communication: emailing, chatting on Skype or Facebook, and online talk using Voice over Internet Protocol (VoIP) applications. Sociability and the socio-interactional affordances of a learning environment seem to be connected (Kreijns et al., 2013). Some studies suggest that sociable social network solutions (e.g. Facebook) are perceived as being overwhelmingly more suitable for sharing materials and resources, for receiving updates and for overall course interaction than traditional learning management systems such as Moodle or Blackboard (Jong, Lai, Hsia, Lin & Liao, 2014). Consequently, sociable learning environments are more likely to afford both task-related and informal interaction between students. Furthermore, when social and interactional affordances are perceived, learners are encouraged to engage in activities that are in accordance with these affordances (Kirschner, Strijbos, Kreijns & Beers, 2004). Learning in collaborative digital environments depends highly on the learners' possibilities to interact and collaborate in the environment. Therefore, it is important to gain more knowledge about socio-interactional affordances.

This study examines what kinds of technological, organisational and socio-interactional affordances students perceive when collaborating in a simulation-based learning environment. Furthermore, this study investigates how these affordances are employed in the collaborative learning task.

3. CASE LEARNING ENVIRONMENT, DATA AND ANALYSIS

3.1 Context

The simulation-based learning environment is a clock-driven business simulation (REALGAME; Lainema, 2003; Lainema & Makkonen, 2003) in which events in the simulation game processes evolve hour by hour. Students were placed in teams of 10-13 members (18 teams in total). Teams were recommended to have at least 3-4 participants online at all times during the 14-hour simulation exercise. Thus, working in shifts was necessary.

In the simulation, the teams made decisions to manage the information and material flows and in the supply chain (purchases, inventories, production, deliveries) of the simulation company. The clock-driven nature of the simulation required that team members run their simulation companies in synchronous collaboration.

All participants had a real-time view of their simulation companies on their computer screens through a remote connection and were able to make decisions in the simulation. Virtual communication tools, such as VoIP (Skype), chat and email, were used for communication in the teams.

3.2 Participants and data collection

Data were collected through reflective essays of 177 undergraduate students participating in an online business simulation course in higher education. The students came from 10 universities (Austria, Belgium, China, Estonia, Finland, New Zealand and the US) and represented 38 different nationalities (the biggest ones being Finnish 52 students, New Zealander 52, Austrian 29, Belgian 15, and Chinese 14).

The students were tasked with writing a reflective essay in English after the first simulation game session of the course addressing teamwork, roles, tasks, and virtual collaboration and communication. Most students wrote lengthy descriptions of their gaming experiences in which they explained how their team got organised and how they worked as a team. All students participating in this study were required to sign informed consent forms.

3.3 Analysis

Data were analysed via qualitative content analysis using a data-driven analysis approach (e.g. Krippendorf, 2014). The data analysis process was inductive, allowing the analytical categories to emerge from the data rather than attempting to fit the data into existing theoretical categories. In this study, content analysis was applied to the data to answer the research question: what issues/elements in the gaming exercise enabled or hindered the team task?

The analysis entailed careful close reading of the data in iterative rounds. First, two of the authors conducted the qualitative analysis independently. During the reading, the observations were summed up and coded in categories of different types of ‘doings’. The findings were mutually discussed, and the analytical categories were further refined to better respond to the aim of the study. Further analyses helped sharpen the focus and yielded three main categories of action potentials: technological, socio-interactional and organisational affordances. The analysis details how participants in the learning simulation perceived and seized the various affordances in the learning environment and how these were intertwined and influenced by each other.

The simulation game exercise consisted of different phases and tasks. First, the participants familiarised themselves individually with the relevant materials and finalised the course pre-assignments. Then, the team members became acquainted with each other and organised the team. At this point, the team work factually began and the participants started to interact with each other and with the learning environment and its elements. The simulation game was run on two separate days (two weeks in between), and there were team assignments and individual assignments between the gaming days and after the final gaming day. Our analysis focuses on two sets of activities: activities before the first simulation exercise and activities during the first simulation exercise. This type of analysis allows us to gauge the specific nature of the affordances perceived and employed at each stage. The next section presents the results of our analysis.

4. RESULTS

We report on the preliminary findings of our analysis on a general level that portrays what kinds of technological, organisational and socio-interactional affordances students perceived when collaborating in the simulation-based learning environment; these affordances were employed in the collaborative learning task. Our analysis indicates that these three types of affordances are intertwined and co-dependent.

4.1 Technological affordances

Our analysis employed Bower's (2008) classification of technological affordances. Table 1 illustrates how the different technological affordances are shown in the data.

Table 1. Identified Technological Affordances (adapted from Bower, 2008)

Technical Affordance	**Explanation**	**Example of how shows in student essays**
Media affordances	Input and output	*Being able to call and interact/discuss with other team members while the game is running was what made the game so alive and exciting* (Team 4)
Spatial affordances	Ability to resize, move and place elements.	
Temporal affordances	Access anytime anywhere, synchronous versus asynchronous.	*I decided to join my team in the morning, at 05:00 UTC+0. At this time a few of my team members already worked on (--).* (Team 12)
Navigation affordances	Capacity to browse other sections of a resource and move back/forward.	*(--) A chat with all the team members inside the programme can help us to converse easier because now we had to handle two programmes at the same time.* (Team 3)

Emphasis affordances	Capacity to highlight aspects of resources.	*(--) We started tutoring new people by explaining everything that we were doing loudly and showing it directly in the simulation.* (Team 3)
Synthesis affordances	Capacity to combine multiple tools to create a mixed media environment.	*We mainly discussed by writing but also had Skype call(s) (--). I prefer not to speak English so writing was ideal for me* (Team 1)
Access-control affordances	Capacity to allow or deny who can operate; capacity to support one–one/many–many contributions.	*I (--) expected that production, inventory and sales would've been spread into different pages making it all faster to control and not (--) waiting someone to finish their own tasks* (Team 1)
Technical affordances	Capacity to be used on various platforms, ability to adapt to bandwidth, efficiency of tools.	*In my shift was one girl who had a bad internet connection and therefore she couldn't take part in our Skype- conference* (Team 3)
Usability	Intuitiveness, ease of manipulating a tool.	*The game was easy to get into (--)* (Team 2)
Reliability	Robustness.	*If the game cut out it would automatically re-connect (--).* (Team 4)

Many of the technological affordances were related to technological prerequisites. When working in a digital learning environment, some basic requirements need to be met before the gaming can take place. For example, in Bower's (2008; see Table 1) classification, media and spatial affordances are normally prerequisites for a functional e-learning system. Teams selected different communication technologies for different purposes and different tasks. For example, during gaming, email was found to be clumsy, but before gaming, it was deemed an efficient form of disseminating information. In teams where members shared more personal information, applications like Facebook were used more often than in teams with less personal information sharing. The choice and use of communication technologies played a key role in how the teams got organised. In teams with a poor audio connection, chat or text messaging was the technology of choice. Some teams moved from audio to chat due to problems with audio. Group discussions in audio were sometimes deemed chaotic due to simultaneous talk and delays in broadcast. However, some teams were successful in using audio and found it useful and convenient. The gaming exercise required simultaneous use of multiple technologies, and some teams quickly saw which combinations were most fruitful.

Our analysis revealed that while the overall learning environment was the same for all teams, the teams utilised and combined the various affordances differently and complementarily. Our findings suggest that the way different affordances were combined depended, for example, on the availability and functionality of the technologies, the participants' personal preferences or a mutual team agreement, or the team members' technical skills. Our findings are in line with Faraj and Azad (2012), who suggested that an affordance is a multifaceted relational structure, not just a single attribute, property or functionality of the technology artefact or the actor.

4.2 Organisational affordances

Organising teamwork in a CSCL environment is challenging for multiple reasons: team members do not know each other beforehand; the team task may be loosely defined, especially in cases where the focus is on solving ill-defined problems and creating new knowledge; and the information provided by face-to-face communication is missing in virtual communication. Particularly in an international context, there may be cultural differences and differences in communicative style between the students. Furthermore, students may have uneven levels and combinations of skills and competences.

Much of the organisational work in the simulation gaming exercise was related to securing the availability and timely delivery of resources. Before the simulation exercise, the teams needed to get organised. Shift planning was needed to ensure that there were enough team members online, meaning a minimum of three people at any given time. The teams also needed to decide how to deal with the responsibilities and roles in the game. It was suggested in the game materials that teams choose designated persons for at least three roles: purchasing raw materials, managing the production, and making sales offers and deliveries to customers. In some teams, one of the team members took the initiative to send out a Doodle poll to let the team members indicate when they were available and which roles they felt most comfortable with. Others used different Excel charts or sent emails to each other. Some teams made plans only for the shifts and not the roles.

In general, I believe our team was overall very unbalanced, as the roles were not clearly defined (--) and ultimately everybody had something to say to whatever was to be performed as company activity (production, offers, sales,...). (Team 12)

However, it appeared that the roles needed not to be very precise and carefully planned for the team to function well:

I think we had very clear responsibilities and everyone did their best and we supported each other and helped when needed. Of course, because we didn't have a business strategy at all, everything we did was intuitive, so our functions or ways to do things were built up just in time in the game. (Team 3)

Communication and organisation for the teamwork went hand in hand, and teams with multiple communicative occasions and versatile organisational tools (Doodle, Excel charts, explicit goal setting) were better prepared and oriented to the simulation exercise. In some of the teams, one or two team members even contacted each team member individually to negotiate a suitable shift and role, which was regarded as a welcomed practice:

Firstly, the communication and enthusiasm of my team was beyond impeccable in my opinion. As soon as the team lists were released, I had emails from most of the members in my group by the end of that day. (Team 3)

Some teams had clear leadership, either by self-selection or by mutual agreement. In these teams, the leadership was more established and visible and acknowledged by most team members. Leadership was partly an issue of controversy, as some participants had reservations for strong leadership. In general, however, teams with clear leadership reported more satisfaction and better results.

(-) I found the team to be relatively effective, although lacking a leader figure. Because of this, I stepped in and created a Facebook group in which we could communicate quicker than that over email. This was effective, and some team members created a roster where it was outlined what hours each individual was online for, and their duty during that given time. (Team 15)

Table 2 presents the categories of organisational affordances. Our analysis yielded three types of organisational affordances or practices, which partly overlap. The categories are organising, managing and leading. The table also presents the activities in each category.

Table 2. Identified Organisational Affordances

Organising	**Managing**	**Leading**
Organising shifts and tasks (Doodle poll, Excel chart)	Managing one's own task	Pointing out critical areas and initiating discussion
Re-organising shifts and tasks during gaming	'Feeling the pulse' – hearing how others are doing	Setting an agenda for team talks
Gathering information from the team and using it to securing and re-arranging resources	Suggesting what to do next – giving orders	Making projections based on the available data
Ensuring all areas are covered	Compromising through team talk – finding middle ground	Discussing and suggesting strategies
	Managing contacts to collaborative teams	Announcing decisions

The most important organisational work before the gaming exercise was to organise the shifts. Teams with enough participants online at any given time were most satisfied with the teamwork. Teams with too few people online found it stressful and chaotic to try to run the simulation company. Our analysis illustrates how organisational affordances are made possible by employing technological affordances, which, in turn, are prerequisites for the whole learning exercise. It is the dynamics of various kinds of affordances and their combinations in the digital learning environment that create the potential for learning.

Decisions in the simulation functions could be executed individually, but intra-team coordination was needed to balance the functions in the simulation company to avoid oversized inventories and bottlenecks along the supply chain. The designated roles of the participants were useful, since the simulation allowed one team member at a time to manage the simulation interface. Teamwork depended on communication and collaboration. Organisational and socio-interactional affordances were both needed and central to the success of the teams. Organising affordances, thus, consisted of combinations of different affordances (see e.g. Sæbø, Federici & Braccini, 2017).

How organising takes place is essentially a retrospective sensemaking activity (Weick, 1995). Despite the centrality of collaboration as an activity including the organisation and execution of the joint task, little research addresses how collaboration is organised and coordinated or how organising for collaboration is afforded in computer-mediated environments. To date, what organising entails in the context of computer-supported learning environments is unclear, and empirical evidence of how organising takes place in computer-supported environments remains scarce. The lack of research puts further impetus on studying computer-supported collaboration from the affordance perspective in more detail.

4.3 Socio-interactional affordances

Some interactional aspects in the gaming exercise were, similar to technological affordances, prerequisites of communication. For example, gaining access to the relevant information at the right time was imperative; without it, the team members could not function properly. This, in turn, was closely linked with the technology in use. Many teams found email and Skype chat clumsy for rapid communication and chose synchronous VoIP-solutions for talking about pressing issues. The analysis revealed that the socio-interactional affordances fall into four distinctive categories: observing, participating, facilitating and chairing. Some affordances can be placed in multiple categories, but the main difference between the affordances is the level of input and activity.

By alternating between technologies and channels appropriately, different kinds of communicative contributions are relevant for the team task. However, if everyone was disseminating information and nobody was drawing conclusions, the team task and its accomplishment would be compromised. A balanced participation and contribution bring results and increases the team's satisfaction with the team's functioning.

I got so enthusiastic that I watched the game even later in my course because I was so excited about the project. Moreover, I am glad to be a part of such project because it teaches us more than any book about crosscultural and virtual communication. (Team 12)

Table 3. Identified Socio-interactional Affordances

Observing	**Participating**	**Facilitating**	**Chairing**
Listening to what others are saying	Listening to what others are saying	Listening to what others are saying	Listening to what others are saying
	Acknowledging what others are saying	Encouraging others to speak	Drawing conclusions
	Listening, stepping back	Facilitating the discussion	Making suggestions
	Responding to what others are saying	Repeating what has been said	Announcing decisions
	Disseminating information	Disseminating information	Disseminating information
	Giving feedback	Giving feedback	Giving feedback
		Negotiating, finding middle ground	Negotiating, finding middle ground

When designing learning environments, it is important to acknowledge the role of technological affordances as enablers or hindrances to the learning exercise. The technological affordances can be designed in ways that encourage and facilitate teamwork and interaction and support the development of organisational skills.

5. CONCLUSION

This study examined what kinds of technological, organisational and socio-interactional affordances were identified by the learners collaborating in a simulation-based learning environment. In addition, we investigated how these affordances are employed in the collaborative learning task.

The study shows that a technology must improve interactions between the individual and the environment to be useful (Kaptelin & Nardi, 2006; Tchounikine, 2019; Stahl & Hakkarainen, 2020). Furthermore, an abundance of affordances does not necessarily mean that they will be perceived or utilised by the actors equally.

Operating in the learning environment required coordinating action to accomplish the team task. Participants evaluated their team success not only in terms of how well the team performed but also in how well the team had worked together and what they had learned. The latter, in our opinion, gives an even better indication of how affordances and their use are connected to learning (see also Jayarathna, Eden, Fielt & Nili, 2020).

Based on our analysis, we can assume that it is useful to have complementary affordances to allow for individual consideration and to foster motivation and more productive ways of working. This finding is in line with recent research on learning in CSCL environments (e.g. Jeong & Hmelo-Silver, 2016; Bonneau & Bordeau, 2019).

Teams chose partly different combinations of communication technology. Before the game session, most teams resorted to asynchronous communication technologies, such as email, to better control the flow of information and to produce a record of all communication. During the simulation game, synchronous communication via Skype was found most appropriate by most teams. However, some teams continued to rely on chat and not talk online. For some teams, this choice was motivated by the team members' reluctance to speak English. However, delays in communication lead to misunderstandings, missing information and confusion. Teams with most self-reported motivation and initial success made changes in their use of technology and communication tool according to what took place in the game. These teams also adapted their organisation according to the situation and used appropriate organisational practices to pursue the best possible outcome for the team at any given situation. Our results corroborate the findings of previous research in highlighting the importance of interactional organisation of teamwork for collaborative problem-solving (Perit Çakır, Zemel, & Stahl, 2009). Furthermore, our results have broader implications, as they stress the salience of flexibility, adaptivity and the accommodation of available resources and affordances to the given task as some of the most important skills needed in all areas of life.

Previous studies have found that teamwork in digital environments benefits from abundant communication (Fjeldstad, Snow, Miles & Lettl, 2012; Choi & Cho, 2019). The data show that teams with less self-reported motivation and successful outcomes had fewer occasions of communication before and during the gaming exercise. These teams also leaned more on asynchronous communication during gaming. The less satisfied teams seemed unable to adjust their team effort or to correct the downfall spiral. By contrast, synchronous communication during the simulation sessions contributed to a more effective teamwork and higher satisfaction. Our results are in line with previous research in suggesting that student-centred learning requires that the learning environment encourages and empowers students to search for information, try different tactics and strategies, test ideas and create new knowledge (Martens, Bastiaens & Kirschner, 2007; Bonneau & Bordeau, 2019). However, these potentials need to be carefully and purposefully designed and integrated in the learning environment, as they do not miraculously appear without purposeful planning and effort. Consequently, we find that it is essential to study affordances in more depth and learn how they can be embedded in learning environments to enhance and empower learning. At best, synchronous collaborations facilitate rich learning experiences, such as the one quoted below.

(--) This online simulation definitely surpassed by expectation of how much I would learn. Learning how to compromise, learning how to negotiate, learning how to speak up, learning how to manage, and most importantly, learning how to work as a collaborative team through an online virtual world. (Team 4)

Some limitations of this study also need to be acknowledged. First, the study solely examines three types of affordances: technological, organisational and socio-interactional, omitting any other types of affordances from the analysis. This choice was made to better focus on the selected affordances and to respect the space limitations of the paper. Further analyses could probe into other types of affordances, allowing for a broader view. Second, the study only presents the preliminary results and does not provide a full analysis of the data. However, already the first analyses and their results bring new knowledge of how the selected affordances in a CSCL environment are perceived and employed. Third, the study does not examine the relation between employed affordances and students' learning outcomes. This type of analysis requires different research methods and analyses and was therefore out of the scope of this research. Despite this limitation, the study provides some preliminary conceptions of beneficial and less beneficial aspects regarding collaborative learning in computer-based environments.

This study is advantageous in illustrating how the selected affordances in a CSCL environment are perceived and employed by the learners. It also shows that despite the abundance of affordances in a learning environment, not all affordances are employed equally by all teams, which, in turn, leads to varying outcomes and different perceptions of the success of the teamwork.

A more thorough understanding of the dynamics of affordances can be used to design accessible learning environments and help educators to better understand how the learning process and the use of affordances can be facilitated and supported.

REFERENCES

Alahuhta, P., Nordbäck, E., Sivunen, A., & Surakka, T. (2014). Fostering team creativity in virtual worlds. Journal for Virtual Worlds Research, 7(3).

Antonenko, P., Dawson, K., & Sahay, S. (2017). A framework for aligning needs, abilities and affordances to inform design and practice of educational technologies. British Journal of Educational Technology, 48(4), 916-927.

Arvaja, M., Salovaara, H., Häkkinen, P., & Järvelä, S. (2007). Combining individual and group-level perspectives for studying collaborative knowledge construction in context. Learning and Instruction, 17(4), 448-459.

Baralou, E., & Tsoukas, H. (2015). How is new organizational knowledge created in a virtual context? An ethnographic study. Organization Studies, 36(5), 593-620.

Berthelsen, U. D., & Tannert, M. (2020). Utilizing the affordances of digital learning materials. L1 Educational Studies in Language and Literature (Special Issue: Danish as L1 in a learning materials perspective), 20, 1-23. https://doi.org/10.17239/L1ESLL-2020.20.02.03

Bonneau, C., & Bourdeau, S. (2019). Computer-supported collaboration: Simulation-based training using LEGO®. Educational Technology Research and Development, 67(6), 1507-1527.

Bower, M. (2008). Affordance analysis–matching learning tasks with learning technologies. Educational Media International, 45(1), 3-15.

BusinessDictionary (2019). Organising. In BusinessDictionary. Retrieved June 27, 2019, from http://www.businessdictionary.com/definition/organizing.html.

Choi, O. K., & Cho, E. (2019). The mechanism of trust affecting collaboration in virtual teams and the moderating roles of the culture of autonomy and task complexity. Computers in Human Behavior, 91, 305-315.

Conole, G. & Dyke, M. (2004) What are the affordances of information and communication technologies? ALT-J, Research on Learning Technology, 12(2), 113-124. https://doi.org/10.1080/0968776042000216183

Dohn, N. B. (2009). Affordances revisited: articulating a Merleau-Pontian view. International Journal of Computer-Supported Collaborative Learning, 4(2), 151-170.

Faraj, S., & Azad, B. (2012). The materiality of technology: An affordance perspective. Materiality and organizing: Social interaction in a technological world, 237-258. https://doi.org/10.1093/acprof:oso/9780199664054.003.0012

Fjeldstad, Ø. D., Snow, C. C., Miles, R. E., & Lettl, C. (2012). The architecture of collaboration. Strategic Management Journal, 33(6), 734-750.

Gall, M., & Breeze, N. (2007). The sub-culture of music and ICT in the classroom. Technology, Pedagogy and Education, 16(1), 41-56.

Gee, J. P. (2004) Situated language and learning: A critique of traditional schooling. London: Routledge.

Gibson, J. J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

Greeno, J. G. (1994). Gibson's affordances. Psychological Review, 101(2), 336-342.

Hartson, R. (2003). Cognitive, physical, sensory, and functional affordances in interaction design. Behaviour & Information Technology, 22(5), 315-338.

Hernández-Sellés, N., Muñoz-Carril, P. C., & González-Sanmamed, M. (2019). Computer-supported collaborative learning: An analysis of the relationship between interaction, emotional support and online collaborative tools. Computers & Education, 138(1), 1-12.

Hossain, L., & Wigand, R. T. (2004). ICT enabled virtual collaboration through trust. Journal of Computer-Mediated Communication, 10(1), JCMC1014.

Jayarathna, L., Eden, R., Fielt, E., & Nili, A. (2020). Contextualizing the effective use of social media network for collaborative learning: An affordance perspective. Proceedings of the 24th Pacific Asia conference on information systems: PACIS 2020. Association for Information Systems, p. 118.

Jeong, H., & Hmelo-Silver, C. E. (2016). Seven affordances of computer-supported collaborative learning: How to support collaborative learning? How can technologies help? Educational Psychologist, 51(2), 247-265.

Jong, B. S., Lai, C. H., Hsia, Y. T., Lin, T. W., & Liao, Y. S. (2014). An exploration of the potential educational value of Facebook. Computers in Human Behavior, 32, 201-211.

Kaptelinin, V., & Nardi, B. (2006). Acting with technology: Activity theory and interaction design. Cambridge: MIT Press.

Ke, F., Pachman, M., & Dai, Z. (2020). Investigating educational affordances of virtual reality for simulation-based teaching training with graduate teaching assistants. Journal of Computing in Higher Education, 1-21.

Kennewell, S. (2001). Using affordances and constraints to evaluate the use of information and communications technology in teaching and learning. Journal of Information Technology for Teacher Education, 10(1-2), 101-116.

Kirschner, P. A. (2002). Can we support CCSL? Educational, social and technological affordances. Open Universiteit Nederland.

Kirschner, P., Strijbos, J. W., Kreijns, K., & Beers, P. J. (2004). Designing electronic collaborative learning environments. Educational Technology Research and Development, 52(3), 47.

Koschmann, T. (2012). CSCL: Theory and practice of an emerging paradigm. Routledge.

Krauskopf, K., Zahn, C., & Hesse, F. W. (2012). Leveraging the affordances of YouTube: The role of pedagogical knowledge and mental models of technology functions for lesson planning with technology. Computers & Education, 58(4), 1194-1206.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. Computers in Human Behavior, 19(3), 335-353.

Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. Educational Psychologist, 48(4), 229-242.

Krippendorff, K. (2004). Content analysis. An introduction to its methodology (2nd ed.). Sage Publications, Thousand Oaks, California.

Lainema, T. (2003). Enhancing organizational business process perception: Experiences from constructing and applying a dynamic business simulation game. Turku School of Economics and Business Administration.

Lainema, T., & Makkonen, P. (2003). Applying constructivist approach to educational business games: Case REALGAME. Simulation & Gaming, 34(1), 131-149.

Lampe, C., Wohn, D. Y., Vitak, J., Ellison, N. B., & Wash, R. (2011). Student use of Facebook for organizing collaborative classroom activities. International Journal of Computer-Supported Collaborative Learning, 6(3), 329-347.

Lin, P. C., Hou, H. T., & Chang, K. E. (2020). The development of a collaborative problem solving environment that integrates a scaffolding mind tool and simulation-based learning: An analysis of learners' performance and their cognitive process in discussion. Interactive Learning Environments, 1-18.

Majchrzak, A., & Markus, M. L. (2012). Technology affordances and constraints in management information systems (MIS). In E. Kessler (Ed.), Encyclopedia of management theory (pp. 832-836), Sage Publications.

Martens, R., Bastiaens, T., & Kirschner, P. A. (2007). New learning design in distance education: The impact on student perception and motivation. Distance Education, 28(1), 81-93.

McLoughlin, C., & Lee, M. J. W. (2007). Social software and participatory learning: Pedagogical choices with technology affordances in the Web 2.0 era. Proceedings ASCILITE, Singapore 2007. https://researchbank.acu.edu.au/cgi/viewcontent.cgi?article=3049&context=fea_pub

Mercer, N. (2010). The analysis of classroom talk: Methods and methodologies. The British Journal of Educational Psychology, 80(1), pp. 1-14.

Michaels, C. F., & Carello, C. (1981) Direct perception. Englewood Cliffs, NJ: Prentice Hall.

Moate, J., Hulse, B., Jahnke, H., & Owens, A. (2019). Exploring the material mediation of dialogic space—A qualitative analysis of professional learning in initial teacher education based on reflective sketchbooks. Thinking Skills and Creativity, 31, 167-178.

Norman, D. A. (1999). Affordance, conventions, and design. Interactions, 6(3), 38-43.

Oliveira, I., Tinoca, L., & Pereira, A. (2011). Online group work patterns: How to promote a successful collaboration. Computers & Education, 57(1), 1348-1357.

Perit Çakır, M., Zemel, A., & Stahl, G. (2009). The joint organization of interaction within a multimodal CSCL medium. Computer Supported Learning, 4, 115–149.

Pozzi, G., Pigni, F., & Vitari, C. (2013). Affordance theory in the IS discipline: A review and synthesis of the literature. Proceedings of the 20th Americas Conference on Information Systems, AMCIS 2014.

Roschelle, J., & Teasley, S. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), Computer supported collaborative learning. NATO ASI Series (Series F: Computer and System Sciences), vol. 128 (pp. 69-97). Berlin: Springer-Verlag.

Salomon, G. (1993). No distribution without individuals' cognition: A dynamic interactional view. In G. Salomon (Ed.), Distributed cognitions: Psychological and educational considerations (pp. 111-138). Cambridge University Press.

Scarantino, A. (2003). Affordances explained. Philosophy of Science, 70(5), 949-961.

Selwyn, N. (2012). Making sense of young people, education and digital technology: The role of sociological theory. Oxford Review of Education, 38(1), 81-96.

Steffens, K., Bannan, B., Dalgarno, B., Bartolomé, A. R., Esteve-González, V., & Cela-Ranilla, J. M. (2015). Recent developments in technology-enhanced learning: A critical assessment. International Journal of Educational Technology in Higher Education, 12(2), 73-86.

Song, Y. (2011). What are the affordances and constraints of handheld devices for learning in higher education. British Journal of Educational Technology, 42(6), E163-E166.

Stahl, G. (2012). Ethnomethodologically informed. International Journal of Computer-Supported Collaborative Learning, 7(1), 1-10.

Stahl, G., & Hakkarainen, K. (2020). Theories of CSCL. Manuscript in preparation. In U. Cress, C. Rose, A. F. Wise, & J. Oshima (Eds.), International handbook of computer-supported collaborative learning. New York, NY: Springer.

Strong, D. M., Johnson, S. A., Tulu, B., Trudel, J., Volkoff, O., Pelletier, L. R., Bar-On, I., & Garber, L. (2014). A theory of organization-EHR affordance actualization. Journal of the Association for Information Systems, 15(2). https://doi.org/10.17705/1JAIS.00353

Sæbø, Ø., Federici, T., & Braccini, A. M. (2017). Combining social media affordances for organising collective action. Information Systems Journal, 30(4), 699-732.

Tchounikine, P. (2019). Learners' agency and CSCL technologies: Towards an emancipatory perspective. International Journal of Computer-Supported Collaborative Learning, 14(2), 237-250.

Wang, C., Fang, T., & Gu, Y. (2020). Learning performance and behavioral patterns of online collaborative learning: Impact of cognitive load and affordances of different multimedia. Computers & Education, 143, 103683.

Volkoff, O., & Strong, D. M. (2013). Critical realism and affordances: Theorizing it-associated organizational change processes, MIS Quarterly, 37(3), 819-834.

Weick, K. E. (1995). Sensemaking in organizations. Thousand Oaks: Sage.

Weidlich, J., & Bastiaens, T. J. (2019). Designing sociable online learning environments and enhancing social presence: An affordance enrichment approach. Computers & Education, 142, 103622.

Xue, S., & Churchill, D. (2019). A review of empirical studies of affordances and development of a framework for educational adoption of mobile social media. Educational Technology Research and Development, 67(5), 1231-1257.

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