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citation for published version (APA)
Koolstra, C. M., & Bos, M. J. W. (2009). The development of an instrument to determine different levels of interactivity. *Journal of Science Communication*, *71*(5), 373-391. https://doi.org/10.1177/1748048509104980

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What is This?

THE DEVELOPMENT OF AN INSTRUMENT TO DETERMINE DIFFERENT LEVELS OF INTERACTIVITY

Cees M. Koolstra and Mark J.W. Bos

Abstract / Many researchers suggest that communication is most effective if a high level of inter-activity between participants is involved. As yet, however, there is neither consensus on how interactivity is defined, nor on how it can be measured. The present study is aimed at finding an operational definition of interactivity that can be used in almost all communication contexts. Addi-tionally, based primarily on three recent reviews on the concept, the study proposes an objective instrument for determining different levels of interactivity. The instrument consists of a checklist for observing the presence of a set of representative characteristics such as synchronicity, timing flexi-bility, control over content, physical presence of participants and the extent to which participants in a communication situation use their senses. The applicability of the instrument is demonstrated by determining the interactivity levels of two exemplary communication situations.

Keywords / interactive media / interactivity / mediated communication / synchronicity

Introduction

Interactivity is one of the main concepts used to characterize information processing through new media. As opposed to the 'old' media such as radio and television, newer technologies such as the Internet, email and instant messaging provide users the possibility of interacting with the producers of messages and/or with other users. The concept of interactivity is not only addressed in studies on media and communication but also in disciplines such as marketing, information science, computer science and education sciences (McMillan and Hwang, 2002). The past few decades have shown an increase in attention paid to interactivity in the scientific literature. A simple search in the Web of Science, using the keywords 'interactivity' and 'inter-active', shows that before the 1980s the concept was seldom addressed, whereas since then the number of articles featuring interactivity has increased at a faster rate than the total number of articles included in the database (see Figure 1).

One of the prime reasons for the growth of interest in interactivity may be the assumed effectiveness of interactive communication. Rogers and Kincaid (1981) were among the first to suggest that interactive communication will result in more mutual

FIGURE 1

The Increase in the Number of Publications about Interactivity in Comparison with the Total Number of Articles in the Web of Science Database
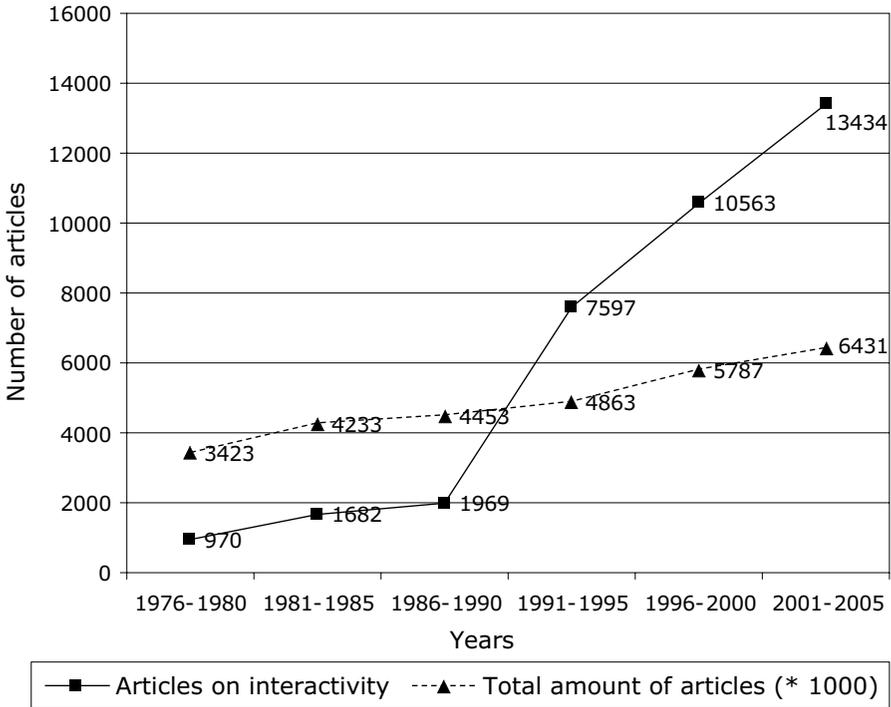
Notes: The search term 'interactivity OR interactive' was used as a quick search string in the *Web of Science* database. Results are categorized in subsets of five years. 1976 was chosen as the starting period because the Arts and Humanities citation index was added in 1975. The *Web of Science* database consists of the Science Citation Index Expanded, Social Sciences Citation Index and the Arts and Humanities Citation Index. The search was performed on 13 August 2006.

understanding between users than non-interactive communication, because the communication process is more open and direct. In comparing information processing through traditional non-interactive media vs new interactive media, Heeter (1989) argued that interactivity 'forces' people to actively seek and process information with the result that it is better retained. Since then, many more authors have suggested that high levels of interactivity between participants are more beneficial for information processing and learning than low levels (or no interactivity at all). The proclaimed advantage of interactive over traditional forms of communication is, however, contested by several other researchers. Sundar et al. (2003), for example, concluded in their effect study on web surfing that *too many* interactive facilities can actually cause people to get the feeling of 'being lost' with the result that possible beneficial effects are minimized. It seems that there are 'non-believers' and 'believers'

in interactivity, as its assumed beneficial effects are contested (e.g. Bailey, 1992) or acknowledged (e.g. Ghose and Dou, 1998; Wu, 1999).

Problematic in the discussions about the effectiveness of interactivity is that, despite the growing number of studies on the concept, there is currently no consensus about how interactivity is defined, let alone on how it can be measured (e.g. Kiousis, 2002; McMillan, 2002). McMillan (2002: 163), for example, stated that: 'Interactivity means different things to different people in different contexts.' One reason why there is no accepted definition of interactivity is that the concept has been adopted as a relevant phenomenon by a wide variety of scientific disciplines. But even within disciplines it seems difficult to reach consensus about the concept. An example among communication scientists is the discussion about the question of whether interactive communication is always mediated or not (e.g. Walther, 1996; Walther and Tidwell, 1996). An additional problem in establishing a shared definition may be that authors have emphasized certain characteristics of interactivity as key elements whereas other characteristics have been downgraded or neglected with the result that theoretical and operational definitions are diverse and incoherent (e.g. Kiousis, 2002). However, one advantage of the many studies that have been conducted is that in recent years the concept has been addressed in review studies that have attempted to get a full picture of the characteristics associated with interactivity (Downes and McMillan, 2000; McMillan and Hwang, 2002; Kiousis, 2002).

Based primarily on these three review studies, the present study aims to (1) find a definition of interactivity that can be applied to the majority of the scientific disciplines and (2) develop an instrument to determine different levels of interactivity. To achieve this, the present study first provides a short chronological overview of the influential studies on interactivity. Second, the study addresses the question of how interactivity can be measured adequately. And third, after the presentation of the new instrument, its applicability is demonstrated by determining the interactivity level in two familiar communication situations.

Chronological Overview of the Studies on Interactivity

One of the first and most influential explications of the concept of interactivity was provided by Rafaeli (1988). His definition of interactivity, as 'an expression of the extent that, in a given series of communication exchanges, any third (or later) transmission (or message) is related to the degree to which previous exchanges referred to even earlier transmissions' (Rafaeli, 1988: 111), is frequently quoted as a primary basis for further theorizing. Bretz (1983) and Williams et al. (1988) were among the first to identify specific elements within communication processes that are essential to interactivity: time, control, exchange of roles and mutual discourse. Heeter (1989) distinguished six elements that partly overlap with these, but also added ideas for further operationalization: availability of choice (people make selections in information), user effort (people participate actively), medium responsiveness (as a characteristic of how adequately media react on user input), monitoring (of ongoing communication), contributing to information and the facilitation of interpersonal

communication. It may be concluded that many studies in the 1980s focused primarily on characteristics of the process and of the medium.

In the 1990s, there was continued attention for media- and process-oriented views on interactivity. Media-related views were primarily based on the rapid developments in technology. Interfaces that allowed users to modify form and content in real time were seen as interactive (e.g. Jensen, 1998; Steuer, 1992). Morris and Ogan (1997) suggested that the new media offer the possibility for both synchronous (e.g. chat rooms) and asynchronous forms of communication (e.g. email, electronic bulletin boards, surfing on the Internet). Other media-specific elements distinguished were: speed, range and mapping (Steuer, 1992); bidirectionality of message traffic, user control of information sequencing and artificial intelligence (Jaffe, 1997); and choice and control (Bezjian-Avery et al., 1998). Blattberg and Deighton (1991) suggested that interactivity is the possibility for people to communicate directly, independent of time and place. Deighton (1996) later specified two key aspects: the ability to speak to someone and the ability to receive a reaction (and save it). Pavlik (1996) described interactive communication as a process of reciprocal influence or control. Likewise, Murray (1997) formulated the importance for users to be able to personally take actions and see the results of these actions. As such, these abilities allow control over the communication process. Ellis (1993) illustrated the characteristic of synchronicity from both a non-mediated and a mediated approach in synchronous (face-to-face), asynchronous (leaving a note), synchronous mediated (e.g. telephone) and asynchronous mediated communication (e.g. through mail). Ha and James (1998: 461) described interactivity as 'the extent to which the communicator and the audience respond, or are willing to facilitate, each other's communication needs'. Jensen (1998: 201) defined interactivity as 'a measure of a media's [*sic*] potential ability to let the user exert an influence on the content and/or form of the mediated communication'. In the late 1990s, some authors approached the concept of interactivity, for the first time, from the subjective view of participants. Examples of elements that find their origin in perceptions are the experienced level of control, responsiveness and personalization (Wu, 1999).

Since 2000, the focus has mainly been on the perceptions of participants in interactive communication situations. Based on interviews with experts, Downes and McMillan (2000) analysed how interactive communication may affect users, and under which conditions participants may feel they have control over the exchange of messages. The authors stated that synchronous communication may be the most interactive form. In their eyes, interactivity increases when two-way communication enables all participants to communicate actively, the timing of communication is flexible to meet the time demands of participants, the communication environment creates a sense of place, participants perceive that they have control over the communication environment, participants find the communication to be responsive and individuals perceive that the goal of communication is oriented more towards exchanging information than towards attempting to persuade. McMillan and Hwang (2002) developed a scale for measuring perceived interactivity by letting participants review websites that were designed to induce low or high interactivity. In the field of advertising research, Liu and Shrum (2002) suggested that the influence of inter-

activity on advertising effectiveness may be a function of both personal and situational (technological) factors. By means of an online survey, Sohn and Lee (2005) measured how respondents perceive the interactivity of the world wide web with the result that control, responsiveness and interaction efficacy were found as the three principal dimensions of perceived interactivity.

Dimensions of Interactivity

As may be concluded from the overview, the multidimensionality of the concept of interactivity has been approached in different ways. Distinctions have been made between: message-based and participant-based dimensions (Downes and McMillan, 2000); process, function/features and perception (McMillan and Hwang, 2002); structural and experiential features (Liu and Shrum, 2002); function/features and perception (Sohn and Lee, 2005); and medium/technology, process and perception (Kiousis, 2002). Although in some cases different names are used for perception (e.g. experiential or participant-based dimension), the distinctions show consensus in the dimension of perceived interactivity. Similarly, although message, process, function, structure, feature and medium/technology may seem to be different aspects of interactivity, in fact they all represent a dimension of inherent characteristics that can be objectively observed during a communication situation. Therefore, a simple distinction between operationalizations of *perception* and *process*, the distinction made by Sohn and Lee (2005), seems to be the most parsimonious.

Measurement of Perceived Interactivity

In all of the aforementioned studies, the perceptional or experiential dimension represents the view in which interactivity is approached from a subjective, user-oriented perspective. Measuring the perception of interactivity of participants in communication situations may be important in order to determine how participants make sense of what is happening and how they respond to messages (e.g. Walther, 1992). It must be noted that perceived interactivity is of course always subjective and that in the case of someone's perception of interactivity simply being measured by asking 'how interactive a communication situation was', it is unknown which judgement criteria are used (which makes the measurement inherently multidimensional). As a result, a communication situation may be perceived as highly interactive by one participant, whereas another participant may perceive the same situation as not interactive at all (e.g. Downes and McMillan, 2000; Newhagen et al., 1995). Therefore, measuring perceived interactivity is only one way of determining the concept of interactivity.

Measurement of Interactivity as a Process

An objective measure for interactivity is also needed. In many studies, interactivity is treated as an independent (or mediating) variable and it should be so measured. When, for example, the learning effect of an interactive course is evaluated, it is

necessary to measure the level of interactivity involved as a predictor of the learning effect (see also Liu, 2003). Furthermore, in many cases interactivity can only be measured without questioning the participant(s) in a communication event. And when interactivity needs to be measured 'value free', a systematic assessment made by a researcher or a trained coder may be preferred over a subjective perception of a participant. Another reason is that an objective instrument may guide producers of interactive technologies (including soft- and hardware) in developing highly inter-active media systems. Finally, an objective measuring instrument may be used to validate a subjective instrument to measure interactivity (and the other way around).

A Prerequisite for Interactivity

Not all communication situations are interactive. To make a distinction between inter-active and non-interactive communication, Rafaeli (1988) has proposed a prerequisite of interactivity. According to Rafaeli, communication is interactive only if messages are exchanged that are content-relevant and interrelated, and at least three interrelated messages are exchanged. If a person sends a message to another person (action), the reply of the receiver may be called a reaction; only in the case of a reaction to the reaction (both related to the first message) may the communication process be called interactive (see also Walther et al., 2005). This prerequisite for interactivity was later called 'third-order dependency' (Kiousis, 2002). Therefore, when in a com-munication situation third-order dependency is absent, interactivity is assumed to be absent, and a measurement of interactivity does not apply to that situation.

Requirements of an Objective Instrument

The first requirement of an objective instrument is, of course, that it should pertain to characteristics of communication situations that can be observed objectively by a researcher or a trained coder. As a second requirement we chose to measure inter-activity independently of medium and content. The advantages of a measurement that is independent of medium and content are that the instrument can be used in a wide variety of settings, for all types of media, and that comparisons can be made between settings and media. In addition, media technologies will develop and change, which would result in the loss of an instrument tailored to a specific medium. The independency of content may help to make the instrument easier to use, because it avoids the problems that messages can be difficult to access, contents of messages can vary greatly and therefore may be difficult to measure and compare.

Definition of Interactivity

The present study uses a definition of interactivity that is based on the definition pro-posed by Liu and Shrum (2002: 54): 'The degree to which two or more communi-cation parties can act on each other, on the communication medium, and on the messages and the degree to which such influences are synchronized.' The definition of Liu and Shrum (2002) speaks of 'communication parties', which may include a

computer as one of the parties. Because many studies on interactivity are based on single users of new media like computers (e.g. 'human-to-computer interaction' [McMillan and Hwang, 2002]; 'media interaction' [Stromer-Galley, 2000]), an up-to-date definition should include this situation. Because we include the medium as one of the possible parties, and our instrument is aimed at measuring interactivity independently of medium and content, we can leave out the second part of the definition developed by Liu and Shrum (2002). The last part of their definition, about synchronicity, can also be left out, because earlier studies have proposed many other elements of interactivity besides synchronicity. This makes our definition more general and the choice for the elements of interactivity is (temporarily) left open. We define interactivity as follows: the degree to which two or more communication parties act on each other in an interrelated manner.

The first part of the definition is the same as the first part of the definition developed by Liu and Shrum (2002) with the one (additional) difference that the word 'can' is left out, because our instrument focuses on 'observing things that really happen' instead of 'thinking about possibilities that may not occur'. On the one hand, leaving out measuring the possibilities of interactivity may seem awkward in cases in which, for example, the interactivity levels of interactive systems such as computers, alarm systems or mobile phones are compared, because some systems may offer much more possibilities for interactivity than others. On the other hand, we argue that systems when not used or activated (by people), are not interactive. A recently bought computer that is still in the box is an example of a system that should not (yet) be regarded as interactive. Along the same line, people have interactive possibilities, but their interactivity can only be observed when (some of) those possibilities are actually used. The last part of our definition presupposes Rafaeli's principle of 'third-order dependency' (Kiousis, 2002; Rafaeli, 1988) in the sense that communication parties act on each other in the context of information exchanges on the same topic.

Elements of Interactivity

The extent to which communication situations differ in levels of interactivity is determined by observing which elements of interactivity are actually present in a communication situation and to what extent. The elements included in our measuring instrument are selected on the basis of the elements provided in the three review studies (Downes and McMillan, 2000; Kiousis, 2002; McMillan and Hwang, 2002). Although Downes and McMillan have made a distinction between message-based and participant-based elements, and our instrument focuses on objectively observable features (and not on subjective perceptions of participants), the set of elements proposed by Downes and McMillan may be regarded as the most comprehensive list. But because there is overlap of elements in the three review studies and some of the elements are specifically aimed at measuring the perception of the user, we analyse which elements will be excluded from our instrument. In addition, we try to determine which elements have been omitted in the reviews and suggest additional elements that should be included in the new instrument. Beforehand, based on

findings from earlier studies (e.g. Kiousis, 2002; McMillan and Hwang, 2002), it must be acknowledged that it seems difficult to make a selection of elements that are exhaustive and exclusive. We nevertheless try to prevent that elements overlap by analysing how earlier studies agree or disagree in their choice of elements.

For each element of interactivity the new instrument includes three possible levels of interactivity. These levels pertain to the presence or absence of an element for one party (or participant), two parties or more than two parties. The highest level of interactivity (score 2) may be assigned if the element is present for at least two parties. The middle level (score 1) is assigned if an element is present for one of the parties. The lowest level (score 0) will be assigned if an element is absent for all parties.

Synchronicity

Time, time elapse, speed and synchronicity are all aspects of duration. Assuming that interactivity increases when less time elapses between exchanging subsequent messages (e.g. Kiousis, 2002; Downes and McMillan, 2000), the highest level of interactivity is assigned to a synchronous exchange of messages. The passage of time between exchanging messages can be easily measured either in factual numbers (e.g. X days, X hours, X minutes and X seconds) or in categories. The usefulness of factual numbers seems to be limited, however, because time may be regarded (and measured) as a continuous variable with an infinite amount of possible outcomes (and comparisons between different outcomes). It may also be noted that the speed with which messages are exchanged is not only dependent on how quickly participants react to each other, but also on the speed of the technology as both hardware and software may affect the transmission speed. Because the new instrument is aimed at determining the level of interactivity independent of medium, the reasons of why transmission speed varies is not taken into account in the score for this element. Therefore, simple categories of *immediate* vs *later* reactions are used. Immediate reactions include situations in which a participant reacts on a message immediately after having processed it, for example when an answer is sent directly after having read an incoming email message. In cases when an answer is sent in reaction to an email message that has been processed an hour (or a day) before, it is called a later reaction. If none of the participants react immediately to a processed message, the score is the lowest (0); if one participant reacts immediately, the score is 1; and if two or more parties react immediately, the score is 2 (see Table 1).

Timing Flexibility

If participants have (or make) the choice between fast or slow reactions to an incoming message, timing flexibility is available (e.g. Kiousis, 2002; Rheingold, 1993). This idea of freedom to react to a message at one's own time may seem to be somewhat in contrast with the element of synchronicity in which little or no time between sending and receiving messages is characterized as interactive. The difference, however, lies in the freedom of choice to react quickly or slowly to messages on the

TABLE 1

Elements of Interactivity Including Category Levels and Scores

Element	Category levels	Score
Synchronicity	Two or more react immediately	2
	One reacts immediately	1
	None	0
Timing flexibility	Two or more have the choice of timing	2
	One has the choice	1
	None	0
Control over content	Two or more exert influence on content	2
	One exerts influence on content	1
	None	0
Number of additional participants	Two or more additional participants	2
	One additional participant	1
	None	0
Physical presence of additional participants	Two or more are physically present	2
	One	1
	None	0
Use of sight	Two or more use sight	2
	One	1
	None	0
Use of hearing	Two or more use hearing	2
	One	1
	None	0
Use of other senses	Two or more use other sense(s)	2
	One	1
	None	0

basis of their availability or transience. Messages that quickly disappear after presentation, such as those presented on television or conversations over a telephone, allow little timing flexibility in processing and reacting, whereas messages that remain available, such as email, instant messaging over a telephone and videotaped TV programmes, do provide timing flexibility. Therefore, the instrument recognizes situations in which all participants have control over timing (e.g. email and chatting), and situations in which some (or one) of the participants have control while others have not (e.g. broadcasting agency vs viewers). In some communication situations none of the participants seem to have any room for timing flexibility in processing and reacting to messages, for example when an immediate consulted decision has to be made.

Control over Content

Although control is one of the most frequently mentioned characteristics in both theoretical and operational definitions of interactive communication (e.g. Downes

and McMillan, 2000; Jensen, 1998; Liu and Shrum, 2002; Sohn and Lee, 2005; Steuer, 1992), the problem with this element seems to be that it may consist of more than one component. The new instrument makes a distinction between two components that can be objectively measured: timing flexibility (see earlier) and control over content. Control over content pertains to whether a participant composes and/or changes the content of a message (e.g. Jensen, 1998; Steuer, 1992; Tremayne and Dunwoody, 2001). In many situations, participants can manipulate the content of messages, for example in email and telephone messages. There is, however, content that is not (or cannot be) changed by participants. Examples are a movie broadcast by a television station, an email message that is forwarded without adding to the content and a web page read by an Internet user. An example in which more than one party have control over the content of the same message is an interpersonal dialogue through which a common point of view (as a message to be exchanged) is reached. In many communication situations, the level of control over content is not distributed equally among all participants. Therefore, the scoring takes into account the number of participants that exert control over the content: none, one or more than one.

Number of Participants

It may be argued that a communication process needs the involvement of at least two participants. However, as discussed before, many authors have included situations in which an individual communicates with a computer or other system, also as interactive communication. Particularly in the context of new technologies, a setting such as one individual using a computer to visit websites and/or to write texts is regarded as one of the typical situations of new interactive forms of dialogue (McMillan and Hwang, 2002). In the 'dialogue' between an individual and a computer, the computer represents one or more other individuals, because messages 'sent' by the computer have in fact been generated by individuals (through constructed software and hardware), and the messages received by the computer may be (indirectly) aimed at other individuals. As such, visiting an Internet forum can be considered as interactive communication, although the 'person-to-person' communication is indirect and delayed. In line with this widely accepted view, the new instrument considers this particular situation, one person using a computer, as (possibly) interactive. However, if one individual is browsing the Internet and there is nobody else directly participating in the action, the level of interactivity in terms of the number of participants is the lowest (score 0). If, in a communication situation, besides the one individual more participants are involved in a direct and active way, the level of interactivity is assumed to increase, because the possibilities available to react to other participants increase. A setting with one *additional* participant receives a score of 1 and the highest score, 2, is given when two or more additional participants are actively involved in the exchange of messages.

Physical Presence

When participants are physically present in a communication situation there are specific possibilities of communicating that are not available when people are distant, such as non-verbal cues and physical contact (e.g. Burgoon et al., 2002). Although there are new communication technologies through which participants can see others who are not physically present in the same environment (e.g. webcams and video telephones), it may be assumed that in most cases (unmediated) physical presence stimulates interactivity. This assumption is based on the idea that face-to-face communication is the 'standard' of interactive communication (e.g. Berger, 2005; Leary, 1990). Physical presence is a fact that can be easily and objectively established in most communication situations. A situation can reflect one of three possibilities: none of the additional participants is physically in the same place (e.g. communication through email); one additional participant is physically present (e.g. two people have a meeting in the same room, and another person participates in the meeting through telephone); and more additional participants are physically in the same room or place (e.g. during a discussion between a teacher and his/her students in a class room).

Use of Sight

People use their senses to communicate with others. The assumption in our instrument is that the more senses are used, the richer the communication and the higher the level of interactivity will be (see also media richness theory, e.g. Daft and Lengel, 1986). In line with this reasoning, some of the new technologies allow for more interactivity because they stimulate more senses and allow for a more direct contact between participants (e.g. Williams et al., 1988). Communication through a video telephone is therefore regarded as more interactive than through a traditional telephone. Sight is probably the sense most frequently used as it includes looking at a person in a face-to-face context, watching a screen (e.g. television, computer and PDA) and reading.

Although none of the three reviews on interactivity explicitly addressed the use of senses as an important element of interactivity, two have included 'responsiveness' as one of the main elements (Downes and McMillan, 2000; Kiousis, 2002). On the one hand, responsiveness may be regarded as a very broad concept that is almost overlapping with the concept of interactivity. On the other hand, it seems to be dependent on sensory activation (e.g. Bretz, 1983; Kiousis, 2002). Also, in line with Durlak's (1987) 'sensory complexity', which is the idea that some systems (e.g. computers) may activate many senses, we have chosen to include in our instrument the two probably most frequently used senses, sight and hearing, and leave room for the optional use of additional senses.

Use of Hearing

The use of hearing is taken into account as a second frequently stimulated sense in communication processes. Like sight, hearing may pertain to both mediated and

non-mediated communication contexts. Whereas most email messages are exchanged without the use of hearing, telephones can be used to communicate through talking and listening (hearing) or sending SMS messages (sight). The scoring of both sight and hearing follows the lines of the scoring of other elements, which means that in a particular communication situation it is observed whether a sense is used by more than one, one or no party.

Use of Other Senses

Although until now computer-mediated communication does not often include the use of other senses besides seeing and hearing, future technological developments may result in the use of smell, taste and touch as well. An example of a technologically already accomplished touch feedback is a car racing computer game in which the steering wheel reacts to bumps on the road. Of course, in non-mediated face-to-face communication, all five senses may be used. Again, based on the ideas that simulation of face-to-face communication and media richness may lead to a high level of interactivity, the present instrument includes the use of other senses as an additional indicator for the level of interactivity.

Elements that were Excluded

Direction of Communication

There is a simple distinction between one-way and two-way communication (e.g. Bretz, 1983). Other authors distinguish three communication 'directions': one-to-one, one-to-many and many-to-many (e.g. Kiousis, 2002). The fact that the level of interactivity may depend on the number of participants who actively join in the exchange of messages has already been included in the instrument (number of participants). In addition, although determining the direction of communication may be important in analysing the communication process, in the choice of our definition we have presupposed that senders and receivers always change roles in interactive communication (third-order dependency). Therefore, determining the direction of communication is necessary to decide whether the communication situation is interactive or not, but it is of no additional use in determining different levels of interactivity.

Content of Messages

Although the three reviews did not explicitly address the content of messages as an indicator of the level of interactivity, it may be suggested that the more communication exchanges refer to earlier transmissions, the more interactive the communication process will be (e.g. Rafaeli, 1988). Analyses of actual content would indeed provide insight in the actual level of interdependence of the messages exchanged. However, systematic content analyses of sets of consecutive messages are not always possible and, when they are possible, they may become complicated and time consuming. Because our instrument was developed for ease of use, content

analyses of messages were not included. It is, however, easy to determine whether participants have control over the content of messages, and we have therefore included this element in the instrument as one of the indicators of interactivity (see earlier).

Elements of Perceived Interactivity

As discussed earlier, elements provided in the three reviews that pertain to the dimension of perceived interactivity such as responsiveness, sense of place and perceived goal of the communication were not included in the instrument, because they pertain to subjective judgements and not to objectively observable characteristics.

Determining the Interactivity Level in Some Examples of Communication Situations

The first hypothetical situation is a simple exchange of email messages between two participants. When participant A sends an email message to participant B, and B replies to that message one hour later, after which A reacts on B's message three hours later, interactivity is at hand, because the prerequisite of third-order dependency is fulfilled. The elements of the new instrument will be scored as follows: synchronicity 0 (both participants reacted later); timing flexibility 2 (both participants chose their own timing in reacting to an earlier message); control over content 1 (both participants had control over the content of their own message but not over the content of the message of the other participant); number of additional participants 1; physical presence 0; use of sight 2 (both participants used their sight to read the email message); use of hearing 0 (the message exchange was text-only); and use of other senses 0. Therefore, the total interactivity score for this situation would be 6. The total score would be higher in a situation in which the participants were simultaneously exchanging email messages and they were working on a joint message that was sent to another person, because then higher separate scores would be assigned to synchronicity, control over content and number of additional participants, respectively. The minimum score for an (interactive) communication situation is 1, because communication always requires the use of at least one sense. The maximum score is 16.

The second example is a situation in which a teacher has a lively face-to-face discussion with five students in a class room. The elements will be scored as follows: synchronicity 2 (there are many immediate reactions); timing flexibility 2 (reactions may be postponed); control over content 2 (two or more participants exert influence over the content of some messages); number of participants 2; physical presence 2; use of sight 2; use of hearing 2; and use of other senses 2 (if, for example, three participants use other senses also, such as touch or smell). Therefore, in line with the suggestion that face-to-face communication should be considered as the standard of interactivity, this communication situation would get the maximum score of 16.

Some examples about variation in specific elements of communication situations that can be compared may also help to get the idea of how scores are

assigned. The difference between an automatically generated email confirmation of an online purchase and a personal return email message tailored to a unique online order of a client is that the first message scores only on synchronicity (for the immediate answer), whereas the second message will score on the elements of timing flexibility, control over content, number of additional participants and use of sight (because the return email message was made up by a person). A face-to-face conversation between two individuals will receive a higher score for interactivity than a conversation by telephone, because the first situation will receive maximum scores on the elements of physical presence, use of sight and (probably) use of other senses. Playing tennis on a tennis court will receive the same scores as playing tennis via a computer game, on the condition that in the computer game situation the two players are in the same room.

Discussion

The present study was aimed to develop a new objective instrument to measure different levels of interactivity to further the progress in research on the concept. Although the literature has provided many definitions for interactivity, an objective instrument to measure it was not previously available. The instrument was designed to be used in a wide range of communication settings, including face-to-face and human-to-computer situations. A problem in developing a new instrument for measuring interactivity lies in the inclusion of all elements that seem to be crucial to the level of interactivity. Therefore, the choice of elements included in the instrument was based on three reviews that have tried to provide a full picture of the studies on interactivity (Downes and McMillan, 2000; Kiousis, 2002; McMillan and Hwang, 2002). Because extra elements were added to the set of elements selected from the reviews, it may cautiously be concluded that the total set of elements represented in the instrument is as exhaustive as possible in the context of what we presently know about (objective) interactivity.

In an analysis of how earlier studies selected the dimensions of interactivity, the present study has made the distinction between *process* and *perception* as two different ways of how interactivity can be measured. When the level of perceived interactivity is measured, questions are asked to participants in a communication setting and the answers reflect subjective judgements of interactivity based on individual experiences in the specific setting. Participants may judge the level of interactivity in relation to earlier experiences in other communication settings. Therefore, the process of judging the level of perceived interactivity takes place in the head of individual participants. Although the output, the judgement itself, may be easy to measure, the process of how an individual makes that judgement may be difficult to assess. The new instrument developed in the present study looks at the other side of the coin: how can we determine the interactivity level of a communication situation by means of objective and observable criteria? Therefore, the instrument is designed to be used by researchers and (trained) coders, and it is aimed at usefulness and simplicity.

An advantage of the new instrument is that it does not focus on possibilities but on facts. Although there are examples of earlier studies that used words like

'can' or 'possibilities' in their definitions of interactivity (e.g. Downes and McMillan, 2000; Kiousis, 2002; Steuer, 1992), for an objective instrument it seems more logical to look at facts of interactivity than at possibilities of interactivity, because it may be that there are many possibilities for (a high level of) interactivity, but that the actual interactivity level may be very low, or that interactivity may even be absent, when the possibilities are not used by participants. Of course, it may also be useful to look at possibilities for interactivity in communication settings. When the discrepancy is determined between the possibilities of interactivity and the actual level of interactivity, it provides a basis for an analysis of *why* possibilities are not utilized. Such an analysis may be useful in, for example, testing new technologies designed for interactive learning. In a testing phase, the present instrument can be used to objectively determine which interactivity possibilities are used, and may then help to make changes in design, of which the effects can be determined in a next testing phase. In addition, the instrument can be used in experimental studies in which interactivity is the independent variable that may affect dependent variables such as learning, information processing, attitude change and mutual understanding between people.

Discussion may remain about whether interactivity is present in human–computer interaction (HCI). Many of the early studies (e.g. Cathcart and Gumpert, 1983; Rafaeli, 1988; Rice, 1984) have implicitly or explicitly assumed that interactivity is confined to communication between people, whether the communication is mediated or not. Nevertheless, most of the recent studies on interactivity and new technologies hold the basic assumption that HCI may also be interactive. Because the present study has chosen a definition for interactivity in which communicating 'parties' include machines or computers, HCI was also included as a situation that may be interactive. The prerequisite of third-order dependency, however, supposes that the first, second and third messages be related to each other. When an individual seeks information on the Internet via Google, the first action is typing a search string, the reaction is a list of hits provided by the search machine. If the person clicks on one of the hits, interactivity is at hand. However, if in the third action the person begins with a new search, interactivity has not taken place, because the third action was not related to the first and second. This simple example illustrates that, based on the selected definition and premise, not all types of HCI are interactive. In addition, searching the Internet via a computer without the co-occurrence of interpersonal communication (e.g. sending an email message to a web master) is not a communication situation that should be regarded as highly interactive. When our instrument is used to measure the interactivity level of such a situation, the score will indeed be low. HCI will get a higher score on interactivity when the computer can respond to more than just input through keyboard and mouse (e.g. verbal and/or visual input) and when it is combined with computer-mediated interpersonal communication (e.g. email and/or chatting).

The new instrument was designed so that the level of interactivity can be measured in an objective way. When the interactivity level of a communication situation is also measured subjectively, through for example a questionnaire administered to participants, the same communication situation will get two scores on

interactivity (provided that perceptional interactivity is measured quantitatively). Comparisons of the two scores in various communication situations will provide information about which of the elements in the objective instrument are dominant in how interactivity is perceived. Whereas in the objective instrument each element has the same weight, which is taken into account in the determination of the total score, it may be that future comparisons will show that some elements contribute more strongly than others to perceived interactivity. In addition, comparing objective and subjective measurements of interactivity offers the possibility of discriminative validation.

Although the objective instrument is designed to measure 'full' communication situations in which two or more persons may participate, the instrument can also be used for measuring the interactivity level for individual participants in a given communication situation. In some situations it may be better to use the objective instrument individually, because comparisons on an individual level do justice to the uneven interactivity levels that may exist between participants in the same communication situation. Another decision has to be made pertaining to how long a communication situation must be observed in order to make a proper measurement. Of course, some communication situations may last only five minutes whereas others may endure much longer time periods. The new instrument can be used in short- and long-term situations, but it must be noted that when a longer lasting situation is measured, the final interactivity score may be inflated, because the score takes into account the number of elements that have been present in a situation. When during a longer situation many elements are only temporarily present, the final interactivity score will be high, whereas the level of interactivity may have been low for most of the time. Therefore, it seems better to measure short segments of time. When short segments are taken as measuring units, and when a series of measurements are made, it is possible to determine that in a longer situation the interactivity level may fluctuate. In addition, when more measurements are taken into account during a communication situation, it may be more realistic to use the average of the different scores as indicator of the interactivity level for the full situation. The preference for measuring a series of short units of time instead of one long unit is of course not new and has been used in, for example, repeated observations of how family members interact with each other (e.g. Bakeman and Gottman, 1997).

A limitation of the present instrument may be that the obtained total score for interactivity is dominated by the number of persons that participate in a communication situation. As discussed before, when there are more active participants in a communication situation the interactivity score will probably be higher than when only one participant and a computer is involved. The maximum score (16) will only be reached if at least two parties participate actively in the communication situation, and it will be easier to reach if three or four parties are active in the same situation. The dependency on the number of participants may seem to be a limitation, but, on the other hand, interactivity may be regarded as a process of exchanging messages between people. When many people are actively involved in the exchange of messages, for example in a lively group discussion, the communication process

may lead to an output (e.g. decision, solution, attitude or conclusion) that is shared by all (or most of) the participants. Of course, in practice there is a limit to the number of participants who can participate actively in a communication situation. The interactivity level may be very high among three participants, whereas it will be difficult to achieve a high interactivity level among, for example, 300 participants. In the context of interactivity and democratic participation, nevertheless, Schultz (2000) has already suggested that although large interacting groups have little time to listen to each other, they have a much greater significance for society than small interacting groups.

Because the instrument only differentiates between the absence and presence of interactivity elements in communication situations and it could be suggested that within each element more levels may exist, to some critics the instrument may seem (too) simple and straightforward. We think, however, that the simplicity of the instrument is advantageous and in line with the scientific principle of parsimony. It was our intention to make the instrument easy to use and it cannot be denied that observing the absence or presence of interactivity elements is easy. The ease of observation makes it also possible to establish the reliability of the instrument through inter- or intra-coder agreement. If within each interactivity element many more levels were to be distinguished, reliability would become problematic. In the present context, in which no instrument for measuring interactivity is available, our choice was to develop an easy-to-use and reliable instrument as a first step and we leave open future steps of adjustment and refinement of the instrument.

As discussed earlier, the instrument should serve to objectively measure interactivity, which may in turn help to establish whether high levels of interactivity lead to positive effects on, for example, learning, attitude change and decision-making. Previous studies that have tried to establish the effectiveness of interactivity are difficult to compare, because researchers have used different definitions for interactivity. Moreover, because these studies have not used uniform instruments to measure interactivity, it is almost impossible to conclude whether interactivity is as effective as suggested by its supporters. The possibility of measuring the level of interactivity in an objective and standardized way may help to establish whether the claim that interactivity is a solution for problems caused by non-interactive communication is based on consistency in the empirical evidence.

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