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The Development of a New Objective Instrument to Measure Different Levels of Interactivity

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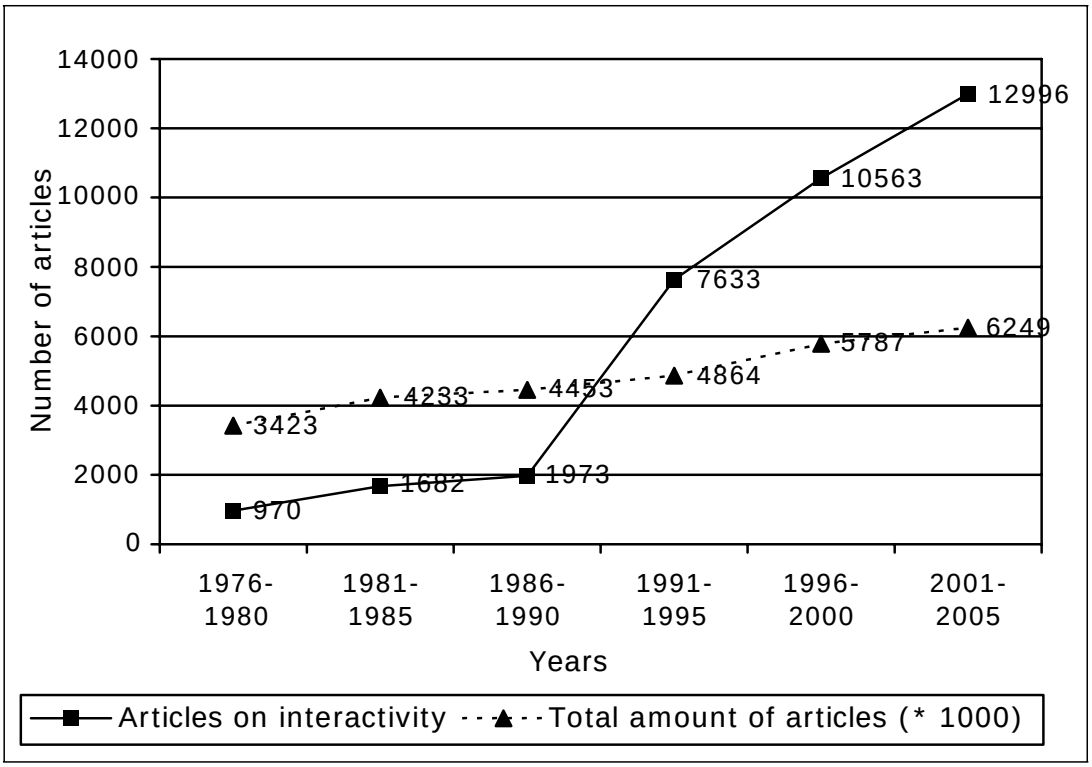
Abstract

Interactivity is a characteristic of communication situations that is drawing more and more attention. Many researchers suggest that communication is most effective if a high level of interactivity between participants is involved. As yet, however, there is neither consensus on how interactivity is defined, nor on how it can be measured. Some studies on interactivity refer only to computer-mediated communication, whereas others refer exclusively to mass media or face-to-face communication. The present study is aimed at finding an operational definition of interactivity that can be used in almost all communication contexts. To that end, a distinction will be made between how people perceive interactivity subjectively and how it can be measured objectively. Based on three recent reviews on the concept of interactivity, the study will propose an objective measurement instrument for interactivity that includes the scoring of a set of interactivity characteristics such as synchronicity, timing flexibility, control over content, and the physical presence of participants. In addition, the instrument includes the extent to which participants in a communication situation use their senses. For example, do participants use sight and/or hearing in the communication process? Using two examples of communication situations, the applicability of the new instrument is demonstrated by determining the level of interactivity regarding the set of characteristics in a parsimonious and quantitative way. Future studies can then establish how strongly the scores obtained with the objective instrument correlate with subjective perceptions of interactivity.

Introduction

Interactivity is one of the main concepts used in evaluations of possibilities for users of new media. As opposed to non-interactive media such as radio and television, newer technologies such as internet, e-mail and chat sessions 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 & Hwang, 2002). The past few decades have shown an increase in the attention for interactivity in scientific literature. A simple search in the Web of Science using the key words “interactivity” and “interactive” shows that before the 1980s the concept was seldom addressed whereas since then the number of articles in which interactivity is mentioned has increased much more strongly than the total number of articles included in the database (see Figure 1).

Figure 1. The increase in the number of publications about interactivity in comparison with the total amount of articles in the Web of Science database.



Notes. The terms "interactivity" and "interactive" were used as quick search strings in the Web of Science database. Results are categorized in subsets of five years. 1976 was chosen as the starting period because the Arts & 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 & Humanities Citation Index. The search was performed on November 20, 2005.

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 settings will result in more mutual understanding between users than non-interactive settings, because the communication process is more direct and open. In comparing information processing through traditional non-interactive media versus 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. The proclaimed advantage of interactive over traditional forms of communication is, however, contested by other researchers. Sundar, Kalyanaraman, and Brown (2003), for example, concluded in their effect study 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 assumed beneficial effects are being contested (e.g., Bailey, 1992) or acknowledged (e.g., Ghose & Dou, 1998; Wu, 1999).

Problematic in the discussions about the effectiveness of interactivity is that, despite of the growing amount 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) stated that: "Interactivity means different things to different people in different contexts" (p. 163). One reason why there is not an accepted definition of interactivity is that the concept has been adopted as a relevant phenomenon of their own by a wide variety of scientific disciplines such as psychology, computer

sciences, education studies, sociology, and communication science. But even within disciplines it seems difficult to bridge the gap between differences in opinions about the concept. An example among communication scientists is the discussion about the question of whether interactive communication is always considered as mediated or not (e.g., Walther, 1996; Walther & Tidwell, 1996). An additional problem in establishing a common definition may be that authors have emphasized certain elements or dimensions of interactivity as key elements whereas other dimensions of interactivity were degraded or neglected, with the result that theoretical and operational definitions are diverse and incoherent (e.g., Kiousis, 2002). However, an advantage of the many studies that have been conducted is that in recent years the concept has been addressed in review studies that attempted to get a full picture of the characteristics associated with interactivity (Downes & McMillan, 2000; Kiousis, 2002; McMillan & Hwang, 2002).

Based on these three review studies, the present study aims to (a) find a definition of interactivity that can be applied to the majority of the scientific disciplines, and (b) develop a new instrument to measure the different levels of interactivity. To achieve this, the present study will first provide a short chronological overview of influential studies on interactivity. Second, the study will address the question of how interactivity can be measured adequately. And third, after the presentation of the new measuring instrument its applicability will be demonstrated by measuring the level of interactivity in two common 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 in 1988. His definition of interactivity as being "… 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, p. 111), is frequently quoted and used as a primary basis for further theorizing. Bretz (1983) and Williams, Rice and Rogers (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 the previously introduced aspects, 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., e-mail, 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, Calder, & Iacobucci, 1998). A more general approach described interactivity particularly in a process-specific context. 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 provide 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). 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). Ha and James (1998) described interactivity as "… the extent to which the communicator and the audience respond, or are willing to facilitate, each other's communication needs" (p. 461). Jensen (1998) defined interactivity as "a measure of a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication" (p. 201).

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) analyzed how interactive communication may affect users, and under which conditions participants may feel they have control over the exchange of messages. Downes and McMillan (2000) stated that synchronous communication may be the most interactive form. In their eyes, interactivity increases when two-way communication enables all participants to actively communicate, 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 toward exchanging information than toward attempting to persuade. McMillan and Hwang (2002) developed a scale for measuring perceived interactivity by letting participants (N = 126) review web sites that were designed to induce low or high interactivity. In the field of advertising research, Liu and Shrum (2002) suggested that the influence of interactivity 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 & McMillan, 2000); process, function/features, and perception (McMillan & Hwang, 2002); structural and experiential features (Liu & Shrum, 2002); function/features and perception (Sohn & 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), these distinctions show a consensus in the dimension of perceived interactivity. And 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 which 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 above-mentioned 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 is 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, however, that the concept of perceived interactivity is of course always subjective. 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 & McMillan, 2000). Therefore, perceived interactivity is only one side of the concept of interactivity.

Measurement of interactivity as a process

An objective measuring instrument 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 consulting 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 interactive media systems. Finally, an objective measuring instrument may be used to validate a subjective instrument to measure interactivity.

A prerequisite for interactivity

Not all communication situations are interactive. To make a distinction between interactive and non-interactive communication, we have selected a prerequisite of interactivity based on Rafaeli’s (1988) definition of interactivity. According to Rafaeli (1988), 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 may the communication process be called interactive. This

prerequisite or condition for interactivity was later called "third-order dependency" (e.g., Kiousis, 2002). Therefore, when in a communication 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 a new objective measuring 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 interactivity independent of medium and content. 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 may 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 contents of messages can vary strongly, and they may be difficult to measure.

Definition of interactivity

The present study uses a definition of interactivity that is based on the definition proposed by Liu and Shrum (2002). Liu and Shrum have defined interactivity as follows: "The degree to which two or more communication parties can act on each other, on the communication medium, and on the messages and the degree to which such influences are synchronized" (p. 54). 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 & Hwang, 2002), 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 to measure interactivity independent of medium and content, we can leave out the second part of the definition developed by Liu and Shrum. The last part of their definition about synchronicity is also 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.

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 the possibilities that may not be used." Again, it must be noted that our definition presupposes the principle of "third-order dependency" (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 a communication situation differs in the level of interactivity, is determined by observing which elements of interactivity are actually present in a communication situation. The elements included in our measuring instrument are a selection of those included as dimensions or elements in the three review studies (Downes & McMillan, 2000; Kiousis, 2002; McMillan & 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 complete 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 will analyze which elements will be excluded from our instrument. In addition, we will 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 & Hwang, 2002), it must be acknowledged that it seems impossible to make a selection of elements that are exhaustive and exclusive. We will nevertheless try to prevent that elements are obviously inclusive by analyzing how earlier studies overlap 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) is 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 time, assuming that interactivity increases when less time elapses between exchanging subsequent messages (e.g., Kiousis, 2002; Downes & 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). Therefore, the proposed instrument uses the simple categories of *immediate* versus *later* reactions. 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 e-mail message. In cases when an answer is sent in reaction to an e-mail message which has been processed an hour (or a day) before, it will be called a later reaction. It may 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 medium: Both hardware and software may affect the transmission speed of a medium. Because the new instrument is aimed at determining the level of interactivity independent of medium, the reasons of why reactions are immediate or delayed will not be taken into account in the score for this element (see Table 1).

Timing flexibility. More or less in contrast with the idea that if less time elapses between sending and receiving messages the more interactive communication will be, there is the idea of the freedom to react to a message at one's own time: 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). Some communication situations allow little timing flexibility in processing messages (for example watching television), while other situations offer more (for example watching a video or answering an e-mail message). The new instrument recognizes situations in which all participants have control over timing (for

Table1. Elements of interactivity including category levels and scores.

Element	Category levels	Scores
Synchronicity	More than one party reacts immediately	2
	One party reacts immediately	1
	None	0
Timing flexibility	More than one party has the choice of timing	2
	One party has the choice	1
	None	0
Control over content	More than one party exerts influence on content	
	One party exerts influence on content	2
	None	1
		0
Number of additional participants	More than one additional participant	2
	One additional participant	1
	None	0
Physical presence of additional participants	More than one additional participant is physically present	
	One	2
	None	1
		0
Use of sight	More than one party uses sight	2
	One	1
	None	0
Use of hearing	More than one party uses hearing	2
	One	1
	None	0
Use of other senses	More than one party uses other sense(s)	2
	One	1
	None	0

Note. The first column represents the elements as indicators of interactivity; the second column provides the categorization for each element in three levels; the third column shows how the levels are scored.

example in communication through e-mail and chatting), and situations in which some (or one) of the participants have control while others have not (e.g., broadcasting agency versus viewers). In some communication situations none of the participants seem to have any room for timing flexibility in processing messages, for example when an immediate consulted decision has to be made.

Control over content. Although control is one of the most frequently mentioned elements in both theoretical and operational definitions of interactive communication (e.g., Downes & McMillan, 2000; Jensen, 1998; Liu & Shrum, 2002; Sohn & Lee, 2005; Steuer, 1992), the problem with this element seems to be that it consists of more than one component. The new instrument makes a distinction between two components that can be objectively measured: timing flexibility (see above) 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 & Dunwoody, 2001). In most situations participants can manipulate the content of messages, for example e-mail 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 e-mail message that is forwarded without adding to the content, or a web page read by an internet user. An example in which more than one party has 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 media, the setting of 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 & 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 man-made 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 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 absent, such as non-verbal cues and physical contact. 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 suggested that in most cases (unmediated) physical presence stimulates interactivity. This suggestion is based on the often-made assumption that face-to-face communication is the “standard” of interactive communication (e.g., 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 e-mail), 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 used, the richer the communication and the higher the level of interactivity (see also media richness theory, e.g., Daft & Lengel, 1986). In line with this reasoning, some of the new media 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 an "old" 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 & 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 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 include both mediated and non-mediated communication contexts. Whereas most e-mail 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 follow 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 no, one, or more than one party.

Use of other senses. Although until now mediated communication does not 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. Of course, all five senses may be used in face-to-face communication. Again, based on the idea 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 senses as indicators for the level of interactivity. The instrument does not include five separate indicators for each sense, because that would make the use of senses too dominant in the total score for interactivity.

Which elements were not included?

Direction of communication. There is a simple distinction between one-way and two-way communication (e.g., Bretz, 1983). Other authors distinguished three communication "directions": one-to-one, one-to-many, and many-to-many (e.g., Kiousis, 2002). Although determining the direction of communication may be important in analyzing 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 the level of interactivity. The fact that there may be one or more additional participants who actively join in the exchange of messages has already been included in the instrument (number of participants).

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). However, as discussed above, determining the degree to which later messages refer to earlier messages would in fact require a content analysis of a set of consecutive messages. Because our instrument was developed for easy use, content analysis of messages was 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 an indicator of interactivity (see above).

Elements of perceived interactivity. As discussed above, elements 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 objective instrument.

Two examples of scoring the level of interactivity with the new instrument

The first hypothetical situation is a simple exchange of e-mail messages between two participants. When participant A sends an e-mail 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 presumably 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 e-mail message); use of hearing 0 (if there was no audio notification when a message arrived); and, use of other senses 0. Therefore, the total interactivity score for this situation would be 6 (whereas the minimum score is

0 and the maximum 16). The total score would be higher in a situation in which the participants are both online exchanging e-mail messages and they are working on a joint message that is sent to another person, because higher separate scores would be assigned to synchronicity, control over content, and number of additional participants, respectively.

The second example is a situation in which a teacher has a highly interactive face-to-face discussion about a specific topic 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 (more than one 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 used also other senses). 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.

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 interactivity 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 new instrument was based on three reviews that have tried to give a full picture of the studies on interactivity (Downes & McMillan, 2000; Kiousis, 2002; McMillan & 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 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 the participants in a communication setting and the answers reflect subjective judgments 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 judgment itself, may be easy to measure, the process of how a judgment is made 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 & McMillan, 2000; Kiousis, 2002; Steuer, 1992), it seems more logical to look at facts of interactivity than at possibilities of interactivity. In measuring the level of interactivity objectively one should look at facts, 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 interactivity may even be absent, when the possibilities are not used by participants. Of course, it may 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 testing new technologies designed for, for example, 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 with the instrument in the 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 exist about whether interactivity is present in human-computer interaction (HCI). Many of the early studies (e.g., Cathcart & 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 media hold the basic assumption that HCI may also be interactive. Because the present study has chosen a

definition for interactivity in which "parties" communicate, 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 message be related to each other. When an individual seeks information on the internet via Google, the first action is the person typing in a search term, 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. 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 e-mail 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., e-mail 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 will supply 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 that is taken into account in the determination of the total score, it may be that comparisons will show that some elements contribute more strongly than others to perceived interactivity. Although the objective instrument is designed to measure "full" communication situations in which more than one person may participate, the instrument can also be used for measuring the interactivity level for each individual participant in a given communication situation. In comparing objective interactivity to perceptual interactivity, 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. When the interactivity levels of a large number of diverse communication situations are measured objectively as well as subjectively, the comparisons of the two interactivity scores will provide insight into which elements of interactivity lead to higher or lower perceived interactivity when they are absent or present. In addition, measuring the interactivity level of a large set of communication situations with both instruments provides information about the validity of each of the instruments.

It may be difficult to decide how long a communication situation must be observed in order to make a proper measurement. Of course, some communication situations may take only five minutes whereas others may last much longer. The new instrument can be used in short and long 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 is 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 & Gottman, 1997).

A limitation of the present instrument may be that the obtained total score for interactivity is dominated by the amount 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 dependence of the instrument 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 amount 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, three hundred 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.

As discussed before, 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. The present study, however, does not hold the pre-assumption that interactivity is always expected to lead to positive results or effects, because such an assumption may obscure an objective measurement of the effectiveness of interactivity. It must be noted that 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 many problems caused by non-interactive media is based on consistency in the empirical evidence.

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