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Adapting and personalizing the communication in a synchronous communication tool

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Abstract In this paper, we present a synchronous text-based communication tool, referred to as Adaptive Communication Tool (ACT), which provides capabilities for adaptation and personalization. ACT supports both the free and the structured form of dialogue. The structured dialogue is implemented by two types of Scaffolding Sentence Templates (SST); i.e. sentence openers or communicative acts. The capability of adaptation is considered in the sense of making suggestions for the supported form of dialogue and SST type and providing the most meaningful and complete set of SST with respect to the learning outcomes addressed by the collaborative learning activity and the model of collaboration followed by the group members. Also, ACT enables learners to have control on the adaptation by selecting the form of dialogue and the SST type they prefer to use and enriching the provided SST set with their own ones in order to cover their communication needs. The results from the formative evaluation of the tool showed that (i) the proposed dialogue form, SST type and the provided set of SST cover students' communication needs, (ii) the capability of personalizing the communication by selecting the desired communication means as well as by enriching the provided SST set satisfied students, and (iii) students used adequately both types of SST resulting into on-task and coherent dialogues.

Keywords adaptation, communicative acts, computer-mediated communication, personalization, sentence openers, structured dialogue.

Introduction

In collaborative learning settings, especially in computer-supported environments, there is no guarantee that the expected interactions that foster learning conditions will occur. Learners do not necessarily have the desired productive collaboration/communication skills (e.g. provide explanations, ask questions) (Soller 2001; Lazonder *et al*. 2003; Jermann *et al*. 2004) and have difficulties to develop metacognition on their own actions or to self-estimate the appropriateness of their participation. A general concern is to develop ways to increase the probability that learning conditions are hold, which favour specific interactions (Dillenbourg 1999). Learners need guidance and support to collaborate effectively and achieve the learning goals successfully. Furthermore, they seem to need feedback on their own actions, which could support awareness, metacognition and thereby self-regulation of their learning activity (Dimitracopoulou 2005). Therefore, a critical issue is how to develop an effective collaborative learning setting and how to monitor, evaluate and coach collaboration through efficient evaluation and scaffolding techniques (Barros & Verdejo 2000; Soller 2001).

Collaboration can be influenced anticipatively by *structuring* the collaborative process aiming to favour the emergence of productive interactions, or retroactively by *regulating* interactions (Dillenbourg 2002).

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These two approaches are complementary. Structuring collaboration aims at creating the appropriate conditions before the interaction begins, whereas regulating aims at supporting the collaboration/communication during learners' interaction (Jermann *et al*. 2004). The structuring of the collaborative process is achieved either by scripting collaborative activities or designing a dedicated communication tool following the *structured dialogue* (Dillenbourg 2002).

The structured dialogue may be fully or semi-structured, implemented through communication interfaces, which utilize the so-called locution or sentence openers. Sentence openers are predefined phrases to start a contribution to the dialogue and may be accompanied with additional text, completed by students (e.g. 'I disagree because . . .', 'I mean . . .', 'OK'). The advantage of using structured dialogue is twofold: (i) enhances the collaborative and learning process, and (ii) enables monitoring and interpretation of the ongoing dialogue and thus supports the development of appropriate regulation approaches (Jermann *et al*. 2004). To elaborate on the first advantage, various research efforts present empirical evidence on the benefits of sentence openers; the comparison of the structured approach followed in AcademicTalk (McAlister *et al*. 2004b; Ravenscroft 2007) with an unstructured approach clearly showed that the structured approach improved argumentation dialogue, influencing positively the educational benefits in terms of the task objectives; Baker and Lund (1997) showed that students using the structured interface produced about twice as much task–focused interactions and slightly more reflective interactions efforts than students communicating via free typewritten text. Also, Hron *et al*. (2000) came to the same results stating that dialogue structuring showed greater orientation on the subject matter, less off-task talk and more coherence in subject matter discussion. Soller *et al*. (1999) report that the subjects felt a high degree of engagement and although some of them found that having to choose a sentence opener was somewhat restrictive, they became more comfortable with the interface once they had the chance to experiment with it.

Despite the advantages of the structured dialogue, the sentence openers are not always used as intended, resulting in subsequent contributions that would not necessarily correspond to the discussion skill represented by the sentence opener (Robertson *et al*. 1998; Soller 2001; Dillenbourg 2002). Also, learners may feel restricted to the use of the predefined sentence openers (Lazonder *et al*. 2003). For this reason, it is argued that the sentence openers should enable the widest possible range of communication with respect to the learning task (Soller 2001) and should be derived from naturally occurring online text-based free dialogues (Lazonder *et al*. 2003).

Apart from the sentence openers, which are widely used in synchronous communication tools, asynchronous communication tools mainly use communicative acts (e.g. Knowledge Forum/CSILE (Scardamalia *et al*. 1994), DEGREE (Barros & Verdejo 2000), AulaNET (Gerosa *et al*. 2001)) in order to support the communication between learners in a structured manner. Communicative acts allow learners to make explicit the underlying goal of their contribution to the dialogue by just selecting an indicative label such as Proposal, Agreement. Weinberger *et al*. (2001) used message constraints and labels to implement 'cooperative scripts' designed to assist students in performing the roles of analyser and constructive critique. They found that cooperative scripts produced more equal participation among students within discussion groups, greater gain in individual students' knowledge transfer, and higher convergence in shared inferences between group members. Also, the studies of Jeong (2004) give indications that the use of message labels can help students sustain and advance discussion threads.

A number of synchronous communication tools have been developed [either embedded in a computer-supported collaborative leaning (CSCL) environment or as standalone tools] to support the dialogue through a structured communication interface. These systems differ in the forms of the dialogue they support, the presentation of the exchanged messages and the adaptation capabilities if any available. Most of these communication tools such as EPSILON (Soller 2001), C-CHENE (Baker & Lund 1996) and BetterBlether (Robertson *et al*. 1998) support only the structured dialogue form through sentence openers and present the dialogue carried out in a chronological order. The set of sentence openers provided is fixed without taking into account the underlying learning task and without giving students the possibility to extend the provided set of sentence openers with their own ones in order to cover their communication needs during the collaborative task. However, the results reported in Baker and Lund (1996)

indicate that the increase of task-oriented messages in case of the structured interface may be attributed to the task-oriented sentence openers that were available. Also, Soller (2001) noticed that student's role during the dialogue was reflected in the conversation act (i.e. sentence openers) usage; that is, while playing the role of a questioner, the student used a majority of conversation acts from the category Request (e.g. 'Can you tell me more . . .', 'Why do you think that . . .') and while playing the role of an advisor, he or she used a majority of conversation acts from the category Inform (e.g. 'I think . . .', 'To justify . . .'). In an attempt to strike a balance between offering just the right amount of support to foster interaction and allowing enough freedom for learners to verbalize their thoughts, some communication tools enable learners to write their opinion in a text-field without selecting a sentence opener. Conference MOO (Jermann 1999), Co-Laboratory chat (Lazonder *et al*. 2003) and the chat tool of LeCS (Rosatelli & Self 2004) enable learners to select between sentence openers and free-written messages to communicate. A different approach is followed in the AcademicTalk tool (McAlister *et al*. 2004a; Ravenscroft 2007) which attempts to guide learners by prompting them to select the appropriate sentence opener with respect to the currently used sentence opener resulting to sequences of legitimate argumentation. Regarding the form of dialogue, Jermann (1999) states that students prefer to use the free form when the message is related to management while the task and strategy contributions are more often expressed by using sentence openers.

The research work presented in this paper aims to address the issue of adapting the communication to the underlying collaborative learning setting and enabling learners to have control on the communication. The so-called ACT (Adaptive Communication Tool) tool aims at promoting the cultivation of cognitive and communication skills and guiding learners appropriately during their communication in terms of:

- *Adapting the communication with respect to the collaborative learning setting*: ACT supports both the free and the structured form of dialogue; the structured dialogue is implemented either through sentence openers or communicative acts [hereafter, we use the term Scaffolding Sentence Templates (SST) to refer both to sentence openers and communicative acts]. Depending on the learning outcomes (i.e. cognitive skills) addressed by the collaborative learning activity and the model of collaboration followed by the group members, the tool proposes the most suitable form of dialogue and SST type (i.e. sentence openers or communicative acts) and provides the most meaningful and complete set of SST adapted with respect to the collaborative learning setting.
- *Enabling learners to personalize the communication*: the tool offers learners the possibility to have control on the adaptation by enabling them to negotiate on and select the form of dialogue (i.e. structured vs. free dialogue) and the SST type they prefer to use and enrich the provided SST set with their own ones in order to cover their communication needs.
- *Regulating the communication*: ACT monitors and analyses the interaction at various levels (quantitative and qualitative analysis is supported) and provides alternative and complementary representations of the interaction analysis results as well as proposes remedial actions to guide learners.

The work presented in this paper focuses on the first two issues elaborating on the adaptation and the personalization that ACT supports. In the next section, a description of the ACT tool is given focusing on the design principles followed, the realization of the communication, and the capabilities offered for adaptation and personalization. The results from the formative evaluation of the ACT tool are discussed, with respect to the adaptation and the personalization it supports. The paper ends with concluding remarks and further research directions.

Design principles of ACT

One of the primary concerns in the design of ACT was to provide the most appropriate means for learners' communication depending on the collaborative setting under consideration. To clarify, the term collaborative setting refers to (i) the learning activity under consideration, that is the learning outcomes addressed in the context of the activity, and (ii) the role that learners may undertake during their collaboration, that is learners may act equivalently or they may undertake specific roles.

As mentioned above, the structured dialogue through sentence openers seems to have positive results in the

cultivation of communication skills and in the achievement of the learning goals while the option of communicating using either the structured form or the free form gives learners the possibility to express themselves on their own words (Jermann 1999; Lazonder *et al*. 2003). Dimitracopoulou (2005) asserts that the free chat interface that allows unstructured synchronous dialogue seems to be more appropriate during the initial brainstorming phase of problem-solving, the eventual decisions regarding task distribution among different members, etc. Taking these as granted, ACT tool has adopted the two forms of dialogue, structured and free form and two types of SST, sentence openers and communicative acts for the realization of the structured dialogue. We decided to adopt communicative acts that are used in asynchronous communication tools as they also guide the dialogue, promote the cultivation of communication skills and enable the development of monitoring and regulation mechanisms. Sébastien and Leroux (2002), in the evaluation of their SPLACH tool, which comprises asynchronous and synchronous conversation tools with communicative acts, showed that students much appreciated the use of communicative acts and they used them adequately. Also, from a series of experiments that we carried out, it seems that learners prefer communicative acts as they believe that they are not restricted to a predefined sentence starter and they have the flexibility to start their message on their own words and just denote their intention by selecting a label (i.e. communicative act) for their message (Gouli *et al*. 2003; Gogoulou *et al*. 2004; 2005).

Towards the direction of examining the open research question of whether sentence openers can be tailored to the topic of conversation (Lazonder *et al*. 2003) and support the most appropriate communication means with respect to the underlying learning setting (Soller 2001), ACT tool adopts the concept of adaptation and attempts to realize it in the context of synchronous communication tools. Jonassen and Grabowski (1993) distinguish between two approaches for adaptation: adapting instruction to learner characteristics for each learning outcome or alternatively adapting instruction for all learners to meet the requirements of the task. Taking into account that the learning task addresses specific learning outcomes that require the use of different skills (Jonassen & Grabowski 1993), adaptation in the context of ACT is considered in terms of providing the appropriate communication means to develop the desired skills with respect to the learning activity. In this sense, ACT supports adaptation of the form of dialogue and the type of SST to the learning outcomes addressed by the collaborative activity. Moreover, the adaptation attempts to guide learners when the collaboration model followed in the context of the activity implies specific roles to be undertaken by the group members. As noticed by Soller (2001), when learners play a specific role, they tend to use conversation acts (i.e. sentence openers) from those categories that best fit the responsibilities of their role; therefore, it is considered essential to accommodate the assigned roles in the provision of the SST set. To this end, the adaptation is realized at two levels: (i) at the level of proposing the form of dialogue and the SST type that are considered more appropriate with respect to the underlying learning setting, and (ii) at the level of providing the most suitable set of SST in case of structured dialogue. However, in order to suit the needs and preferences of individuals, personalization is also supported. As explicitly stated in Baker *et al*. (2001), it could be preferable to build in CSCL systems the possibility that students can adapt and negotiate tools to their perceived needs. Personalization concerns the degree of learner control over the system decisions (Snow 1980) and may vary and take place at the beginning of the interaction and/or during the interaction. ACT enables learners to intervene both at the beginning of their interaction with the tool by selecting the form of dialogue and the SST type they prefer to use as well as during their communication by enriching the provided SST set with their own ones in order to cover their communication needs.

Summarizing the above issues, ACT aims (i) through adaptation to foster the cultivation of the desired skills with respect to the learning outcomes and the collaboration model addressed in the context of the collaborative activity, increase task-oriented behaviour, and prevent floundering, and (ii) through personalization to support learner control on the adaptation towards to a more individualized communication.

Modeling collaborative learning setting in ACT and communicating with ACT

In ACT, the collaborative setting includes the activity, which may have one or more subactivities and the collaboration model, which determines the number of the group members, whether the members are going to

collaborate having the same duties or undertaking different roles, the duties of each role and the role that each member undertakes as well as who is going to act as the moderator of the group (one of the group members acts as the moderator, being responsible for the coordination of the group process, the summarization of the debate and the submission of their answer). The collaborative learning activity and subsequently its subactivities serve a specific learning goal, which is further analysed to learning outcomes that may be classified to one of the four levels [i.e. we have adapted the six categories of cognitive processes proposed in Mayer (2002)] Comprehension level (Remember+Understand), Application level (Apply), Checking-Criticizing level (Evaluate) and Creation level (Analyse+Create). Moreover, there are cases where a collaborative learning activity may aim to the discussion of a topic, brainstorming, etc., addressing no specific level of learning outcomes.

Taking into account the work of Johnson and Johnson (1994) and Soller (2001) in defining Collaborative Skills Categories/Taxonomies and assigning sentence openers to collaborative skills as well as the results of the three empirical studies that we conducted (Gouli *et al*. 2003; Gogoulou *et al*. 2004), we defined the following main discourse categories: Proposal, Opinion, Question, Reason, Clarification, Agreement, Disagreement, Inference, Motivation (i.e. stimulating interlocutors to participate), Need (i.e. asking for help/support) and Social Comments (i.e. characterizing off-task messages). Also, combinations of the above-mentioned discourse categories are used (e.g. Proposal and Reasoning). Inspired by the typology of communicative acts proposed by Bunt (1995) (i.e. task-oriented and dialogue control acts) and used by Jermann (1999) and Baker and Lund (1997), we distinguish three categories of SST:

- *Cognitive-oriented SST*: SST dedicated to the cultivation of cognitive skills in accordance with the level of the learning outcomes addressed by the activity (e.g. the sentence openers: 'I propose', 'I agree with'; the communicative acts: 'Proposal', 'Agreement') or the skills implied by the roles assigned to the group members,
- *Communication-oriented SST*: SST facilitating the communication and the social interaction (e.g. the sentence openers: 'I don't know. Can you help me?', 'I need time to think'; the communicative acts: 'Social Comments', 'Comments on the Activity'); these SST are independent from the learning setting of the activity, and
- *Moderator-oriented SST*: a subset available only to the moderator of the group (e.g. the sentence openers: 'We conclude that the answer is', 'Let's move on to the next question'; the communicative acts 'Final Answer', 'Group Coordination').

For the determination of the most appropriate sets of the SST, a research-based approach was followed; the supported sets of the SST have resulted from the analysis of the text-based free dialogues and the feedback received from the learners participated in the empirical studies (Gouli *et al*. 2003; Gogoulou *et al*. 2004).

Figures 1 and 2 present the main screen of ACT at the communication mode where all group members are logged in. The main screen consists of the following areas (Fig 1):

- The *Dialogue Area*, which shows the dialogue that has taken place. The messages are recorded, numbered and presented in a chronologically sent order. Each dialogue message has the form: [message_number] [sender]: [message composed by the sender].
- The *Message Composition Area*, which enables learners to construct the desired message on the basis of the SST provided.
- The *Message Submission Area*, which enables learners to submit the message to all or to selected members of the group.

During their communication, learners may have access, through the toolbar or the menu, to (i) the Dialogue Tree, where the sequence of the messages is presented according to the reference message and learners have feedback in visual form of any messages that should be answered, (ii) the facility of managing their Personal Phrases (see section 'Personalizing the Communication'), (iii) the results of the analysis of the dialogue showing in graphical form their own and their interlocutors' participation with respect to the underlying discourse categories, (iv) the Personal Guide that gives advise for the promotion of their communication and cultivation of the desired skills, and (v) various information kept in the Learner Model (LM) or Group Model (GM) such as learner's (or group) participation behav-

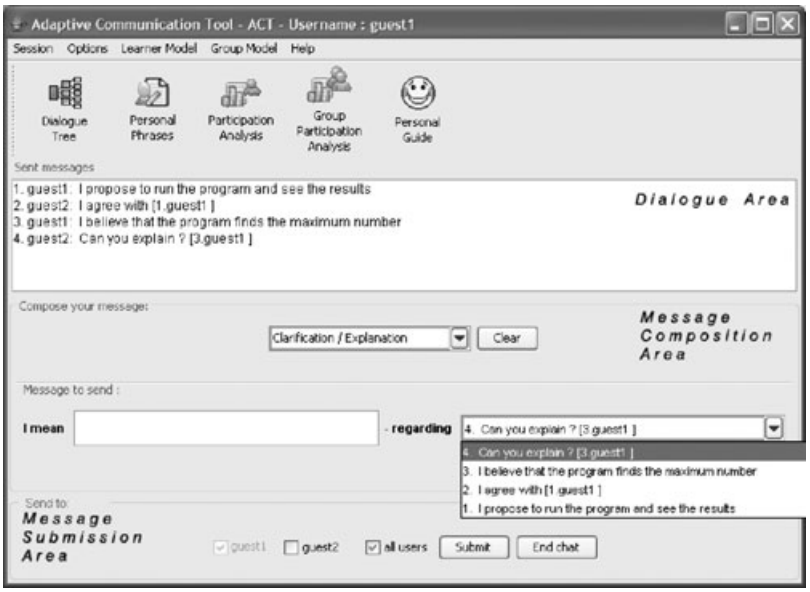

Fig 1 A screen shot of ACT in communication mode where the dialogue is carried out through sentence openers.

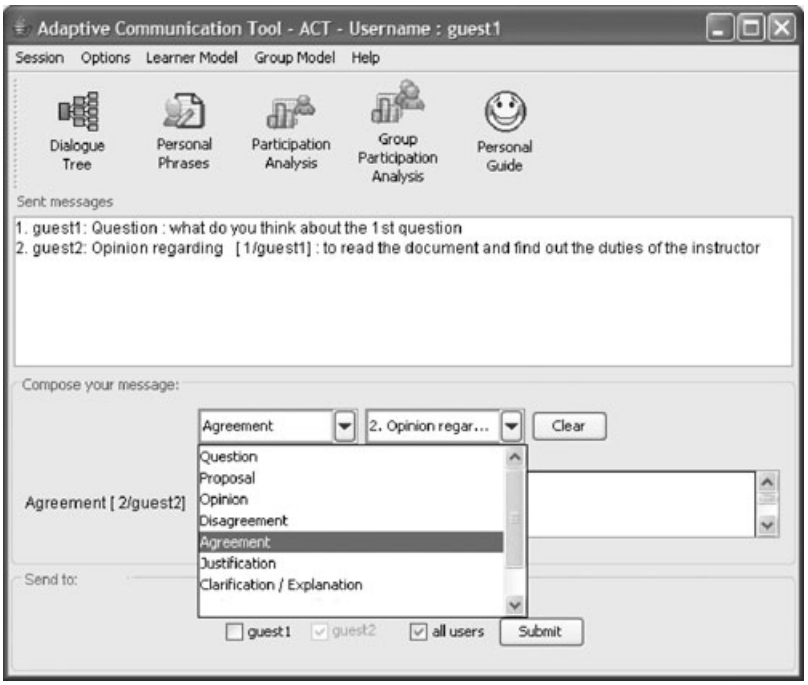

Fig 2 A screen shot of ACT where the dialogue is carried out through communicative acts.

iour with respect to the discourse categories of the message contributions, learner's defined SST.

In the Message Composition Area, learner has access to the list of sentence openers (or communicative acts) and can construct his or her message by filling in the required arguments depending on the sentence opener (or communicative act) template [a comprehensive description of the available templates is given in Gouli *et al*. (2005)]. For example, in Fig 1, the learner 'guest1' has selected to use the sentence opener 'I mean . . . – regarding . . .' where the first argument has to be filled in by the learner in order to explain his opinion while the second argument is a reference message and the tool gives the possibility to select the desired one from the list of messages that have been exchanged. Figure 2 shows the use of communicative acts; the

learner 'guest1' has selected to use the communicative act 'Agreement' from the available list of communicative acts (e.g. Question, Proposal) and make a reference to the second message sent by learner 'guest2'.

Adapting the communication

As stated above, the adaptation is considered in the sense of making suggestions for the form of dialogue and the SST type and providing the most meaningful and complete set of SST with respect to the collaborative setting. We followed a research-based approach and three qualitative empirical studies were conducted; the results of the studies drew implications about the form of the dialogue and the type and set of the provided SST (Gouli *et al*. 2003; Gogoulou *et al*. 2004). In summary (Gogoulou *et al*. 2005), when the learning activity addresses learning outcomes of a specific level or implies specific roles to the group members, then the structured form of dialogue is proposed in order to foster interaction in the desired directions and support the provision of feedback/guidance through the implemented regulation mechanism. In the context of learning activities that ask learners to discuss/exchange ideas on a specific topic, the free form is considered more suitable. Regarding the type of SST, we propose the sentence openers for the Comprehension, Application and Checking-Criticizing levels of cognitive skills as they are more concrete and can be identified and assessed more easily. In the case of the Creation level and when the model of collaboration implies different roles, the communicative acts are considered more appropriate, as for higher order cognitive skills, it suffices to guide/assess learners in terms of their intention/action.

Taking into account the results of the studies, we determined, revised and enriched the set of sentence openers and communicative acts making available a reasonable set for the cultivation of the desired skills. The set of sentence openers/communicative acts that is adapted concerns only those dedicated to the development/cultivation of cognitive skills (i.e. cognitive-oriented SST); the rest are not affected and are available in all cases. Thus, the ACT tool relates (i) the level of the learning outcomes and the models of collaboration to a specific form of dialogue and SST type, and (ii) the SST to specific levels of learning outcomes and roles implied by various collaboration models. In any case, the teacher may proceed to modifications and set the desired relations (e.g. he or she may determine that communicative acts are proposed for all levels of learning outcomes).

In case the structured dialogue is selected, all group members have at their disposal the same set of SST if they collaborate having the same duties. For example, in case the activity addresses learning outcomes of the Comprehension level, then all members may use sentence openers like 'I propose', 'I agree' while in case the activity addresses learning outcomes of the Checking-Criticizing level, then all members have at their disposal sentence openers like 'I propose . . . because . . .', 'I agree . . . because . . .' urging them to justify their point of view. In case a model of collaboration with roles is followed, the provided SST are different for the group members fulfilling the corresponding roles appropriately. For example, in the case of the 'Driver-Observer' model, the 'driver' uses communicative acts like 'Proposal', 'Clarification-Explanation', 'Justification' and the observer communicative acts like 'Question', 'Opinion'.

Personalizing the communication

In the context of personalizing the communication, ACT enables learners to negotiate on the form of dialogue and the SST type they prefer to use. Specifically, learners can discuss during the login phase and decide in common on the means they prefer to use for their communication (e.g. ACT may propose to learners the free form of dialogue but learners may decide to use the structured form with sentence openers). The tool informs and explains to group members about the proposed form of dialogue and the proposed SST type. Also, the tool assists learners in the negotiation process, by supporting accessibility to the corresponding LM and GM in order to become aware of their communication preferences/selections. Once learners select the desired form of dialogue and the desired SST type, they enter into the communication mode and have to communicate/collaborate through the communication means they selected; it is not possible to switch between the two forms of dialogues and the two types of SST while working on an activity.

Despite the efforts of determining and providing the most complete set of SST, it might be fruitful to allow learners, during their communication, to define their own SST in case the available ones do not cover their

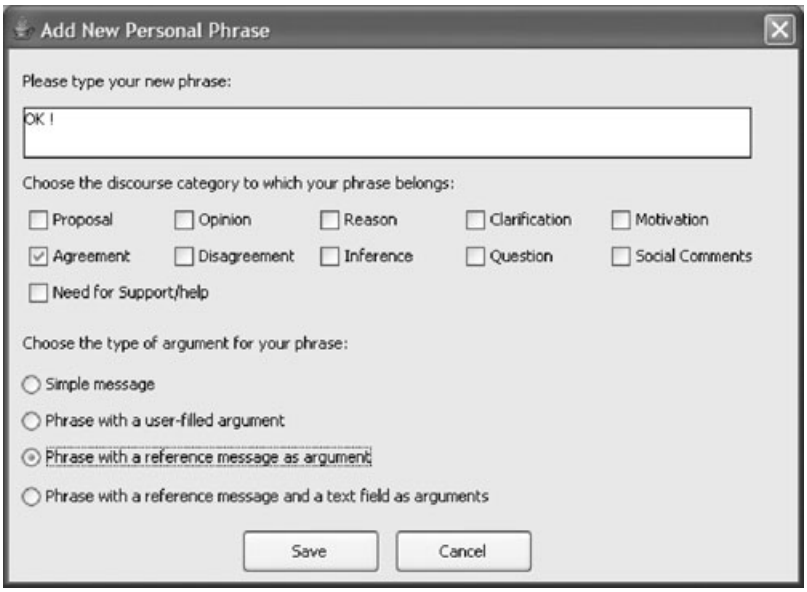

Fig 3 Definition of a personal phrase (Scaffolding Sentence Template).

needs. The learner's defined SST are part of his or her LM and become available each time he or she uses the ACT tool. For each personal SST, the learner defines the text to be displayed, the discourse category (e.g. Proposal, Question) and the accompanied arguments; in Fig 3, the learner 'guest1' has defined the sentence opener 'OK!' belonging to the discourse category of Agreement and having as argument a reference message. The arguments and the discourse categories defined by the learner are used for the analysis of the dialogue during the regulation process.

Although, this capability enables learners to articulate their thoughts on their own words, it may be argued that learners' defined SST may be wrongly set (e.g. wrong selection of the underlying discourse category). But as the regulation mechanism analyses also learners' SST, the produced feedback may help them to reflect on their definitions and revise them (e.g. if a learner has set the discourse category of his or her personal SST as Proposal and uses it as Agreement/Disagreement following an interlocutor's opinion, the feedback provided by the regulation mechanism may indicate that it is wrongly used, explaining that an opinion should be followed by an agreement, a question, etc.). Besides, any form of personalization is considered essential as it provides learners the possibility to develop responsibility for their learning choices and intervene and guide instructional decisions (Kay 2001). In the next section, we discuss further the above issue giving indicative examples of how students used the specific capability and the mis-settings that were observed.

Empirical evaluation

Research questions

For the evaluation of the ACT tool, we carried out four studies. In the first study reported in Gogoulou *et al*. (2005), learners acted equivalently and used sentence openers or communicative acts for their communication following the suggestions made by the adaptation mechanism of ACT. In summary, the results of this study showed that (i) students had no difficulties in using the provided SST but they proposed grouping of SST in order to be more easily accessible (students' suggestion was implemented in the revised version of the tool in terms of the underlying discourse categories), (ii) the adaptation framework proved to be appropriate regarding the provided set of the SST, and (iii) the capabilities of enriching the predefined set of SST and presenting the dialogue in tree structure were considered useful.

The rest three studies that are reported in this paper are complementary and have been designed to investigate the following research questions:

- Is the proposed form of dialogue (free or structured), type of SST (sentence openers or communicative acts) and set of SST in accordance with students'

preferences? Which are the students' preferences? (the second and third study)
- Is the capability of having control on the adaptation and personalizing the communication considered useful? (the second and third study)
- How students used the capability of enriching the provided set of SST with their own ones? (the fourth study)
- Are the dialogues on-task and coherent? Do students make 'good' use of the provided SST? (the second and third study)

The evaluation is based on students' subjective estimations revealed from their answers to questionnaires, on the data kept in their LMs and on the analysis of their dialogues.

Procedure – subjects

The second study was carried out during the spring-semester of the academic year 2004–2005 in the context of the postgraduate course of 'Distance Education and Learning', and the third and fourth ones during the winter semester of the academic years 2005–2006 and 2006–2007 respectively in the context of the undergraduate course of 'Didactics of Informatics'. In all cases, the students participated in a lab session after the final exams of the semester. Each lab session lasted 2.5 h. The participants were informed that their participation and active involvement would count towards their overall mark. In total, 80 students participated in the three studies; in the second study 22 students in dyads, in the third study 26 students in dyads and two triads and in the fourth study 26 students in dyads. All the students had little experience in using a synchronous communication tool.

Before their participation in the study, the students attended one training lesson, which lasted 3 h, in a conventional classroom aiming to introduce the concepts of the structured dialogue, the sentence openers and the communicative acts and the capabilities of the ACT tool for communication, adaptation and personalization.

Task – materials

In all studies, the working sheet included (i) two introductory activities enabling students to explore the facilities of the tool and become familiar with the use of sentence openers and communicative acts; the students communicated having the same duties, (ii) a collaborative learning activity following a specific collaborative framework; this activity constitutes the source of the analysis for drawing results, and (iii) a questionnaire, including multiple choice and open questions, asking students to express their opinion about the proposed form of dialogue, the provided set of SST, the interface design, the usefulness of the facilities provided and to recommend any improvements.

In the second study, for the elaboration of the collaborative learning activity, the group members were assigned specific roles (i.e. the 'teacher' and the 'student'). The students communicated following the suggestions resulted from the adaptation framework; that is, they communicated using the structured dialogue implemented through communicative acts where each member had available a different set of communicative acts dedicated to the responsibilities of his or her role. In the context of the collaborative learning activity of the third study, the group members collaborated equivalently in order to evaluate a given lesson plan. For the purposes of the experiment, six groups communicated through structured dialogue with sentence openers (SD/SO), four groups through structured dialogue with communicative acts (SD/CA) and five groups used the free dialogue (FD). Finally, in the context of the collaborative learning activity of the fourth study, the group members also collaborated equivalently in order to evaluate a lesson plan designed by one of their peers. From the 26 students, 12 communicated using sentence openers and the rest 14 using communicative acts.

All the dialogues were automatically logged on the ACT server in two forms: in chronological sent order (Fig 4) and in tree form where the messages are recorded in tree structure according to the reference message (Fig 5).

Results – discussion

In the following, we discuss the results revealed from the experimental studies with respect to the research questions posed.

1. gradX(29/06/2005 19:20:57) *Question:* Do you believe that Distance Education follows Modular System?
2. gradX (29/06/2005 19:22:52) : *Question:* Why don't you answer?
3. gradY(29/06/2005 19:23:05) *Proposal with Argument:* No, since Modular System is a tool for Open Education.
4. gradX(29/06/2005 19:24:44) *Question:* Please fill the following proposition: "Distance Education ... Open Education"
5. gradY(29/06/2005 19:26:17): *Proposal:* Can you help me?
6. gradX(29/06/2005 19:27:16) *Answer:* try to find the relation between the two concepts, if one of them involves the other one.
7. gradY(29/06/2005 19:28:24) : *Proposal:* Distance Education characterizes Open Education
8. gradX(29/06/2005 19:30:28) *Disagreement* [7.gradY]: Distance Education is not a characteristic of Open Education.
9. gradX(29/06/2005 19:31:08) *Question:* Which one of the two concepts do you think that is superset (wider)?
10. gradY (29/06/2005 19:31:54) *Proposal:* I think the concept of Open Education
11. gradX(29/06/2005 19:33:00) *Agreement* [10.gradY]: You are right.

Fig 4 Excerpt 1 gives a representative dialogue episode in chronological sent order where the two students use different communicative acts according to their role in the context of the second study.

1. stdZ(24/02/2006 12:49:51): *I believe that* the approaches used are quite good.
   __2. stdW(24/02/2006 12:50:33): *I agree with* [1.std01087] and we should use it as a criterion.
3. stdZ(24/02/2006 12:52:30): *I propose* to define as first criterion "how the educational goals are achieved" and as a second criterion "the time planning for the two activities".
   __4. stdW(24/02/2006 12:52:50): *Very good idea* [3.stdZ]
   __5. stdW(24/02/2006 12:53:06): *We conclude that the answer is* [3.stdZ]
      __6. stdZ(24/02/2006 12:53:24): *I agree with* [5.stdW]
7. stdZ(24/02/2006 12:54:56): *I believe that* an additional criterion could be whether the activities fit the students.
   __8. stdW(24/02/2006 12:55:44): *Can you explain?* [7.stdZ]
      __ 9. stdZ(24/02/2006 12:56:16): *I mean that* we could use a criterion concerning the use of examples and tasks; whether they are compatible to the students' knowledge level – *regarding* [8.stdW].
10. stdW(24/02/2006 12:55:44): *I propose* to use this criterion.

Fig 5 Excerpt 2 presents a dialogue episode in tree form where the two students use sentence openers in the context of the third study.

Is the proposed form of dialogue, type and set of SST in accordance with students' preferences? Which are the students' preferences?

As far as students' opinion on the provided set of SST is concerned (students' answers to relevant questions of the questionnaire were examined), it seems that the predefined SST covered their communication needs. The results of the second study complement the results of the first study discussed in Gogoulou *et al*. (2005). A total of 86.5% of the students characterized the provided set sufficient, while a percentage of 77.3% mentioned that the use of the specific SST facilitated their communication. Regarding the adaptation of the SST to the different roles of the collaboration model, students have various views; half of them (50.1%) believe that the provided SST should be different for the two roles in order to cover the duties of each role while 22.7% of the students consider the adaptation of the SST to the roles as indifferent. A small number (27.2%) states that all group members should have the same set of SST regardless of the assigned roles so that all members feel equivalent. From their comments while justifying their opinion, it seems that when they acted as 'students' asking 'teacher' questions for clarifications/explanations, they felt restricted in comparison with their interlocutors (i.e. 'teachers'), as they did not have at their disposal the communicative act 'Proposal' to make proposals.

As far as students' preference of the form of dialogue is concerned, it seems that the results slightly incline towards the structured form (59.4% prefer the structured form while 40.6% the free form). Regarding the SST type, although all students had the chance to use both types of SST during the introductory activities, their preference seems to depend on the SST type that they used in the context of the main activity. It is worthwhile mentioning that the students who used the free form of dialogue prefer communicative acts. According to their comments, the main reason for preferring communicative acts is that they consider more convenient and friendly to make a selection in order to characterize and compose the message on their own words instead of trying to select the most appropriate sentence opener and adapt their message to the predefined sentence starter. The above findings are taken as indications for students' preferences; to draw safer results, it is necessary to have the same sample of students to use the tool for long periods of times in the context of different activities that propose different types of SST in order to examine their preferences in terms of the tool suggestions and the context of the activity.

Is the capability of having control on the adaptation and personalizing the communication considered useful?

Students appreciated the personalization of their communication. More specifically, regarding the capability of intervening in the adaptation by selecting the desired dialogue form and SST type, the students of the third study (84.4%) mentioned that it is useful to be able to make your own selections. Also, the students of the second study (77.3%) considered useful the capability of defining their own SST; a percentage of 22.7% commented that the provided set of SST is sufficient; therefore, it is not necessary to have such a capability. This result is also verified from the analysis of their dialogues and the examination of the data stored in the LMs; only one student out of the 22 students participated in the second study defined the SST 'Yes, teacher' as he wanted to express his agreement to the teacher's opinion/comments, although the communicative act 'Agreement' was available.

How students used the capability of enriching the provided set of SST with their own ones?

The results of the second study regarding the capability of enriching the provided set of SST were considered rather limited as students communicated following specific roles. Therefore, in the context of the fourth study, we decided to further investigate this capability and examine how it is used by students who act equivalently and use either sentence openers or communicative acts. The analysis of the LMs of the 26 students participated in the study revealed the following:

- Four out of 12 students who used sentence openers defined also personal phrases while none of 14 students who used communicative acts used this capability; the total number of the personal defined sentence openers was 17.
- Sixteen out of 17 personal phrases were correctly defined as far as the discourse category is concerned. One student defined wrongly the word 'No' as Opinion; looking closer to the dialogue he contributed, we observed that he used 'No' followed by the phrase 'I think . . .' only once as an answer to his interlocutor's question of whether he has any idea.
- Three out of the 16 phrases that were correctly defined were characterized as activity specific. It seems that two out of the 12 students who used sentence openers, wanted to have at their disposal phrases related to the context of the activity, e.g. 'What grade do you propose?'. These phrases could be avoided as the students could use the sentence opener 'May I ask . . .' and complete with the message they wanted. The rest (13) phrases from the 16 correctly defined could be also avoided as their underlying intention was the same with some of the available sentence openers (e.g. the personal phrases 'Very good', 'OK', 'You are right' have the same intention as the sentence opener 'I agree . . .' and could be avoided).

From the above, it may be argued that students feel the need to add phrases when they use sentence openers, can correctly define their own phrases, and the user-defined phrases could be avoided as there are available predefined SST with the same underlying intention.

Are the dialogues on-task and coherent? Do the students make 'good' use of the provided SST?

The examination of the dialogues of the second and the third studies showed that students exchanged on-task messages and they tried to use correctly the provided SST. More specifically, a thorough analysis of the dialogues recorded in the third study was carried, showing that almost all messages were on-task (453 out of 461); seven of the off-task messages were observed in the dialogue carried out by one of the FD groups. All students used correctly the provided SST; only in five out the 274 messages, incorrect use of the SST was recorded. More specifically: (i) two cases show that students used the sentence opener 'I think . . .' or 'I propose . . .' instead of 'I agree . . .' to express their agreement (e.g. see the tenth message of Excerpt 2 in Fig 5, where the student stdW used the sentence opener 'I propose' instead of using 'I agree' and making reference to the seventh message), (ii) one student used the sentence opener 'Can you explain . . .' instead of 'May I ask . . .', (iii) one student characterized his contribution as 'Proposal' instead of using the communicative act 'Need for Support', and (iv) one student, acting as moderator, used the communicative act 'Final Answer' even though he wanted just to express his agreement. These misuses may be characterized as accidental.

As far as the acceptable/non-acceptable sequence of the messages is concerned, the students who communicated through the structured form (SD/CA and SD/SO

groups) tried to follow their interlocutor's message, to express their point of view by asking questions for clarifications, agreeing or disagreeing and trying further to elaborate on their opinion/proposal when they were asked to provide explanations/justifications. The degree of participation was equal and all members attempted to promote the discussion. This observation is also verified by some students' attitude to elaborate further on their agreements or disagreements and make more comprehensive their opinion; for example, in the second message of Excerpt 2, student with username stdW not only agrees with stdZ's belief but also expresses his opinion to use it as a criterion. The non-acceptable sequence of messages is attributed to the excessive use of SST denoting opinion or proposal instead of approval or disapproval. Particularly, this trend is slightly higher in the case of sentence openers (21.1%) in comparison with communicative acts (13.1%). The excessive use of proposals/opinions led to 'flat' dialogues where the depth of the dialogue subtrees did not exceed the two.

Regarding free dialogue, the non-acceptable sequence of messages is becoming even higher. In total, 40.1% of the total messages were scrappy; the students either let their interlocutor's messages to pass over and they elaborated on a different issue or they tended to express their opinion without making a clear reference to their interlocutor's message or they kept writing messages without waiting for their interlocutor's answer. Also, this flow of messages did not lead to comprehensive dialogues; it was quite hard to follow the dialogues and draw conclusions about the groups' answer to the activity tasks, whether they share common views about the issues discussed and whether they have reached a common acceptable decision. In contrast, in one case where the phrases used were the same or resembled the sentence openers provided by ACT, the corresponding dialogue was more comprehensive and coherent (in that group only three out of the 36 messages were characterized as non-acceptable sequence). It is also worthwhile mentioning, that in two free dialogues, the students tried to avoid rewriting their interlocutor's message when they wanted to make a reference to that message, and used the corresponding message number (facility that ACT supports in case of the structured form of dialogue).

In order to examine whether the form of dialogue has any effect on the coherence of dialogue (i.e. whether the sequence of messages is influenced by the form dialogue), a chi-squared test was conducted considering the three groups (SD/CA, SD/SO and FD). The observed chi-squared value indicated that the sequence of messages depends heavily on the form of dialogue ($\chi^2 = 28.92$, d.f. = 2, $P < 0.05$). To further examine the relationships between the three cases, *t*-tests were conducted for pairs of groups. Specifically, the statistical analysis showed that the SST type does not seem to influence the coherence of the dialogues; the difference between SD/CA and SD/SO is insignificant as resulted by the two-tailed *t*-test ($t = -0.970$, $P = 0.360 > 0.05$, d.f. = 8). This result confirms the above-mentioned observation that in both cases the non-acceptable sequence of messages was quite small. On the contrary, the form of dialogue seems to influence the sequence of messages. Specifically, the correlation of the SD/CA with FD shows that there is a significant difference ($t = -2.511$, $P = 0.04 < 0.05$, d.f. = 7), while the use of SO seems to have a slight effect on the sequence of messages as the result of the two-tailed *t*-test was $t = -2.013$, $P = 0.075 > 0.05$, d.f. = 9. However, if we have a closer look to the analytical results per group, we notice that the positive, creative and 'good' collaboration of one group that communicated using the free dialogue but in fact it seems that the members communicated as they were using sentence openers, contributes positively to the above results for the benefit of the free form of dialogue. If we exclude this group from the statistical analysis, we obtain results that are clearly for the benefit of structured dialogue; the difference is highly significant as indicated by the results (for the groups SD/CA and FD the results are $t = -4.030$, $P = 0.007 < 0.05$, d.f. = 6, while for the groups SD/SO and FD the results are $t = -3.030$, $P = 0.016 < 0.05$, d.f. = 8). It becomes apparent that the structured form of dialogue, the capability of referencing messages and the provided SST result into more comprehensive and coherent dialogues.

Concluding remarks and outlook

The structured dialogue that may be followed as one of the structured approaches aims to favour the emergence of productive interactions. The ACT tool supports both the free and the structured dialogue. In case of structured dialogue, two types of SST are supported; sentence openers and communicative acts. In an attempt to guide learners' thinking towards productive directions, struc-

ture the content of their dialogue towards the learning goals of the activity and provide the most meaningful and complete set of SST, the tool supports an adaptation framework. The adaptation framework attempts to specify and propose the most suitable means for communication with respect to the underlying learning outcomes of the activity and the collaboration model followed. The ACT tool enables learners to negotiate on the form of dialogue and the SST type they prefer to use and make the desired selections. Furthermore, learners have the capability to define their own SST if they consider that the provided ones do not cover their needs. The learner's defined SST are part of his or her model and become available each time he or she uses the ACT tool.

The results of the studies that were conducted show that the proposed dialogue form, SST type and the provided set of SST cover students' communication needs. However, their preference of the SST type is inclined to the communicative acts as they state that this type enables them to start their phrase as they wish and just make a selection in order to characterize their message. The capability of personalizing the communication satisfied students and they considered useful both the capability of selecting the desired communication means and the capability of enriching the provided SST set. Also, students used both sentence openers and communicative acts adequately conveying in their written message the underlying intention of the SST used. Comparing the use of sentence openers versus communicative acts, it seems that the underlying type of SST does not influence the coherence of the dialogue. In both cases, the students tried to keep on task and elaborate on their interlocutor's messages. On the contrary, the use of the free form of dialogue seems to influence negatively the coherence and the readability of the resulted dialogues.

Open issues in developing synchronous text-based communication tools with adaptive capabilities that could direct future research are (i) how the adaptation mechanism supported can accommodate learners' characteristics kept in the learner model concerning learners' preferences and selections on the dialogue form and SST type in order to propose the most suitable communication tool covering their needs and preferences, and (ii) how learners' individual preferences on the form of dialogue and the type of SST could be exploited in the direction of forming groups.

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