Integrating e-mail use in design & technology lessons

Hans van der Meij
Twente University
the Netherlands

Marja van Graft
Stichting Leerplan-ontwikkeling SLO
Twente University
the Netherlands

Kerst Boersma
Utrecht University
the Netherlands

Abstract
We describe an exploratory study on the introduction of design & technology education and e-mail use in elementary school. In the study, fifth-graders (10-12 years old) completed a series of six lessons revolving around the creation of a flying object. During the lessons the children could exchange their experiences through e-mail with the children of a partner school that also took part in the project.

In most of the participating 16 schools, the project meant their first encounter with design & technology education and the use of e-mail. E-mail use was also coupled to an increase in groupwork. Schools were given various kinds of support to deal with the obstacles: lack of sufficient computers, insufficient knowledge and training support, and lack of lesson materials containing an integrated ICT component. This paper focuses on the introduction of e-mail.

We begin by briefly discussing the specific issues involved in design & technology education. Thereafter, we describe the content of a booklet detailing the seven-step approach to e-mail use in elementary school. Each step in this booklet describes the main pitfalls and solutions of running an e-mail project.

Our second discussion revolves around the exchange patterns between groups of children that emerged. We concentrate on the patterns of compounding and stacking. Compounding occurs when the children exchange e-mails that transcend lessons. The ‘old’ section of the e-mail consists of a response to the issues the partner brought up about a previous lesson. The ‘new’ section of the same e-mail deals with the current lesson. In stacking the e-mails are sent out more quickly. Thus affording an exchange of ‘just-in-time’ information. The analyses of exchange patterns also showed an intriguing positive correlation between e-mail frequency and e-mail volume. That is, when children sent out more e-mails, the e-mails also tended to be longer.

Thirdly, we address the question of content. One of the findings from the study is that question-answer exchanges accounted only for a limited portion of the communications. Indeed, had these been limited to such exchanges, and all other things would have remained

equal, this would have cut-off 85% of the communications. Another striking finding is that the e-mails do not display a great deal of true interactivity. Instead it seemed to be well-characterized by a scenario of "We tell you our story – You tell us yours".

One of the conclusions of the paper is that an integrated use of e-mail in the curriculum will require a considerable effort of schools and teachers to make it a success. There are obstacles of a technical, managerial and conceptual nature for which solutions must be found. Another conclusion is that functional e-mail use by elementary children is yet to be defined; there is still a lot to be discovered about how children can use e-mail effectively. We end the paper by making a few suggestions about the road ahead.

Introduction

The dissemination of e-mail in elementary school has not kept pace with its place in business. In business, e-mails are frequently used with about 3 billion e-mails sent out every day. In a majority of schools in the Netherlands and most other countries in the world, e-mail has yet to find its place in the curriculum. Indeed, according to a recent international survey on Information, Communications and Technology use (ICT) a majority of pupils will not ever have used e-mail by the time they leave elementary school (Bos, Pelgrum, Visscher & Voogt, 1999). In other words, schools have yet to discover the special advantages of e-mail use by children.

In Kid e-mail we tried to discover and handle a few critical obstacles in ICT-use in elementary school and to study emerging practices. The leading thoughts of the project were the following:

- ICT-use should offer a specific value beyond information skills training. It should be a means to an end, not an end in itself. Therefore, e-mail use was integrated within a series of lessons.
- Schools and teachers should be supported in handling the innovation. In the absence of well-documented practices and research, we opted for a 'structured freedom' approach. That is, beyond certain basics, teachers and children had numerous opportunities to discover their own ways of making e-mail work for them.
- The domain of design & technology typically asks pupils to deal with fuzzy or 'wicked' problems. The use of e-mail can be a natural asset in this respect because communication is especially important for handling these sorts of problems.
- By combining the introduction of e-mail use to the introduction of design & technology education we expected to leverage each innovation. Use of e-mail in the design & technology lessons could stimulate the acceptance of this domain in the school's curriculum. Conversely, as schools yet have to develop a routine for engaging in design & technology education this might make the use of e-mail therein more easy to accept.

This paper first describes the innovations of the project, namely the introduction of design & technology education, of e-mail use and, for some schools, of groupwork. We skip a description of the set-up of the project (see Van der Meij, 1999) to focus on the main issues concerning e-mail. We begin with a brief description of the 7-steps approach to e-mail use in elementary school. This plan discusses a number of critical obstacles that schools and teachers must handle. Next, we pay attention to the exchange patterns and their impact on the e-mails themselves. Finally, we detail the contents of the e-mails. The latter findings offer a

first insight into the question whether e-mail works for the children, whether they benefitted from engaging in this type of conversation.

Introducing design & technology education and e-mail use & groupwork

The introduction of design & technology education. Teacher support came mainly from a teacher manual describing the four lessons for pupils at the age of 10 to 12 years (Blijerveld, Van Graft & Loenen, 1998). The lessons all evolve around a project in which the children must design a flying object that can stay airborne for at least 5 seconds and that can bridge a distance of 3 meters or more.

The design of the lessons follows the TPMC-heuristic [Think-Plan-Make-Check], a common instructional approach for design & technology education in secondary schools in the Netherlands (Doornekamp, 1997). The first lesson invites the children to advance their ideas about flying. The next lesson focuses on setting up a plan and drawing the object. In the lesson that follows the children actually produce their flying object. The final lesson revolves around testing and evaluation. The manual informs the teacher about classroom organization, objectives, lesson time and materials. In addition, the subject matter for each lesson is presented along with some suggestions for further reading.

E-mail use & groupwork. Although schools and teachers often do not lack motivation, a large majority of children in elementary school do not (learn to) use e-mail in school (Ten Brummelhuis, 1998; Ten Brummelhuis & Drent, 2000). There are many obstacles, of which the following are mentioned most often: (a) lack of sufficient (and fast) computers, (b) insufficient knowledge and training support, and (c) lack of lesson materials containing an integrated ICT component (Ten Brummelhuis, 1998; Ten Brummelhuis & Drent, 2000). In Kid e-mail we tried to handle these problems as follows.

Computer Access. In many elementary schools computer access is an important obstacle. For this reason, schools that wanted to participate in the project had to guarantee easy pupil access to the computer(s). In some cases this meant that schools had to provide access to the computer of the school principle. With a mean computer - child ratio of 1 : 23 (Ten Brummelhuis, 1998) additional measures are necessary to handle the lack of sufficient computers. The measure we chose was teaming up children. Besides being an efficiency argument, groupwork could also have a positive impact on the children's problem solving because it can stimulate important thought processes such as activation, articulation, argumentation, evaluation and reflection. For this reason, groupwork was also not restricted to the moments of e-mail exchanges. The children worked in groups on their task throughout the project.

ICT-knowledge & skills. Schools were invited to join the project only if the participating teacher was a skilled e-mail user. Schools had to report this on their application form. [During the project we discovered that this self-report was not accurate enough. A few teachers could hardly manage even the most basic computer and e-mail tasks needed to run the project (e.g., managing incoming and outgoing mails). At that time it was too late to intervene.] Participants were also offered technical support should they need so.

Integrated learning materials. Thanks to the simultaneous start of the lesson development and e-mail use therein, information about the domain and e-mail truly formed an integrated part. Thus, each design & technology lesson had a section describing the use of e-mail. A

separate section dealt with the more general problems of setting up an e-mail project. In Kid e-mail a group of children from one school was to exchange e-mails with a group from another school that also participated in the project. Thus, schools were teamed up with a partner school and they were informed about how to facilitate their communication. All these issues on running an e-mail project were later summarized in a book (in Dutch) titled "E-mail in the classroom" (Boersma, Hulsbeek, Loenen, Van der Meij, & Smit, (1998).

E-mail use

Issue 1: Coping with the problems of e-mail use in elementary school: A seven-steps approach.

Schools that embark on an e-mail project often do not yet know exactly which obstacles they have to surmount. Therefore we broke down the process into seven steps and described these in a separate section of 24-pages in "E-mail in the classroom" (Boersma et al., 1998). Each step describes the main pitfalls and solutions. In addition, there are examples and tips and there is a checklist that can be used as a job aid. A brief sketch of the content of the booklet comes from the summaries for each step.

Step 1: Organizing the e-mail facilities and e-mail knowledge and skills. The first key to running a successful e-mail project is a proper organization. Before you (the teacher) can use e-mail in the classroom a number of issues have to be dealt with in advance. You should check your facilities to see if they are adequate for the job. In addition, teachers and children should have some level of proficiency in handling the computer and an e-mail program.

Step 2: Organizing the communication with the partner school. One of the key issues in an e-mail project is setting up a good line of communication with the partner school. Together with your partner you should decide in which project you intend to use e-mail. Your initial contact could be made with e-mail. In that way you not only save time, it also allows you to find out whether your e-mail connection works properly. Preferably you also meet each other face to face at least once. During that meeting you can effectively discuss a variety of organizational issues (e.g., planning, number of groups, problem management).

Step 3: Organizing the processes of sending and receiving e-mails in the classroom. Before you know it, you may be inundated with e-mails whose distribution to the children in your classroom is troublesome because the senders have not identified themselves. You should make preparations to prevent these and other problems in handling e-mails. E-mail management is needed and you should attend to issues such as making firm appointments about the moments of sending and receiving e-mails, as well as about distributing the e-mails to your children.

Step 4: Deciding about the content of an e-mail. What would you like your children to write in their e-mail? Some of the answers to this question depend on the project that you are running. But even then you still face a number of difficult choices. For example, you may want to structure the e-mails by prescribing sections like "introducing ourselves", "our design choice", "our design plan" and "our questions". Also, you may want to point out that writing an e-mail should agree with "netiquette". That is, the children should follow a few basic rules of conduct for corresponding through e-mail (e.g., no flaming). In addition, you should decide whether the children should compose their e-mail 'on-the-fly', that is while working on the computer, or whether you prefer them to write out their e-mail on paper first.

Step 5: Sending out e-mails. Before sending out e-mails, you should probably check on one or two of these e-mails to see if their content is not offensive. Invariably, you too are likely to experience technical failure. Check your e-mail connection regularly and back-up all e-mails that are sent. To prevent spreading any viruses, you should consider sending out only appendices in RTF-format. Make sure that all children have a chance to actually work on the computer. Especially in groups with divergent computer skills, there is a risk that the least experienced children are deprived of the opportunity of handling the computer.

Step 6: Receiving e-mails. In some schools this task is delegated to a child who acts as the e-mail manager. The e-mail manager should check the mailbox regularly, preferably at least once a day, and print out the incoming mails. At this moment, the appointments you made earlier about the presence of identifiers pays off nicely. Unclear deals backfire and the e-mail manager may need to spend a considerable time sorting out who should get what. This problem gets worse when all unidentified messages are attached to a single e-mail.

Step 7: Distributing and processing incoming e-mails. Most schools have yet to build up a routine for dealing with the e-mails in the lessons. It may be advisable to split each lesson into three distinct moments to facilitate this process of integrating e-mail use in classroom work. The first moment, ten to fifteen minutes, should be spent on distributing the e-mails and processing the e-mail. Groups should then make notes for their reaction. Thereafter, the teacher gives the planned lesson. The third moment again evolves around e-mail. The children consult their notes to write a reaction and they think about what they want to tell their e-mail partner. Ideally, the e-mail is then also typed and sent off immediately.

Issue 2: Exchange patterns: incidental, compounding, stacking & structural.

One type of e-mail practice that is likely to affect e-mail functionality is the *exchange pattern*, a regular pattern of e-mails sent out from one group to another. In Kid e-mail these patterns are defined as a combination of two factors: exchange rate and participation. The exchange rate measures the number of e-mails sent out in each lesson by a group of children. An exchange rate of 2 or more is a high score that affords a reasonably fast exchange of information. The participation score measures the number of times that each group sends out at least one e-mail in each lesson. A participation score of 75% indicates that a group has e-mailed its partner group in three (of the four) lessons. A score of 75% or more is considered to be high, and a signal of a fairly stable pattern of communication with the partner throughout the project.

By distinguishing the low scores and high scores for each frequency measure, the exchange patterns have been categorized into four distinct exchange types or approaches: incidental, compounding, stacking and structural (see Figure 1). Because the two frequency measures are interdependent, chance alone favors the presence of the incidental and the structural approach. We focus on compounding and stacking, however, because these exchange patterns leading to two conceptually distinct types of communication.

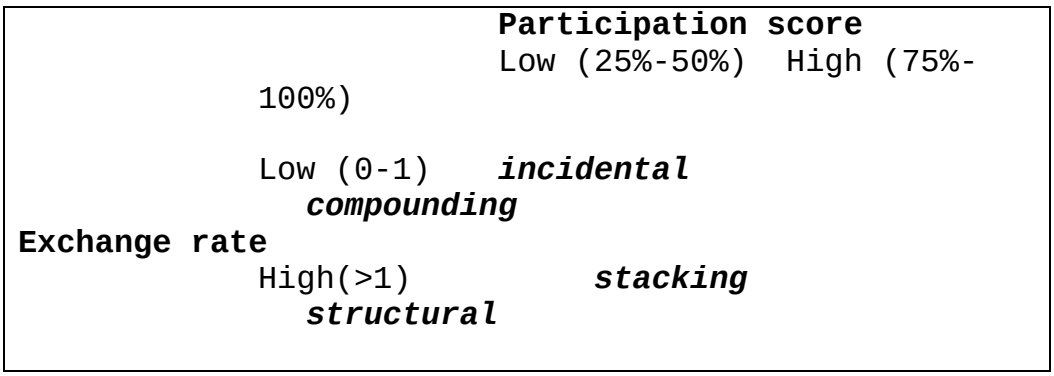


Figure 1. A typology of exchange patterns based on a combination of scores for e-mailing frequency across lessons (the participation score) and within lessons (the exchange rate).

In theory, the frequency pattern in *compounding* should lead to e-mails that transcend lessons. There should be an 'old' part with a reaction to the e-mail about the previous lesson received from the partner group. In addition, there should be a 'new' part in which the group communicates about the current lesson. The main characteristic of a *stacking* approach is that groups interact frequently within lessons. Stacking maximizes the possibilities for communication about current issues. Information can be given and received 'just-in-time' because the children react quickly to the issues brought up by the e-mail partner. Stacking might make it easier for children to react to each other's e-mails and raise the interactive nature of the exchange. In that sense stacking somewhat resembles chatting. As we discuss the exchange patterns, we will deal first with the frequency data and then examine whether the e-mails also display the predicted conceptual fit. This will be done only for compounding and stacking.

The *incidental approach* dominated. On a total of 87 e-mail groups, 56 groups (64.4%) had a low e-mail frequency throughout the project, resulting in more or less haphazard exchanges. Apparently, for these groups the obstacles were too hard to overcome. Not surprisingly, the incidental approach has been found predominantly for groups with no or very limited prior experience in e-mail use (see Results).

The exchange patterns of 11 groups (12.6%) fitted perfectly within the *compound approach*. In compounding each e-mail ideally consists of an 'old' section and a 'new' one. The old section is the Reaction of the group to the issue(s) raised by its e-mail partner. The other part, the Stimulus, contains the issues of the ongoing lesson that the e-mail producing group likes to communicate. For 3 of the 11 groups the frequency data and e-mail content converged into prototypical compounding. These children send out e-mails regularly during the project. In addition, their e-mails transcend lessons; they are a mixture of 'old and new'. One section of the e-mail reacts to issues from the previous lesson brought up by the partner group. Another section advances topics from the current lesson that the group wants to communicate to its partner (see Figure 2).

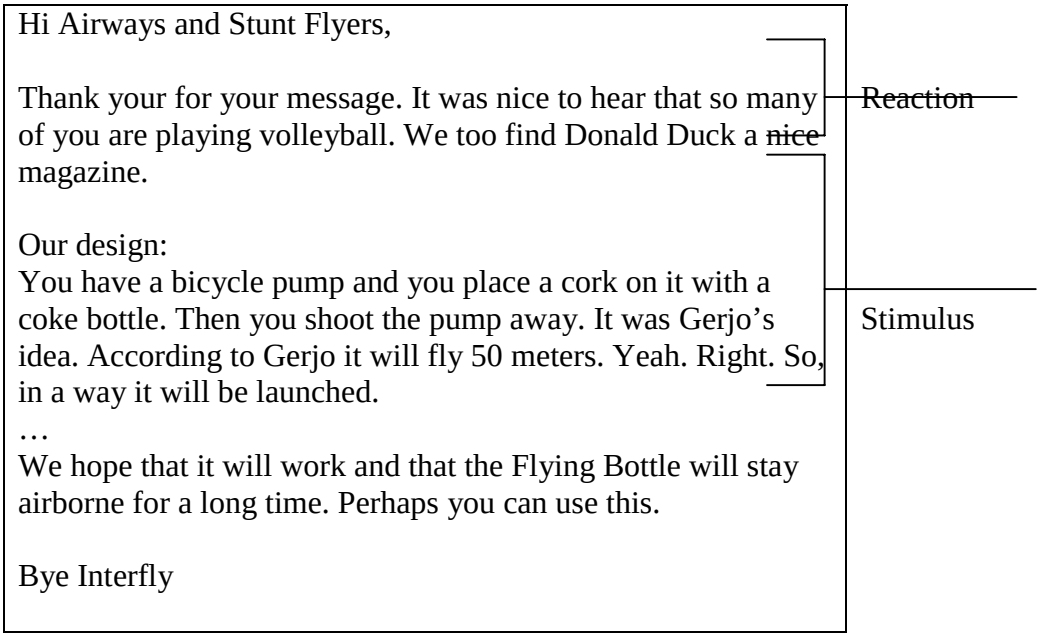
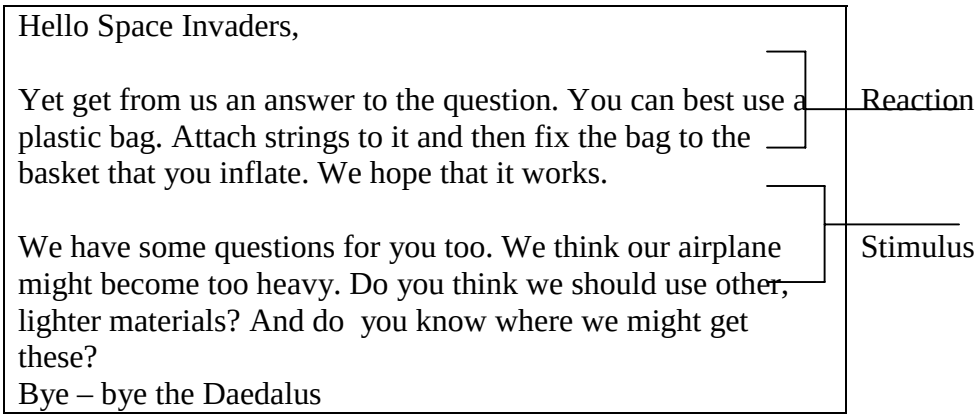


Figure 2. In compounding an e-mail ideally consists of two parts. One part deals with certain items brought up in the last e-mail from the partner group. This Reaction concerns topics from an earlier lesson. The second part is what the group would like to tell about their work. This Stimulus concerns topics from the current lesson.

There were 3 groups (3.4%) whose e-mail frequency fitted a *stacking* approach. Only 1 group sent out e-mails that also agreed with the conceptual characteristics of stacking. Besides a minimum of two e-mails per lesson, this group also reacted timely (i.e., before the beginning of the next lesson) to an issue brought up by its e-mail partner. There is again a mixture of Reaction and Stimulus in the e-mail, only this time both pertain to the same lesson. In addition, the next e-mail may be even shorter and just be a reaction. Figure 3 illustrates an e-mail exchange of this nature.



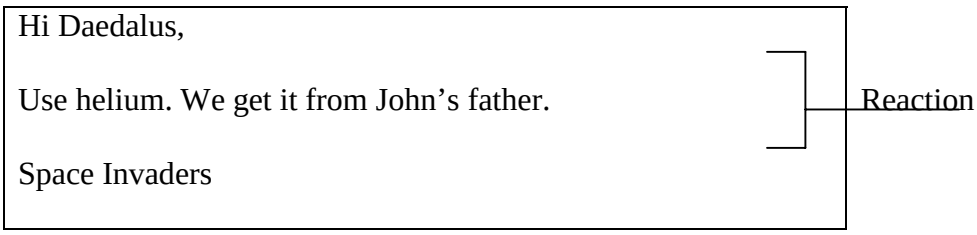


Figure 3. In stacking e-mails are exchanged swiftly enough for groups to share views on current issues (i.e., the same lesson).

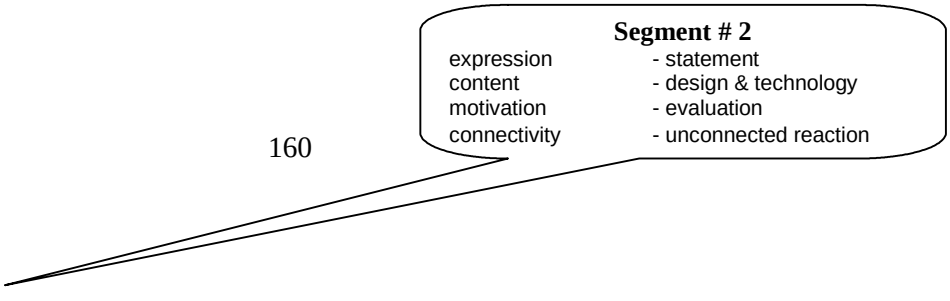
In the *structural approach* the e-mails are relatively plentiful. Exchanges of this nature typically show flexibility in the use of e-mail. Therefore, it does not surprise that 94% of the 17 groups with a structural approach came from schools in which the children had already been familiar with e-mail use. As indicated earlier, we see the structural exchange pattern as a hybrid of compounding and stacking.

Relationships between frequencies and volume. There was a statistically significant correlation between the participation scores and exchange rates on the one hand and e-mail volume - the number of segments per e-mail – on the other (respectively $\tau = 0.40$, $p < 0.001$, and $\tau = 0.69$, $p < 0.001$). Indeed, exchange rate and volume still correlated positively and in a statistically significant way after eliminating the effect of participation ($\tau_{xy.z} = 0.56$, $p < 0.001$). Contrary to some beliefs, these data indicate that children who send out more e-mails, also send longer rather than shorter e-mails. It is interesting to speculate that this finding supports the idea that e-mail functionality carries its own rewards. By communicating regularly and with more substantive (i.e., longer) e-mails the interaction remains valuable and is maintained better throughout the project.

Issue 3: E-mail substance. What is communicated through e-mail?

Before we describe the main outcomes from the analyses, we should briefly detail the database and the analyses that led to these results. The data were gathered from 301 children with a mean age of 11 years. The children formed 87 groups that sent out a total of 214 e-mails. As indicated earlier, there is a widespread variation in the number of groups that used e-mail during a particular lesson. In this paper we concentrate on the results for the four lessons combined because these data offer the most comprehensive overview.

Coding and scoring the e-mails followed a two-step procedure in which segmentation preceded categorization. In segmentation, each e-mail was divided into meaningful units. Usually a segment constitutes a principle sentence or a (subordinate) clause. In categorization, each segment was classified on the following dimensions: (1) linguistic expression (e.g., the presence of questions, responses and assertions), (2) content (e.g., communications about design & technology issues such as the use of materials and technological principles), (3) motivation (e.g., communicating uncertainty, problems and judgements), and (4) connectivity (e.g., the issue of whether questions are responded to). Inter-observer agreements on all four dimensions yielded a satisfactory score of 0.66 or higher (Cohen kappa). Figure 4 shows the outcome of an analysis.



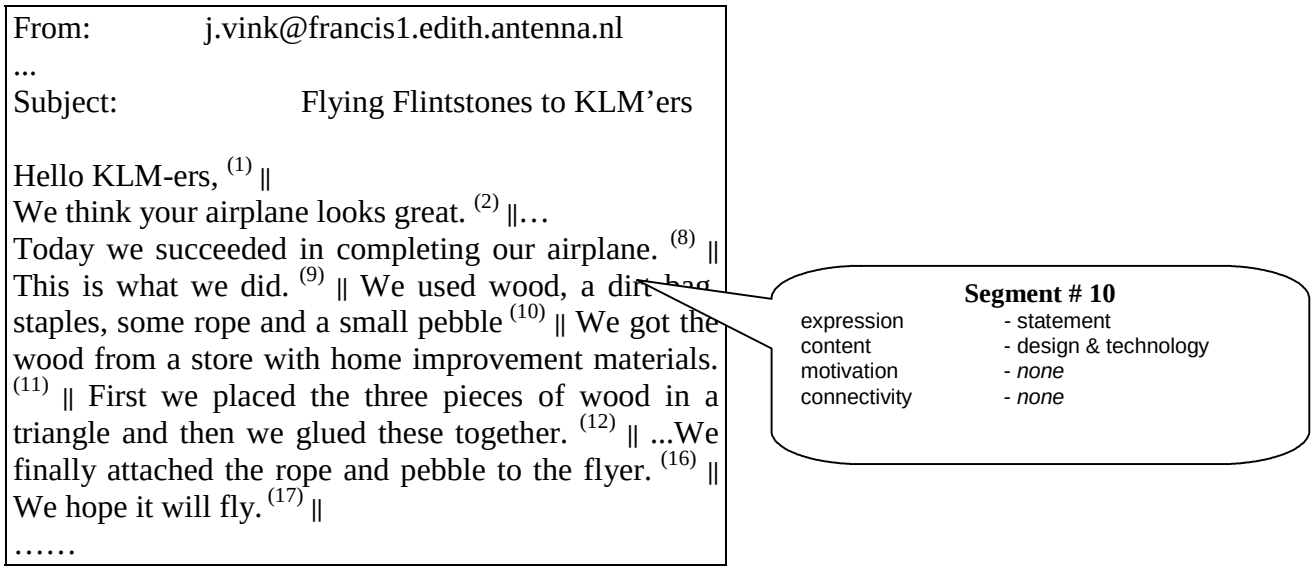


Figure 4. An illustration of a segmented and categorized e-mail.

Dimension 1. Linguistic expression. An obvious and meaningful dimension for classifying the e-mails concerns the linguistic means employed by the children. In our analyses we concentrated on three basic types: Assertions, Questions and Responses. Table 1 shows that the e-mails consisted mainly of Assertions, of statements in which pupils told something. That is, nearly 9 (81%) of the 11 segments in the average e-mail is an Assertion.

Table 1. The mean appearance of a linguistic expression in an e-mail

	Mean	Standard deviation
Assertions	8.85	5.80
Questions	0.98	1.20
Responses	1.06	2.08

The presence of Questions and Responses is about balanced and would seem to suggest that groups generally tend to discuss their partner's question(s) in their e-mailed response. A close inspection of the data shows otherwise. Only 59% of the e-mailed Questions led to a Response. The remainder of the Responses clearly was a reaction on an Assertion. In other words, what these data indicate is that the reaction-inviting nature of questions is not as strong as people sometimes expect. The data also reveal that it is not always necessary to ask a question to evoke a reaction. People also often respond to statements.

The findings for Questions and Responses support our view that one should not constrain the use of e-mail into an exchange of question and answers. Had we done so, this would have cut-off 85% of the communications, all other things being equal. More importantly, it would

also empty the communication from valuable social talk. Social talk, or socialization, helps build up a relationship with the partner and contributes to creating a common ground.

Dimension 2. Content. The content dimension includes a broad spectrum of varied topics. These have been grouped in the categories of communication, personal talk and design & technology.

The rubric of Communication contains all segments in which the children say something about the process of communicating with their partner. For example, they may ask whether the other group has the capacity to answer their question ("Do you know it?"), or the children may express their desire to receive an answer ("We hope that you write back soon"). Within this category we have also classified expressions that serve to introduce the real topic as in "We have a question".

The presence of a category called Personal Talk should come as no surprise. Teachers in the project sometimes explicitly expressed their concern about this aspect of the e-mail exchange, fearing that the exchanges would result in little else but chatter about pop music, sports and the like. It is true that these issues were classified under this rubric. But so were all expressions about the children's preferences, knowledge & skills for school work. In addition, the category also contained very general remarks such as "A photograph was taken of our group".

The category of Design & Technology is of special interest because it covers all expressions about the domain. Obviously, one would want the main body of an e-mail to deal with this aspect since it can serve its role as a means for reflection, articulation and evaluation only if the discussions relate to the subject matter at hand. The various subcategories that fall within Design & Technology are the following: context, goal or objective, result or evaluation, materials & tools, planning and design principles.

The reader should note that the Content dimension is the only dimension in which the main categories are <u>not</u> mutually exclusive. Some segments belong to two categories instead of just one. For example, the segment "We have a tip for you concerning the design of your aircraft" scores into the category Communication as well as in Design & technology.

Table 2. The mean appearance of a topical expression in an e-mail

	Mean	Standard deviation
Communication	3.43	2.54
Personal Talk	5.44	4.40
Design & Technology	5.58	1.61

Table 2 shows that the presence of segments with Personal talk and Design & technology information is about even. Compared to the total mean of 11 segments per e-mail, each comes close to a 50%-score. A close inspection of the data for the individual lessons revealed that the data for Personal Talk are somewhat inflated by their dominating presence in the first lesson. Here, as one would expect, children first introduced themselves to their e-mail partner. Because the children told little else, 74% of the segments in this e-mail moment

fitted within the category of Personal Talk as opposed to a meager 20% expressions on Design & Technology issues.

From lesson two onwards the distribution changes in favor of the latter. In the plan lesson Personal Talk was found in 37% of the statements, in the make lesson this was 36% and in the check lesson it had slightly rose to 42%. In these lessons the scores for Design & technology were respectively 65%, 82% and 58%. In other words, the data reveal that there is a good deal of social talk. Children e-mail about issues that relate to themselves personally and to their relationship with their e-mail partner. The exchanges are not predominantly filled with this type of talk, however. Most of the e-mails have the right substance with children exchanging information about topical issues.

Almost a third of the expressions (also) concern issues of communication. This seems just about the right amount. Communicating about communication should not overshadow the real content of an e-mail. But neither should the children treat e-mail very differently than other forms of written communication. Just as in writing a letter, they should follow certain formal rules as advocated by netiquette.

A division of the e-mails into the classes “start”, “body” and “ending” suggests that this is also what the children did. The mean number of segments falling into start or ending of an e-mail was respectively 1.01 and 0.91. In other words, the children nearly always included some kind of address to start their e-mail (“Hi we’re John, Mickey and Ronald”, “Hello Marc and the others” and “Hi group four from the Kohnstamm school”) and they also almost invariably provided closure (“Greetings from Joanne, Anne and Mira” and “Mazzeltof, the Flying Wacko’s”). The examples illustrate that, just as in any other ongoing communication, there is variation in the use of formal an informal types of address.

Because start and ending together take up 2.92 segments of the average e-mail, this leaves room for about 0.5 segments on Communication within the body text. This is probably a little too low. Because the groups of children communicate on a distance and neither group knows exactly what the other is doing all kinds of miscommunications are lurking around the corner. For example, we, the coders, frequently noted that the children did not ask for clarification about an important statement that we felt was in need of further explanation (“we’re making an air balloon with 10 balloons and wings”, “At the bottom of our airship there is a cork that you have to twist to make the propellor turn”). About these and other communication issues, the children should probably have e-mailed more.

Dimension 3. Motivation. In preparing the codebook we were surprised by the frequent presence of statements about the children’s motivational states. These observations prompted us to examine this dimension in some detail in the children’s e-mails.

The heading Evaluation refers to all expressions involving a judgement or assessment. The judgement may concern a situation, a product or a personal characteristic. For example, the children might tell their partner “our group is cozy” or a certain event is labeled as “It was funny”. Some of the Evaluations related to the flying object as in “Our plane did not go very far”. The third type of Evaluation involved an assessment of personal qualities or capacities. Typical examples are expressions such as “I am pretty good in many things in school” and “I know a lot about computers”.

The category Problem & Trouble houses a rather mixed variety of expressions that all share an implicit or explicit request for help or information. The most interesting

subcategories are those of ignorance and doubt. Ignorance refers to statements or questions that give no cue whatsoever of the probable response. For example, the children might state "We just don't know what we should build", or they might ask "Do you have tips for us on this?" Doubt refers to expressions in which the children signal uncertainty. Expressions of doubt transfer some information about the topic at hand. A segment that was classified as such was "We do not know exactly how to insert the elastic". The third subcategory in this rubric is the social conflict. It refers to a disagreement between group members, or between the two partner groups.

Table 3. The mean appearance of a motivational expression in an e-mail

	Mean	Standard deviation
Evaluation	2.14	2.48
Problem & Trouble	1.22	1.30

As Table 3 shows, the children included an Evaluation in their talk in about twenty percent of the expressions or segments. The children reported their Problem & Trouble slightly more than once in every e-mail. We are yet unsure on how we should interpret or value these findings. We think that these motivational expressions serve an important role in strengthening the commitment between the partner groups. They probably fortify the bond between the groups when they share important motivations such as feeling unsure or having a row. To understand this role, and to detect possible others, we need to search for literature that deals with the question of how expressions of emotions impact on a communication.

It is informative to mention another finding on motivation. The project was found to have led to favorable changes in the children's self-efficacy beliefs. A before – after test of self-efficacy beliefs indicated that boys as well as girls felt more at ease with 'design & technology' after the project than before. In addition, after project completion there was also no longer a statistically significant difference between boys and girls on competence for design & technology, whereas at the start of the project the boys felt significantly more competent (see Van der Meij, 1998; 1999).

Dimension 4. Connectivity. This dimension contains all expressions that signal interactivity. In the e-mails from the children we discovered three types of connected discourse: connected reactions, unconnected reactions, and adoption.

In a Connected Reaction the children explicitly refer to, or repeat, their partner's question or statement before presenting their reaction to it. E-mail programs have a reply feature for facilitating this type of connectivity. Reply allows users to copy the original e-mail into a new message and annotate the old one with '>'marks to distinguish it from the reaction. In the project none of the groups used the reply feature. They all created their new e-mails from scratch. A typical example of a Connected Reaction is "The gas you asked about is called helium".

In an Unconnected Reaction, the children respond to an expression of their e-mail partner without explicitly mentioning this. Especially when these reactions are found somewhere in the middle of an e-mail, they seem to appear right out of the blue. Only their content reveals that the expression addresses an issue brought up by the e-mail partner. An Unconnected

Reaction could be a response to a question as in “The answer is four”. Without preamble an Unconnected Reaction is comprehensible to the receivers when they recollect the relevant statement from their earlier e-mail (often sent out one week earlier), else they must consult their earlier e-mail.

Adoption is an important, and in one way also unique, subcategory. It refers to expressions that are connected to each other by type similarity. In Adoption an individual child, or group, imitates a particular style or uses the typology from another group member, or group, to write its own e-mail. A typical example of Adoption is found in introductory e-mails in which two or more group members use the same format for presenting themselves. This led to e-mails with repetitive rounds of presentations in the format “I am … and my hobbies are …”. To our knowledge, this format was not prescribed by the teacher, but spontaneously adopted by the group after being introduced by one of its members. Adoption occurs within groups as well as across groups.

Table 4. The mean appearance of connective discourse in an e-mail

	Mean	Standard deviation
Connected Reaction	0.85	1.68
Unconnected Reaction	0.42	1.03
Adoption	4.26	7.73

Connectivity is an intriguing dimension because it signals how interactive the exchanges truly are. The data show that there is much room for improvement. On average only about 1 segment of an e-mail – about 10% – connects to some part of an earlier e-mail of the partner group. And even this figure probably overstates the case because nearly one-third of the reactions are not explicitly connected so that children may fail to notice the link. Recall too that only 59% of the questions was responded to which is not much better than an even chance of getting a response or a non-response. In short, the majority of the exchanges seem to be characterized by a scenario of “We tell you our story – You tell us yours”. True interactivity is scarce.

The position of Adoption is a puzzling one in this perspective. In contrast to the reactions they constitute a fair proportion of e-mail talk. In all fairness, however, and well in line with the presence of Personal Talk, the mean figure for Adoption is inflated by a dominance in the first e-mail with a score of 69.7%. In the plan and make lessons Adoption is considerably lower, namely 20.9% and 16.1%. In Evaluation it rises again to 44.5%. The latter is probably due to the fact that the children are bound to tell comparable things, telling each other about the conditions of testing and the results from testing.

The topic of learning together is rapidly gaining attention from researchers. One of the most intriguing concepts in this respect is what we call co-construction of knowledge. Co-construction of knowledge has a special value in two ways. One, it is knowledge that is founded on the contributions of many and thereby probably advances the knowledge of an individual more than if he or she would be working alone. Two it is socially constructed. It is based on grounding, on creating a shared understanding. In other words, co-construction of knowledge is valuable intellectually as well as socially. As input to this discussion, the data

on connectivity in general, and on Adoption in particular, are well-worth further examination in new studies.

Conclusion

An overwhelming majority of elementary schools still has very limited computer access and computer time available for their pupils. Indeed, the use of ICT is yet to find a structural place within the school curriculum. For example, most pupils nowadays learn how to type and handle the keyboard at home rather than in school. And for e-mail use it would be most helpful if teachers would already prepare the children for this type of correspondence in their lessons about written forms of communication. This situation changes rapidly, however. As a result, the need for structural support and documented practices become more pressing for some of the understudied computer uses. E-mail use is one such largely unexplored phenomenon. Kid e-mail attempted to shed some light on this topic.

One important finding of the project is that the introduction of e-mail use was by no means an easy matter. Notwithstanding our efforts to give adequate support, schools had to put in a considerable effort to make the project a success. Schools faced a variety of foreseen and unforeseen obstacles of a technical, managerial and conceptual nature. One of the obstacles was a lack of skills. Some teacher's proficiency was not sufficient to allow them to deal with e-mail attachments or technical failures. Some children too were hampered by a lack of skills, especially those in typing and keyboard use. These children were often teamed up with more skilled classmates. Unfortunately this turned out to be counterproductive for these children, as often only the more proficient children were privileged to work with the computer.

An important problem is the fact that e-mail use by children is yet to be defined. There is still a lot to be learned about how e-mail can be used effectively. Children are likely to benefit from receiving e-mails with invited as well as uninvited information ("we never thought of that"). This is, of course, why we adopted a 'structured freedom' approach and why we suggested rather than prescribed certain actions. This is also an important reason why we do not advocate using e-mail merely for an exchange of questions and answers. Communication cannot do without socialization. People should attend to their social relationships as well as to content.

On the question of raising the effectiveness of e-mail, there are valuable insights to be found in language lessons on writing. Indeed, netiquette shares many characteristics with formal rules for writing a letter. But following the rules from netiquette is not enough. The e-mails should also have enough substance and connectivity to afford co-construction. This will not be easy to realize. Helping children do so in a manner that does not crush their spontaneity promises be a difficult and challenging task for the road ahead.

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