Virtual project rooms for education in engineering

RUDOLF G. VAN VLIET[†]*, MONIKA M. ROELING[‡],
RICK DE GRAAFF[§] and ALBERT PILOT[¶]

Virtual project rooms (VPRs) may support collaborative project-based learning groups by facilitating project management, documentation and communication. In this study a set of experiments was carried out at Eindhoven University of Technology using the MS Outlook/Exchange software as a groupware platform for design-oriented group projects. The results of the questionnaires filled out at the end of the courses show that students are fairly positive about group work supported by groupware. The documentation function is appreciated most by the students, also for those groups who collaborate intensively in a face-to-face setting. The involvement of the tutor, the flexibility of the VPR and the technical performance of the groupware are important factors for the success of a VPR for group work.

1. Introduction

Groups of students working on a project, problem or task are rather familiar in higher education nowadays. These groups need facilities for communication, for working on documents and for group management. A virtual project room (VPR) may support collaborative learning groups. It facilitates communication within and between student groups and between students and tutors, and supports documentation and the work on group documents, provides access for tools and administration, etc. A VPR can be a central place for a project team of full-time or part-time students, with a wide range of groupware facilities. In 2001, Eindhoven University and Utrecht University started a 2-year project on the development and implementation of VPRs. The aim of this project is to gain expertise on VPRs, which becomes visible by a series of educational activities within both universities, as well as in products related to the development and evaluation of these activities.

The VPRs in this project use standard software, design-oriented tasks, prepared public folders, easy-to-use templates, asynchronous tutor-moderated discussion, etc. in all cases additional and supportive to face-to-face class meetings. In this paper the technical and the educational requirements for such VPRs and their use by groups of students and tutors is described. An example of a VPR-based educational engineering project is described.

[†] Educational Service Centre, Eindhoven University of Technology, The Netherlands.
[‡] Centre for Technology for Sustainable Development, Eindhoven University of Technology, The Netherlands.
[§] IVLOS (Institute of Education), Utrecht University, The Netherlands.
[¶] IVLOS (Institute of Education) and Department of Chemistry, Utrecht University, The Netherlands.
* To whom correspondence should be addressed. e-mail: r.g.v.vliet@tue.nl

The VPR originates from the concept of the asynchronous learning network or ALN (Bourne 1998) and the approach of computer-supported collaborative learning (CSCL). See De Graaff *et al.* (2003) for a further discussion on CSCL. The usefulness of project work and case-oriented tasks within higher education is broadly recognized (Simons *et al.* 2000). Traditional group work, however, demands workspaces and has to be scheduled with other study activities. In particular, the organization of multidisciplinary groups with students from different departments may cause scheduling problems. When part-time students or part-time teachers are involved the problems may even get worse. Applying a VPR helps to solve these problems. It also makes digital communication and the shared use of digital documents easier to handle. Another advantage of using a VPR is that students learn to collaborate within virtual groups, which may be a very useful skill when they join a company or research institute after completing their study, for many modem companies use groupware to support collaboration between members of working groups.

2. Use of a VPR

A VPR in itself is not an educational method but can, in our case, be considered as an educational means: a predefined structure of folders on a network server, allowing the client computers to share these folders with a certain level of access. This access can be from 'read only' to 'full access', including the permission to create or delete files and subfolders. But a VPR is more than hardware and software; it is also a flexible environment to work and learn when carrying out project activities.

Many forms of project work and case study methods can be facilitated by a VPR. One can use a VPR to gather completed tasks and give the student feedback. It is emphasized that the students should have the possibility to view each other's work and to see what the tutor answers to individual questions. Working in such a way provides the opportunity for the students to co-operate in pairs or small groups. More complex use of this method is feasible with student groups working on an elaborate project task, implying division of labour, planning, progress checks, research, design, testing, evaluation and reporting. The VPR will then be used more intensively and the demand for specific functions will be greater. The teacher's role will be more that of a moderator and less that of knowledge supplier or chairman.

3. Project on VPR development and implementation

In 2001, Eindhoven University of Technology (TU/e) and Utrecht University (UU) started the project VPRO2 (VPRs for research and design-oriented education) concerning the development and dissemination of VPRs. One of the main goals is to yield knowledge and experience about the application of groupware, more specifically MS Outlook/Exchange, as a means to support various kinds of collaborative learning projects. A second goal of this project is to provide pre-designed structures and templates in which project work can be carried out. The structures and templates are tried out within pilots that are part of existing curricula. The pilots with the best outcome are used as examples of good practice, which leads to a higher degree of standardization. This in turn eases the training of teachers and students on the use of VPRs.

In our case the so-called 'Outlook Public Folders' (Microsoft 2001) provide the necessary functionality to build a VPR structure without the need of any additional software. These public folders are special folders on the Exchange server, which can be accessed from MS-Outlook, the client counterpart for MS-Exchange (see figure 1). Outlook allows
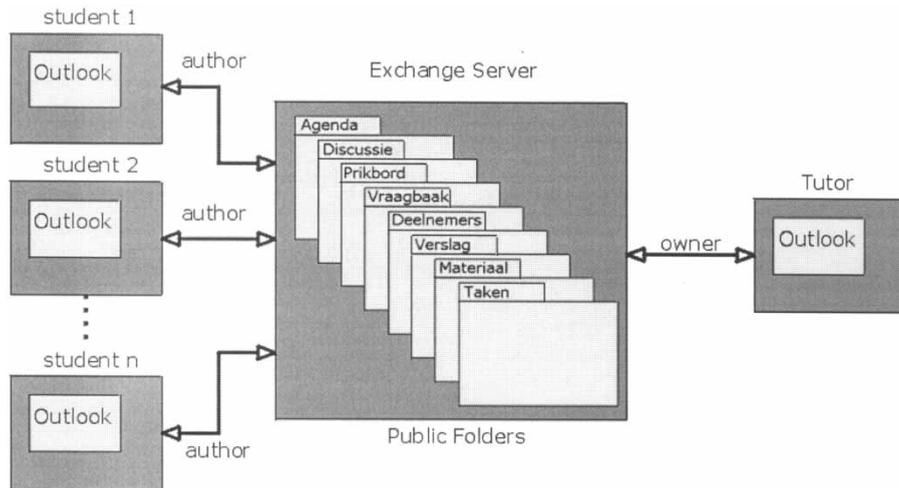
Figure 1. Public folders on an Outlook/Exchange platform serve as VPR groupware.

the definition of several types of public folders with different types of content, such as appointment items in the calendar folder, mail items in the discussion and report folders, contact items in the participants folder and task items in the tasks folder.

Simple VPRs will use only a subset of all those possible folders and the tutor and students should decide which folders would be useful for the specific VPR project. A minimal set will contain a participant's folder, a calendar folder, a report/archive folder and a discussion folder. In small VPR projects the discussion folder can also be used for questions to the tutor and for reporting.

The tutor acts as the owner of the VPR public folders, giving the participants permission to perform certain actions within the folders, such as file creation, editing and deleting. The folder structure should be adapted to the project assignment, and the tutor must have a clear view on what the VPR group will need for their activities. In Outlook it is quite easy to arrange the access permissions such that only the VPR group itself can access the VPR folders. If necessary, other people from outside the group can be given read-only access.

In contrast to the modules for computer-mediated conferencing (CMC) in the most common virtual learning environments, as for example Blackboard (2002), Outlook is very flexible and can be customized in many ways. There are many views to look at the content of the different Outlook public folders, as there are different ways of sorting and grouping items in all folders. Moreover, the members of a VPR group can design their own VPR folder structure, if desired. As Outlook itself contains an e-mail program as well, the e-mail facilities are integrated within the VPR environment.

Outlook/Exchange also allows inter-institutional use of VPRs. Either two or more institutes use the Exchange server of one of the partners, or their local Exchange servers can be synchronized to exchange VPR data between them.

4. Design of the experiments

During the academic year 2001/02, VPR experiments were carried out in four design-oriented engineering project groups on sustainable technology (SD) at TU/e. The

total number of students involved was 19. This multidisciplinary project (MDP) forms an obligatory part of the 'Technology and society' curriculum and is also obligatory for other students who want to obtain a special certificate in SD. The projects are being organized by the Centre for Technology for Sustainable Development, which is also responsible for several other courses on sustainable development at TU/e. Usually the students work in subgroups on authentic cases over a period of several months, and most of the work takes place in face-to-face meetings, lab experimentation and self-study. In the year 2001/02, one of the groups consisted of part-time students who met only once every 2 weeks in a face-to-face session; other communication in this group happened electronically, mostly facilitated by the VPR. In the same year, VPRs were used in three other groups as a support tool for communication, documentation and project management.

4.1. *Project characteristics*

The educational projects on sustainable technology at TU/e usually last 20 weeks for part-time students and 10 weeks for full-time students. The themes can be found in the area of sustainable energy, sustainable resources, sustainable design or environmental problems. The students have different backgrounds and they receive a broad assignment from a real 'customer', which gives the project a sense of authenticity (see figure 2). The tutor(s) will monitor the group process, giving the groups feedback and helping them to solve practical problems. The teacher's role differs significantly from the tutor's role. The teachers are experts in the relevant subject and they are the ones who will assess the group's performance and quality of the end product.

In the first weeks of their project, the groups search for information, start reading on the subject and write a plan of action, which is evaluated by the teachers. Halfway, the students write a draft report on the first half of their project and they clarify their future plans. They also give an interim presentation during which there is time for questions and discussion. At the end of the project the teachers evaluate each group based on the final report and the final presentation. The customer advises the teachers about the work delivered, he does not give a grade. The tutor informs the teachers about the group process.

5.   Speed, the first good practice

The first experiment concerned a group seven part-time technology and society students, carrying out a MDP on sustainable development. We describe this experiment in
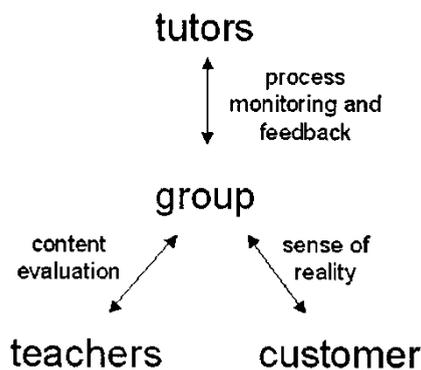

Figure 2.   The organizational diagram of a multidisciplinary project.

more detail, because it shows many strong and weak points in the design and use of a VPR. This group was considered as particularly interesting, because its members were busy with their jobs during the day, leaving not much time for their studies. Therefore, it was assumed that the VPR would help the students to collaborate at any time and in any place, thus allowing them to function more efficiently within their project group, in spite of their very busy schedules. Although the students in this pilot group were all following the same study, the multidisciplinary character could be found in the fact that they had different preliminary training.

5.1. *Background of the assignment*

In this specific case the 'customer' was someone who happened to receive many questions from final-year secondary school students, who have to write a paper on a combination of their major subjects. In some cases their teachers allow them to work on a real problem, including experiments and the building of a working model. In such cases, it is desirable to have a clear and detailed assignment suitable for secondary school students. From this idea the 'customer' formulated an assignment for this specific MDP group, concerning the development of an attractive assignment for secondary school students. The customer was especially interested in the relation between technological development and sustainability, which should be geared to the secondary school students' perception of their environment. He proposed a radio-controlled electric model car, powered by solar cells (the kind of cars that are usually battery powered). The assignment implied a coarse project plan, according to table 1, which shows a total project period of 20 weeks.

5.2. *The project start-up*

The first face-to-face project group was intended to introduce the students to their tutors, to their assignment and to the VPR. During this first evening session the students practised with their new VPR, using their notebook computers. (All TU/e students possess a notebook computer.) It was interesting to see that the students, from early in the session, were very eager to start collaborating online. This was obviously facilitated by the room setting, which was in a meeting configuration instead of a classroom arrangement. Their computers were connected to the network and the VPR was operational within minutes. One of the first minor assignments for the students was to give their group its own name. It initiated an animated discussion both face-to-face and within the VPR. They came up with the name 'SPEED', which appeared to be the acronym for 'solar power exceeds everyone's dreams'. All students placed their address card into the 'Participants' folder (see figure 3). Photographs of the students and their tutors were

Project planning and milestones	
Week 1	Getting to know each other and the tutors, introduction to the VPR and the assignment
Week 5	Analysis of the task and project plan
Week 9	Interim report
Week 10	Interim presentation
Week 19	Final report
Week 20	Final presentation

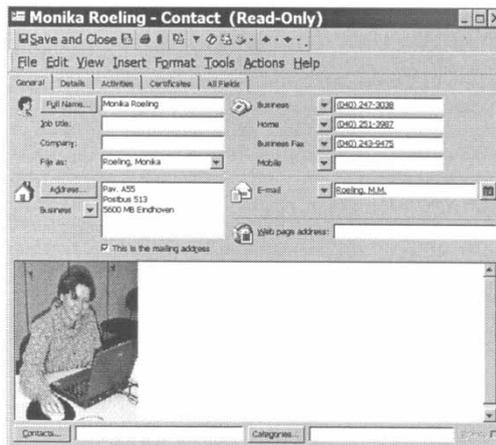Table 1. Project planning and milestones.

Figure 3.   Example of an address card.

taken during the meeting and added to this folder later. They were advised to appoint a chairman, a minutes secretary and a postmaster. They decided to work with circulating roles for the chairman and the minutes secretary and they also decided that handing over these roles had to take place during a face-to-face meeting. The postmaster, who had to take care of the VPR folders, was appointed for the full project, for practical reasons concerning his extended permissions for some of the VPR folders. During the first meeting the students were told that the purpose of the VPR was mainly to facilitate their project work, but also to ease the communication between the group and their tutors, and to let the tutors monitor the group. As soon as they understood that their contributions to the VPR folders were to be evaluated, they started to send funny postings, just to generate traffic. The joking, however, ended very soon, and they resumed their more serious discussion before the end of the first meeting.

5.3.   *Further development of the project*

During the first weeks there was relatively little traffic within the VPR. In a normal educational project the tutor would attend the weekly meeting to see what is going on, but in this case it was quite difficult to determine whether or not the group was working hard enough, with almost nothing to read in the VPR folders. An important difference between face-to-face and VPR communication was experienced. This had to do with the limited possibilities for observation within a VPR. The tutor should know the participants well before he can tell anything about their behaviour in the VPR. In the group described here, one of the participants who appeared to send very few postings to the VPR folders was asked what was wrong and the tutors suggested that his contribution would not lead to a sufficient grade. As a consequence, the entire group turned on the tutors. Afterwards it became clear that the student involved contributed very well during face-to-face meetings. During the next face-to-face meeting the tutors tried to clear the air, but it was difficult to do so. On the other hand, the students used the opportunity to complain about a series of things:

- How could the tutors ever think that one student was not joining in with the group?

- The assignment was far too difficult.
- How could the customer expect that they, the students, know anything about what happens in a secondary school, and what was the relevance for their education, etc.
- Why should they as students use the public folders and why should they be judged for the use?
- They had the feeling that 'Big Brother' was watching them.

It turned out that the group consisted of an already existing group of six students with just one new member, for whom it was not so easy to become a real member of that group. It also appeared that the students met each other more often than expected, due to the fact that they used to meet during lectures. However, from their interim presentation it appeared that, in spite of the warnings from the tutors, the level reached was rather poor. Obviously, the students had difficulties with the assignment: more specifically, it was too broad. The teachers emphasized that continuing the way they had followed so far would lead to an unsatisfactory mark.

From that moment on the group started to work very hard. They had to write a new plan of work to convince the teachers that their final report would be satisfactory and they realized that it was about time to manufacture a prototype of their radio-controlled solar car. These actions generated an intense traffic within their VPR.

Eventually, they produced a final report, tutorials for the secondary school teacher and his students (also available on CD) and a working prototype of the solar car (see figure 4). They performed an impressive final presentation in which (among other things) they showed a movie of their working prototype. The customer was very pleased with the result. Overlooking the entire project, the group performed quite reasonably, due to what they achieved during the last period of their project.

5.4. *Folder structure and postings*

To obtain an operational VPR a set of public folders is needed and the students must be members of an Exchange distribution list in the first place. Assigning public folder access permissions to a distribution group is much easier than to individual students (see figure 5). Moreover, making alterations to the folder permissions is also much easier when it concerns a distribution group. Before the start of the project, the public folders were set up according to the structure depicted in table 2, and based on

Figure 4.   Two SPEED members performing the first try-out with the solar car.
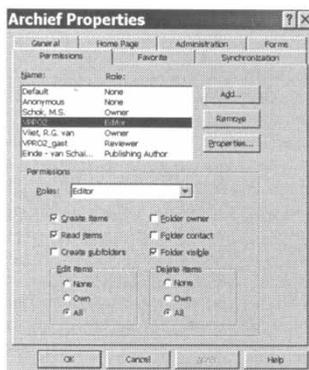
Figure 5.   Setting permissions for the VPR folders is not difficult.

earlier experiences. The access permissions to the folders and the number of postings
in each folder at the end of the project are shown. The tutors had full rights as the own-
ers of the folder set.

The Calendar folder, the Tasks folder (figure 6) and the Participants folder are
defined as the 'group management' folders, where the participants can write appoint-
ments, personal data and tasks, and where they (and their tutors) can monitor task pro-
gress. The Archive folder, the Under construction folder, the Study matter folder and
the Determined folder are the so-called documentation folders. Manuals and tutorials
needed by the students were placed in the Study matter folder, a read-only folder to the
students. The group used the Under construction folder to work collaboratively on
shared documents, using the editing facilities of Microsoft Word. The Mailbox folder,
the Discussion folder and the Oracle folder formed the category of communication
folders. The Mailbox folder was used as a shared mailbox, where the postmaster stored
important e-mail messages. The Discussion folder was used for brainstorming and
decision-making, if there was not time enough during the face-to-face meetings. As
can be seen from table 2 and figure 7, there were many items in the Discussion folder,
although the postmaster moved a great deal of the items to the Archive folder.
Questions from the students to their tutors were posted to the Oracle folder

Folder	Read files	Create and edit files	Delete files	Create subfolders	Number of postings
Archive	group	group	pm	pm	70
Calendar	group	group	group		16
Determined	group	group	group		11
Discussion	group	group	pm		105
Mailbox	group	pm	pm	pm	27
Oracle	group	group			48
Participants	group	group	group		10
Study matter	group				7
Tasks	group	group	group		34
Under construction	group	group	group		91

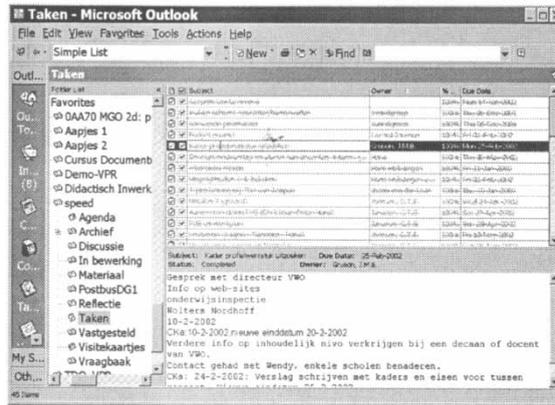Table 2. Folder permissions (group = all members, pm = postmaster).

Figure 6.   At the end of the project all tasks were marked as completed.

(see figure 8). The tutors were expected to answer these questions within a reasonable span of time (e.g. 24–48 h). To notify the tutors each time a question was posted, the Oracle folder was provided with a so-called 'rule'. This rule had been designed in such a way that every question was being forwarded to the tutor's mailbox, preventing the tutors from missing a question. Adding a rule to a public folder is quite easy to do in Outlook.

5.5.   *Other groups*

As said before, we consider the SPEED group to be an example of interesting practice. In the same year three more MDP groups used a VPR. Unlike the SPEED group these groups were formed by full-time students, who used to meet each other and the tutor(s) at least once every week. The VPR was offered to them, but the use of it was on a voluntary basis. All three groups decided to use the VPR, and one group asked for an Outlook training, as they felt insecure about their Outlook skills. All three groups succeeded in finishing their project, making use of the VPR, each group in its own way.
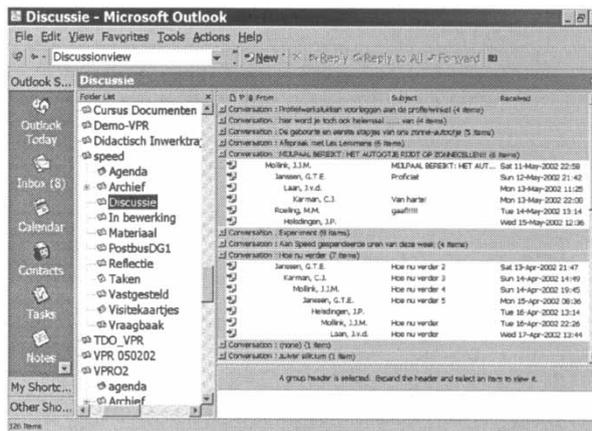

Figure 7.   This is how conversation topics and threaded discussion can be viewed.
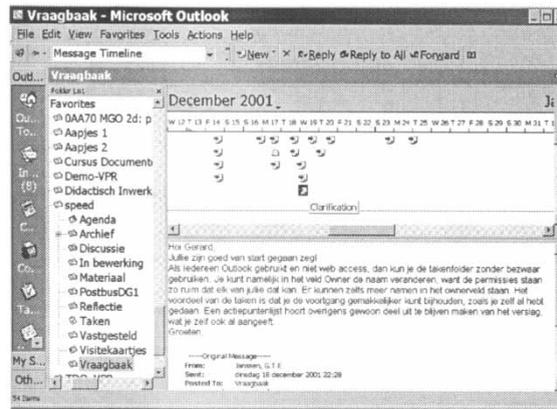
Figure 8.   The message time line view applied to the Oracle (Vraagbaak) folder.

6.   Results

In this section we give the results of the four experimental groups with a total num-
ber of 19 students and specifically describe the differences between them to focus on
success factors in the design and use of a VPR. It was expected that the part-time group
would be more positive about the use of the VPR than the full-time groups, as virtual
communication was more essential for them than for the full-time groups. It was also
expected that differences between groups would be greater for the judgement on the
usefulness of the communication and project management folders than for the docu-
mentation folders, as shared archives and document folders might be useful for any
kind of group work irrespective of the amount of virtual or face-to-face contact.

Evaluation data were gathered using log-files and (online) questionnaires contain-
ing five-point scale answer options and space for further remarks. The questionnaires
were distributed immediately after the project. Additionally, interviews were con-
ducted with a sample of students and tutors. The questionnaires and interviews cov-
ered the following subjects: usefulness and implementation of the group projects,
supervision of the projects, usability and usefulness of the VPR, predetermined format
of the VPR, student and tutor training in VPR usage, infrastructure and technical sup-
port. The answers were scored on a five-point scale and means and standard deviations
were calculated for each course and over all groups. A summary of the most relevant
mean scores per group is given in table 3.

All groups were fairly positive about the usefulness of group work and the clarity
of task division (questions 1 and 2). Students were slightly positive about the useful-
ness of feedback they received from their tutors and the amount of coaching they
received, both face-to-face and virtually (questions 3 and 4). It was particularly the
part-time, i.e. most virtual group, which was less positive about the amount of tutor
feedback and coaching. This indicates that in a distance learning group frequent feed-
back and coaching are necessary, also when using a VPR. Students were slightly posi-
tive about the usefulness of the VPR for project work (question 5). Clear differences
between groups were found in the appreciation of the VPR as a support tool for col-
laboration within the group (question 6, ranging from 2.83 to 3.75). Interestingly, how-
ever, the part-time group was not more positive about the usefulness of VPR than the
full-time groups. There might be an interaction with the technical appreciation of MS

Translated and abbreviated questions	Full-time $N=12$ M	Part-time $N=7$ M	Over-all $N=19$ M
Group work	*3.94*	*3.53*	*3.78*
1. Group work useful	4.58	3.71	4.26
2. Clarity task division	4.58	4.29	4.47
3. Received tutor feedback	3.00	3.43	3.16
4. Coaching from tutor sufficient	3.58	2.76	3.24
VPR usage	*3.46*	*3.07*	*3.32*
5. VPR folders useful (total)	3.27	3.20	3.25
5a. Group management folders	2.92	2.56	2.79
5b. Documentation folders	3.68	3.26	3.53
5c. Communication folders	3.21	3.79	3.42
6. VPR useful for collaboration within group	3.75	2.83	3.41
7. VPR useful for interaction with tutor	3.42	3.33	3.39
8. VPR instruction and support sufficient	3.42	3.33	3.39
9. VPR technical performance sufficient	3.45	2.67	3.16

Table 3. Mean scores on a five-point scale: 1 = very bad, 5 = excellent.

Exchange/Outlook (question 9). The part-time group, which scored negatively on this question, merely accessed the VPR from home by means of an analogue modem, which may have negatively influenced the performance. Furthermore, they criticized the low frequency of face-to-face meetings, for which they felt the VPR was not an equivalent alternative. The sub-answers to question 5 show that the students in all groups were more positive about usefulness of the documentation and communication folders than about the group management folders. The full-time groups were slightly more positive about the documentation folders than the communication folders, whereas the part-time group was more positive about the communication folders. The part-time group was less positive about the usefulness of the group management and documentation folders than the full-time groups, but slightly more positive about the communication folders.

Two of the full-time students were interviewed. They would rather have had two Outlook VPR instructions: one at the start of the project, with the ability to create their own folder structure, and the second one after a couple of weeks to check if everything is functioning well. They would also like to have a group e-mail address and better access from outside the campus.

7. Discussion and recommendations

The results show that all experimental groups were positive about the group work itself. Differences in judgement were relatively small for the documentation folders, which can therefore be considered as useful for all groups irrespective of the intensity of their face-to-face contact. It is important to pay attention to the specific use of the VPR as an objective instead of just a means to reach the objective. By telling the students that their folder behaviour will be evaluated, they get the idea that the VPR is the objective, which may lead to more frequent use, but also gives negative feelings such as 'Big Brother' is watching you. The students indicated that they like to work in smaller groups. In their opinion, the decisiveness in big groups is too small. The tutor should believe in the use of the VPR and show enthusiasm. The presence of sufficient

notebooks/computers and software is very important. Furthermore, it is very important to take into account that the communication within a VPR is not identical to normal communication.

Contrary to our expectation, the part-time group was not more positive about the usefulness of the VPR than the full-time groups. This result was probably influenced by the technical problems the part-time students experienced, and the lack of contact they felt, which the VPR could not overcome sufficiently.

The additional remarks and interviews indicate that it is important that both tutors and students have influence on the set-up of the VPR and can adapt the VPR structure according to their needs during the project work. A VPR should be felt as a flexible tool, not as an imposed fixed format. Examples of good practices, however, can serve as flexible templates and starting points for future groups using a VPR.

In the pilot experiments, collaborative learning took place primarily in face-to-face contact, outside the VPR. The study has shown, however, that the VPR supported the collaborative group work in a relevant way and, to an important extent, regarding additional communication and shared documentation.

It is hard to change early negative feelings. The students complained about the VPR but nevertheless used it to set a dinner date after the project!

Acknowledgements

References

BLACKBOARD, 2002, Using the Discussion Board in Blackboard, http://www.columbia.edu/~ds2016/online_faculty/PDFs/Bb55CollabToolsDiscussionBoard.pdf

BOURNE, J. R., 1998, Net-learning: strategies for on-campus and off-campus network-enabled learning. *Journal of Asynchronous Learning Networks*, **2**(2), http://www.aln.org/publications/jaln/v2n2/v2n2_bourne.asp.

DE GRAAFF, R., DE LATT, M. and SCHELTINGA, H., 2003, 'CSCL-ware' in practice: goals, tasks, constraints. In J. W. STRIJBOS, P. KIRSCHNER and R. MARTENS (eds), *What we know about CSCL in Higher Education* (Dordrecht: Kluwer Academic) (in press).

SIMONS, P. R. J., VAN DER LINDEN, J. and DUFFY, T. M. (eds), 2000, *New Learning* (Dordrecht: Kluwer Academic).

MICROSOFT, 2001, Collaborating with others using Outlook and Exchange, http://www.microsoft.com/education/?ID = OutlookExchTutorial

About the authors

Ruud van Vliet works as an educational consultant and teacher trainer with the Educational Service Centre of Eindhoven University of Technology. He has an MSc in Electrical Engineering and has been teaching various subjects. He is involved with several projects on the application of ICT for educational purposes and gives a number of courses on the same subject.

Monika Roeling works as a teacher with the Centre for Technology for Sustainable Development of Eindhoven University of Technology. She has an MSc in Chemical Engineering and has been working with VPRs as a tutor for more than 2 years now.

Rick de Graaff is consultant/researcher in higher education pedagogy at Utrecht University (IVLOS Institute of Education). He is specifically interested in computer-supported collaborative learning and has managed and carried out curriculum innovation projects in both Arts and Sciences faculties. He has a PhD in second-language acquisition and language pedagogy.

Albert Pilot is Professor of Curriculum Development at IVLOS Institute of Education, and also Professor of Chemistry Education in the Department of Chemistry, both at Utrecht University in The Netherlands. His work is concentrated in the field of curriculum development, innovation processes and the use of information and communication technology in education. His PhD was on learning problem-solving in science, more specifically in thermodynamics, at Twente University, where he was engaged in curriculum development in engineering education for many years.