Articles

Aspects of Teamwork Observed in a Technological Task in Junior High Schools

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One of the proclaimed goals of technology education is to provide pupils with teamwork skills (Barlex, 1994; Denton, 1994; Dyrenfurth, 1996; Raizen et al., 1995; Williams & Williams, 1997). Team performance surpasses that of the individual, particularly when the issue under consideration requires a variety of capabilities, experience, and judgment skills (Katzenbach & Smith, 1993). The importance of teamwork has become more widely recognized in recent years, corresponding with the information explosion and the need to solve more and more complex and interdisciplinary problems. Global competition in high-tech areas forces organizations to adopt sophisticated and effective methods of work and management. Teamwork has become one of the focuses of interest among new approaches to the management of technological projects and general organizational management, such as TQM and QWL (Goodman et al., 1987). The rapid development of communication systems, the ability to transfer information with speed, and the availability of video-conferencing, create new possibilities for people to work together even at a distance of thousands of kilometers. As a consequence of these developments, it is necessary to devote further attention to the provision of teamwork skills in the framework of technology education. The present study examines different aspects of pupils' teamwork that develop during a technological task, with an aim to cast additional light on teamwork in technology and to contribute information for the establishment of a methodology for teamwork in technology education.

Theoretical Background

Different aspects of teamwork in the world of high-tech industry will be examined and, where relevant, adapted to technology education. Katzenbach and Smith's (1993) definition of team is: "A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable." Therefore the first aspect of teamwork is identified: a team cannot operate without a *goal*. In the world of technology, the team's goal will usually be the

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design and construction of a product that meets human requirements and improves the quality-of-life. It should be emphasized that in the technological-business world, successful teamwork is measured mainly in terms of the quality of the developed product. This is not necessarily applicable to education, where primacy is given to learning and the processes associated with it.

The second aspect of teamwork is the *composition* of the team. A team will function effectively only when the members complement each other's abilities, skills, and expertise. It is the interaction processes, the mutual inspiration and enrichment, that turn the group of individuals into a team. Team members must complement each other not only in terms of their professional capabilities, but also in their work style. Parker (1991) identified four "team player styles": A *contributor* who is task oriented, a *collaborator* who is goal oriented, a *communicator* who is process oriented and a *challenger* who is question oriented.

The third aspect is the *decision-making process and leadership development* in the team**.** The growing emphasis on teamwork focuses the question concerning decision-making processes and the development of leadership in the team itself. Various ways of decision-making in the team can be identified: *Random*, opting for one of the ideas suggested by the team members; *Minority opinion* (imposed in various ways); *Majority Decision or Consensus*; and *Leader's Decision* (Barak, Maymon & Harel, in preparation).

A distinction between a manager and a leader is currently emerging in organizations. The manager is typically appointed by higher management and represents a link between management and work teams. The manager's role is to ensure that the team has available the skills and the technical means required for the job (Janz & Harel, 1993; Parker, 1991). The leader, on the other hand, may emerge from among the team members, on the basis of his/her professional expertise and charismatic personality. The leader's role is to clarify the goals, strengthen the professional skills, and nurture the cooperation among team members (Katzenbach & Smith, 1993).

The fourth aspect is *team development*. A team develops from individuals through a series of stages in accordance with the shared experiences of its members. Tuckman (1965) identified four stages of team development that have been adopted by other researchers (Baired et al, 1990; Jaques, 1984; Parker, 1991):

Forming	Team members become acquainted with each other. Information such as personal schedules is exchanged. Determining each team member's main strength and assignment of roles and responsibilities.
Storming	Members jockey for position. Dissatisfaction, competition and conflict surface. Members become aware of their differences and try to determine how they will work together.
Norming	A group consensus emerges. The group comes to agreement on its purpose or function. Members are clear what their

	roles and responsibilities are. The group has a sense of identity and members strive to work together.
Performing	Group structure, norms, and behavior are understood and accepted. Members know how to work with each other. They can handle disagreements and misunderstandings effectively. The group is focused on accomplishing its purpose.

The above characteristics of teamwork are drawn from the workplace; what can be extrapolated to technology education? An apparent consensus is that in order to impart teamwork skills to pupils, they need hands-on experience in teamwork concerning a technological project, under conditions as similar as possible to those found in high-tech industries. Theoretically, in a school technology project, the pupils can themselves go through the processes of constructing the team, various decision-making circumstances, and team development. However, a fundamental difference exists between teamwork in the workplace and at school. In the workplace, the team's main goal is to complete the task of producing a product according to predetermined targets. At school, the main aim is to teach the pupils how to operate as a team, and the technological project is of much less importance.

Teamwork in technology education has similarities to the methods for cooperative learning. Slavin (1990) surveyed a range of methods for cooperative learning. An example of one of the methods of cooperative group learning is Student Teams-Achievement Divisions (STAD). This method employs competition between groups while encouraging cooperation within groups. The team score is based on individual improvement on quiz scores in a way that enables even the low achievers to contribute the maximum amount of points to the group. Another known method for cooperative learning is Group Investigation (Sharan and Sharan, 1992). The groups choose topics from a unit being studied by the entire class, and carry out cooperative inquiry, discussion and projects. Each group presents or displays to the entire class. One more example is the JIGSAW method (Aronson et al., 1978): students are assigned to six-member teams to work on academic material that has been broken into sections. Next, members from different groups meet in expert groups to discuss their section. Then the students return to their teams and take turns teaching their teammates about their section. Most of these types of cooperative learning structures have been well researched and consistently show significant gains in achievements and other outputs such as inter-group relations, pupils' self-esteem, locus-of-control, time-on-task, and classroom behavior (Slavin, 1990; Whicker et al. 1997). Qin, Johnson, & Johnson (1995) compared the impacts of cooperative versus competitive learning on problem solving through a meta-analysis of 46 studies published between 1929-1993. They found that members of cooperative teams outperformed individuals competing with each other on different types of problem solving, where superiority was greater on nonlinguistic than on linguistic problems. This finding reinforces the belief that technology studies are a particularly suitable frame for promoting teamwork in the schools.

The distinguishing feature of the technological task is that pupils' efforts are focused on design and production, which impinges on the goal presented to the team, the skills required of the team members, the sort of decisions that have to be made, and the criteria of success. There is a range of opportunities in technology to present the pupils with stimulating tasks that culminate in the construction of a product or system whose properties can be tested according to objective criteria. Therefore, there is less need in technology studies as compared with other fields, for teacher intervention for the purpose of creating motivation by means of quizzes, points, ranks, or student presentations.

The Study

Background

The general aim of this study was to increase the understanding of pupils' teamwork behavior within a technological task. To this end, a four-hour workshop was developed in which pupils designed and constructed an envelope for a hot-air balloon from tissue paper. This workshop was part of the "hot-air balloon" year project, which is described briefly below to clarify the context in which the research took place. Nevertheless, the workshop can be performed on its own as a technological project.

As part of an overall effort to promote and renew science and technology education in junior-high schools in Israel, an integrated physics and technology learning program that involved the design and construction of hot-air balloons was developed in the Technion (Barak, M., Raz, E., & Karniel, B., 1996). The seven schools in which the workshops took place were selected from among 22 schools that were involved over the previous three years in this program in the Galilee. The hot-air balloon educational project was planned for an entire school year. Pupils study physics for approximately 100 hours and technology for approximately 80 hours, together providing the theoretical background for designing the hot-air balloon. In the final trimester, pupils devoted about 30 hours to constructing and flying the hot-air balloon. A group of ten pupils was sub-divided into smaller teams, each building a different part of the hot-air balloon: the basket, the electronic control system, and the gas system and burner. Due to technical limitations and its size (eight meters in height and five meters in diameter), the pupils did not sew the balloon envelope themselves; rather, it was manufactured commercially. As a substitute, in this workshop the pupils constructed a smaller model of the envelope (two meters in height and 1.25 meters in diameter).

The teachers participated in in-service courses in which they studied both subject matter and didactics. Each school was allocated a tutor who worked individually and collectively with the teachers, with an emphasis on non-evaluative help to the teacher. This supervision was matched to the individual needs of each teacher (Barak et al., 1997; Glickman, 1990).

The Balloon Envelope Assignment

The pupils' task was to design and construct a scale model of the hot-air balloon envelope using tissue paper. Teamwork is essential for completing the task. The workshop was designed to enable pupils to attain most of the requisite goals of teamwork in the technological realm in accordance with the workplace model. The workshop stages were:

1. *Presenting the problem.* The pupils confront the issue of constructing a 3-D body from 2-D material. Peeling an orange was used, for example, to present the idea of constructing the envelope from sections.
2. *Planning.* Issues deliberated by the pupils included the balloon's radius and height, angle at the apex, and the number of vertical sections (6 to 12). The latter has significance for the balloon's circumference and radius since the greater the number of sections, the larger the balloon. Pupils coped with issues of shape, stability, and amount of work involved. A typical envelope designed by pupils is shown in Figure 1. During the planning stage, each group prepared a template from a sheet of Bristol board, fitting it to the dimensions of the available sheets of tissue paper. This template was used for cutting the tissue paper sections that form the envelope.
3. *Constructing.* The actions carried out in this stage were: choosing the colors and combinations of tissue paper to be used; gluing the sheets of tissue paper together in order to obtain long strips; positioning and cutting the tissue paper using the template; sticking the sheets of paper in a particular order; sticking a strip of Bristol board to stabilize the lower opening; gluing the open end; and correcting defects such as open seams, tears in the paper, and faults in the decorations. This task required the whole team to solve various technical problems such as how to apply glue and in what order it should be applied, how to prevent the cut-outs from sticking together, how to correct an error made in the order of assembly, and so forth. On completion of this activity, the model hot-air balloon envelope was ready for flying.
4. *Testing and evaluating the product.* A trial launch was carried out in the classroom using a blower heater. Subsequently the envelope was launched outdoors using a gas burner. The evaluation related to performance and aesthetic aspects: Did the envelope rise? How high did it go? Was it stable? Are the colors attractive? Were the materials accurately assembled? The evaluation is informal, made by the pupils themselves and the teacher.

The workshop was designed such that each of the four stages of the technological task advanced the pupils to a higher level of teamwork, as illustrated in Figure 2.

The assignment comprised four technical stages, which paralleled the phases of teamwork development. This enabled close examination of the dynamics and interactions in each area, within a relatively brief assignment, without expecting pupils to gain all the skills in every field.

Purpose of the Study

The purpose of this study was to examine the processes of teamwork that emerge during a short workshop, the aim of which was the completion of a technological task. Several questions were addressed: To what extent can a short

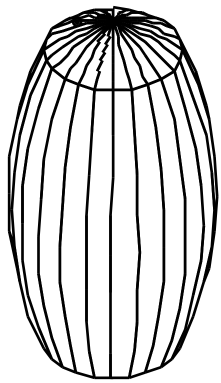

Figure 1. A hot-air balloon envelope

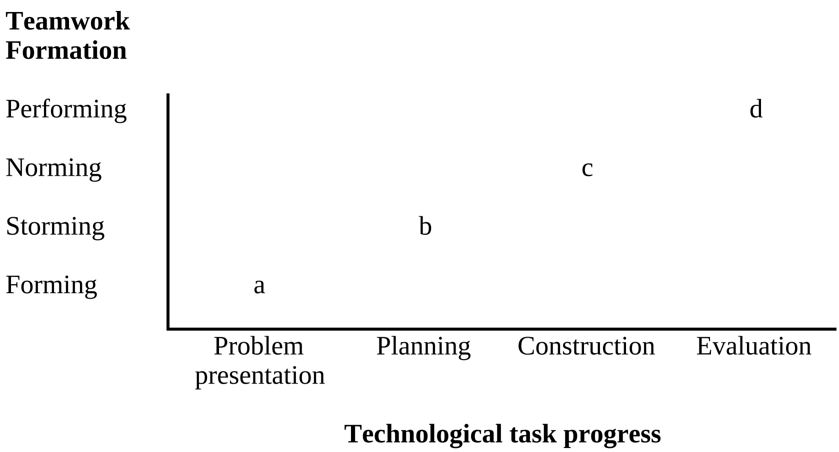

Figure 2. Stages in teamwork development in relation to task progress.

workshop promote teamwork among pupils working on a technological task? What are the factors that promote pupils' motivation for the task? How are teams composed? How do teams develop and function in relation to the progress on the technological task? Which patterns of decision-making and leadership occur during teamwork? What function do teachers play in their pupils' teamwork? Through observing the pupils at work, we sought insights for the development of teaching and learning methods to provide pupils with teamwork skills in the field of technology.

Population

The workshop was implemented at the 9th grade level in seven schools (A-G) in northern Israel. The schools were diverse in the socioeconomic populations they served. Table 1 illustrates that 45 pupil teams were observed in nine workshops, each team composed of three to five pupils (total 172 pupils). Each team designed and constructed its own balloon envelope. Sixteen technology and physics teachers guided their pupils in the workshops.

Table 1
Research Population

School	Girls	Boys	Number of Teams
A1		16	4
A2	31		7
B	5	8	4
C1	8	8	4
C2	7	5	3
D		21	7
E	8	7	4
F	4	17	5
G	12	15	7
Total	75	97	45

Methodology

Open-ended observations were employed throughout the workshops to examine the processes taking place in the class with respect to teamwork. To overcome the weaknesses associated with such observations, several observers were used: the researcher as a non-participant observer, the school's tutor, and the class teacher(s) as participant observers.

On the basis of the trusting relationship between the teachers and the research team, the research team believed that they could learn more about classroom processes from a qualitative study in the classroom rather than to attempt to measure the complex phenomena of teamwork by quantitative means. The researcher tried to merge into the background so that her presence would not be felt. The teachers worked directly with the pupils. The five tutors, who had met the pupils on previous school visits, conducted, in effect, informal interviews with the pupils. These observers thus complemented each other in their degree of familiarity with the pupils and their involvement with them. The observations took place on different occasions in schools that were differentiated by their location, the socioeconomic background of the pupils, the composition of the teaching staff, and the experience of the teaching staff in teaching science and technology.

Data were collected using the method of triangulation (Cohen & Manion, 1980) for observers, method (observations, interviews and questionnaires), and time and place (seven schools). All three observers took written notes on processes that occurred during the workshop. The next stage involved methodical analysis of the information collected by the observers, with an aim to identify the characteristics of each team's work in terms of the theoretical model. The functioning of each team was grouped according to the following categories: motivation, team composition, decision-making processes and leadership, stages of team development in relation to the progress made on the balloon envelope, and group cohesiveness.

Results

Pupils' motivation towards the goal

Pupils' motivation on a task can be measured (according to Sharan & Shaulov, 1990) by the degree of involvement and the level of purpose and energy the pupils demonstrate in relation to their work, and the degree to which they are prepared to devote extra time beyond regular school hours in order to achieve the goal. The balloon envelope workshop was planned for four hours, the average time needed to complete the task in earlier trial runs. Cases were observed where the pupils argued with the teacher about the time limit for the workshop and whether they would manage to finish the task on the same day. These arguments abated as pupils became engrossed in their work. In 44 out of the 45 observed groups, pupils worked continuously and without time constraints, staying behind to work during recesses and after school hours until such time as the last group had completed its envelope and had flown its balloon. Both teachers and observers noted the high degree of involvement of pupils in the workshop. High motivation was perceived among all the pupils to complete the task of constructing the hot-air balloon envelope, despite the differences between the groups in terms of pupils' background, level and style of teamwork obtained and extent of teacher intervention. Interviews with the pupils and teachers revealed four main sources of this motivation:

- The intrinsic interest the subject held for the pupils.
- The challenge with which they were presented.
- The practical work, leading to an attractive product.
- The change in classroom atmosphere, pupil-pupil and pupil-teacher relations.

In some cases, the high-level of motivation to complete the task contributed to high cooperation among group members, and to mutual assistance between groups. However, other cases of high motivation among group members found spontaneous expression in competitiveness towards other groups.

Team composition

In all workshops but one, the pupils organized their own groups. Freedom of choice in group formation led most pupils to single-gender groups. It can be seen from Table 2 that 38 of the 45 groups were single-gender. In a few cases, teachers transferred a pupil from one group to another, generally to make the groups comparable in size. Only one teacher determined the groups himself, and in that particular class, three of the five groups were of mixed gender.

Table 2
Group Composition by Gender

School	Girls Only	Boys Only	Mainly Girls	Mainly Boys	Number of Groups
A1		4			4
A2	7				7
B	1	2		1	4
C1	2	2			4
C2	1	1	1		3
D		7			7
E	2	2			4
F		2		3	5
G	2	3	1	1	7
Total	15	23	2	5	45

Observations of the single-gender groups revealed that girls were less argumentative and aggressive within their groups than were the boys. The boys were more competitive and less willing to offer help to other groups. One girls-only group that finished the construction first was the last group to launch their envelope because they helped other groups and held back at the flying stage. The researchers concluded that when groups are formed spontaneously, their composition tends to be homogeneous to the exclusion of pupils possessing the different skills necessary for performing the task. This should come as no surprise: when the groups are formed prior to the pupils being aware of the ensuing task, they prefer to work with their friends or same-gender peers. From this perspective, the teacher must ensure that the groups are balanced in relation to gender, skills and expertise so that students of different backgrounds learn to work with each other, similar to the workplace. To achieve this, the teacher should involve the pupils in the considerations employed to create the groups by first presenting them with the kind of activities which the group will need to perform and the skills required to attain the goal.

Stages in Team Development

Teams develop in stages and the workshop was designed such that in each phase of progress on the balloon envelope, pupils' teamwork also developed. It was easy to keep track of task performance via the tutors' observations because the pupils' sketches, envelope sections, and finally the finished product were readily visible. In contrast, monitoring the group's functioning as a team was far more complex because the passage from one stage to the next was not clear-cut. The findings from the observations are summarized in Table 3 in which the pupils' activities on the technological task are presented in conjunction with their behaviors relating to teamwork in the four anticipated stages of development.

The stages of progress on task performance and the development of teamwork described in Table 3 are a summary of the processes observed among the 45 teams who built their own envelopes. Clearly, there were differences among the groups in terms of proficiency on the task as well as interpersonal relations among group members. The researchers hoped to identify, at the very least, the stage at which the group began to show rudimentary signs of teamwork in performing the technological task such as group discussions, joint decision-making, acceptable role assignment, joint activity, and interdependence of the group members for performing the task. Table 4 presents the number of groups in which teamwork was observed according to at least one of the above features, at different stages of task performance.

Table 4 illustrates that most groups began to function as teams during the planning or construction stage, namely the second and third stages. Only a minority acted as teams within the initial stage of presenting the problem, and two teams achieved this level of cohesion only in the final stages of the project. Out of the 45 groups observed, only one group failed to function as a team by the end of the workshop, due to arguments among group members and negative leadership.

Table 3
Teamwork Development Matched to Progress on the Technological Task

Stage	Pupils' activity on task	Teamwork characteristics
a	*Problem presentation*: Pupils receive their first information concerning the envelope task, project targets and restrictions. They review the theoretical background.	*Forming*: Pupils do not yet know how much they must work with others. Pupils need encouragement from the teacher to begin to work as a group.
b	*Planning*: Each group makes decisions about their envelope's colors, dimensions, and number of sections. They prepare the template from paper board.	*Storming*: The task requires several joint decisions. The group has its first experience in decision making and joint problem solving.
c	*Construction*: The team selects paper sheets, connects them in layers, cuts, glues and assembles the envelope. This is hard to achieve individually.	*Norming*: Pupils work together, share tasks, help each other, and exchange information. Each pupil has a role in the teamwork, but cooperation is essential.
d	*Testing and evaluation*: All teams fly their balloons, comparing their envelopes.	*Performing*: The team presents its product jointly. Outwardly, the team appears cohesive. Each member has a place in the team.

Leadership and Decision-making

The team had to make decisions while working on different topics such as the number of sections for constructing the envelope, the shape of the Bristol board, the colors and decoration of the envelope, and the assignment of duties. The observers monitored the decision-making patterns within the teams and sorted them into four categories: Consensus Decision, Random Decision, Teacher Intervention Decision, and Leader Decision.

The most prevalent pattern of decision-making was consensus (44.4%), followed by random decision (24.4%), teacher intervention (20%), and leadership (11.1%). Groups operating under consensus lacked a dominant leader who imposed his/her decisions on everyone. In those few groups in which such a leader was present, the other group members perceived this charismatic personality to be more able, and they were willing to accept this leadership. Teacher intervention occurred when the group got involved in lengthy arguments and was unable to reach a decision. In some cases, the teacher joined the group and considered himself to be part of the group, becoming a dominant figure in the group. These outcomes demonstrate that in a group task such as this, spontaneous leadership development should not be anticipated. If we want to provide pupils with the skills for assuming leadership and functioning as a team under a leader, we have to initiate situations in which pupils can have hands-on experience. It should be pointed out that although the schools represent different socioeconomic backgrounds, all the patterns of decision-making were found in most of the schools; no particular pattern of decision-making is associated with a particular population.

Table 4
Number of Groups Exhibiting Initial Teamwork at Stage of Progress on Task Performance

Stage / School	Presenting the problem	Planning the envelope	Constructing the envelope	Flying and evaluation	Team-work not achieved	Total # of groups
A1	1	2	1			4
A2		2	5			7
B	3	1				4
C1	1	1	1	1		4
C2		2	1			3
D		2	4	1		7
E		3	1			4
F		5				5
G		3	3		1	7
Total	5	21	16	2	1	45

Group Cohesiveness

Another feature of teamwork in school is the *cohesiveness* of the team. Group cohesion is defined as “the relation of individual group members to the group as a whole” (Schmuck & Schmuck, 1978), and the degree of interest held for what happens in the group as opposed to that which occurs in other groups.

Cohesion expresses the commitment of individual group members to the group. The main criterion chosen to indicate cohesiveness was the existence of between-group competitiveness. The competition among the various groups in each class developed spontaneously, even though no competition was declared and no prizes of any kind were promised for excellence. Competition focused on questions such as: Who will finish first? Whose balloon will be the biggest/have the prettiest colors/be free of holes? Whose balloon will fly best/highest/longest? Pupils invested much effort in choosing unique colors for the envelope and its decoration.

The observers ranked the cohesiveness of a team as *high* (37.8%) when all group members cooperated so that their group would succeed in the competition with other groups, as *moderate* (42.2%) when some of the members stood to one side, and as *low* (20%) when group members showed no interest in what the group was doing nor in the competition against other groups. While 80% of the groups functioned with moderate or high cohesiveness, at least one group in most of the classes exhibited low cohesiveness. In most cases, the competition between the groups was subtle, and a positive atmosphere was maintained in the class. Despite the competition, there were cases of groups helping each other. The pupils' solidarity sometimes affected the whole class and was not limited to their own team. In contrast, some groups invested much effort not to be outdone by other groups, despite tension among its own members. Even in the absence of extrinsic rewards, such as declaring the winner or awarding prizes, inter-group competition develops naturally when the task stimulates the pupils.

The Teachers

Sixteen teachers participated in this study. Most workshops involved two teachers working in collaboration on the hot-air balloon project: the physics teacher and the technology teacher. Prior to conducting the school workshops, the teachers participated in a special four-hour workshop, identical in format to the pupils' workshop: they split into teams and worked on the design and construction of balloon envelopes. The lessons learned from the teachers' workshop were used to improve the module; the teachers were partners in the development of the idea, and its implementation in the classes.

Three profiles describing the teachers' function in the pupils' workshops were identified:

1. *The Facilitator*. Some teachers were subtly involved in the teams' work. They clarified technical issues, helped groups to overcome difficulties, and handled interpersonal problems, but avoided intervening in final group decisions or assignment of duties to the pupils.
2. *The Manager*. Some teachers found it difficult to allow autonomy to their pupils, and they became involved as managers in the decisions, assignment of duties, and performing the task, but they did not stay in one particular group.
3. *The Foreman*. A few teachers became dominant figures in the teams. They worked alongside a particular group throughout, and guided them

closely. They made the decisions, gave instructions, and assigned duties, thus preventing the pupils from functioning autonomously. A teacher-run group achieved well, often being the first to complete the task, but its development as a team was doubtful.

Many teachers experienced difficulty in changing their traditional role. Teachers must learn to “let go” and become facilitators so that autonomous teamwork can develop in the groups.

Conclusions

This research attempted to uncover aspects of teamwork crystallization and development among pupils engaged in a short technological task. The advantage of a short task, which the pupils begin and end in a single session (4-6 hours), is that the work is performed intensively, an effort is made to complete the task, and the pupils receive immediate feedback. Such a task enabled us to uncover a number of processes connected with teamwork.

The first outcome relates to the effectiveness of a short technological task as a means for promoting teamwork. The present study shows that a relatively short technological task which is open-ended and requires pupils’ shared decision-making and mutual dependence, can result in teamwork development. High motivation among pupils, which is a key to creating teamwork, can be achieved by presenting a technological task that combines intellectual challenge with practical ability, and allows pupils to experience the process that terminates in a desired product. The changes in classroom atmosphere as well as pupil-pupil and pupil-teacher relationships are also sources for increasing pupils’ motivation.

When pupils are highly motivated, competitiveness develops spontaneously among different teams in the same class, or alternatively the teams operate with mutual aid, and the entire class becomes one team. In both cases, investing effort in planning a technological task that stimulates challenge is preferable to the teacher initiating competition or ranking among the groups.

The second outcome concerns teamwork development. It would be a mistake to think that the mere assignment of pupils to a work-group leads to meaningful teamwork. The theories that address the development of teamwork in the workplace describe the phases through which the group passes, from the stage group members become acquainted with each other, through consolidating an efficient form of teamwork. In the field of technology it is common to identify several phases of the “design process,” from the presentation of a problem or a human need, through the production of an artifact or a system, and its evaluation and improvement. We have shown that a technological task at school can be based on interaction between these two dimensions. Curriculum planners and teachers can design technology projects so that the pupils will develop teamwork gradually and practice the necessary behavior patterns for teamwork in conjunction with progress on the task. In our example, groups functioned as teams at earlier or later stages, but on completion of the task most of the groups were functioning as teams.

Another aspect that was uncovered in the present study was the potential for groups to develop different patterns of role assignment and decision-making such as consensus, random decisions or teacher intervention. The fact that in our case, spontaneous development of leadership within groups was rare can be explained partially by the fact that the groups managed to complete the task without a leader. In a long-term technological project, the team may require leadership. Pupils can be trained in leadership by appointing a leader to the group via democratic ballot within the group, for instance. Further research is required to expose the processes of leadership development and to compare the dynamics of groups that function with or without a leader. Cross-cultural research may enlighten us with regard to how cultural differences affect leadership, decision-making in the group, and the gender composition of the group.

Finally, concerning the teacher's role: after years of teaching by traditional methods, teachers face difficulties in promoting significant teamwork in class, mainly because this means transferring more autonomy and responsibility to the pupils. This seems to be especially difficult in technology, where the teacher has to supervise pupils' proper use of tools and materials. On the one hand, teachers have to select pupils' projects and oversee the groups' composition in order to ensure that pupils with different abilities and academic achievements, boys and girls, will learn to work together. This is not only a matter of educational value, but also an essential aspect of preparing pupils for teamwork in "real life." On the other hand, teachers have to detach themselves from the traditional role in which they are the center of attention in the classroom.

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